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Exchange Traded Contracts for Difference: Design, Pricing and Effects*

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ABSTRACT:

Contracts for Difference (CFDs) represent a significant financial innovation in the design of futures contract. Their use in over-the-counter markets has grown significantly and has created controversy in the UK, but to date there have been no published academic studies examining CFD markets. In 2007, the Australian Securities Exchange (ASX) introduced exchange-traded CFDs on individual stocks and other financial instruments. This paper analyzes the contract design and consequences for pricing relationships between CFDs and the underlying stocks. Using the unique database of ASX CFD trades and quotes, we test empirically whether the pricing relationship conforms to theoretical expectations, how spreads in the derivative market are related to those in the physical market, and draw

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out implications for successful design and trading arrangements for the introduction of new derivative contracts.

Introduction

Contracts for Difference (CFDs) are an important financial innovation, taking the form of a specific type of financial futures contract designed such that its price should equal that of the underlying security. Their use by hedge funds and individual traders has grown rapidly in recent years across a number of countries. However, to date, there has been no academic research published on these financial instruments. This partly reflects the fact that CFDs have generally been traded over the counter (OTC) and as a consequence there is an absence of reliable data for empirical analysis.

In this paper, we make use of data on exchange traded CFDs introduced by the Australian Securities Exchange in late 2007 to undertake the first empirical study of CFD pricing and trading. We explain how contract characteristics and trading arrangements (both for current OTC and exchange traded CFDs) preclude a pure arbitrage pricing relationship, but can be expected to lead to CFD prices close to parity with the price of the underlying security. Drawing on this analysis we develop and test hypotheses about the relationship between bid-ask spreads in the CFD and underlying market and implications for "parity pricing" of trades. These results provide insights into important features of contract design and trading arrangements for successful introduction of new derivatives. Besides being the first paper to examine exchange-traded CFDs, an important contribution of this paper is establishing the link between spreads in the futures market and spreads in the underlying.

The nature of the trading platforms used and consequent ability of market makers to hedge risks is important in this regard as a potential determinant of spreads, pricing, liquidity and ultimate success of innovative derivative contracts such as these. The analysis and results of this paper should thus be of interest to securities exchanges and regulators contemplating introduction of such products, as well as to academics interested in microstructure research.

Another contribution of the paper is to highlight the potential impact which a successful introduction of exchange traded CFDs may have on broader financial market structure. First, since CFDs are a futures style contract which enable traders to take short positions in particular stocks, they have become of increasing interest in the context of the recent debates about, and regulatory changes to, short selling. Whether they have the potential to assist in developing greater transparency about short selling is a question we consider later. Second, as a close substitute for individual share futures (which they replaced in Australia), the ability to design a successful exchange traded CFD contract would have implications for the future of individual share futures contracts in those countries where they currently trade (and others where they may be a candidate for introduction). Third, exchange traded CFDs are a close substitute for margin lending arrangements, but with traders (or price makers) with short positions effectively providing credit (via the clearing house arrangements) to those with long positions. Finally, exchange traded CFD's are a competitive threat to the more well developed OTC market.

In section 1 we first provide a brief description of the characteristics of CFDs for readers unfamiliar with this financial product. We consider the international development of the CFD market and some of the regulatory issues and debates surrounding the availability of CFDs to retail investors and other matters such as disclosure of effective equity positions, insider trading, and voting rights. In Section 2 we outline the contract specifications of the ASX exchange traded CFDs. There we demonstrate how the contract design does not admit a pure arbitrage proof of the relationship between CFD and underlying prices. Nevertheless it is argued that the CFD price should lie within relatively tight bounds around the price of the underlying physical, which we term "parity pricing". Section 3 contains a review of related literature that informs development of hypotheses. These relate to behaviour of open interest around ex-dividend dates arising from contract specification, the relationship between bid-ask spreads in the CFD and underlying market, and the tightness of "arbitrage" bounds between CFD trade prices and those of the underlying stocks. Section 4 describes the data used and presents summary statistics. In Section 5, we investigate aspects of the trading and pricing of exchange listed CFDs, their relationship to the underlying physical market for the stock, and provide tests of the hypotheses. Section 6 concludes with some observations on the potential future development of exchange traded CFDs in competition with individual share futures contracts and OTC contracts for difference, together with suggestions for future research.

1. CFD Structure and Market Development

1.1 Structure

Contracts for Difference (CFDs) are futures-style derivatives designed such that their theoretical price, absent transactions costs, should be equal to the price of the underlying security. They provide the opportunity for investors to take highly levered, margined, "effective" positions in stocks or other traded financial instruments without taking actual physical positions.[3]

To understand CFDs it is simplest to initially assume that the contract has a defined expiry date T at which time instantaneous arbitrage forces the CFD price (P_T) and underlying stock price (S_T) to equality. This may occur either by a requirement for physical delivery of the stock or a cash settlement equal to the price difference. (In practice, as discussed later, an infinite expiry date, margin requirements, and transactions costs complicate the analysis of CFD pricing). The buyer and seller of this hypothetical CFD at date $0 < T$ at price P_0 enter a contract with the following cash flow obligations: (a) at date 0 there are no cash flows; (b) at date T there is a cash flow from seller to buyer of $(P_T - P_0) = (S_T - P_0)$; (c) at each date t until expiry the buyer pays the seller a contract interest amount of rS_{t-1} where r is the contract rate of interest per day; (d) at any date t prior to expiry on which a dividend (D_t) is paid on the stock, the seller pays the buyer an equal amount.

It is relatively straightforward to show, by induction, that this contract design causes the CFD price to be always equal to the contemporaneous stock price ($P_t = S_t$). Consider the arbitrage strategy established at date T-1 (the day before contract expiry) which involves short selling the stock for one day (and investing the proceeds at an interest rate of r per cent until date T) and buying the CFD at date T-1. The short sale position involves paying the equivalent of any dividend D_T paid on day T to which a holder of the stock on day T-1 becomes entitled, and requires purchase of the stock at date T to close the short position. Table 1 sets out the cash flows involved. It is clear that absence of arbitrage opportunities requires that $P_{T-1} = S_{T-1}$.

(Insert Table 1)

Demonstrating that $P_t = S_t$ for any $t < T$ follows by induction, by showing that if $P_{t-i} = S_{t-i}$ then $P_{t-i-1} = S_{t-i-1}$. This follows immediately by substituting in Table 1 the closing out at date t-i of an arbitrage portfolio established at date t-i-1, and where settlement of the CFD is replaced by its sale in the market at date t-i at price $P_{t-i} = S_{t-i}$.

[3] CFDs are offered on exchange rates and indices as well as individual stocks, although for ease of exposition the subsequent discussion focuses upon stocks.

This pricing relationship can also be understood by reference to the well known cost of carry relationship between spot (S) and futures (F) prices on a dividend paying stock. Considering only date T-1 prior to expiry at T for simplicity of exposition, this can be written as:

$$F_{T-1} = S_{T-1}e^{r} - D_{T}, \quad (1)$$

where the basis difference ($F_{T-1} - S_{T-1}$) arises because of the income stream paid on the underlying asset and the opportunity cost of interest foregone on a physical stock position relative to a futures position. CFDs differ from futures because the buyer pays contract interest ($S_{T-1}(e^{r} - 1)$) and receives the dividend (D_T). Hence:

$$P_{T-1} = F_{T-1} - (S_{T-1}(e^{r} - 1) + D_{T} = S_{T-1}. \quad (2)$$

As the cash flows in Table 1 suggest, the purchase of a CFD is essentially equivalent to borrowing to purchase the underlying stock (but without acquiring ownership of the stock, and where the amount borrowed changes daily in line with the underlying stock price). Conversely, the sale of a CFD is equivalent, in cash flow terms, to a strategy of short selling the stock each day, investing the proceeds, and closing out the previous day's short position.

In practice, CFDs differ significantly from the hypothetical CFD considered above. They were initially introduced as over-the-counter (OTC) products by financial firms (referred to as CFD providers[4]) who provide bid-ask quotes for traders. No settlement date is specified and traders close out positions previously established, at dates of their discretion, by offsetting trades at the price quoted by the CFD provider. That price is not contractually tied to the underlying stock price, creating potential basis risk for the trader (in addition to counterparty risk). CFD providers manage their counterparty risk by requiring traders to post margin accounts to which profits and losses are added (with this practice making CFDs basically equivalent to a margin loan arrangement). The ASX CFD contract essentially mimics the OTC variety. Because it is an exchange traded future, traders enter contracts via market trades with anonymous counterparties, which are then novated to make the exchange clearing house the counterparty. Positions are closed by subsequent offsetting trades in the market.

These practical features mean that the pure arbitrage based pricing argument, involving a fixed expiry date when CFD, and physical prices converge, does not

[4] Major contract providers include the companies CMC and IG Markets.

immediately hold. Other explanations for a near one-to-one (parity pricing) relationship between CFD and underlying physical prices must be sought. We focus here on the OTC market, and consider how the ASX contract is designed to achieve this outcome in a later section.

CFDs are a substitute product for margin lending and short sale facilities offered by stockbrokers and investment banks, provided that CFD prices quoted by the OTC providers closely track the underlying stock prices.[5] Competition for investor business, and reputational risk, is one reason for expecting near parity pricing between CFDs and the underlying stocks.

The costs of risk management by CFD providers are another reason. Consider, for example, a CFD provider who quotes an ask price which is significantly below the underlying stock price and/or quotes of other CFD providers. The provider will attract mainly customers wanting to buy CFDs and to hedge her net short position will be required to buy physical stock at a price greater than quoted in the CFD. She will thus have negative cost of carry (greater interest expense on funds borrowed to finance physical hedging purposes than interest income from long CFD positions). Conversely quoting CFD prices above the underlying will attract customers to short positions and involve paying more interest to those customers than received on short hedging positions in the physical market. In practice, some CFD providers simply "pass through" CFD trades as buy/short sell orders directly to the physical market on their own account to ensure a hedged position, thereby linking CFD prices quoted directly to the underlying. This is sometimes referred to as Direct Market Access (DMA).

1.2 Market Development

CFDs have become popular because they enable market participants to achieve leveraged equity positions, hedge existing positions, implement strategies involving short positions, and possibly avoid stamp duty or other taxes on transactions in the underlying assets.[6] CFDs were originally introduced as over the counter (OTC)

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[5] They are also potential (albeit imperfect) substitutes for structured products such as instalment warrants where an initial instalment provides the investor with an option to purchase the stock for an outstanding amount (well below the initial market price) and provides entitlements to dividends paid. The substitutability is imperfect because of the optionality involved (although generally the warrant is sufficiently in-the-money to make this of little significance) and because the leverage implicit in the warrant is lower.

[6] In the UK, stamp duty is levied on physical share transactions, but not on CFD transactions, nor on share transactions by registered financial intermediaries (such as CFD providers) hedging derivative transactions, thereby creating a tax incentive for position taking by hedge funds and other investors via

products in the London market in the early 1990s, aimed at institutional investors. They have since become popular with retail investors and have been introduced in many countries. While they are prohibited in the USA, OTC CFD's on US stocks are offered by providers based outside the USA to non-residents. In November 2007, the Australian Securities Exchange (ASX) became the first exchange to design and list exchange-traded CFDs. At May 31 2008 there were contracts available on 49 leading stocks.[7]

In the UK, the over the counter CFD market has grown substantially since 2003. The value of transactions is estimated to have increased from around 10 per cent of the value of London Stock Exchange equity transactions in 2001, to around 35 per cent in 2007 (FSA, 2007). Survey data collected by PriceWaterhouseCoopers and reported by FSA(2007) indicate that most UK CFD providers have counterparties who are primarily hedge funds, other financial institutions or corporates. The average size of contract ranged across the six respondents from 30,000 to 1.3 million pounds. The most common term for CFD positions was 3 – 6 months, and CFD providers most often hedged the resulting exposure with transactions in the underlying asset.

In June 2008, the London Stock Exchange announced (London Stock Exchange, 2008; Sudbury, 2008) plans to introduce exchange traded CFDs involving a combined order book with the underlying stock. However, in April 2009 it was announced that this project had been indefinitely put on hold due to the impact of recent market conditions on the ability of customers' development capacity (Sukumar, 2009). This issue of links between trading platforms for derivatives and the underlying security and implications for market development is one we return to in the concluding section.

The Australian OTC market has also grown substantially, but the main participants tend to be individual investors rather than hedge funds or institutions.[8] According to the Financial Standard (2008) there were around 20 providers of over-the-counter CFDs in Australia in 2008, and a survey of providers indicated around

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CFDs rather than in the physical market. Oxera (2007) provides more details on stamp duty arrangements.

[7] Trading in the ASX CFDs is still quite small compared to the underlying stocks. In mid September 2008, the weekly value of CFD trades on major stocks were less than 0.5 per cent of the value of weekly trading on their underlying stocks.

[8] Internationally, hedge funds and institutional investors have typically been able to do "equity swaps" (Chance, 2004) if they wish to take leveraged long or short positions with their prime brokers, and thus not required the services of CFD providers.

30,000 active traders. "Contract size is between $30,000 and $40,000. Investors trade twice a week and hold their positions from three to five days" (Financial Standard, 2008, p3).[9]

The development of CFD markets has not been without controversy. First, the scope given to unsophisticated investors to easily take highly leveraged positions has caused concern amongst those interested in investor protection. Second, traders with open positions in OTC CFDs are exposed to the possibility that CFD providers may subsequently set prices which deviate from underlying physical prices, or widen spreads, to the traders' detriment. There is also counterparty exposure should the CFD provider fail. The significance of both adverse pricing and counterparty exposure is potentially reduced where CFD providers are large, well capitalized institutions, dependent upon reputation for continued business, and subject to competition.

A third area of controversy has arisen from the ability of investors to accumulate significant economic interests in particular companies by way of CFD positions without having to disclose those positions. Although long CFD positions do not provide voting rights, the hedging practices of CFD providers (buying shares in the physical market) provide an indirect linkage and the possibility of readily available conversion of a CFD position into a physical position without affecting market prices.[10] In the UK, the FSA (2007) has outlined concerns associated with possible attempts of CFD holders to influence corporate governance and with acquisition of undisclosed economic positions. In July 2008 the FSA announced that a holding in excess of a 3 per cent stake in a company through CFDs (or other derivative transactions) would be required to be disclosed, and in March 2009 brought the date for introduction of this requirement forward from September 2009 to June 1 2009.

The introduction of exchange traded CFDs by the ASX has been marketed as overcoming some of the possible problems of OTC CFDs referred to above, including reduction in counterparty risk and exposure to adverse pricing. But, more generally there are potentially significant implications for the operations of equities markets and the future of margin lending.

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[9] By comparison, the average value per trade for the ASX CFDs has been just under $18,000. Discussions with an executive of one of the large CFD providers in Australia also indicated that most customers typically purchased CFDs (ie long positions) rather than selling.

[10] The trader with a long CFD position could close out that position and buy the physical stock concurrently being offered in the market by the CFD provider unwinding their hedged position.

First, CFDs enable traders to take short positions on traded stocks by selling the CFD, without having to short sell the physical stock. With a well developed CFD market it would be possible, in principle, to ban short selling on the physical market (other than by designated price makers in the CFD market who are hedging positions), and have short selling occurring through an arguably more transparent OTC CFD market.[11] Since a well designed CFD contract will ensure that CFD prices track those of the underlying, there may be little if anything to be gained by market makers cross hedging long CFD positions in the physical market rather than directly in the CFD market. However, whether a close link between CFD and underlying stock prices would exist if physical short selling were generally prohibited or restricted only to designated price makers, and whether the traded CFD market could achieve the depth required to facilitate within market hedging by market-makers, are open questions (to which we return in the concluding section of the paper where we also consider how alternative trading platforms may answer some of these questions). Since transactions costs are relevant considerations in hedging decisions, a comparison of the transactions costs (including bid-ask spreads) in the CFD and underlying markets is an important area for study.

Second, a long ASX CFD position is an alternative to purchasing stock using a margin loan facility provided by a financial institution. The funding is indirectly provided by those with short CFD positions (and who receive interest on the implicit loan), while the counterparty for both long and short positions is (through novation) the exchange clearing house (which, in effect, becomes a financial intermediary with matched assets and liabilities). Interest on a standard margin loan is calculated on the initial loan (initial stock price minus margin account balance). As a result of the contractual cash flows in the hypothetical CFD contract as illustrated in Table 1 it appears that interest is being calculated on a changing loan size equal to the current stock price. But because gains and losses are credited to the margin account which earns interest, the net loan equivalent for the CFD is actually the initial stock price minus initial margin.[12] So there is little difference in the structure of the cash flows

[11] While the counterparty to the CFD seller, who is taking a long CFD position, might wish to hedge by short selling the physical, that counterparty may be a trader who wishes to be long in the stock, or a designated price (market) maker who can hedge by taking an offsetting short position in the CFD market.

[12] This argument assumes margin accounts earn interest at the overnight cash rate (which is the interest rate applied to CFDs). In fact margin accounts of brokers at the ASX earn interest at the overnight cash

between a standard margin loan and a CFD, as shown in Appendix 1. Consequently, the growth of a traded CFD market provides a significant source of potential competition for participants in the margin loan market, with the extent of competition depending upon the interest rate charged on the positions.

2. *The ASX Exchange Traded CFD Contract*

2.1 Details of the contract

The ASX CFD Market began trading on 5 November 2007, with the listing of CFD contracts on 16 stocks with a further 33 contracts on stocks listed later that month.[13] Contracts on a number of AUD bilateral exchange rates, gold, and the Australian equity index (S&P ASX 200) have also been listed. The introduction of the market coincided with the delisting of a number of Individual Share Futures[14] contracts on leading ASX stocks which had failed to sustain significant trading activity and interest since their introduction in the first half of the 1990s.

The ASX CFD contract is based on a mixed limit-order book and designated price maker (DPM) electronic trading system structure operating through the SYCOM trading platform (which is not linked directly to the ITS platform used for the underlying stocks, creating potential complications for instantaneous hedging by DPMs as discussed later). The small number of approved DPMs[15] provide bid and ask prices, and traders can submit market or limit orders (through brokers) advising whether they are position opening or closing transactions. The CFD price is quoted per unit of the underlying equity security (one contract equates to one share).

To illustrate the design of the contract, consider the case of a buyer of N CFD units on company XYZ at date 0 at a price of $\$P_0$ per unit for a contract value of $\$N\times P_0$. If she sells N units at some later date T at a price of $\$P_T$, she will have a net gain ignoring interest payments of $\$N(P_T - P_0)$.[16] On each day over the life of the

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rate minus 25 basis points, and arrangements between brokers and their clients are a matter of negotiation.

[13] Subsequent mergers have seen two contracts delisted, and in early 2009 four further stock CFD contracts were listed.

[14] Brailsford and Cusack (1997) provide an overview of these contracts and their pricing. Ang and Cheng (2005) discuss the design and introduction of new single stock futures on US markets.

[15] Eight DPMs were listed in an initial media release by the ASX.

[16] As the contract value changes, margin payments and receipts will be made to the trader's account, such that when the contract is closed out by the trader, her net gain or loss will be reflected in the account balance. Initial margins required by the Exchange are set as a cash amount and ranged from 5.5 to 27.2% of the settlement price with an average of 13.8% as at 1 September 2008 (based on margins set at current levels on 5 June 2008)

contract, the buyer has the following contractual arrangements. She must pay *contract interest* each day given by:

$$CI_t = r_t \times N \times S_{t-1}$$

where r is the daily contract interest rate (set equal to the Reserve Bank of Australia's target overnight cash rate), and where S_t is the previous day's daily settlement price established at the end of each day by the ASX. While CFD trades during the course of the day may (if exact parity pricing does not occur) differ from the contemporaneous underlying share price, the settlement price is set equal to the closing underlying share price. The CFD buyer must also pay an *open interest charge* (ie a position charge) each day given by:

$$OIC_t = r^*_t \times N \times P_{t-1}$$

where r^* is a daily charge rate set by the exchange and which has been 1.50% p.a. from the date of initial trading. (DPMs receive a rebate of the OIC as part of the incentive arrangements with the ASX aimed at achieving parity pricing and low spreads).

The seller of the contract receives the equivalent contract interest amount each day, but must also pay an open interest charge. The OIC charged to both buyers and sellers thus reflects a charge levied by the ASX on positions. The buyer also receives, and the seller pays, amounts equal to any cash dividend paid on the underlying stock. These transactions occur on the ex-dividend day, such that no difference arises between entitlements to cash dividend amounts on the CFD and the underlying stock.[17] However, a potentially significant complication arises because of the Australian dividend imputation tax system, under which many companies pay *franked dividends* which carry a tax credit for Australian taxpayers.[18] Australian tax law, however, precludes use of such tax credits where the shareholder has not held the shares for at least 45 days around the ex-date, or has engaged in hedging transactions involving the stock.

Absent that legal preclusion, equivalence between entitlements of CFD positions and underlying stock positions would be maintained by CFD buyers receiving, and CFD sellers paying, a cash amount equal to the value of franking credits attached to any dividend paid. However, any DPM who has a net short CFD

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[17] There is a timing difference however in the cash receipt, given the gap between ex-dividend dates and dividend payment dates.

[18] Cannavan , Finn and Gray (2004)consider the implications of franked dividends for the pricing of individual share futures in Australia (which were delisted by the ASX with the introduction of CFDs).

position may have hedged this exposure by purchase of the underlying stock, in which case any tax credit received on the stock would not be useable. Requiring the DPM to make payment of a cash amount equal to the tax credit would thus make them unwilling to take short CFD positions over a period approaching ex-dividend dates.

Consequently, the arrangements for payment and receipt of amounts between CFD participants related to franking credits take the following form. First, to simplify the net payment positions, at the end of the day immediately prior to an ex-div day, long and short open positions of DPMs in each stock are mandatorily matched off (closed out) at the daily settlement price to give a net open position. Second, any trader (other than DPMs) who is short CFDs is required to pay, on the ex-dividend date, an amount equivalent to the tax (franking) credit attached to dividends on the underlying stock. This short franking credit payment (SFC) can be expressed as:

$$SFC = Fs \times N$$

where Fs is the franking credit amount per share.[19] If DPMs are in a net short position, they are not required to pay a short franking credit amount.

Third, the buyers of CFDs receive the SFC amounts paid. Thus if DPMs have a net long position in CFDs in a particular stock, then all long positions (traders and DPMs) receive the full franking credit entitlement on their CFD position.[20] If DPMs have a net short position in CFDs in a particular stock (denoted as Ds), then traders with long CFD positions will share pro rata the SFC from traders with short positions. Since, in this case, total long positions exceed total short positions of traders (denoted by Ts), the long franking credit cash flow (LFC) for a holder of N units is less than the full value of the franking credits on the underlying shares and given by:

$$LFC = [Ts/(Ts+Ds)] \times Fs \times N$$

The closing of offsetting positions at the end of day (settlement) price on the ex-div date is accompanied by a transfer of the equivalent amount of the underlying stock next morning. This mandatory close out at a daily settlement price set equal to the closing share price has the potential to force equality between CFD and underlying stock prices. This however only operates immediately prior to ex-div dates when the

[19] Although there is ongoing debate in Australia about the market valuation of franking credits, the ASX treats the franking credit as having full value (ie $1 of tax credit is deemed equivalent to $1 of cash) for this purpose.
[20] Whether DPMs are able to use the tax credits received, given their trading and hedging activities is problematic.

complications introduced by franking credits may distort the relationship and reduce incentives of traders to hold positions over the ex-div date.

2.2 Arbitrage or Parity pricing?

An important question regarding the ASX traded CFDs is whether an arbitrage relationship links the CFD and underlying stock prices. The possible existence of an exact one-for-one relationship and lack of basis risk is obviously valuable for marketing of the CFD contract to traders interested in taking synthetic positions in the underlying stock using CFDs. Also relevant, since they can limit the exploitation of arbitrage opportunities, is the size of transactions costs in the market. This consists of bid-ask spreads and fees and charges imposed by the exchange and by brokers through whom clients trade.

Arbitrage activities by DPMs are more likely than by individual traders, given the lower transactions costs DPMs face. They are rebated the OIC as part of incentive arrangements with the ASX, face very low transactions fees, and as financial institutions should be able to access short term interest rates close to the RBA target cash rate making the cost of carry of hedged positions relatively small. However, pure arbitrage (rather than "risk arbitrage") strategies are not possible. The absence of a terminal date at which some no-arbitrage relationship exists between the derivative contract price and that of the underlying precludes the development of an arbitrage pricing relationship for earlier dates.[21] While the netting-off of DPM positions on the ex-div date at the daily settlement price (DSP) which is the closing stock price provides one potential link between derivative and underlying prices, there is no guarantee that any netting-off will occur (if for example all DPMs are in short positions at that time). Consequently we must look to other factors which induce "parity pricing".

In its marketing material, the ASX (2008) suggests that use of the Daily Settlement Price (DSP) for determining variation margins (and open interest cash flows) is one factor which may contribute to "arbitrage" pricing. However, as shown in Appendix 1, this only affects the pattern of cash flows over the life of the contract

[21] An infinite expiry date does not necessarily preclude deriving an exact arbitrage pricing relationship as Merton (1973) and Chung and Shackleton (2003) have shown for the case of an American call option on a dividend paying stock with no (ie infinite) expiry date. However, in that case the exercise of the option generates a payoff which is linked to the underlying stock price. For a CFD, closing out the position generates a payoff linked to the difference between the CFD price at that date and when the position was opened, both of which could be independent of the contemporaneous stock price.

and not the eventual profit or loss, and hence it is not a factor that will drive the CFD price and the stock price to equality.

Other relevant factors include competition for business between DPMs and their hedging activities. Because the design of the CFD makes it a close substitute for leveraged stock positions, but only if CFD prices maintain a near-parity relationship with underlying stock prices, DPMs will find it necessary to maintain a near parity relationship if they are to attract traders into the CFD market. Their ability to do so is aided by the relative ease of hedging CFD positions created by immediate transactions in the underlying market. However, because trading arrangements mean that hedging and CFD transactions are not necessarily able to be effected instantaneously, and a risk that non-parity pricing may prevail when the hedge is unwound, there is some risk associated with implementing the hedge. Also, spreads in the underlying market create a cost of hedging as do differences between the contract interest rate on CFDs and interest rates DPMs can access in the market for funding (investing proceeds) of long (short) stock hedging positions. But at some sufficiently large basis difference, the opportunity would exist for significant net interest earnings on a "risk arbitrage" position. It is also likely that confidential commercial arrangements between the ASX and DPMs provide incentives for quoting prices which keep the basis small.

3. Prior research and hypothesis development

In the absence of prior literature on CFDs[22], studies of individual share futures (ISFs) and research on the relation between spreads in options markets and spreads in the underlying asset market inform our hypothesis development in this section.

3.1 Individual Share Futures (ISFs)

Whilst there are some important differences between CFDs and individual share futures (ISFs) they have many common features, and are potential substitutes as evidenced by the ASX decision to replace ISFs with CFDs. Because there are no published studies on CFDs we briefly describe the previous research on ISFs. Most of this research has focused on the relationships/interactions between the ISF and the underlying asset. These studies broadly fall into three categories. First, there are a number of studies that examine the cost of carry and violations in the no arbitrage conditions. Jones and Brooks(2005) found that daily ISF settlement prices traded at One Chicago contradicted the cost of carry model, with a number of ISFs settling at

[22] There is some published work on Contracts for Difference in energy markets, but this refers to a different type of contract which does not have the distinguishing features of the financial market CFDs.

prices below the underlying. Brailsford and Cusack (1997) using minute by minute data found evidence of frequent, small pricing errors before transaction costs on Australian ISFs. On allowing for transaction costs, pricing errors were rare, except on very illiquid contracts.

The second category of research examines the impact of ISFs on the volatility of the underlying. Mazouz and Bowe(2006) found that the introduction of ISFs by LIFFE had no impact on the volatility of the underlying stocks traded on the LSE. Dennis and Sim (1999) found a similar result for the ISFs traded on the Sydney futures exchange.

Third, Lien and Yang in a series of papers examined the impact of changes in the settlement of ISFs on the Australian market. Lien and Yang (2004a) showed that a switch from cash settlement to physical delivery resulted in an increase in the futures, spot and basis volatilities. The switch also resulted in an improvement in futures hedging effectiveness. Other research found that the introduction of ISF contracts reduced the option expiration effects on the underlying (Lien and Yang, 2003; 2005).[23]

Another strand of research examines the low trading volumes of ISFs, which have remained a puzzle given that ISFs have lower transaction costs, fewer short selling restrictions and greater leverage than positions in the underlying. Jones and Brooks (2005) found that for all nearby contract days at One Chicago, 41% had zero trading volume. McKenzie and Brooks (2003) report comparably low volume levels for Hong Kong ISFs, with the ISF trading days for individual contracts ranging from 0.9% to 42% of the total number of trading days available.[24] Brailsford and Cusack (1997) report low volumes for Australian ISFs, with the volume ranging from 0.5% to 3.1% of the volume of the underlying. Lien and Yang (2004b) attribute the difference in the return autocorrelations between ISFs (typically negative) and the underlying assets (typically positive) to low ISF trading volumes. Despite the thin trading

[23] Lien and Yang (2003) find that the change in settlement method had little impact on the expiration effects. However in a subsequent paper (Lien and Yang, 2005) they show that the change increased the option expiration effects. These different conclusions may be due to the different methodologies and modeling procedures employed. The 2003 paper employed a parametric model that used daily data from January 1991 to December 2000. The 2005 paper employed non parametric statistics and a 5minute data set from 1993 to 1997.

[24] McKenzie and Brooks (2003) also find that it is not the arrival of news that motivates trading in ISFs. Large ISF trading days occurred randomly throughout the sample and had virtually no relationship to news arrival (proxied by cash market volume).

Cannavan, Finn and Gray (2004) use Australian ISF data to estimate the market value of franking credits to be close to zero.

3.2 Spreads

Madhavan (2000) provides a review of market making and bid-ask spreads focusing on the physical rather than a derivative market. He suggests that price, risk, volume as a measure of market activity and market capitalization explain most of the cross-sectional variation in stock spreads, leading to the following model for bid-ask spreads in the stock market,

$$SS = \beta_0 + \beta_1(1/P) + \beta_2 \ln(1+V) + \beta_3\sigma + \beta_4 \ln(M). \qquad (3)$$

SS is (percentage) stock spread, *P* is price, *V* is trading volume, σ is stock volatility and *M* is market capitalization. Price inverse is used because the minimum tick induces convexity in the percentage spreads. Madhavan (2000) and Mayhew (2002) provide evidence that the effect of volume and price may also be non-linear. Inventory based models of the bid-ask spread predict a negative relation with volume, a negative relation with the inverse of price and a positive relation with stock volatility.[25] Adverse selection models predict a negative relation between market capitalization and spread because low-priced low market capitalization firms will have less analyst following and greater information asymmetry.

It is reasonable to expect market activity in the underlying asset market to play an important role in determining spreads in a derivative market. Cho and Engle (1999) and Kaul, Nimalendran and Zhang (2001) develop models of market making in options markets where the cost of hedging provides the link between spreads in the derivative market with those in the underlying asset market. Typically in these models the spread in the option market is found to depend on the spread in the underlying stock plus a number of control variables such as volume and price in the option market and the volatility of the underlying stock, similar to the model specified in equation (3). de Fontnouvelle, Fishe and Harris (2003) model bid-ask spreads using pooled regressions similar to equation (3) and find that the spread in the options market is significantly related to the spread in the underlying stock.

3.3 Hypothesis development

In this section we develop a number of hypotheses of interest in their own right, but also relevant for assessing the design features of the CFD contract. We

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[25] See for example Stoll (1978), Amihud and Mendelson (1980) and Ho and Stoll (1983)).

consider first the implications of the unusual contract design concerning dividends and tax credits.

Short positions must pay the dividend plus franking credit cash flow and long positions only receive part of the franking credit depending on the net short position of the DPMs. Because ex-div drop-off rates are generally less than the grossed up value of franked dividends, traders with short positions would incur a net loss over the ex-div date. But DPMs would be less averse to short positions because they are not required to make the franking credit cash flow payment. Consequently, traders contemplating taking long positions around the ex-div date would anticipate that DPMs would be net short. This will lead to long franking credit cash flows receipts being less than the full value of the franking credit. A long CFD position will therefore be less attractive than being long in the underlying stock. The open interest (OI) of traders should thus decline as the ex-dividend date approaches. This implies that the total OI will tend to comprise primarily residual positions of DPMs. The ex-div net-off of DPM positions will thus lead to substantial declines in the OI position at ex-div dates.

While in the case of unfranked dividends(where the tax credit issue does not arise), traders may perceive gains from being long – due to the expected dividend drop off rate being less than unity, similar reasoning suggests a shortage of traders wishing to be short. DPMs, however, may be less concerned about being short because they will typically hedge their positions. Hence we anticipate less evidence of a decline in OI in cases of unfranked dividends, and that there is likely to be a higher proportion of short positions held by DPMs in those cases. The foregoing leads to the following hypothesis.

H1: The Open Interest in the CFD market will fall significantly at the ex-div date. ($OI_{t-} > OI_{t+}$, where t- and t+ refer to dates just prior to and after the ex-div date respectively), and will be greater in the case of franked relative to unfranked dividend payments.

While this hypothesis reflects an idiosyncratic imputation tax related effect, it raises the more general issue of whether OI is a relevant measure of liquidity, such that fluctuations in OI are relevant for CFD pricing, which is taken up in the subsequent discussion.

Next, we consider bid-ask spreads. Following the models of de Fontnouvelle, Fishe and Harris (2003) and Cho and Engle (1999), we argue that for DPMs in the CFD market the cost of hedging is directly related to the bid-ask spread in the stock market.[26] For example, to hedge a short position in the CFD market a DPM would take a long position in the stock at the ask price and close the position by selling the shares at the bid price. Thus the bid-ask spread in the stock market (together with any spread between wholesale interest rates (for funding the stock purchase) and the RBA target cash rate received on the short CFD position) represents the cost of the hedge. Idiosyncratic stock volatility may already be impounded in the stock spread, but we include it as a control variable, because the separate trading platforms for CFD and the underlying create a problem of latency and the risk for the DPM of being "legged" (ie not completing the hedge before prices change) on hedging transactions. In addition, overall market volatility is included as a proxy for general market uncertainty which is particularly relevant given the time period over which CFDs have been trading. In addition to the bid-ask spread in the underlying stocks and the volatility measures being determinants of the spread in the CFD market, we include a number of control variables in our regressions. One is the inverse of the underlying stock price reflecting the effect of minimum tick size, as discussed earlier. Liquidity in the CFD market, measured by open interest and/or trading volume, is also a potentially relevant determinant of spreads. However, given that DPMs hedge in the underlying market, it is more likely to be liquidity in that market than in the CFD market which is more relevant. We thus include the lagged volume of trades in the CFD (measured as the log of one plus trade volume to overcome the problem of a significant number of zero observations) and the (log of the) value of trades in the underlying (reflecting adverse selection costs as discussed earlier and liquidity). (Use of lagged OI did not generate significant results, and incomplete data for this variable led to a significant drop in the number of useable observations).

Accordingly the percentage spread is modelled using the following specification.

[26] Ding and Charoenwong (2003) examine thinly traded futures markets and suggest that on days when a trade occurs in thinly traded futures markets, the spread becomes lower. They also consider the relationships between the spread, volatility and transactions volume as well as whether a high activity level as reflected in more quote revisions is associated with a lower spread.

$$CFDS_{i,t} = \beta_0 + \underset{+}{\beta_1} SS_{it} + \underset{-}{\beta_2} \ln\left(M_{i,t}\right) + \underset{+}{\beta_3} \left(1/P_{i,t}\right) + \underset{+}{\beta_4} \sigma_{s,t} + \underset{+}{\beta_5} \sigma_{m,t} + \underset{-}{\beta_6} \ln\left(1+V_{i,t}\right) + \underset{+}{\beta_7} IS_t + \underset{+}{\beta_8} D_t \quad (4)$$

where the subscripts *i* and *t* refer to contract *i* and time *t* respectively, and the signs under the coefficients reflect their expected signs. CFDS (SS) is the percentage spread of the CFD (the corresponding stock) at time t. Instead of stock capitalization, which has changed markedly for all stocks over the period of our study, reflecting the international financial crisis, we use M, the dollar value of the day's trades in the stock. The coefficient on M is expected to be negative (larger companies have lower adverse selection costs) and may also reflect a liquidity effect of greater trading activity in the underlying at a particular point in time leading to narrower spreads in the derivative. P is end of day stock price (the settlement price for the CFD), $\sigma_{s,t}$ ($\sigma_{m,t}$) is stock (market) volatility (measured as the natural logarithm of the ratio of high over low price for the day), and V is the daily dollar volume of trading in the CFD. IS_t is an interest rate spread – the 30day bank bill rate minus the 30 day Overnight Interest Swap (OIS) rate which should capture changes in the funding cost of hedging positions for DPMs. D_t is a dummy variable equal to unity on September 22 and 23, otherwise zero.

Because DPMs are rebated the OIC and face very low trading costs, the zero profit spread from market making activities resulting from competition should, in the absence of hedging risks, be not much wider than those in the underlying market. However, for customers, there is a potentially much wider spread which is consistent with them being willing to take positions in the CFD rather than in the underlying using margin loans, short selling, or trading the physical (and forgoing interest on funds used etc).

This arises because the effective interest cost/return on long/short CFD positions is lower/higher than that associated with margin loan purchases or investing proceeds from short positions in the physical. Incorporating the Open Interest Charge on positions levied by the ASX of 1.50% p.a., the effective interest cost (return) on CFD positions is c+1.50 (c-1.50) % p.a., where c is the RBA target cash rate. Over the period of our study, the indicator margin lending rate averaged 3.4% higher than the RBA cash rate. The interest paid on bank cash management accounts (in excess of

$50,000), which would be an upper bound on returns paid by brokers to retail clients on cash generated from short sales was 1.1% lower than the RBA cash rate.

It is possible to use these figures to estimate an indicative maximum CFD spread which would still entice clients into the CFD market rather than trading the physical (holding all factors other than the spread costs constant). Assume for simplicity that parity pricing holds (in the sense that the average bid-ask price for the CFD and underlying is the same) and that there are zero spreads on the underlying. Let m be the amount borrowed using a margin loan (and the effective borrowing given the margin requirements for CFDs), and let x be the amount by which borrowing/investment interest rates are greater/less than the RBA cash rate (c). A trader would be willing to purchase a CFD in preference to the underlying at any price $P < P^u = S + mS(x - 0.0150)$. Similarly a trader would be willing to sell a CFD in preference to shorting the underlying at any price $P > P^l = S - mS\ (x - 0.0150)$. Assuming margin requirements of 20 percent such that m = 0.8 and, on the basis of the retail spread figures presented above, that x = 0.0300, we have $P^u = S(1+0.8(.0150)) = 1.0120\ S$ and $P^l = 0.988\ S$, or a spread of 1.20 per cent either side of the underlying price, or 2.40 per cent in total. The degree of competition between DPMs, together with their operating costs will determine the extent to which the quoted spreads in the market approach this limit rather than reflecting the lower spreads in the underlying.

These arguments lead us to state:

H2A: Bid-Ask spreads in CFDs will be significantly greater than in the underlying stock ($Spread_{CFD(i),t} > Spread_{Stock(i),t}$ for each stock i at all times t).

H2B: Spreads in the CFD market will be directly related to spreads in the stock market through the model stated in equation (4).

The fact that interest differentials mean that retail customers may be willing to trade CFDs rather than the underlying at relatively wide spreads is relevant for examining the possibility of “mispricing”. CFD trades may occur at some distance from parity with the underlying either because contract design and trading deficiencies prevent “near-arbitrage” pricing, or because imperfect competition between DPMs means that they are able to exploit the wide spreads within which customers are willing to trade. Hypothesis 3 tests whether contract design, competition, ASX incentives to DPMs, and the other factors described in Section 3 are sufficient to keep CFD and underlying prices aligned in the absence of an exact arbitrage result.

H3: There is no difference in price of contemporaneous trades of CFDs and underlying stock, beyond that attributable to transactions costs. ($| CFD(i),t - S(i),t | < \varepsilon$. where t are the times at which contemporaneous trades in CFD and underlying stock i occur and ε is some measure of transactions costs.

4. Data and Market Characteristics

The main source of data for this study is the SIRCA Taqtic data base and comprises trade and quote data and market depth data for the period November 5, 2007 (the commencement of the market) through to December 31, 2008. The data consist of all trades and quotes and the best bid and ask price on ASX equity CFDs and their underlying stocks. Information is also provided on the open interest at the close of each trading day (although there are significant gaps in this part of the data). In addition, the ASX provided copies of their "daily parameter file" which gives information on dividend and franking credit cash flows at ex-div dates.

To examine the relationship between the CFD and underlying markets (Hypothesis 3), each CFD trade was time matched to the spot trades that occurred both before and after the CFD trade. (Each trade comprises a number of contracts where each contract refers to one share of the underlying stock). This resulted in a data set that consisted of 190,450 observations. Data cleaning removed a further 462 observations, leaving the remaining 189,988 observations for analysis. To compare liquidity in the two markets (Hypothesis 2) we use the market depth data to calculate the spreads in each market. This data consist of 201,430,727 observations of the bid-ask price pairs giving the best bid and best ask in the market at any point in time. A new quote occurs in this dataset when the best bid or the best ask is changed or a trade has occurred. To examine open interest positions (Hypothesis 3), end of day data was collected. Observations for each CFD for each trading day are used, although data for some CFDs on some days were not available.

5.1 Descriptive Statistics

In order to gain a preliminary understanding of the CFD markets, their dynamics and the relationship to the underlying spot markets, the following statistics are examined;

- Daily CFD trading volume
- Number of CFD trades per day
- Daily CFD trade size
- Time between CFD trades (minutes) within the day[27]
- Time between the CFD trade and the subsequent stock trade (minutes)
- $ difference between the CFD price (P_t) and the subsequent stock price (S_t) which may be considered a mispricing error, on the assumption that the stock price represents the "fair" CFD price.
- % difference between the CFD price and the subsequent stock price (where the difference is calculated as a percentage of the observed CFD price)
- % of trades where the CFD volume equals the subsequent stock volume

The last statistic seeks to provide a very crude measure of the percentage of CFD trades that are immediately hedged by DPMs, although it clearly suffers from a number of limitations. For example, it will not identify those hedges where a CFD position is hedged through more than one stock trade. This will have the effect of understating the hedging activities in the market.

Table 2 presents summary statistics for the full sample and for a select group of companies. The companies chosen include two more heavily traded CFDs – BHP (a large mining company) and TLS (the national telecommunications company), two thinly traded CFDs – CSR and CSL, and two CFDs with trading volumes that are close to the mean trading volume - Fairfax (FXJ) and QBE Insurance (QBE).

(Insert Table 2)

The results highlight the infancy of the listed CFD market in Australia. The mean (median) daily trading volume over the period was 9023 (4645) shares per CFD with the mean (median) number of CFD trades per day being 8.93 (4.00). The illiquidity of the market is reflected in the mean (median) time between trades of 22.41 (2.65) minutes. Even a relatively heavily traded CFD like BHP has a mean (median) time between CFD trades of 10.75 (3.07) minutes. The small mean (median)

[27] By restricting this calculation to trades within the day, those days with only one CFD trade are excluded from the analysis

trading size of 1010 (500) reflects the fact that the listed CFD market has been targeted at the retail investor. The time between the CFD and the subsequent stock trade is more a reflection of the liquidity in the underlying assets with a mean (median) of 0.068 (0.006) minutes or 4.1 (0.4) seconds.

It is also apparent that the development of the CFD market has been uneven, with a number of contracts exhibiting very little activity. Figure 1 presents a histogram of the mean daily number of CFD trades per stock. There are less than 5 trades per day on average for over 50 per cent of the contracts, with many of the remainder having less than 10 trades per day on average. Only the BHP CFD contract appears to have elicited significant trading interest. Table 3 presents the distribution of daily CFD trades, showing that on average only 60.5 percent of CFDs trade on any given day, and that trading is concentrated in a small number of CFDs with the three most popular contracts on any day accounting for just over 50 per cent of the total daily value of trades on average.

(Insert Figure 1) (Insert Table 3)

Figure 2 shows that total trade value and open interest have languished through the turbulent economic environment of 2008, and gives rise to the question of whether exchange listed CFDs will prove to be viable, or whether they will join the long list of "failed financial innovations" on futures exchanges.[28] It is worth noting however that the decline in value of OI and trades reflects the significant decline in the average value of stocks since their peak in November 2007, implying that volumes have not exhibited such a decline. Moreover, turnover in the first quarter of 2009 (after our study period which included a period of significant market disruption due to the financial crisis) was between 3 and 4 times that experienced in the fourth quarter of 2008. Also important to note, is the fact that a general prohibition on short selling of stock on the ASX was introduced on September 22, remained generally in force until November 13, but was continued through the end of 2008 for financial stocks. The effect of this is considered in our empirical work in the next section.

5. *Contract Design and Market Efficiency*

We directly test each of the hypotheses developed in Section 4.

5.1 *Behaviour around the ex-dividend date: H1*

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[28] Johnson and McConnell (1989)) is one of many studies which have examined the causes of failure of futures contracts. See Tashjan (1995) for a review of the theory of optimal futures contract design, where a case is made that most new contracts fail to attract a sustainable level of trading volume.

Hypothesis 1 predicts that the open interest will decline substantially at the ex-div date particularly in the case of franked dividends.[29] Table 4 provides a test of this hypothesis, by calculating the percentage change in the average OI for 6 days after the ex-div date relative to the average OI for 6 days prior to that date for the 100 cases of dividend payments observed over the period. A value less than zero is consistent with the hypothesis, and a 6 day window was chosen to allow for the effects of low trading volume and gaps in the OI data.[30] It is clear that there is a highly significant fall in OI in the case of franked dividends, and a lesser, but still significant fall in the case of unfranked dividends. (In this latter case, the distribution is highly skewed, with two large increases in open interest occurring after the ex-div date for CFDs where there was little open interest beforehand).

As noted earlier, the institutional arrangements for netting-off of long and short DPM positions at the ex-div date automatically reduces the OI position if there are DPMs with positions on both sides of the market. A large reduction in OI due to this netting indicates that there are few traders with open positions in the market prior to the ex-div date, which is consistent with the hypothesis. We also test whether there is any difference in the decline in OI between the unfranked dividend and franked dividend cases. It was hypothesized that traders would have greater incentives to exit CFD positions before the ex-date when dividends were franked, and hence that the decline in the OI for unfranked dividends should be less. A t-test for the difference in means gives a t-value of 1.667 which has a p-value of 0.0515 for a one-tailed test of the null hypothesis of equality against the decline being larger for the franked dividend cases. While not conclusive, this is not inconsistent with the argument that there will be less decline in trading positions in the case of unfranked dividend payments.

Hence, we conclude that Hypothesis 1 is not rejected. This raises an important issue for the long run viability of the contract design, relating to whether such significant declines in open interest around ex-div dates reduce the liquidity of the contract, and whether this matters for contract viability. We consider this later in our discussion of the determination of CFD spreads.

5.2 Spreads in the CFD market: H2

[29] It is also suggested that the share of short positions held by DPMs would be higher in the case of unfranked dividends, but the necessary data to test this proposition was not available.

[30] Similar results were obtained with a 3 day window when one outlier (for which OI dropped to near zero on the ex-div date but then increased markedly) is dropped.

Two measures of spread are considered. The absolute spread is measured as *Spread1* and *Spread2* is a measure of percentage spread.

$$Spread1 = AskPrice - BidPrice$$
$$Spread2 = 100 \times \frac{AskPrice - BidPrice}{(AskPrice + BidPrice)/2}$$

Consistent with prior practice, most of our analysis focuses upon the percentage spread figure.

The average number of quote revisions per day for the stocks in the sample is 10,965 with the average time difference between quote revisions 2.75 seconds. For CFDs the average time difference between quote revisions is 29 seconds and there are on average 2,587 quote revisions per day. We use a time-weighted average across all spreads in a given contract on a given day to give a daily measure of *Spread1* and *Spread2* for each company's stock and CFD, thus reducing the effects of any intra-day patterns.

The average percentage stock and CFD spreads are plotted for each company in Figure 3. Figure 4 takes the average of the percentage spread across companies for stocks and CFDs for each day and then plots these cross-sectional averages through time. Two features of the behaviour of the CFD spreads are immediately apparent. First, there has been a general upward movement in the average percentage spread through time. Second, a major disruption to the spread levels occurred on Monday 22 and Tuesday 23 September 2008, following an announcement of a ban on short-selling of all stocks on the prior weekend. On those days the spreads on CFDs for several companies jumped to levels significantly above the average spread for the time period.[31] Even though the short-selling ban continued for all stocks until November 13 and for financial stocks past the end of our study period, there was clarification on September 23rd that DPMs hedging CFD positions (as well as other market makers hedging derivatives position) were exempt from the ban.

(Insert Figure 3) (Insert Figure 4)

The absolute spreads and percentage spreads for each company's stock are significantly less than the corresponding spreads for its CFD. There is no day in the

[31] The absolute spreads for AWC, BHP BLD, CSL, NAB, MQG, QBE, RIO, WES, WOW, WPL were greater than $1.00 on either one or both days. For example, the largest absolute spread on 22 September is $2.97 for Woodside Petroleum's (WPL) CFD, whereas the mean absolute spread is 14.99 cents and the standard deviation is 17.54 cents.

sample period on which the average CFD spread is less than the average stock spread for any company. The average across all company stocks across time of *Spread1* is 1.8406 cents and of *Spread2* is 0.2014%. For CFDs the same statistics for *Spread1* and *Spread2* are 6.3470 cents and 0.7293%. In conclusion, there is strong support for Hypothesis 2A.

We now explore in more detail the relation between spreads in the CFD market and those in the underlying stock. Before we do this test, recall the crude measure of hedging activity presented in Table 2, which indicates that 22.14 percent of trades in CFDs are cases where the CFD volume equals the subsequent spot volume. Given the lack of liquidity in the CFD market, it is likely that many of the CFD trades involve a trader transacting with a DPM who would be expected to automatically hedge the resulting position in the liquid spot market. This provides preliminary support for the model of CFD spreads proposed in Equation 4.

To examine the determination and behaviour of CFD spreads in more detail it is important to consider in more detail the nature of our data. The data set consists of a panel with the number of days T=245, and the number of cross-section units N=46.[32] The literature examining panels such as this with both large N and large T, where time series properties are relevant, is only relatively new and has seen a rapid expansion in the last 5 to 10 years. Banerjee (1999), Phillips and Moon (2000), Coakley, Fuertes and Smith (2006) provide reviews, and as noted by Smith and Fuertes (2008), although the literature in this area is growing rapidly, there are still many gaps.

The issues associated with large T and N data sets are complex, with panels differing in the degree of heterogeneity of the parameters, the orders of integration with the possibility of cointegrating relations over time and across variables in the cross-section, the number of factors influencing the dependent variables, as well as cross-sectional dependence between residuals, and or residuals and regressors. The considerable challenges have meant that no clear consensus on the most appropriate econometric methods has emerged to date. Our preliminary analysis focuses on two important issues, the orders of integration of the variables and the existence of cross-sectional dependence.

Stationarity of variables

[32] One company, St George Bank was removed from the analysis due to a large number of missing observations. The panel is also slightly unbalanced with the total number of observations being 11,248 (A fully balanced panel would have 46x245=11270 observations).

In the first stage of analysis, univariate unit root tests on each of the variables were employed. Table 5 summarises the results of the Augmented Dickey Fuller (ADF) test and the KPSS test.[33] The results suggest that generally CFD spreads, stock spreads and the inverse of the stock price are likely to be I(1) processes, however there are a number of time series that would appear to be I(0). The KPSS test suggests that stock value, stock volatility, market volatility (proxied by the All Ordinaries Index) and CFD volume are generally I(1). The ADF test however suggests that these variables are generally I(0).[34]

(Insert Table 5)

The results of the unit root test are therefore far from definitive. A visual inspection of the data reveals that many spreads significantly increased in magnitude and volatility after September 2008. This shift occurred more abruptly in some spreads than others. For illustrative purposes, Figure 6 displays the CFD spread percentages for BHP, NWS and TAH. These three CFDs were chosen because they are representative of many of the other CFD spreads in the sample. BHP shows a clear spike in the spread on September 22 and 23. From this point forward, the mean and the variance in the spread appears to have increased. NWS shows no significant increase in the spreads in September, however the mean and variance of the series over the entire sample appear to be increasing with time. TAH shows an increase in the spread on September 22 and 23. The spreads increase and are more volatile subsequent to that date, however there is a general trending downwards towards the end of the sample.

(Insert Figure 5)

Whether these features of the data should be treated as evidence of a structural break after September or of non stationarity is unclear. This is further complicated by the fact that unit root tests have difficulty in distinguishing unit roots from structural

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[33] It is well known that both tests suffer from low power. It is also well known that the ADF test results may be sensitive to the lag order and the KPSS tests may be sensitive to the bandwidth for the estimated kernel density. For this reason the ADF test employs the Akaike Information criterion (AIC) and Schwarz Information criterion (SIC) to determine the lag length. The KPSS test determines the optimal bandwidth via the data based methods of Newey and West (1994) and Andrews (1991). All unit root tests and panel regressions were estimated using Eviews version 5.0.

[34] The tests for the AOI volatility are also mixed with the ADF test supporting an I(0) process and the KPSS test supporting an I(1) process: 1) ADF – SIC: -3.13** I(0) , 2) ADF – AIC: -2.79* I(0) , 3) KPSS – Newey West 0.81*** I(1) , 4) KPSS – Andrews 0.96*** I(1). Tests for the interest rate spread suggest that it is I(0): 1) ADF test – SIC: -3.65*** I(0), 2) ADF-AIC: -4.00*** I(0), 3) KPSS – Newey West 0.29 I(0), 4) KPSS – Andrews 0.21 I(0).

changes (Perron, 2006).[35] In this paper, we view the time series behaviour of the above data as evidence of a unit root for two reasons, although we also examine the implications of assuming a structural break. First, there are a number of CFD spreads that are similar to NWS, which visually shows no signs of a structural break. Secondly, as discussed below, the impact of heterogeneity in the levels of integration across panel data is relatively easy to deal with and the effects on parameter estimation are reasonably well understood.[36]

The potential non-stationarity of the variables raises the question of cointegration and the possibility of spurious regression. To examine these issues univariate OLS regressions of equation 4 was estimated. It is well known that if the variables and errors are I(1), then the individual OLS regression results are spurious.[37] If however the residuals are I(0) then the series are cointegrated and the OLS regression exhibits super-consistency.

Univariate tests on the OLS residuals revealed that the residuals were generally I(0). The ADF (KPSS) test suggested that the residuals were I(1) for only two (eight) regressions (5% level of significance).[38] This preliminary evidence therefore suggests that a methodology that allows for the possibility of integration in the variables and the residuals is required.[39] These methods are discussed in the model estimation section below, but before we turn to this we need to examine the possibility of cross-sectional dependence.

Cross-sectional dependence

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[35] The other issue here is the relatively short time period – just over 12 months. The power of these tests depends on the time span of the data – not the number of observations, suggesting that these procedures may suffer from low power. Further, over a longer time span, one would expect that the CFD spreads will be I(0) processes. The non-stationarity of the data is therefore largely a statistical problem that needs to be adequately dealt with to ensure reliable inference is obtained.

[36] A series of panel unit root tests were also performed. The basic idea with these tests is that the additional information available in the cross-section can be used to improve the reliability of the tests. The following tests were performed in Eviews v5.0: the Levin, Lin and Chu test, the Im, Pesaran and Shin test, the Fisher Chi-square ADF test, the Fisher Chi-square PP test and the test of Hadri. See Eviews v5.0 for further details of the tests. The results are again inconsistent across the tests and are available on request. Each of these tests however, also have a number of limitations, see Breitung and Pesaran (2008) for a review. Importantly each of these tests performs poorly in the presence of cross-sectional dependence (Maddala and Wu, 1999). This we will see is a feature of this data set. Panel unit root tests that allow for cross sectional dependence include Pesaran (2003) and Chang (2004). These tests are not examined here.

[37] The I(1) error term will cause t values to diverge, the Durbin Watson statistic to approach zero and the R squared to approach unity as the sample size T goes to infinity.

[38] Panel unit root tests also supported the stationarity of the residuals.

[39] Whilst individual equations may exhibit cointegration, the mixed results of the unit root testing for the variables and residuals suggest that cointegration across the entire panel is unlikely. See Ashworth and Byrne (2003) for an application and discussion of panel cointegration methods.

The more recent panel literature has emphasised the importance of allowing for latent common factors that induce cross-sectional dependence. Ignoring this dependence may lead to inconsistent parameter estimation if the common factors are correlated with the regressors (Coakley, Fuertes and Smith, 2006). The existence of cross-sectional dependence seems likely in this data set. Stock spreads across assets for example are likely to move together, exhibiting cross sectional dependence. Further, it does not seem unreasonable to suggest that a common factor could drive CFD spreads, stock spreads and stock and market volatility.[40]

Table 6 examines the presence of cross-sectional dependence. The table reports the average cross-sectional correlation measure between each of the variables and from the OLS residuals from Equation 4. Given that there are 46 cross-sections, each average correlation measure represents the average of 1035 correlations. Each of the variables (with the exception of CFD volume) exhibit reasonably high levels of cross-sectional correlation, ranging from 0.34 to 0.50.[41] The following test of the statistical significance of the contemporaneous correlations between the residuals was performed

$$H_0 : \rho_{12} = \rho_{13} = \rho_{14} = ... = 0$$
$$H_a : \textit{At least one correlation is non zero}$$

where the test statistic is $\lambda = T\left(\rho_{12}^2 + \rho_{13}^2 + \rho_{14}^2 + ...\right)$, with a critical value of $\chi^2_{N(N-1)/2}$, where N is the number of equations (i.e 46). The test statistic of 21,767 for the residuals clearly rejects the null at a 1% level of significance, thereby supporting the existence of significant cross sectional dependence. Table 6 also reports the proportion of variability explained by the *p*th principal component (*p* = 1,2) from the relevant correlation matrix. This measure also supports the presence of cross-sectional dependence and a common factor structure.

In summary, the preliminary results suggest that a panel regression model of CFD spreads using the variables in equation 4 needs to be robust to: i) heterogeneous

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[40] On a related issue, ignoring cross unit cointegration can also have serious consequences. Banerjee, Marcellino and Osbat (2005) show via simulation that the presence of cross-unit cointegration can substantially bias upwards the probability of a type I error in panel unit root tests – i.e rejecting the null of a unit root too often. Banerjee, Marcellino and Osbat (2004)show that if cross unit cointegration is present and is ignored when using panel cointegration methods, the consequences are "dramatic" and the inference misleading. As discussed in footnote 38 above, panel cointegration is unlikely in this context.

[41] CFD volumes for many CFD often had a zero volume of trading for the day. This explains the lower levels of cross-sectional dependence in this variable.

orders of integration, where each variable in the panel may be an I(1) process for some of the N units and an I(0) process for the remaining units; ii) the possibility of integrated residuals, and iii) the presence of cross-sectional dependence. It is to these matters that we now turn.

Model Estimation

As noted above, there are a number of considerable challenges associated with regressions using large T and N panels. It is difficult to identify the most appropriate estimator given the uncertainty surrounding the stationarity of the variables and residuals, the uncertainty surrounding the appropriate latent factor structure(s) that drive the cross-sectional dependence, and the extent of heterogeneity across the units in the panel. It is therefore considered prudent to consider a range of estimators and examine the sensitivity of the results (Smith and Fuertes, 2008). This section applies five alternative estimation methodologies that can handle non stationary time series and cross-sectional dependence: 1) Pooled OLS (POLS) as suggested by (Phillips and Moon, 1999), 2) an OLS estimator of a cross-section regression (CS) as suggested by (Pesaran and Smith, 1995), 3) Two way fixed effects (2FE), 4) the Mean Group (MG) estimator of (Pesaran and Smith, 1995) and 5) the Common correlated effects mean group (CCMG) estimator of (Pesaran, 2004). (See Appendix 2 for more detail).

(Coakley, Fuertes and Smith, 2006) discuss each of these estimators (along with several others) as ways of dealing with panels that exhibit cross section dependence and non stationarity. They propose a very general structure that nests a large number of alternative data generating processes (DGPs) and use this to illustrate when each of these alternative estimators are appropriate. Via simulation, (Coakley, Fuertes and Smith, 2006) consider the performance of each of these estimators under stationary and non stationary settings, cross sectional dependence, cointegration, common factors that drive regressors and common factors that drive errors and regressors. A key finding of their paper is that the CCMG estimator was the most robust with non stationary data where the residuals and regressors had common factors driving the cross-sectional dependence. Other estimators were also shown to be satisfactory, however they were not as efficient as CCMG.[42]

[42] These results however must be viewed with caution. The results are not asymptotic and monte carlo simulation results may be specific to the DGPs considered. Further, whilst (Coakley, Fuertes and Smith, 2006) consider a wide range of DGPs that exhibit stationary and non stationary variables, cross sectional dependence, cointegration and no cointegration, common factors etc, the tests do not consider the performance of the estimators when the DGP is a complex mixture. For example, the asymptotics

Table 7 presents the results which are generally quite robust to the alternative estimators. Most parameters subject to some exceptions discussed below are stable across the alternative estimators. Price inverse, stock volatility and CFD volume are statistically significant for all estimators. Stock spread is statistically significant for all estimators except for the CS regression, where the lower section of Table 7 indicates that this is due to high collinearity with the stock price in the cross-section. Stock trading value is not significant in any of the regressions. The September dummy generally supports an increase in spread at that time of 1.5 to 2%. The signs of all variables are also consistent with expectations.

The insignificance of the market volatility and interest spread variables in the CCMG estimator suggests that the inclusion of the latent factor proxies (the cross sectional averages of the stock spread, stock value, price inverse, stock volatility and CFD volume which seek to capture the cross-sectional dependence) has rendered these market wide variables insignificant. This suggests that the market volatility and interest spread variables in the pooled OLS and MG regressions act as common factors, partly capturing the cross-sectional dependence.

Given the robustness of the results to the alternative estimators, we focus on the Pooled OLS results for detailed discussion. Table 8 presents those results both for the full sample and for subsamples prior to and after the announcement of the short selling ban. Tests for a structural break at that time were performed using a Chow breakpoint and Chow forecast test using both the MG and CCMG estimators which estimate equations for each CFD. In only a very small number of cases (eg 5 of 46 for the CCMG estimator for the breakpoint test and 2 of 46 for the CCMG estimator for the forecast test) was the null hypothesis of no structural break not rejected. The table also reports a 2 tailed t test of the differences in the coefficient estimates between the two sub-samples.

For the first subsample (prior to the shortselling ban) the coefficient on the stock spread is insignificantly different from unity, but it is significantly above unity for the second subsample when the shortselling ban was in operation. This is further

(of previous papers) and the simulation studies assume that all variables are either I(1) or I(0). They do not consider the situation where the one variable may have different orders of integration across units. Table 2 for example reveals that approximately 50% of CFD spreads are I(1) processes with the remaining 50% being I(0). Another example could be that a common factor drives the regressors and errors for some cross sections but not others. These issues remain largely unexplored in the literature. It is therefore acknowledged that these results must be viewed with caution. Nonetheless, the results appear quite robust to alternative estimation techniques and therefore the inference seems reasonable.

confirmed by the t test of -543.6 (p value 0.000) which strongly supports the difference in the coefficient estimates. While in subperiod 1, the CFD spreads are higher than stock spreads (Fig 4), this is attributable to factors other than a “direct markup” on the underlying stock spread. The intercept term of 0.35 (35 basis points) is of similar order of magnitude to the average difference between CFD and stock spreads over this period (Figure 4). Since other explanatory variables have been argued to capture the effects of risks involved in hedging, it is tempting to interpret this coefficient estimate as indicating either exploitation of the wider feasible spread for customers by DPMs or reflecting cost recovery associated with development and implementation of trading algorithms and systems.

In the second subperiod when CFD spreads jump (Figure 4), there is also greater sensitivity to stock spread. The dummy variable for the period of market turmoil on September 22 and 23, 2008 is significant, with its value indicating that spreads were around 2 percentage points higher than usual on those days. The sensitivity of the spread to the inverse of the stock price falls significantly in the first subsample. Higher priced stocks had lower spreads and while that was still so in the second subsample, the effect was somewhat muted. There is also significantly greater sensitivity of CFD spreads to short term market volatility in the second subsample and some suggestion of increased sensitivity to individual stock short term volatility. The larger effect of stock market volatility on the CFD spread (relative to individual stock volatility) is most likely due to the effect of individual stock volatility being reflected in the stock spread which is highly significant. These results are suggestive of responses to perceived increase in hedging risks by DPMs.[43]

5.3 Mispricing: H3

The descriptive statistics in Table 2 which examine the $ and % difference between the CFD and the next spot trade provide preliminary support for hypothesis 3, with the average $ and % mispricing being approximately zero in total and for all stocks. However it is important to establish whether any mispricing is beyond those attributable to transaction costs.

[43] Panel unit root tests on each of the sub-samples also provide mixed results. Whilst the residuals are stationary, the results for the dependant and independent variables are mixed. These findings which point to the possibility of heterogeneous orders of integration further support the estimation methods adopted in this paper.

The determination of the appropriate transaction costs is notoriously difficult. The transaction costs associated with one round trip for the CFDs must be added to the transaction costs associated with taking the appropriate position in the underlying. This paper follows Chung(1991), Klemkosky and Lee (1991) and Brailsford and Cusack (1997) who only examine mispricings that exceed predetermined thresholds. For example, the study of the Australian ISF market by Brailsford and Cusack (1997) considered transaction cost bounds of 0.5% and 1%.

In our case, however, our preceding analysis of bid-ask spreads consistent with trader participation in the CFD market, rather than alternative transactions in the underlying market provides some guidance. To the extent that quotes by DPMs exploit that relatively large spread within which customers will trade, it is likely that trades will occur in the CFD market at potentially large deviations from concurrent trades in the underlying market. Our indicative spread calculations suggest that deviations of greater than 1 per cent would indicate either mispricing or full exploitation by DPMs of the feasible retail trader spread – arising from their willingness to deal at non-parity prices because of the interest advantages compared to alternative trading strategies. Deviations of greater than 0.5 per cent are suggestive of DPMs quoting spreads wider than would be anticipated under perfect competition, leading to trades at "non-parity" prices. But it should also be noted that in some cases (discussed below) the time lag between CFD and subsequent stock trades is several minutes, implying that not all CFD trades are immediately hedged and giving rise to the possibility of parity violations due to non-synchronous trading.

Table 9 examines the mispricings that exceed the transaction cost bounds of 1% (Panel A) and 0.5% (Panel B). The table presents the results for all CFDs along with the six individual CFDs presented in Table 1.

(Insert Table 9)

The results suggest that the CFD market is generally efficient, with violations in the transaction cost boundary only occurring 0.68% (2.97%) of the time for transaction costs of 1% (0.5%). Across all stocks, mispricings are more likely to be negative. That is, CFDs are more likely to be underpriced than overpriced. This is reflected in the negative and statistically significant mean and median values of -0.33% and -1.04% in Panel A and -0.10% and -0.51% in Panel B, and in the number of negative violations being greater than the number of positive violations. The Wald-Wolfowitz runs test also finds that mispricings are not randomly spaced over time.

For all CFDs except for FXJ (with transaction costs of 1%), the results suggest that there are clusters of mispricing violations which are not caused by random fluctuation.

Figure 6 presents a histogram of the number of CFDs against the percentage of violations in the price bounds. Figure 6 (panel a) considers transaction costs of 1% , revealing that 31 CFDs (representing 72% of CFDs) exhibit boundary violations less than 2% of the time. When transaction costs are at 0.5% (panel b), 26 CFDs (representing 60% of the total) exhibit boundary violations less than 6% of the time. Only 5 CFDs experience boundary violations more than 30% of the time when transaction costs are at 0.5%. Each of these CFDs have a relatively high time between the CFD trade and the subsequent spot trade. They also have a very low number of trades per day with means (medians) ranging from 1.9 to 3.1 (1 to 2).

(Insert Figure 6)

On considering all CFDs individually (results available on request), there are four CFDs that exhibit statistically significant negative mispricing for transaction costs of 0.5 and 1%. There are also four CFDs that exhibit statistically significant positive mispricing for both sets of transaction costs. Caution however must be exercised in the interpretation of these results. The use of the mean/median can be misleading for two reasons. First, the power of the tests is generally low due to the small sample sizes involved. Second, a CFD could experience many large positive and negative mispricings, and the t test may be unable to reject the null of a zero mean. The use of the median (and the Wilcoxon test) partially overcomes this limitation, however exclusive reliance on the median may still be prone to this problem.

On examining the number of violations for BHP (the most popular CFD), it is very clear that the pricing of the BHP CFD generally appears very efficient with mispricings only occurring 0.18% (0.37%) of the time for transaction costs of 1 and 0.5% respectively. This suggests that if adequate market depth and liquidity develops, pricing will reflect parity relationships, despite the inability to undertake riskless arbitrage in CFDs.

As Table 2 and Figure 1 indicate, daily trading volumes in CFDs of a number of stocks are relatively small. Consequently, the economic significance of observed mispricings must be interpreted with caution, and the longer time lags between CFD and stock trades is also relevant in this context.

5.4 Factors explaining mispricing

With the volume of trade in the CFD as a significant determinant of the spread it is likely that any mispricing will be related to the number of contracts traded. So following the approach of Brailsford and Cusack (1997) the absolute value of the pricing error is regressed on the number of contracts traded and a dummy variable that captures the higher level of pricing errors on introduction of a new contract. The idea is that as the market matures, any mispricing will be more quickly arbitraged away. The following regression is estimated

$$|e_t| = \alpha + \beta_1 D_{start,t} + \beta_2 D_{sept,t} + \beta_3 Vol_t + \beta_4 D_{sept,t} Vol_t + \beta_5 |e_{t-1}| + \varepsilon_t \quad (5)$$

where e_t is the mispricing at time t defined as the difference in cents between the CFD trade at time t and the subsequent stock trade, (i.e this measure ignores transaction costs and provides a mispricing for each CFD trade - a regression that explains boundary violations is performed below), $D_{start,t}$ is a dummy variable equal to 1 if trading occurs in the first 7% of the data sample (an approximation for the first month of trading[44]) otherwise zero, $D_{sept,t}$ is a dummy variable equal to 1 for days after and including September 22, 2009, otherwise zero, Vol_t is the number of CFD contracts traded at time t, and ε_t is the residual at time t. Further, where outliers for the dependent variable were observed, intercept dummy variables were employed (at most only 2 to 3 dummies were required, if any). The regressions are estimated via OLS with Newey West standard errors to ensure that inference was robust to heteroscedasticity.[45]

Table 10 presents the regression results for an illustrative sample of CFDs. The results suggest that there is some evidence that the mispricing was actually lower on the introduction of the CFDs, consistent with the development of the market depicted in Figure 2 and Figure 4. This strange result whilst statistically significant appears economically insignificant. The significant intercept dummy β_2 indicates that

[44] The regressions were also estimated where the dummy was equal to 1 (zero otherwise) if trading occurred in the first 14% (2 months approximation) and 21% (3 months approximation) of the sample. All regressions were also re-performed using $|e_t|/\text{CFD}_t$ as the dependent variable. The results and conclusions are generally robust to these alternative specifications with the following exceptions. The September intercept dummy was positive and significant for the TLS and FXJ assets. The different start dummies provided mixed results for FXJ and QBE. Volume was clearly negative and significant for the other 5 QBE regressions.

[45] Brailsfod and Cusack (1997) also find that pricing errors are affected by the underlying stock carrying dividend entitlements. Dividend entitlements will affect the pricing of the ISF given the cost of carry, however this should not affect the CFD price.

mispricings were higher in the period after September 22, 2008 for BHP, QBE, CSL and CSR.

The evidence also suggests that for TLS and FXJ there is a negative relationship between CFD volume and the extent of mis-pricing. The negative relationship can be interpreted as high volume levels being indicative of a liquid and efficient market in which mispricings do not occur. This finding of efficient pricing is consistent with the conclusions of efficiency drawn above.

The significant lagged dependent variable for most CFDs suggests that mispricing errors are persistent. This finding is consistent with the Wald-Wolfowitz runs test presented in Table 9, which suggests that violations in the transaction costs bounds tend to occur in clusters.

(Insert Table 10)

A further regression (estimated using data for all CFDs) of the percentage of violations (from Table 9) against the average number of trades (from Table 2) also reveals a statistically significant negative relationship between mispricing and volume of trading. Regressing the percentage of violations against the average volume per day (also from Table 2) did not give significant results. See Table 11 for the results.

(Insert Table 11)

In summary our findings are largely consistent with the research examining the pricing of ISFs. The overall negative mispricing is consistent with the findings of Jones and Brooks (2005), who find that ISF prices tend to be underpriced relative to their fair value. The negative relationship between CFD volume and the extent of mis-pricing summarized in Table 11 is consistent with the findings in Table 3. The findings are also consistent with Brailsfod and Cusack (1997) who find that for ISFs, after transaction costs pricing errors are rare except on illiquid contracts.

6. Conclusion

Contracts for difference (CFDs) are an important innovation in financial futures markets, that to date have not been studied in the literature. We have described the nature of CFDs and provided details on the nature of the first exchanged-traded stock CFDs. An interesting feature of a CFD is that it has no explicit maturity date. Instead the CFD position can be closed out at any time at a price equal to the CFD price at that time. There is thus no explicit link between the CFD and its underlying stock that can be used to derive an arbitrage-free price for the CFD. However, we argue that there are other market factors such as competition and close substitutes that will result in the CFD trading at a price close to the underlying.

We show this to be the case in our empirical tests, where we explore the characteristics of the 47 stock CFDs trading on the Australian Stock Exchange, although we demonstrate that spreads are significantly wider in the CFD market (partly reflecting its relative infancy) than in the underlying market. We also demonstrate one of the weaknesses of the contract specification arising from the treatment of franking (tax) credits, which causes the CFD open interest to decline substantially around ex-div dates, although open interest is less relevant for CFD market liquidity than liquidity in the underlying market where market makers can directly hedge their CFD exposures.

For policy makers and securities exchanges, the ability to create an exchange traded CFD which demonstrates efficient pricing has a number of implications. For exchanges, listed CFDs warrant consideration as a possible replacement for individual share (stock) futures (ISFs) which have been introduced in a number of countries over the past decade, and which they replaced in Australia They also provide the opportunity for development of a transparent market for short-selling, which in the light of recent experience and regulatory actions warrants further examination. While a close link between CFD and underlying stock prices requires DPMs to be able to hedge long CFD positions by shorting the underlying the stock, there may be merit in forcing traders (both retail and wholesale) to short-sell through such a derivative market by permitting only DPMs to short-sell in the physical market to hedge positions taken on in that role.

In that regard, the future design of CFD trading platforms and market arrangements is an important issue, with the consideration of an integrated order book model by the London Stock Exchange indicative of potential developments (and its deferral of introduction also indicative of logistical difficulties). As our results indicate, the separation of the CFD market and its underlying on the ASX creates difficulties for instantaneous risk-free hedging, leading to wider spreads in the CFD market which retard market development. It is, in principle, possible to combine CFD and underlying stock orders in the one limit order book, which would force equality between their prices. To do this, novation of CFD trades would be required, such that a trade involving a CFD purchase and underlying stock sale, for example, would lead to the clearing house or a DPM being the novated buyer of stock and seller of the

CFD. A trade involving a CFD sale and underlying stock purchase would involve the clearing house or DPM being a novated seller of stock, and thus having to draw on its inventory holdings or borrowing stock to deliver. Precluding short sales, other than by DPMs, and forcing traders wishing to take short positions to do so via selling CFDs may be more transparent than current short-selling arrangements. Thus, both securities exchanges and regulators should find the results of our empirical analysis of the first attempt at design of an exchange traded CFD market of interest.

Also important is the role of listed CFDs as a potential competitor for margin lending facilities from financial institutions. A successful exchange traded CFD leads to the clearing house becoming, in effect, a financial intermediary with a matched book of assets and liabilities with CFD sellers indirectly extending credit to CFD buyers through contracts with the clearing house as counterparty. Provided that margining arrangements successfully keep the counterparty risk to the clearing house low, the potential exists for the clearing house to provide more attractive interest rate terms to both CFD buyers and sellers than may be available elsewhere. And as with margin lending and OTC CFDs, there are public policy concerns regarding retail investor understanding of the risks and costs involved and appropriate investor protection regulation.

A number of areas for future empirical research can be readily identified. A number of studies referenced earlier have examined the nature of lead-lag relationships between individual share futures and share prices. Others have considered how changes in contract terms affect volatility of the futures and the spot, and the basis as well as futures hedging effectiveness and option expiration effects. While the thinly traded nature of CFDs (and ISFs as well) limits the lessons which can be gained from such studies, there is scope for further work in this area. More generally comparison of the performance of CFDs versus ISFs on a number of different metrics is warranted given the potential for choice between these alternative contracts by organized exchanges.

Finally, a more detailed examination of market maker behaviour is warranted. Our analysis of trade data indicates that a significant proportion of CFD trades are replicated soon after in the physical, suggestive of DPM hedging. This is supported by our examination of the spread in the CFD market, which we find to be determined by the spread in the underlying stock, consistent with the hedging models suggested in the literature (Cho and Engle, 1999) and (de Fontnouvelle, Fishe and Harris, 2003).

Given current relative spreads in the two markets, the question of the relationship between DPM profits and risk bearing is an important one in the context of the potential future growth and development of the CFD market.

Appendix 1

Consider the cash flows from a long position in a CFD where the stock daily settlement price (DSP) on successive days is given by S_0, S_1,....,S_n. For simplicity of exposition we assume there are no dividends. We initially assume no initial margin requirement and consider the implications of changing this assumption later. We also assume no "open interest charges" of the form levied by the ASX which have the effect of introducing a spread between borrowing and lending rates. The long CFD position is opened at price CFD_0 at the end of day 0. The daily rate of interest charged on the long position is *r* applied to the DSP of the previous day. Table A illustrates the daily cash flows into/from the margin account (row 4) as a result of daily gains or losses on the position and the daily interest charge on the long CFD. In row 5 the daily profit/loss is assumed to accrue at rate *r* in the margin account until the sale of the CFD at day *n* at price CFD_n.

1	Day	0	1	2	….	n
2	Stock price	S_0	S_1	S_2	….	S_n
3	CFD price	CFD_0				CFD_n
4	Margin account gain/loss		$S_1–CFD_0– rS_0$	$S_2–S_1(1+r)$		$CFD_n - S_{n-1}(1+r)$
5	Gain/loss (compounded to day n)		$(S_1–CFD_0– rS_0)(1+r)^{n-1}$	$[S_2–S_1(1+r)](1+r)^{n-2}$	….	$CFD_n – S_{n-1}(1+r)$

Table A: Daily cash flows on a long CFD position.

For example, at the end of day 1, the gain/loss to the margin account on the long CFD is the difference between the day DSP (S_1) and the opening CFD price (CFD_0) minus the interest that must be paid on the long position (calculated using the day 0 DSP, S_0). This is given by

$S_1 – CFD_0 – rS_0$.

On day 2 the gain/loss is given by

$S_2 – S_1 – rS_1$.

The sum of row 5 entries is the cumulative gain/loss on the position when it is closed out at day *n* and is given by

Σ_{CFD}=[-CFD_0-rS_0](1+r)$^{n-1}$+[S_1(1+r)$^{(n-1)}$-S_1(1+r)$^{(n-1)}$] + [S_2(1+r)$^{(n-2)}$-S_2(1+r)$^{(n-2)}$] +....
+ CFD_n,

simplifying to

$$\Sigma_{CFD} = CFD_n - CFD_0(1+r)^{n-1} - rS_0(1+r)^{n-1} \qquad (A1)$$

Equation (A1) shows that the gain or loss on the long CFD position at the close of day *n* consists of two components. One is the value of the CFD at day *n* minus the value of the CFD at day 0 (when the position was opened) compounded up at a rate equal to r. The second is an interest component: the interest on the opening day's position, compounded up at the CFD interest rate. Note that the ultimate profit/loss does not depend on share prices over the intervening period (or how the DSP is determined other than for date 0), as expected for a futures contract with deterministic interest rates (Cox, Ingersoll and Ross, 1981). Because the initial margin and ASX open interest charge of 1.5% per annum are fixed charges, including these does not alter the conclusion.

If the CFD price were equal to the share price, equation (A1) simplifies to

$$\Sigma_{CFD} = S_n - S_0(1+r)^n, \qquad (A2)$$

a formula that differs from the gain/loss on a long forward position in the stock because of the interest charge on the long CFD position. Adding into equation (A2) the date n cumulated interest and principal on a non-zero initial margin requirement demonstrates the equivalence of a long CFD position with a long, margin loan, financed position.

Appendix 2 – Panel Regression Methods

For notational purposes let the parameter vector $\beta = (\beta_1, \beta_2, ...\beta_6)$ denote the slope coefficients for the regressors in Equation 4 above. The pooled OLS (POLS) approach ignores any parameter heterogeneity and estimates

$$CFDS_{it} = \beta_0 + \beta x_{it} + \varepsilon_{it}, \quad \varepsilon_{it} \sim iid\left(0, \sigma^2\right), \quad i = 1,...., N, \; t = 1,.....T \qquad (A1.1)$$

If the variables are non stationary and cointegrate, the estimator is consistent. Phillips and Moon (1999) showed that the estimator is still consistent even when the errors are

I(1).[46] This result is of importance here, given that the residuals from the OLS regressions above showed very mixed results, with some regressions suggesting the residuals were I(1). If however cross unit cointegration is present (in the dependent and independent variables) and ignored, Banerjee *et al* (2004) show via simulation that inferences using the pooled approach can be terribly misleading. Further, if cross sectional dependence between the regressors and residuals exists and is driven by the same factor, the estimator is inconsistent.[47]

The cross section (CS) regression of Pesaran and Smith (1995) estimates

$$\overline{CFDS}_i = \beta_0 + \beta \bar{x}_i + \varepsilon_i, \quad \varepsilon_i \sim iid\left(0, \sigma^2\right), \quad i = 1, ..., N \qquad \text{(A1.2)}$$

where $\overline{CFDS}_i = T^{-1}\sum_{t=1}^{T} CFDS_{it}$ and $\bar{x}_i = T^{-1}\sum_{t=1}^{T} x_{it}$ are the unit means. This procedure obviously removes any unit root issues. If cross-sectional dependence between the errors and regressors is driven by a common factor, under certain circumstances the estimator may still be consistent.

The well known two way fixed effects (2FE) estimator is

$$CFDS_{it} = \beta_{0i} + \beta_{0t} + \beta x_{it} + \varepsilon_{it}, \quad \varepsilon_{it} \sim iid\left(0, \sigma^2\right), \qquad \text{(A1.3)}$$

where the intercepts differ by unit and time. If a common factor causes the errors and regressors to be contemporaneously correlated, the estimates remain consistent as long as the loadings attached to the factors are independent.

The mean group (MG) estimator allows for different slopes and separately estimates the following regression for each unit by OLS

$$CFDS_{it} = \beta_0 + \beta_i x_{it} + \varepsilon_{it}, \quad \varepsilon_{it} \sim iid\left(0, \sigma_i^2\right). \qquad \text{(A1.4)}$$

The overall coefficient for each explanatory variable in the panel is then calculated as the average of the *N* estimates. i.e $\hat{\beta} = N^{-1}\sum_{i=1}^{N} \hat{\beta}_i$. The standard errors are calculated as $s.e = \sqrt{1 / N\left(N-1\right)\sum_{i=1}^{N}\left(\hat{\beta}_i - \bar{\beta}\right)^2}$. Like POLS, even if the errors are I(1), the

[46] This result is at odds with the univariate time series literature, where it is well known that an I(1) error results in a spurious regression. By using a panel however, the strong noise of the residuals is reduced by the pooling of data, thereby enabling a consistent estimate of the beta vector to be obtained.

[47] Urbain and Westerbund (2006) complement these results analytically showing that the statistics diverge with the size of the cross section. If however at least one variable does not cointegrate across units, normality is again possible, with the centre of the distribution located at the long run average coefficient.

individual OLS regressions will be spurious, however the averaging will reduce the effects of the noise in the residuals and allow a consistent estimate for large *N*.

Finally, the Common Correlated effects mean group (CCMG) estimator estimates the following

$$CFDS_{it} = \beta_{0i} + \beta_i x_{it} + c_{1i}\overline{CFDS_t} + c_{2i}\overline{x_t} + \varepsilon_{it}, \quad \varepsilon_{it} \sim iid\left(0, \sigma_i^2\right) \qquad \text{(A1.5)}$$

where $\overline{CFDS_t}$ and $\overline{x_t}$ represent the cross section averages which act as proxies for the latent factors. Like the MG estimator, individual OLS regressions are estimated and the coefficients are calculated as the average of the estimates. Standard errors are also calculated in the same way as the MG estimator.

TABLE 1: Arbitrage Portfolio cash flows for CFD purchase and stock short sale. This Table shows the cash flows associated with establishing an arbitrage portfolio at date T-1 involving a long position in a hypothetical CFD contract which expires at date T and a short position in the underlying stock, assuming that the CFD contract interest rate and that available on the proceeds of the short sale are equal. Absence of arbitrage implies that at date T-1 the stock price (S_{T-1}) and the CFD price (P_{T-1}) must be equal. Proof of price equality for earlier dates is by induction, substituting proceeds of market sale of the CFD on the next day for CFD settlement cash flows.

	Date T-1	**Date T**
Short sell stock at date T-1	$+ S_{T-1}$	
Invest proceeds of short sale	$- S_{T-1}$	$+ S_{T-1} (1+r)$
Pay any dividend D_T		$- D_T$
Buy and deliver stock at date T		$- S_T$
Buy CFD at date T-1		
Pay contract interest		$- rS_{T-1}$
Receive dividend		$+ D_T$
CFD settlement		$+(S_T - P_{T-1})$
Net Cash Flow	0	$S_{T-1} - P_{T-1}$

TABLE 2: Descriptive Statistics: CFD Trading, November 2007 – December 2008

		Daily CFD trade volume	Number of CFD trades per day	CFD trade size	Time between CFD trades (mins)	Time between CFD & next stock trade (mins)	$ price diff between CFD & next stock trade	% price diff between CFD & next stock trade	% of CFD trades where CFD vol equals next stock vol
All	Mean	9023	8.93	1010	22.41	0.068	-0.0018	-0.01%	19.31%
	Median	4645	4.00	500	2.65	0.006	-0.0000	-0.00%	
	Std dev	13399	12.63	1729	47.53	0.230	0.0839	0.36%	
	Min	0	0.00	1	0.00	0.000	-8.9500	-31.30%	
	Max	280000	288.00	83000	351.35	18.061	5.1900	29.70%	
BHP	Mean	33791	34.23	987	10.75	0.035	-0.0012	-0.00%	12.64%
	Median	28110	31.50	750	3.07	0.007	-0.0000	-0.00%	
	Std dev	24499	17.89	1203	20.09	0.076	0.0574	0.16%	
	Min	2800	4.00	1	0.00	0.000	-2.6700	-7.44%	
	Max	150510	94.00	15000	269.88	1.283	0.3700	1.02%	
TLS	Mean	21609	2.46	8788	62.47	0.104	-0.0004	-0.01%	21.49%
	Median	12000	2.00	5000	20.86	0.011	-0.0000	-0.00%	
	Std dev	32497	2.37	10026	85.22	0.217	0.0132	0.31%	
	Min	1	1.00	1	0.00	0.000	-0.0500	-1.15%	
	Max	280000	16.00	83000	303.89	1.822	0.0600	1.37%	
FXJ	Mean	9597	2.29	4191	19.72	0.221	-0.0021	-0.10%	10.58%
	Median	5000	1.00	3000	0.61	0.026	-0.0050	-0.23%	
	Std dev	9569	2.33	3729	53.13	0.430	0.0162	0.61%	
	Min	500	1.00	200	0.00	0.000	-0.0400	-2.13%	
	Max	36000	12.00	21000	251.01	2.282	0.0300	1.02%	
QBE	Mean	6654	7.46	892	28.00	0.055	-0.0008	-0.00%	27.13%
	Median	3000	5.00	500	2.62	0.005	-0.0000	-0.00%	
	Std dev	9499	7.76	1252	56.09	0.141	0.0629	0.27%	
	Min	67	1.00	1	0.00	0.000	-0.8500	-4.18%	
	Max	58305	62.00	8399	335.77	2.260	1.1900	5.22%	
CSL	Mean	2253	5.84	389	37.21	0.094	0.0007	0.00%	14.12%
	Median	1500	4.00	500	6.62	0.011	-0.0000	-0.00%	
	Std dev	2296	5.40	262	65.11	0.224	0.0580	0.16%	
	Min	20	1.00	1	0.00	0.000	-0.2000	-0.52%	
	Max	13750	31.00	3000	345.87	2.246	0.5400	1.65%	
CSR	Mean	4313	1.92	2504	44.08	0.192	0.0004	-0.00%	31.25%
	Median	3000	1.00	2000	0.72	0.011	-0.0000	-0.00%	
	Std dev	5527	1.42	2530	81.14	0.528	0.0238	0.89%	
	Min	200	1.00	200	0.00	0.000	-0.0400	-1.97%	
	Max	41500	8.00	15000	304.49	3.451	0.2100	7.02%	

TABLE 3: Daily Distribution of CFD Trading:

November 19, 2007 – December 31, 2008

Statistic	Percentage of CFD's traded	Share of total value traded of		
		Largest CFD traded	Second largest CFD traded	Third largest CFD traded
Average	60.5%	28.0%	15.9%	10.8%
Minimum	29.8%	11.2%	3.7%	2.6%
Maximum	80.9%	87.0%	31.1%	21.0%

TABLE 4: Ex-dividend day behaviour of Open Interest

This table shows the percentage fall in the average open interest for six days after the ex-div date compared to the six days prior.

Statistic	Unfranked dividends	Franked dividends
Number of observations	31	69
Mean	-0.39	-0.72
Std deviation	1.08	0.34
t test	-1.99**	-17.81***
Median	-0.69	-0.83
Wilcoxon test	-3.61***	-6.77***
Proportion <0	90%	94%

***,**,* Denotes statistical significance at the 1%, 5% and 10% levels of significance respectively

TABLE 5: Summary of Univariate Unit Root tests

This table displays the number of times that the test supported an I(1) variable using a 5% (10%) level of significance. ADF is the augmented Dickey Fuller test, KPSS is the test of Kwiatkowski, Phillips, Schmidt and Shin. SIC and AIC are the Akaike and Schwarz information criteria respectively. The bandwidths for the KPSS test were determined using the method of Newey-West and Andrews. See Eviews v5.0 for details.

	Lag length/ Band-width	CFD Spread	Stock Spread	Stock value	Price Inverse	Stock Volatility	CFD Volume
ADF	SIC	18 (15)	32 (27)	3 (1)	39 (37)	4 (3)	0 (0)
	AIC	27 (23)	41 (37)	9 (7)	40 (38)	18 (17)	7 (5)
KPSS	N-West	40 (44)	44 (45)	27 (34)	38 (40)	43 (45)	28 (29)
	Andrews	32 (42)	37 (44)	24 (35)	12 (33)	45 (46)	29 (30)

TABLE 6: Cross-sectional dependence

Residual is the OLS residual from Equation 4. $\overline{\rho}_{ij}$ denotes the average cross section correlation, $\%V_p$ denotes the proportion of variability explained by the pth principal component (p = 1,2) from the relevant correlation matrix.

	CFD Spread	Stock Spread	Stock Value	Price inverse	Stock Volatility	CFD volume	OLS Residual
$\overline{\rho}_{ij}$	0.47	0.50	0.35	0.50	0.34	0.07	0.19
$\%V_1$	0.52	0.50	0.36	0.60	0.35	0.11	0.27
$\%V_2$	0.10	0.12	0.06	0.17	0.05	0.05	0.13

TABLE 7: Estimation Results – Coefficients and t values

Each of the five estimation methods are robust when the data exhibits non-stationarity (in the variables and the residuals) and cross-sectional dependence. The pooled OLS method pools the data (forming 11,248 daily observations) and estimates one regression via OLS. The Cross section method calculates for each of the N=46 assets, the average value over time for each variable. This creates 46 observations and facilitates the estimation of one regression via OLS. The two way fixed effects estimator is a panel estimator that allows the intercept terms to differ by unit and time. The reported constant is an average intercept with the fixed effects coefficients (not reported) representing deviations from the mean. The mean group (MG) estimator estimates equation 4 separately for each of the N=46 assets. The reported coefficients represent the average. The CCMG estimator adds the cross section averages of stock spread, stock trading value, price inverse, stock volatility and CFD volume to equation 4. The new equation is then separately estimated for each of the N=46 assets. The reported coefficients represent the average across each of the regressions.

***, **, * denotes significance at the 1%, 5% and 10% levels respectively. n.a denotes not applicable, this is due to the nature of the estimator. For further details see the Appendix. Newey-West standard errors are employed.

Method	Constant	Stock Spread	Stock trading value	Price inverse	Stock Volatility	Market Volatility	CFD volume	Interest spread	Sept dummy
Pooled OLS	-0.313* (-1.81)	2.094*** (17.86)	-0.002 (-0.23)	14.350*** (22.13)	3.376*** (9.83)	6.495*** (10.01)	-0.008*** (-4.27)	0.006*** (9.51)	1.755*** (19.41)
Cross section	1.015 (1.10)	0.439 (0.47)	-0.043 (-0.92)	20.518*** (4.05)	5.431** (2.30)	n.a	-0.029** (-2.07)	n.a	n.a
Two way FE	-0.621** (-2.04)	2.947*** (18.42)	0.026 (1.53)	15.732*** (23.19)	1.976*** (5.04)	n.a	-0.007*** (-3.24)	n.a	n.a
Mean Group	-0.451** (-2.00)	1.857*** (6.29)	0.003 (0.21)	20.241*** (2.78)	2.059*** (4.09)	6.624*** (5.91)	-0.009*** (-2.85)	0.007*** (3.02)	1.581*** (7.43)
CCMG	-0.147 (-0.39)	1.594*** (4.99)	0.008 (0.59)	28.106*** (2.48)	1.453*** (3.12)	0.488 (0.56)	-0.006** (-1.86)	3.5e-04 (0.39)	0.039 (0.10)

Cross sectional sensitivity – Coefficients and t values

Stock spread and price are highly correlated in the cross-sectional regression (coefficient of 0.96). As a consequence the above table examines the regression results when either the spread or the price were removed. The results are consistent with the high levels of correlation between these two variables. Newey-West standard errors are employed.

Method	Constant	Stock Spread	Stock value	Price inverse	Stock Volatility	Market Volatility	CFD volume	Sept dummy
Cross section	-1.240 (-1.591)	3.543*** (8.855)	0.065 (1.451)	-	7.142*** (2.752)	n.a	-0.031** (-2.193)	n.a
Cross section	1.325** (2.374)	-	-0.057* (-1.716)	23.152*** (11.033)	5.387** (2.336)	n.a	-0.030** (-2.204)	n.a

TABLE 8: The relation between spreads in the CFD market and those in the underlying stock: Subsample Analysis

This table shows the results of running a Pooled OLS regression for equation (4):

$$CFDS_{i,t} = \beta_0 + \underset{+}{\beta_1} SS_{it} + \underset{-}{\beta_2} \ln\left(M_{i,t}\right) + \underset{+}{\beta_3} \left(1/P_{i,t}\right) + \underset{+}{\beta_4} \sigma_{s,t} + \underset{+}{\beta_5} \sigma_{m,t} + \underset{-}{\beta_6} \ln\left(1+V_{i,t}\right) + \underset{+}{\beta_7} IS_t + \underset{+}{\beta_8} D_t$$

where the subscripts *i* and *t* refer to contract *i* and time *t* respectively, and the signs under the coefficients reflect their expected signs. CFDS (SS) is the percentage spread of the CFD (the corresponding stock) at time t, M is the dollar value of the day's trades in the stock, P is end of day stock price (the settlement price for the CFD), $\sigma_{s,t}$ ($\sigma_{m,t}$) is stock (market) volatility (measured as the natural logarithm of the ratio of high over low price for the day), V is the daily dollar volume of trading in the CFD, IS_t is an interest rate spread – the 30day bank bill rate minus the 30 day OIS and D_t is a dummy variable equal to unity on September 22 and 23, otherwise zero.

Period	Constant	Stock Spread	Stock value	Price inverse	Stock Volatility	Market Volatility	CFD volume	Interest spread	Sept dummy
Full	-0.313*	2.094***	-0.002	14.350***	3.376***	6.495***	-0.008***	0.006***	1.755***
	(-1.81)	(17.86)	(-0.23)	(22.13)	(9.83)	(10.01)	(-4.27)	(9.51)	(19.41)
	Adj R square	0.423	F statistic (p value)	1021.06 (0.000)					
2.1.08 19.9.08	0.351***	0.902***	-0.015***	16.434***	1.891***	1.794***	-0.010***	0.002***	n.a
	(5.51)	(12.10)	(-4.39)	(28.05)	(12.09)	(6.51)	(-13.88)	(6.38)	
	Adj R square	0.690	F statistic (p value)	2529.48 (0.000)					
22.9.08 31.12.08	-1.623***	3.850***	0.070**	10.841***	2.522***	9.281***	-0.008	-0.002	1.856***
	(-2.76)	(12.79)	(2.18)	(8.59)	(2.90)	(4.53)	(-1.12)	(-1.00)	(11.50)
	Adj R square	0.337	F statistic (p value)	199.73 (0.000)					
t test of difference in coefficient estimates#		-543.6***	-	238.87***	-40.56***	-204.80***	-	-	-

The t test is a test of the difference in the means of two independent populations having unequal variances. The t test compares the estimates from the two sub-samples. The critical values for the two tailed test at a 5% level of significance are -1.96 and 1.96.

***, **, * denotes significance at the 1%, 5% and 10% levels respectively.

TABLE 9: CFD price boundary violations

CFD	No of violations (% of sample)	No of negative violations (% of sample)	W-W runs test (p value)	Descriptive statistics of % difference between CFD and subsequent spot price for cases of violations: Avg (t test)	Median (Wilcoxon test)	Std dev	Min	Max	Time between CFD and subsequent spot price (minutes): Avg	Median
Panel A: Transaction costs +/- 1%										
All	405 (0.68%)	224 (0.38%)		-0.33% (-1.73)*	-1.04% (-2.53)**	3.84%	-31.30%	29.70%	0.159	0.010
BHP	14 (0.18%)	13 (0.17%)	0.000***	-2.43% (-3.96)***	-1.63% (-3.04)***	2.21%	-7.44%	1.02%	0.026	0.019
TLS	3 (1.01%)	1 (0.34%)	0.000***	0.43% (0.54%)	1.08% (0.53%)	1.13%	-1.15%	1.37%	0.012	0.007
FXJ	6 (7.69%)	5 (6.41%)	0.341	-0.98% (-2.28)**	-1.15% (-1.99)**	0.96%	-2.13%	1.02%	0.065	0.012
QBE	6 (0.42%)	3 (0.21%)	0.021**	0.11% (0.07)	-0.57% (0.10)	3.31%	-4.18%	5.22%	0.041	0.012
CSL	2 (0.18%)	0 (0%)	0.002***	1.63% (53.88)***	1.63% (1.34)	0.03%	1.60%	1.68%	0.001	0.001
CSR	11 (9.24%)	7 (5.88%)	0.001***	0.29% (0.36)	-1.09% (-0.27)	2.49%	-1.97%	7.02%	0.073	0.036
Panel B: Transaction costs +/- 0.5%										
All	1757 (2.97%)	931 (1.57%)		-0.10% (-2.13)**	-0.51% (-2.41)**	1.94%	-31.30%	29.70%	0.164	0.014
BHP	29 (0.37%)	24 (0.31%)	0.000***	-1.30% (-3.57)***	-0.66% (-3.34)***	1.93%	-7.44%	1.02%	0.039	0.020
TLS	14 (4.71%)	7 (2.35%)	0.018**	0.08% (0.35)	-0.01% (0.28)	0.82%	-1.15%	1.37%	0.022	0.009
FXJ	38 (48.72%)	19 (24.36%)	0.000***	-0.12% (-0.91)	-0.03% (-1.56)	0.82%	-2.13%	1.02%	0.213	0.040
QBE	23 (1.60%)	10 (0.70%)	0.005***	0.15% (0.41)	0.56% (1.06)	1.78%	-4.18%	5.22%	0.112	0.017
CSL	10 (0.93%)	1 (0.09%)	0.003***	0.71% (3.69)***	0.60% (2.70)***	0.58%	-0.52%	1.68%	0.095	0.016
CSR	43 (36.13%)	22 (18.49%)	0.030**	0.07% (0.33)	-0.51% (-1.00)	1.40%	-1.97%	7.02%	0.108	0.021

***,**,*, Denotes statistical significance at the 1%, 5% and 10% levels of significance respectively. The t test (Wilcoxon test) was employed to test whether the mean (median) was significantly different from zero.

W-W runs test – denotes the Wald-Wolfowitz runs test for randomness. A statistically significant result indicates that there are clusters of violations which are not caused by random fluctuation.

TABLE 10: Pricing errors regressions – coefficients and t values

CFD	α	β_1	β_2	β_3	β_4	β_5	Adj R squared	F stat (p value)
BHP	1.362***	-0.142	0.921***	-3.4e-05	-1.5e-04	0.285***	0.802	4538.17***
	(20.83)	(-1.61)	(4.67)	(-1.62)	(-1.00)	(9.02)		(0.000)
TLS	0.919***	-0.187*	0.122	-7.5e-06**	-1.2e-05	0.196**	0.046	3.847***
	(8.35)	(-1.67)	(0.91)	(-2.17)	(-0.46)	(2.06)		(0.002)
FXJ	1.149***	-0.214	0.061	-4.1e-05*	-3.7e-06	0.280**	0.061	1.99*
	(4.71)	(-1.64)	(0.18)	(-1.98)	(-0.07)	(2.17)		(0.090)
QBE	2.502***	0.548	2.383***	-4.2e-05	-0.001	0.039	0.639	362.92***
	(17.21)	(1.44)	(4.39)	(-0.90)	(-1.56)	(1.35)		(0.000)
CSL	3.120***	-0.636	2.916**	0.001	-0.004**	0.132***	0.315	84.35***
	(14.90)	(-1.60)	(4.26)	(1.15)	(-2.54)	(4.41)		(0.000)
CSR	1.065***	0.147	0.473**	2.1e-05	-3.6e-05	0.024	0.877	139.82***
	(13.17)	(0.59)	(2.57)	(1.07)	(-1.21)	(0.95)		(0.000)

Table reports the results from the following regression

$$|e_t| = \alpha + \beta_1 D_{start,t} + \beta_2 D_{sept,t} + \beta_3 Vol_t + \beta_4 D_{sept,t} Vol_t + \beta_5 |e_{t-1}| + \varepsilon_t$$

where $e_t = (CFD_t - S_t) \times 100$ (i.e the mispricing error is measured in cents), $D_{start,t} = 1$ if the observation is in the first month of the sample, otherwise zero, $D_{sept,t} = 1$ for dates after and including September 22, 2008, otherwise zero. ***,**,* Denotes statistical significance at the 1%, 5% and 10% levels of significance respectively. Newey-West HAC standard errors are employed.

TABLE 11: Boundary violation regressions – coefficients and t values

Transaction costs	λ_0	λ_1	Adj R squared	F statistic (p value)
1%	0.031***	-0.002***	0.136	7.76***
	(5.60)	(-3.35)		(0.008)
0.5%	0.155***	-0.008***	0.200	10.74***
	(5.67)	(-3.53)		(0.002)

The following regression is estimated via OLS with Newey West standard errors

$$V_i = \lambda_0 + \lambda_1 Trade_i + \varepsilon_i$$

where V_i is the percentage of mispricing for the CFD of stock *i*, and $Trade_i$ is the average number of trades per day for the CFD of stock *i*.

*** Denotes statistical significance at the 1% level of significance.

FIGURE 1: Distribution of Mean CFD Trades per Day by Company: November 5, 2007 – December 31, 2008

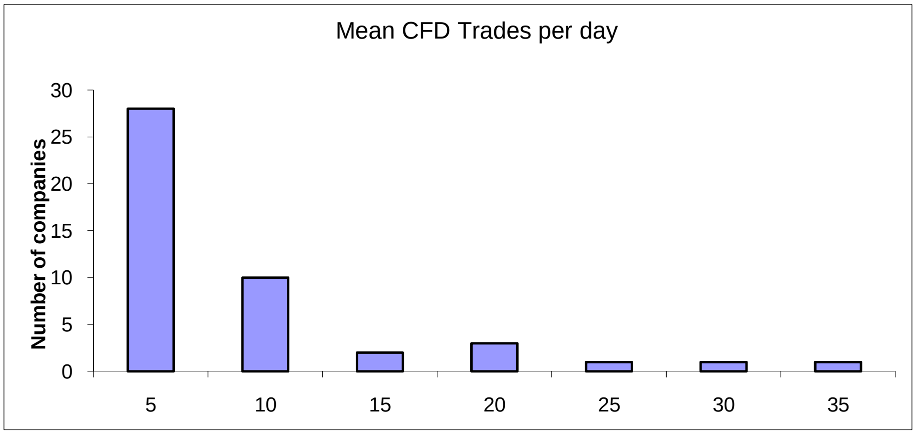


FIGURE 2

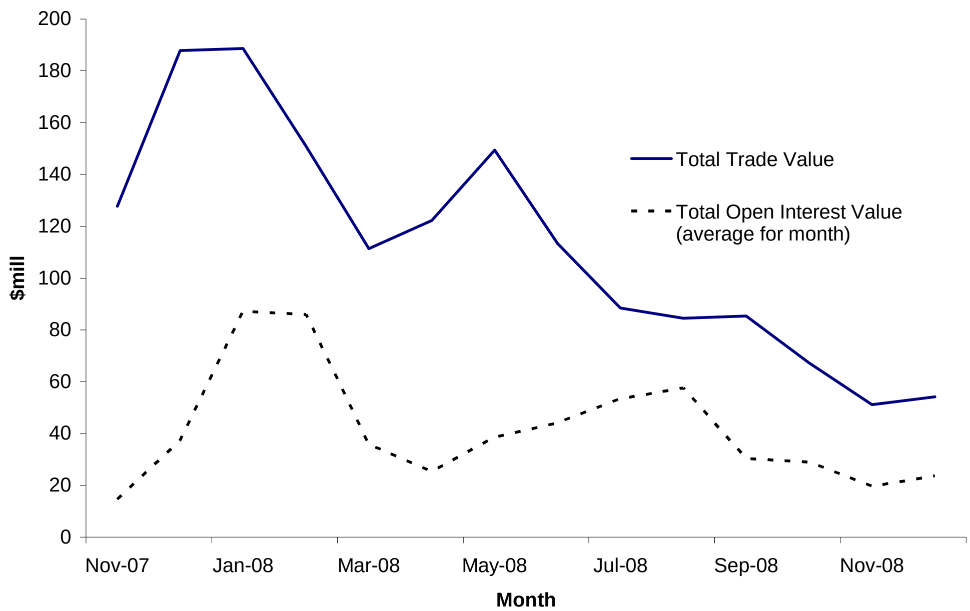


FIGURE 3: Distribution of percentage spreads for stocks and CFDs across companies.

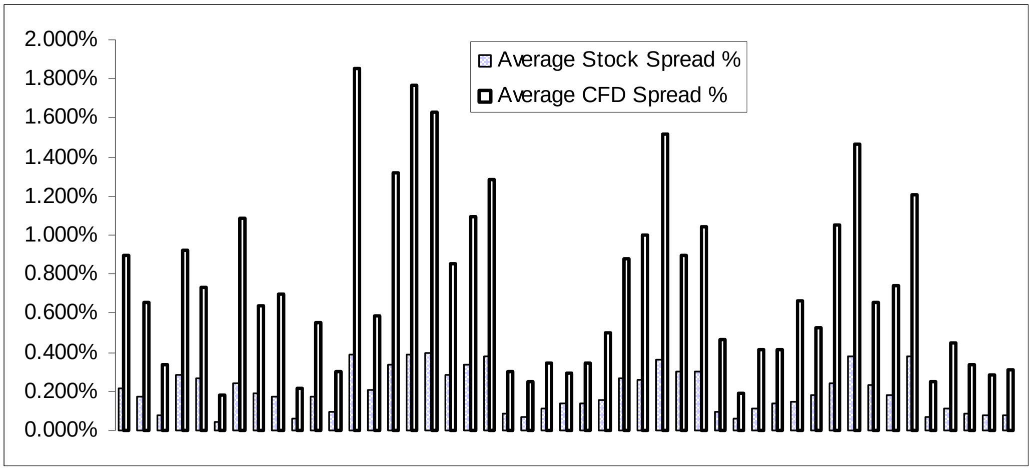


FIGURE 4: Average percentage spreads for stocks and CFDs across time

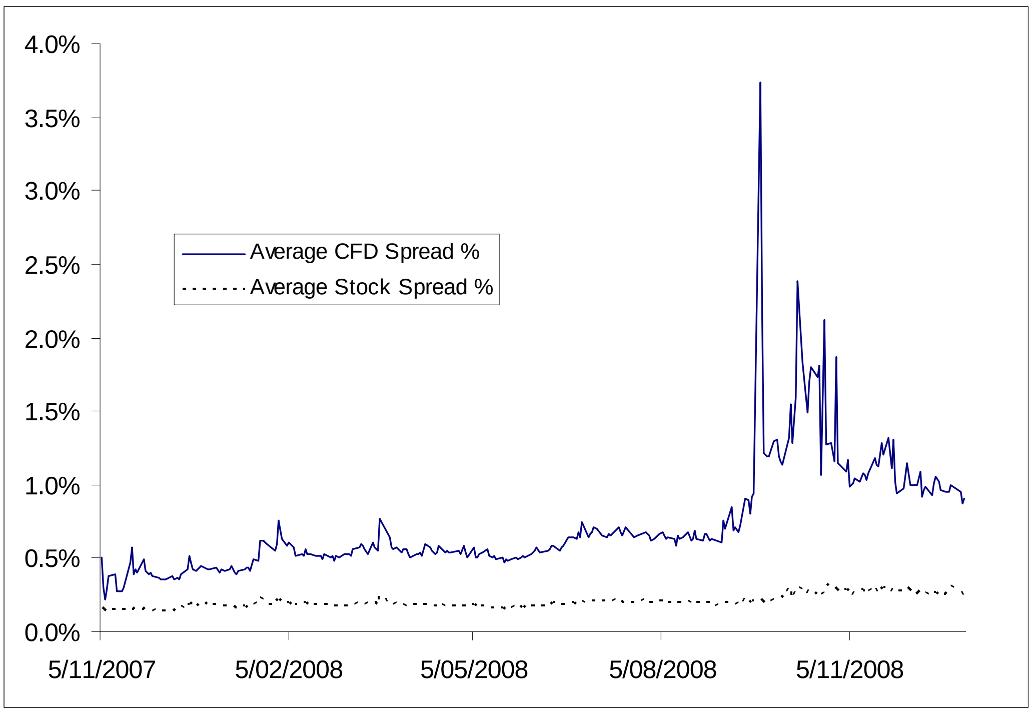


FIGURE 5: CFD Spreads (%) for selected stocks

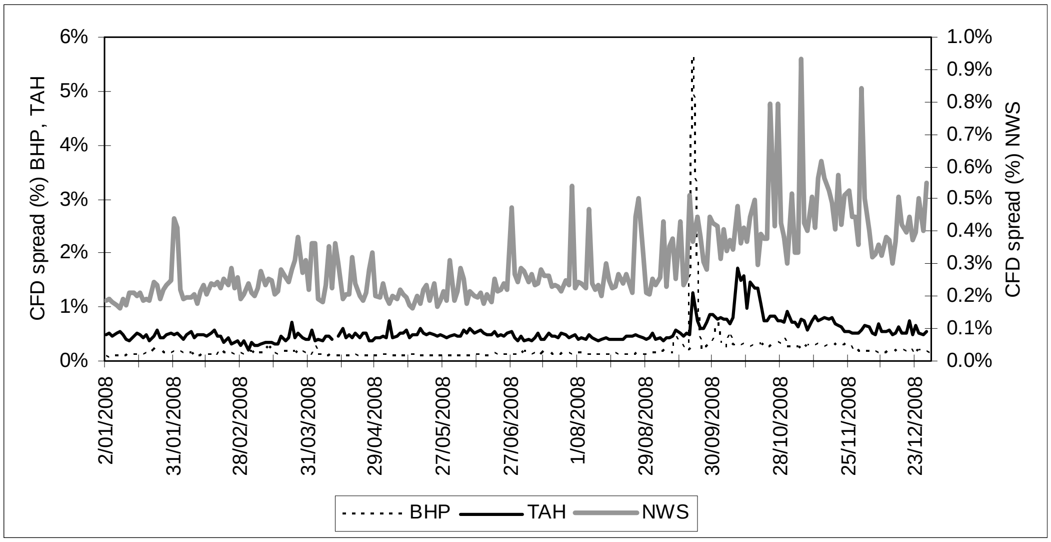
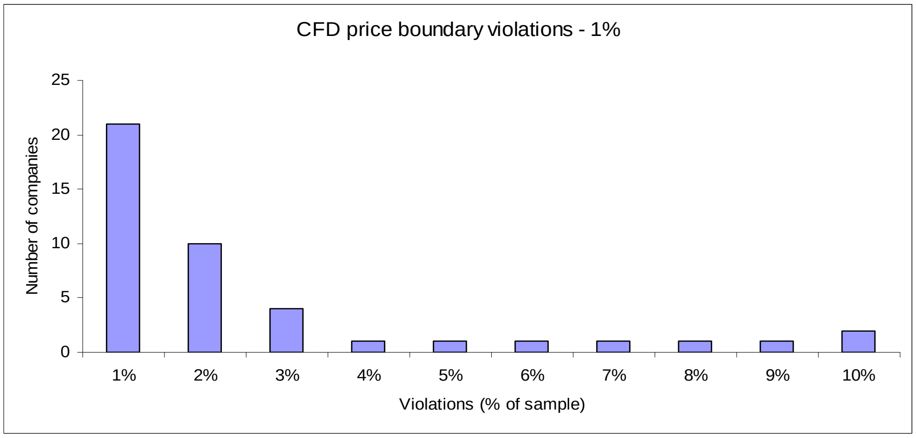
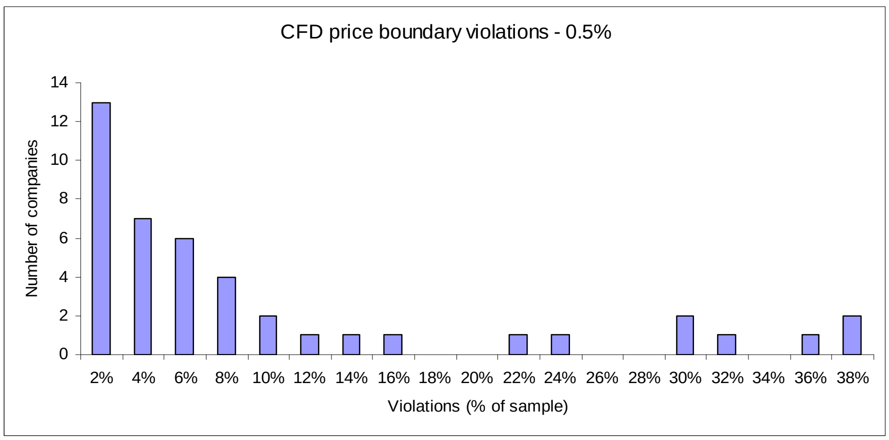


FIGURE 6: Distribution of the price boundary violations by company

a) Transaction costs of 1%



b) Transaction costs of 0.5%



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