

# Chapter 1

## Introduction

In the absence of a derivatives market, investors would have only one trading location to alter portfolio positions when they acquire new information that is expected to influence asset values—the cash market. There are costs involved in altering exposure to assets such as money market and fixed-income securities or stock index portfolios. The costs include explicit costs in the form of broker commissions and implicit costs in the form of bid-ask spreads and market impact costs. The futures market provides an alternative location that investors can use to alter their risk exposure to an asset when new information is acquired. Investors will be inclined to transact through the futures market if they are convinced it is a more efficient mechanism than the cash market for achieving the same investment objective. The factors they consider are liquidity, transaction costs, taxes and the leverage advantages of futures contracts.

The market that investors consider to be the most efficient to use to achieve their investment objective will be the market where prices will be established to reflect new economic information. That is, price discovery will occur in the market that offers investors the opportunity to trade at the least cost (see Fleming, Ostdiek and Whaley, 1996). Price information is then transmitted to the other market through the process of arbitrage. If the futures price deviates from the cash market price by more than the opportunity cost and transaction costs involved in buying or selling the physical asset and holding it through the relevant time period, arbitrageurs pursue a strategy to bring them back into line (Kumar and Seppi, 1994; Neal, 1996). This mechanism ensures that the two markets are informationally linked; the cash market price reflects the information impounded in the futures market and the futures price reflects the information impounded in the cash market.

Arbitrage arguments can be used to determine the theoretical futures price according to the cost-of-carry model (Cornell and French, 1983). In the case of a stock index futures contract, information is needed about the value of the cash market index, the dividend yield on the basket stocks in the index that would be earned up to the maturity date and the cost of financing a position until the maturity date. The theoretical futures price that will prevent arbitrage profits can be shown to be equal to:

$$\text{Futures price} = \text{Cash market price} + \text{Financing cost} - \text{Dividend yield}$$

where the “Financing cost” is the cost of financing a position until the maturity date of the futures contract and “Dividend yield” is the dividends over the same period.

Several assumptions must be made to derive the theoretical futures price using the arbitrage argument. Whenever these assumptions are violated, discrepancies can arise between the actual futures price and the theoretical futures price. Six assumptions unique to stock index futures highlighted by Fabozzi and Modigliani (2003: 312) are:

1. The interest rate at which the interim dividend payments can be reinvested until the maturity date is known in advance.
2. The dividend amounts and the pattern of dividend payments for all the stocks in the index up to the maturity date of the futures contract are known.
3. For the arbitrage to work when the futures price is below its theoretical value, the investor must be able to use the proceeds from selling the cash index short.
4. In the case of a short sale of the stocks in the index, all stocks must be sold simultaneously.
5. Another difficulty in arbitraging the cash and futures market is that it is too expensive to buy or sell every stock in the index. Instead, a portfolio containing a smaller number of stocks may be constructed to ‘track’ the index.
6. The basic arbitrage model ignores not only taxes but also the differences between the tax treatment of cash market transactions and futures transactions.

This dissertation begins by examining the empirical implications of the cost-of-carry valuation model for Australian stock index futures. The first of three studies develops and estimates the parameters for a tax-adjusted cost-of-carry model where different marginal tax rates apply to interest and dividends versus capital gains on stocks and investors receive imputation tax credits accompanying cash dividends. The second study examines the mispricing of stock index futures and measures the impact of unexpected information arrival together with specific risks and transaction costs faced by arbitrageurs acting to narrow price discrepancies between the cash and futures markets. After evaluating the effectiveness of the information transmission mechanism

between the cash and futures markets, this dissertation turns to examine the importance of informed trading in determining interest rate and stock index futures prices. The third study investigates the extent to which the direction of trade initiation and trade size influence price discovery in futures markets.

The first study for this dissertation develops a tax-adjusted cost-of-carry model for Australian stock index futures and estimates the value of the debt tax shield, cash dividends and imputation tax credits flowing from the basket stocks in the index. The study adapts and extends the framework developed by Cannavan, Finn and Gray (2004) to infer the value of cash dividends and imputation tax credits using the prices of Australian individual share futures (ISFs) and low exercise price options (LEPOs). Revised arbitrage arguments are used to demonstrate that the value that investors place on the debt tax shield for the financing of the set of shares of the underlying index and on the cash dividends and imputation credits flowing from the index are reflected in the prices of the futures relative to the underlying index values. In addition to the dividend components, the debt tax shield is shown to be a significant factor in the pricing of the futures contract. Empirical estimates are provided after important changes to the income tax regime including a reduction in capital gains tax from July 1999 and the introduction of rebates for unused franking credits from July 2000. Moreover, the estimates derived using index futures prices are for a broad-based market portfolio that is more directly relevant to index fund managers.

Estimates of the value of cash dividends and imputation tax credits derived from the prices of stock index futures provide a useful alternative to similar estimates from studies that analyse the ex-dividend behaviour of share prices (such as Beggs and Skeels, 2006). The most common analytical approach is to draw inferences about the relative value of dividends and capital gains from the ex-dividend share price drop-off, which is conventionally defined as the ratio of the price change at the ex-dividend date to the dividend amount. Several methodological and econometric problems are associated with the standard dividend drop-off approach including the noise in share prices on ex-dividend days that inflates the standard error of the estimates even for large samples and the implicit assumption that the capitalised value of the dividends is independent of the degree of franking (Cannavan, Finn and Gray, 2004). An advantage of the alternative approach used in this dissertation is that there are many more observations available. Every futures trade provides another observation, whereas the dividend drop-off methodology generates only a single observation per dividend event.

The second study for this dissertation examines the price linkage between Australian stock index futures and the portfolio of shares in the underlying index. It is generally accepted that this linkage is maintained by arbitrageurs (see MacKinlay and Ramaswamy, 1988). The purpose of this study is to extend Brailsford and Hodgson's (1997) analysis of stock index futures pricing based on the former Australian All Ordinaries Share Price Index contract. The study analyses the pricing efficiency of SFE SPI 200™ Index futures that were introduced in May 2000 and are currently the most actively traded equity derivative in Australia. With the introduction of the new contract, the underlying index changed from a base of approximately 320 of the largest stocks to the 200 largest stocks traded on the Australian Stock Exchange. Mispricing is expected to be lower for the new contract due to more active trading in the constituent stocks (Butterworth and Holmes, 2000). The analysis is extended to incorporate the impact of unexpected volume in the underlying stocks, in addition to price volatility and unexpected volume in the futures market. The additional variable has not been widely analysed elsewhere and is included in the belief that spot market trading volume has an impact on the pricing efficiency of index futures.

Further expanding upon previous research, the analysis controls for specific risks and transaction costs faced by arbitrageurs acting to exploit price discrepancies between the spot and futures markets (according to the cost-of-carry model). Prior research documents greater absolute magnitudes of mispricing for longer times to maturity (MacKinlay and Ramaswamy, 1988; Yadav and Pope, 1990; 1994). Risks involved in executing arbitrage strategies, specifically interest rate volatility and dividend yield uncertainty, are included to resolve which of these risks deter arbitrageurs from driving prices towards theoretical levels further out from maturity. The existence of transaction costs implies that the price of the index futures can fluctuate within a band around its theoretical value without representing a profit opportunity for even the most favourably situated arbitrageurs (Modest and Sundaresan, 1983). The influence of intraday variations in transaction costs represented by bid-ask spreads in the spot and futures markets and securities borrowing are estimated whereas previous mispricing studies have relied upon constant total transaction costs for different classes of investors (for example Chung, 1991). These extensions enable a more comprehensive examination of stock index futures pricing incorporating unexpected information arrival in conjunction with the relative efficiency of the arbitrage mechanism that transmits information between the spot and futures markets.

The third study for this dissertation assesses the market impact of large futures trades and the speed of adjustment in the limit order book surrounding large-trade execution. In the microstructure literature in this area, futures markets have received considerably less attention than equity markets, despite the vital role they play in risk transfer and price discovery in global financial markets (Grossman and Miller, 1988). Previous work based on futures markets has concentrated on stock index futures. For example, Berkman, Brailsford and Frino (2005) examine the impact of different trade sizes using a small sample of two expiration cycles in the one year for the FTSE 100 stock index futures contract. They find only a small permanent price impact associated with trades in index futures, implying that trades in stock index futures are primarily liquidity motivated and carry little information. Their results are surprising given the inherent leverage and lower transaction costs of futures are likely to attract informed traders (Fleming, Ostdiek and Whaley, 1996). Even more surprising, they find no statistically significant relationship between permanent price effects and trade size. Further evidence is provided regarding the information signal conveyed by large trades using an extensive sample of twenty-eight expiration cycles spanning seven years for a suite of interest rate and equity index futures contracts that differ with respect to their risk profiles and baseline liquidity levels.

The analysis tests whether liquidity effects are significantly associated with information content as measured by trade size. Information asymmetry in futures markets, where investors trade to resolve differential private views on market-wide information, is likely to be fundamentally different in nature to information asymmetry in equity markets, where investors trade to exploit stock-specific information (Chan, 1992; Frino, Walter and West, 2000). In futures markets, information advantages are derived from superior information processing skills rather than from leakages of private information. Therefore, the liquidity supply response to large trades is analysed to determine whether liquidity providers in futures markets make the same strategic choices to those in equity markets. Specialists and other liquidity providers in equity markets have been shown to actively manage adverse selection risk by adjusting both bid-ask spreads and depth (Koski and Michaely, 2000). Furthermore, the systematic component of adverse selection that remains for contracts such as stock index futures written over a basket of securities, where the individual equity-specific component of adverse selection tends to be diversified away, is revealed (Subrahmanyam, 1991; Gorton and Pennacchi, 1993).

Research on how order-driven financial markets provide liquidity when large trades arrive is often confined to bid-ask spreads (for example Hasbrouck, 1991), with inadequate attention given to the inevitable disruptions to the supply of liquidity that sustains the continued ability to trade. The replenishment process for market depth, in particular, reflects how quickly the adverse selection problem dissipates after large block trades at the same time that there is a surge in demand to trade on the information contained in the block itself. An electronic limit order book operated without the presence of designated market-makers for the Australian futures market provides an ideal setting to explore these issues and widen the assessment of the liquidity response to include quoted depth. The absence of designated market-makers removes a market entry barrier that could otherwise sustain agency market power and influence patterns in liquidity provision and trading activity around large trades (Tse, 1999).<sup>1</sup> The electronic limit order book facilitates a study based on data that is captured online in real time and where all bids and offers are revealed to other traders through a continuous auction system of trading. Comparable data for other futures markets such as those operating in the United States are not available.

At a practical level, the evidence presented in this dissertation demonstrates how futures markets form prices and provide liquidity in response to large trades. An assessment of the market impact indicates how traders' wealth is affected by large trades and clarifies the cost of trading large blocks. The time taken for liquidity to return to normal levels provides a benchmark for expected market effects beyond price changes in the wake of large market orders striking the order book (equivalent to the benchmark provided by Moulton, 1998 for large trades on the NYSE). This benchmark is beneficial to investment managers and brokers as they contemplate the timing of trade execution after a large trade. It also provides a guide to futures exchanges, regulators and policy makers as they evaluate the effects of large individual trades on the continued ability to trade.

Even so, the results do not measure the cost of immediacy against the timing and opportunity costs of waiting to execute a specific institutional order. The search for liquidity may be an elaborate process. A trader can use agents to disguise her identity or

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<sup>1</sup> Many futures markets rely on the presence of locals, who trade as principals on their own accounts and act as 'voluntary market makers' in the sense that they provide liquidity to incoming market orders. Unlike the specialists at the New York Stock Exchange (NYSE) or the dealers at the National Association of Securities Dealers Automated Quotations (NASDAQ), locals have no obligation to recurrently bid or offer.

'probe trades' to assess the market's inventory and possible reaction. Most orders are broken up and worked in more easily digested pieces (Wagner and Edwards, 1993). Informed traders may attempt to trade when others are trading (Choe, McInish and Wood, 1995). The results simply indicate the average price and liquidity effects associated with large individual trades given traders' actual behaviour.

In summary, this dissertation develops a tax-adjusted cost-of-carry model for Australian stock index futures by relaxing the assumption in previous research that investors face the same marginal tax rate on dividend income, income from futures trading and short-term capital gains on stocks. The tax-adjusted cost-of-carry model is then applied to evaluate the effectiveness of the information transmission mechanism between the cash and futures markets. Previous research in this area is extended to incorporate the impact of unexpected trading volume in the cash market together with specific risks and transaction costs faced by arbitrageurs. Finally, analyses are undertaken of the price and liquidity impact of large trades in futures markets and to extend the assessment of the liquidity response to include market depth.

The remainder of this dissertation is organised as follows. Chapter 2 reviews the literature relating to the effect of taxes on stock index futures prices, the efficiency of the arbitrage mechanism for transmitting information between the cash and futures markets and the response of the futures market to the information contained in large trades. Gaps in the previous research to be addressed in this dissertation are identified. Foundations for the empirical research including the institutional setting, data sources and methodology for each study and the results of the three studies are presented in chapters 3, 4 and 5. Chapter 6 summarises the main conclusions and discusses the implications of the research.