

Copyright is owned by the Author of the thesis. Permission is given for a copy to be downloaded by an individual for the purpose of research and private study only. The thesis may not be reproduced elsewhere without the permission of the Author.

A Market Microstructure Examination of Australian
Treasury Bond Futures Overnight Options

by

Liping Zou

A Dissertation Submitted in Fulfilment of the Requirements for
the Degree of Doctor of Philosophy

Massey University

2004

To my parents

&

My dear husband Max and daughter Rosie

This dissertation is completed with their love and encouragement

ACKNOWLEDGEMENTS

There are so many people to whom I am indebted for encouragement and assistance during the process of completing this dissertation. I would like to express my sincere appreciation to my supervisors, Professor Lawrence C. Rose and Associate Professor John F. Pinfold; their great guidance, support and patience are reasons for the completion of this dissertation.

I would also like to acknowledge statistical advice from Associate Professor Denny Meyer and Dr. Xiaoming Li. Special thanks are due to Professor Henk Berkman and Associate Professor Martin Young for their constructive comments. I also wish to thank Associate Professor Christine Brown for insightful comments on a conference paper containing early material from the dissertation.

ABSTRACT

The creation of the Black-Scholes-Merton options pricing model and its publication in 1973, expanded risk management financial research and practice. Concurrently, there have been many assets created in the derivative markets. In line with this, the introduction of Australian Treasury-Bond futures overnight options at the Sydney Futures Exchange (SFE) during 1993 offers a unique opportunity to examine trading behavior with a different market microstructure. This dissertation is the first study of its kind to investigate the market microstructure of the SFE overnight options market. This work explores market microstructure aspects of Australian Treasury Bond futures overnight options regarding market liquidity, transaction costs, market order flows, information asymmetry, and market volatility.

We first present an institutional overview of the Sydney Futures Exchange (SFE) and discussions about products traded at the SFE. This builds the foundation for the following empirical studies. Next, we examine trading behaviours of 3-Year and 10-Year T-Bond futures overnight options by looking at intra-night bid-ask spreads, trading volume, and volatility patterns. We observe different intra-night bid-ask spreads, trading volume, and volatility patterns compared to stocks and long dated options. Third, the impact of overnight options introduction on the underlying 3-Year and 10-Year T-Bond futures market is examined. Results indicate that the introduction of overnight options has influence on the underlying 3-Year and 10-Year T-Bond futures. Fourth, we examine information shocks on the underlying futures return volatility and present optimal time-varying models to estimate and forecast the underlying futures return volatility. The analysis undertaken allows us to recommend the most appropriate models for predicting return volatility for the underlying futures market, and hence presents a key element in the puzzle of how best to price these innovative products. Finally, implied, forecasted, and realized volatility are examined to determine information content of implied volatility when predicting future volatility. This information may be useful to traders wishing to accurately price overnight options.

Table of Content

Chapter 1 Introduction	1
Chapter 2 The Sydney Futures Exchange (SFE): An Introductory Overview	8
1. Introduction	8
2. Overview of the SFE	10
2.1 Historical Perspective	10
2.2 Institutional Structure	12
3. Floor Trading Versus SYCOM Trading	13
3.1 SFE Floor Trading	13
3.2 Participants of the Trading Floor	15
3.3 Floor Trade Execution	16
3.4 SYCOM Trading	17
3.5 SYCOM Trading Hours	17
3.6 SYCOM Trading Volume	18
3.7 SYCOM Technical Specifications	19
3.8 SYCOM Trading Execution	20
3.8.1 Order Type	20
3.8.2 Procedures for Executing Orders on SYCOM	22
3.8.3 Other SYCOM Features	23
3.8.4 Summary of SYCOM Key Features	24
4. Products Traded at the SFE	25
4.1 Interest Rate Products	25
4.1.1 Australian and New Zealand 3-Year and 10-Year T-Bond Futures and Options	25
4.1.2 SFE's 90-Day Bank Bill Futures	26
4.1.3 NZFOE 90-Day Bank Bill Futures and Options	26
4.1.4 One-Session Options on Australian 3-Year and 10-Year TBond Futures	26
4.2 Equities	26
4.2.1 Index Futures and Options – SPI 200 TM and NZSE-10	26
4.2.2 Individual Share Futures	27
4.2.3 Equity Options	27
4.3 Currency	27
4.4 Commodities	27
4.4.1 Electricity	28
4.4.2 Wool	28
4.5 Trading Nominal Value and Trading Total Volume	28
5. Clearing and Settlement Procedures	29
5.1 Central Counter-Party (CCP) Clearing	30
5.2 Delivery Versus Payment (DVP)	31
5.3 Central Securities Depository (CSD) Services	31
5.4 Issuing and Paying Agency (IPA), Cash Transfer and Payments, Confirmations and Settlements	32
6. Financial Integrity of the SFE	33
7. Conclusion	34

Chapter 3 Interest Rate Products Traded at the Sydney Futures Exchange (SFE) 36

1. Introduction	36
2. The Underlying Market	38
3. Overview of the 3-Year and 10-Year T-Bond Futures	39
3.1 Price and Volume for 3-Year T-Bond Futures	40
3.2 Price and Volume for 10-Year T-Bond Futures	40
3.3 Average Daily Volume and Open Interest for 3-Year T-Bond Futures	41
3.4 Average Daily Volume and Open Interest for 10-Year T-Bond Futures	42
3.5 Yield Comparison	43
4. Overview of Overnight Options and Intra-Day Options	44
4.1 Trading Volumes for 3-Year and 10-Year T-Bond Futures Overnight Options	45
5. Contract Information	47
5.1 3-Year and 10-Year T-Bond Futures	47
5.1.1 Contract Specification	47
5.1.2 Valuation for 3-Year and 10-Year T-Bond Futures	47
5.2 Options on the 3-Year and 10-Year T-Bond Futures	47
5.2.1 Contract Specification	47
5.2.2 Valuation for 3-Year and 10-Year T-Bond Futures Options	48
5.3 One-Session Options on 3-Year and 10-Year T-Bond Futures	48
5.3.1 Contract Specification	48
5.3.2 Valuation for the One-Session Options	49
5.4 Tick Value Calculation	49
6. Conclusion	49

Chapter 4 Intra-Night Trading Behavior of the Australian Treasury-Bond Futures Overnight Options 51

1. Introduction	51
2. Literature Review	53
2.1 Patterns of Bid-Ask Spreads and Its Determinants	54
2.1.1 The Inventory Model	55
2.1.2 The Asymmetry Information Model	56
2.1.3 Differing Market Structure Theory	56
2.2 Patterns of Trading Volume	57
2.3 Patterns of Volatility	58
2.4 Impacts on Intra Day/Night Patterns with Macroeconomic News Releases	58
3. Data and Methodology	59
3.1 Data	59
3.1.1 Data Sample	59
3.1.2 Database Construction	59
3.2 Methodology	60
3.2.1 Calculation of standardized Relative Bid-Ask Spreads	60
3.2.2 Calculation of Time-Weighted Average Standardized Relative Bid-Ask Spreads	61
3.2.3 Calculation of Standardized Trading Volume	61
3.2.4 Calculation of Volatility	62
3.2.5 F-Statistics for Intra-Night Bid-Ask Spreads, Trading Volume, and Return Volatility Patterns	62
3.2.6 Impact of US Macroeconomic New Releases	63
4. Analysis	63
4.1 Trading Behavior of the 3-Year and 10-Year T-Bond Futures Overnight Options	64
4.2 Changes in Quoted Bid-Ask Spreads, Trading Volume and Trading Frequency	67
4.3 Intra-Night Trading Patterns	69
4.3.1 Intra-Night Bid-Ask Spreads Patterns	69

4.3.2 <i>Intra-Night Patterns of Trading Volume</i>	73
4.3.3 <i>Intra-Night Volatility Patterns</i>	78
4.4 <i>F-Statistics for Intra-Night Standardized Relative Bid-Ask Spreads, Standardized Trading Volume, and Standardized Return Volatility Patterns for Overnight Options</i>	82
4.5 <i>The Impact of US Macroeconomic News Releases on Intra-Night Patterns</i>	84
5. Conclusions	88
<i>Chapter 5 Influence of Overnight Options Introduction on Underlying Markets</i>	91
1. Introduction	91
2. Literature Review	93
2.1 <i>Theoretical Literature</i>	93
2.2 <i>Empirical Literature</i>	94
3. Data and Methodology	96
3.1 <i>Data</i>	96
3.2 <i>Methodology</i>	97
3.2.1 <i>Impacts on Liquidity</i>	98
3.2.2 <i>Impacts on Order Flows</i>	99
3.2.3 <i>Impacts on Volatility</i>	100
3.2.4 <i>Binomial Sign Test, Wilcoxon Signed Ranks Test and Van der Waerden (normal scores) Test</i>	100
3.2.5 <i>Variance of Pricing Error</i>	101
4. Analysis	103
4.1 <i>Liquidity Impacts</i>	103
4.2 <i>Order Flows Impacts</i>	106
4.3 <i>Volatility Impacts</i>	108
4.4 <i>Variance of the Pricing Error</i>	111
5. Conclusions	115
<i>Chapter 6 Information Shocks, Volatility Patterns and the Choice of an Optimal Time-Varying Model</i>	117
1. Introduction	117
2. Literature Review	119
2.1 <i>Linear Models</i>	119
2.2 <i>Non-Linear Models</i>	120
2.3 <i>News Impacts on Volatility</i>	123
2.4 <i>Forecasting</i>	124
3. Data and Methodology	125
3.1 <i>Data Sample</i>	125
3.2 <i>Methodology</i>	125
3.2.1 <i>Time-Weighted Daily Price</i>	125
3.2.2 <i>Linear GARCH Model</i>	126
3.2.3 <i>The GARCH-M Model</i>	128
3.2.4 <i>Exponential GARCH Model</i>	129
3.2.5 <i>The TARARCH Model</i>	130
3.2.6 <i>The News Impact Curve</i>	130
3.2.7 <i>Out-Of-Sample Forecasting</i>	132
4. Analysis	133
4.1 <i>Descriptive Statistics</i>	134
4.1.1 <i>Return Volatility Patterns for Australian T-Bond Futures</i>	134
4.1.2 <i>Descriptive Statistics</i>	135
4.2 <i>Model Estimation</i>	137
4.2.1 <i>GARCH Model Estimations</i>	138

4.2.1.1 Parameter Estimations for the 3-Year and 10-Year T-Bond Futures	138
4.2.1.2 Goodness-Of-Fit Statistics for the 3-Year and 10-Year T-Bond Futures	142
4.3 Out-of-Sample Forecasting	144
4.4 Plotting the Estimated News Impact Curve	147
5. Conclusions	151
<i>Chapter 7 Implied, Forecasted, and Realized Volatility of Overnight Options</i>	<i>153</i>
1. Introduction	153
2. Literature Review	154
3. Data and Methodology	158
3.1 Data Sample	158
3.2 Methodology	159
3.2.1 Implied Volatility	159
3.2.2 Realized Volatility from Trade Prices	160
3.2.3 Forecasted Volatility from GARCH Models	160
3.2.4 Estimation From ARIMA(p, d, q) Model	160
3.2.4.1 Autoregressive Model	161
3.2.4.2 Moving Average Model	161
3.2.4.3 Autoregressive Moving Average Model	161
3.2.4.4 Autoregressive Integrated Moving Average Model	162
3.2.5 The Relation Between Implied, Forecasted, and Realized Volatility	162
3.2.5.1 Regression Analysis	163
3.2.5.2 Alternative Regression Analysis	164
3.2.6 Putting It All Together	165
4. Analysis	165
4.1 Descriptive Statistics for Implied, Forecasted and Realized Volatility	166
4.1.1 3-Year T-Bond Futures and its Overnight Options	166
4.1.2 10-Year T-Bond Futures and its Overnight Options	167
4.2 Time Series Properties for T-Bond Futures and its Overnight Options	170
4.2.1 3-Year T-Bond Futures and its Overnight Options	170
4.2.2 10-Year T-Bond Futures Overnight Options	171
4.3 The Relation between Implied, Forecasted and Realized Volatility	178
4.3.1 Implied and Realized Volatility for 3-Year T-Bond Futures Overnight Options	178
4.3.2 Implied and Realized Volatility for 10-Year T-Bond Futures Overnight Options	181
4.3.3 Implied and Forecasted Volatility for 3-Year T-Bond Overnight Options	184
4.3.4 Implied and Forecasted Volatility for 10-Year T-Bond Overnight Options	185
4.4 An Alternative Specification of Implied and Realized Volatility	187
4.4.1 3-Year T-Bond Futures Overnight Options	188
4.4.2 10-Year T-Bond Futures Overnight Options	190
4.5 Implied, Forecasted and Realized Volatility: Putting It Together	190
5. Conclusions	196
<i>Chapter 8 Conclusions</i>	<i>198</i>
<i>Bibliography</i>	<i>208</i>
<i>Appendix 1 Chronological History of the SFE</i>	<i>220</i>
<i>Appendix 2 SYCOM Technical Specifications and Features</i>	<i>225</i>
<i>Appendix 3 Additional SYCOM Windows</i>	<i>227</i>
<i>Appendix 4 Contract Specifications</i>	<i>229</i>

Appendix 5 Tick Value Calculation

233

Appendix 6 Forecasting Statistics

234

Tables

Table 2.1	Ranking of Financial Futures and Options Exchanges	12
Table 2.2	Exchange Traded Volumes (Contracts)	12
Table 2.3	SYCOM Trading Hours and the Equivalent Times	18
Table 2.4	The Trader Book Window	23
Table 2.5	Regulatory Framework at the SFE	33
Table 4.1	Number of Quotes and Trades for 3-Year and 10-Year T-Bond Futures Overnight Options	64
Table 4.2	Mean and Median Relative Bid-Ask Spreads, Trading Volume, Trading Frequency Over Time	68
Table 4.3	F-Statistics for Standardized Intra-Night Bid-Ask Spreads, Trading Volume, and Volatility Patterns	85
Table 4.4	T-Test for Mean Spreads, Trading Volume, and Volatility With and Without US Macroeconomic News Releases	87
Table 5.1	Relative Bid-Ask Spread Ratios for 3-Year and 10-Year T-Bond Futures	106
Table 5.2	Trading Volume Ratios for 3-Year and 10-Year T-Bond Futures	108
Table 5.3	Volatility Ratios for 3-Year and 10-Year T-Bond Futures	111
Table 5.4	Coefficients of VAR for Pre and Post Introduction Period	113
Table 5.5	Coefficients of VAM for Pre and Post Introduction Period	114
Table 6.1	Descriptive Statistics for 3-Year and 10-Year T-Bond Futures	137
Table 6.2	Parameter Estimations for 3-Year and 10-Year T-Bond Futures	140
Table 6.3	Goodness-Of-Fit Statistics for 3-Year and 10-Year T-Bond Futures	144
Table 6.4	Out-of-Sample Forecasting for 3-Year and 10-Year T-Bond Futures	146
Table 7.1	Descriptive Statistics for 3-Year T-Bond Futures and its Overnight Options Volatility	168
Table 7.2	Descriptive Statistics for 10-Year T-Bond Futures and its Overnight Options Volatility	169
Table 7.3	ARIMA(p,d,q) Models for 3-Year T-Bond Futures and Its Overnight Options' Implied, Forecasted, and Realized Volatility	172
Table 7.4	ARIMA(p,d,q) Models for 10-Year T-Bond Futures and Its Overnight Options' Implied, Forecasted, and Realized Volatility	175

Table 7.5	The Relationship Between Implied and Realized Volatility for 3-Year T-Bond Futures Overnight Options	180
Table 7.6	The Relationship Between Implied and Realized Volatility for 10-Year T-Bond Futures Overnight Options	183
Table 7.7	The Relationship Between Implied and Forecasted Volatility for 3-Year T-Bond Futures Overnight Options	186
Table 7.8	The Relationship Between Implied and Forecasted Volatility for 10-Year T-Bond Futures Overnight Options	187
Table 7.9	Alternative Specification of Implied and Realized Volatility for 3-Year T-Bond Futures Overnight Options	189
Table 7.10	Alternative Specification of Implied and Realized Volatility for 10-Year T-Bond Futures Overnight Options	191
Table 7.11	Optimal Model for 3-Year T-Bond Futures Overnight Options Volatility	193
Table 7.12	Optimal Model for 10-Year T-Bond Futures Overnight Options Volatility	195

Figures

Figure 2.1	The SFE Corporate Structure	13
Figure 2.2	The Sydney Futures Exchange Trading Floor	15
Figure 2.3	Catwalk and Information Screens	16
Figure 2.4	The SYCOM Trading Volume to the Total SFE Volume	18
Figure 2.5	Access to SYCOM Trading Interface	19
Figure 2.6	Location of the Hubs	20
Figure 2.7	The SFE Nominal Value and Total Volume	29
Figure 2.8	Bilateral Trade Before and After Novation	30
Figure 3.1	Daily Price Range and Volume For 3-Year T-Bond Futures	40
Figure 3.2	Daily Price Range and Volume For 10-Year T-Bond Futures	41
Figure 3.3	Average Daily Volume and Open Interest for 3-Year T-Bond Futures	42
Figure 3.4	Average Daily Volume and Open Interest for 10-Year T-Bond Futures	42
Figure 3.5	SFE 3-Year T-Bond Futures Versus CBOT 2-Year T-Note Futures	43
Figure 3.6	SFE 10-Year T-Bond Futures Versus CBOT 10-Year T-Note Futures	43
Figure 3.7	SFE 10-Year T-Bond Futures Versus Eurex Euro-Bond Futures	44
Figure 3.8	Monthly Volumes for Overnight Options on 3-Year and 10-Year T-Bond Futures	46
Figure 4.1	Intra-Night Numbers of Bids, Asks and Trades for 3-Year and 10-Year T-Bond Futures Overnight Call Options	66
Figure 4.2	Intra-Night Numbers of Bids, Asks and Trades for 3-Year and 10-Year T-Bond Futures Overnight Put Options	67
Figure 4.3	Time-Weighted Average Relative BAS for 3-Year and 10-Year Overnight Options Over Time	69
Figure 4.4	Intra-Night Time-Weighted Average Standardized Relative Bid-Ask Spreads Patterns for 3-Year T-Bond Futures and its Overnight Options	71
Figure 4.5	Intra-Night Time-Weighted Average Standardized Relative Bid-Ask Spreads Patterns for 10-Year T-Bond Futures and its Overnight Options	72
Figure 4.6	Intra-Night Patterns of Standardized Trading Volume for 3-Year T-Bond Futures Overnight Options and the Underlying Futures	75
Figure 4.7	Intra-Night Patterns of Standardized Trading Volume for 10-Year T-Bond Futures Overnight Options and the Underlying Futures	77

Figure 4.8	3-Year T-Bond Futures and its Overnight Options Intra-Night Volatility Patterns	79
Figure 4.9	10-Year T-Bond Futures and its Overnight Options Intra-Night Volatility Patterns	81
Figure 5.1	Mean Relative Bid-Ask Spreads Before and After the Overnight Options Introduction	104
Figure 5.2	Mean Volume Before and After the Overnight Options Introduction	107
Figure 5.3	Volatility Before and After the Overnight Options Introduction	110
Figure 6.1	Patterns of Return Index for the Underlying 3-Year T-Bond Futures	135
Figure 6.2	Patterns of Return Index for the Underlying 10-Year T-Bond Futures	135
Figure 6.3	News Impact Curve for the 3-Year T-Bond Futures	149
Figure 6.4	News Impact Curve for the 10-Year T-Bond Futures	150