

Downside Risk and Volatility Dynamics in Financial Markets

by Alice Carole Thomas

Thesis submitted in fulfilment of the requirements for
the degree of

Doctor of Philosophy

under the supervision of Assoc. Prof. Jianxin Wang and
Assoc. Prof. Christina Nikitopoulos Sklibosios

University of Technology Sydney
Business School (Finance Discipline Group)

April 2022

Certificate of Original Authorship

I, Alice Carole Thomas declare that this thesis, is submitted in fulfilment of the requirements for the award of Doctor of Philosophy, in the School of Business (Finance Discipline Group) at the University of Technology Sydney.

This thesis is wholly my own work unless otherwise reference or acknowledged. In addition, I certify that all information sources and literature used are indicated in the thesis.

This document has not been submitted for qualifications at any other academic institution.

This research is supported by the Australian Government Research Training Program.

Production Note:

Signature: Signature removed prior to publication.

Date: 07/04/2022

Acknowledgements

I am grateful to my principal supervisor, Assoc. Prof. Jianxin Wang for his encouragement and knowledge along my PhD journey. I would like to extend my sincere thanks to my co-supervisor, Assoc. Prof. Christina Nikitopoulos for her precious time, constant support and invaluable feedback. I cannot imagine what my candidature would have been like without her.

Thanks also to UTS that hosted my research and the staff members of the Finance Discipline Group. I would like to express my gratitude to the UTS Graduate Research School, UTS School of Business (Finance Discipline Group), and the Financial Research Network (FIRN) for providing financial assistance that allow me to attend various conferences and workshops. I would like to also thank Prof. Daniel Smith, Prof. Talis Putnins, Assoc. Prof. Adrian Lee, Assoc. Prof. Marco Navone, Prof. Xuezhong He, Dr Chen Yang, Assoc. Prof. Vitali Alekseev, and fellow PhD students at UTS for their suggestions on different components of this thesis.

Most importantly, I am thankful to my family: my parents and brother. They have been extremely supportive of me throughout this entire process and have made endless sacrifices to get to where I am today.

Table of Contents

List of Figures	v
List of Tables	vi
Abstract	ix
Chapter 1. Introduction	1
1.1. Motivation and Literature Review	1
1.2. Thesis Structure	8
Chapter 2. Forecasting with New Measures of Extreme Downside Risk	11
2.1. Introduction	11
2.2. Measuring Extreme Downside Risk	16
2.3. Data and Preliminary Analysis	20
2.4. Forecasting Extreme Downside Risk	30
2.5. Investment Strategy	43
2.6. Robustness Tests	46
2.7. Conclusion	47
Appendix 2.1. Cross-correlation between Forecasting Variables	49
Appendix 2.2. Excluding GFC Period	50
Appendix 2.3. Alternative Thresholds in RDRS Measure	56
Chapter 3. The Economic Impact of Daily Volatility Persistence on Energy Markets	62
3.1. Introduction	62
3.2. Modeling Volatility Persistence	66
3.3. Data and Preliminary Analysis	71
3.4. The Role of Volatility Persistence in Energy Futures Markets	74
3.5. Forecasting Performance	84
3.6. Conclusion	91
Appendix 3.1. The HAR-CVP-CV Models - CVP Coefficients	98

Appendix 3.2. Data Filtering	100
Appendix 3.3. Seasonality Tests and Adjustments	102
Appendix 3.4. RV Measures	104
Appendix 3.5. Macro-economic Variables	106
Appendix 3.6. Alternative Models for CVP	109
Appendix 3.7. Sharpe Ratio	113
Chapter 4. Liquidity Provision Channels and Oil Price Volatility	114
4.1. Introduction	114
4.2. Data and Preliminary Analysis	118
4.3. The Role of Liquidity Provision in Determining Volatility	128
4.4. Liquidity Provision and the Shape of the Futures Curve	138
4.5. The Impact of Macro-economic Shocks	143
4.6. Conclusion	150
Appendix 4.1. Alternative Smoothed Hedging Pressure Trailing Periods	153
Appendix 4.2. Interest-adjusted Spreads with Different Maturity Date	154
Chapter 5. Conclusion and Directions for Future Research	159
5.1. Forecasting with New Measures of Extreme Downside Risk	159
5.2. The Economic Impact of Daily Volatility Persistence on Energy Markets	160
5.3. Liquidity Provision Channels and Oil Price Volatility	161
Bibliography	163

List of Figures

2.1.1	Probability of Extreme Negative Returns in U.S. Stocks	12
2.1.2	Probability of Extreme Negative Returns for General Electric, Microsoft, CSX, Walmart, and Newmont Mining.....	12
2.3.1	Semi-annual EDR Measures	22
2.3.2	Monthly EDR Measures	23
3.2.1	Daily Prices and Realized Variances.....	70
3.4.1	Daily Conditional Volatility Persistence (CVP)	84
A.3.2.1	Volatility Signature Plots	101
4.2.1	Crude Oil Weekly Realized Variance.....	119
4.2.2	Hedging Pressure, Smoothed Hedging Pressure, and Net Trading.....	120
4.2.3	Crude Oil and Petroleum Inventory	122
4.2.4	Futures Interest-adjusted Spreads	123
4.2.5	VIX and Term Spread	125

List of Tables

2.3.1	Distribution of Stocks	21
2.3.2	Statistics of Selected Variables	25
2.3.3	Contemporaneous Correlation	27
2.3.4	Stationarity and Long-memory Tests	30
2.4.1	Forecasting EDR in the Cross-Section (Six Months Ahead).....	32
2.4.2	Forecasting EDR in the Cross-Section (One Month Ahead).....	33
2.4.3	Forecasting EDR in the Time Series (Six Months Ahead)	36
2.4.4	Forecasting EDR in the Time Series (One Month Ahead)	37
2.4.5	Out-of-sample Forecasting Performance	40
2.4.6	Out-of-sample Forecasting Performance under Bearish and Bullish Mar- ket Conditions	42
2.5.1	Market timing using the In-sample EDR Forecasts	44
2.5.2	Market Timing using the Out-of-sample EDR Forecasts	46
A.2.1.1	Contemporaneous Correlation between Forecasting Variables	49
A.2.2.1	Forecasting Monthly EDR in the Cross-Section (PRE-GFC Period)	51
A.2.2.2	Forecasting Monthly EDR in the Cross-Section (POST-GFC Period).....	52
A.2.2.3	Out-of-sample Forecasting Performance (PRE-GFC and POST-GFC Period).....	53
A.2.2.4	Market Timing using the One Month Ahead EDR Forecasts (PRE- GFC Period)	54
A.2.2.5	Market Timing using the One Month Ahead EDR Forecasts (POST- GFC Period)	55
A.2.3.1	Forecasting EDR in the Cross-Section using Different RDRS Thresh- olds (Six Months Ahead)	57
A.2.3.2	Forecasting EDR in the Cross-Section using Different RDRS Thresh- olds (One Month Ahead)	58

A.2.3.3	Out-of-sample Forecasting Performance using Different RDRS Thresholds.....	59
A.2.3.4	Market Timing using the In-sample EDR Forecasts across Different Thresholds.....	60
A.2.3.5	Market Timing using the Out-of-sample EDR Forecasts across Different Thresholds.....	61
3.3.1	Descriptive Statistics of Conditioning Variables	74
3.4.1	The HAR-CVP-CV Models for Crude Oil	75
3.4.2	The HAR-CVP-CV Models for Natural Gas	76
3.4.4	Contribution of the CVP-CV Determinants to Volatility Variation	94
3.4.5	CVP Variance Decomposition	95
3.4.6	Statistical Properties of CVP	95
3.5.1	Out-of sample Forecasting Performance	96
3.5.2	Realized Utility	97
A.3.1.1	The HAR-CVP-CV Models for Crude Oil	98
A.3.1.2	The HAR-CVP-CV Models for Natural Gas	99
A.3.3.1	Seasonality Test	102
A.3.4.1	Descriptive Statistics of RV-based Volatility Measures	105
A.3.5.1	Conditioning Variables.....	108
A.3.6.1	The HAR-SV and HAR-CVP-SV Models.....	111
A.3.6.2	The HAR-RQ and HAR-CVP-RQ Models.....	112
A.3.7.1	Realized Utility with Varying Sharpe Ratio.....	113
4.2.1	Statistical Properties.....	127
4.3.1	The HP Models	131
4.3.2	The HP Models with Returns Shocks	135
4.3.3	The HP Models Conditioned on Rising and Falling Market Conditions..	137
4.4.1	The HP Models in Inverted Markets	141
4.4.2	The HP Models in Normal Markets	142
4.5.1	The HP Models Conditioned on Financial Sector Risk.....	145
4.5.2	The HP Models Conditioned on Business Cycle Risk	148

A.4.1.1	The HP Models using Different Smoothed Hedging Pressure Trailing Periods.....	153
A.4.2.1	The HP Models in Inverted Markets using 3-month Futures Spread.....	155
A.4.2.2	The HP Models in Inverted Markets using 6-month Futures Spread.....	156
A.4.2.3	The HP Models in Normal Markets using 3-month Futures Spread	157
A.4.2.4	The HP Models in Normal Markets using 6-month Futures Spread	158

Abstract

Adverse price movements in stock and energy markets threaten the stability and efficiency of financial markets. Devising more accurate risk measures is essential for protecting investment portfolios against these shocks. Energy futures markets have been shown to have volatility structures comparable to traditional stock markets, perhaps even more so after the financialization of commodities markets. Their interconnectedness means that macro-economic and energy-specific factors, through newly identified impact channels, can influence energy price.

The main contributions of this thesis include:

- ▷ *Forecasting with new measures of extreme downside risk – Chapter 2.* The first study proposes two alternative measures of stock-specific extreme downside risk, based on the downside realized semi-variances and cumulative returns. The suitability of these measures for improving the prediction of extreme downside risk is assessed against existing metrics in the literature. Their forecasting performance is evaluated by adopting a more industry-relevant forecasting horizon of one month. The proposed measures have better in-sample and out-of-sample forecasting performance. The performance of an investment strategy that precludes stocks with a high extreme downside risk is evaluated. Irrespective of the forecasting horizon, the new measures earn the highest risk-adjusted returns. This strategy may serve as a tool for fund managers to efficiently time the market.
- ▷ *The economic impact of daily volatility persistence on energy futures markets – Chapter 3.* The second study examines the role of daily volatility persistence in transmitting information from the macro-economy in the volatility of energy markets. Macro-economic factors, such as the VIX, the credit spread, and the Baltic Exchange Dirty Index, impact future volatility via the volatility persistence in crude oil markets. Conversely, the impact of these factors on the volatility persistence of natural gas markets is limited. There is also evidence that traditional market state variables, including returns and variances, are also transmitted to volatility via the volatility persistence channel. This variation in daily

volatility persistence is economically significant, contributing to a large proportion of future volatility. Based on the utility benefits of volatility forecasts, the volatility persistence-adjusted volatility models provide almost three times as much benefit to investors compared to competing volatility models, even after accounting for transaction costs and varying trading speeds. This chapter identifies a new transmission channel of macro-economic information in the volatility of energy markets with substantial economic impact in forecasting.

- ▷ *Liquidity provision channels and oil price volatility – Chapter 4.* The third study re-evaluates the role of hedgers and speculators as liquidity providers and their effects on weekly oil price volatility. By using two measures of hedging pressure that capture the liquidity provision by speculators and hedgers, hedging pressure driven by the speculators' liquidity provision decreases volatility, while hedging pressure induced by hedgers' liquidity provision increases volatility. Oil volatility tends to be more responsive to hedgers' short-term liquidity provision than variations induced by speculators' liquidity provisions. The liquidity provision by hedgers and speculators is significant determinant of volatility in inverted and normal markets with the effects being more pronounced in inverted markets. Further financial and business cycle risks have a measurable impact on how liquidity provision channels affect volatility. This chapter refines the role of hedgers and speculators in determining oil price volatility via two distinct liquidity provision channels with opposite effects on volatility.