Commodity Derivative Pricing under the Benchmark Approach

Ke Du

A thesis submitted for the degree of
Doctor of Philosophy
at the University of Technology, Sydney.
27 February 2013.

UNIVERSITY OF TECHNOLOGY, SYDNEY
CERTIFICATE OF AUTHORSHIP/ORIGINALITY

I certify that the work in this thesis has not previously been submitted for a degree nor has it been submitted as part of requirements for a degree except as fully acknowledged within the text.

I also certify that the thesis has been written by me. Any help that I have received in my research work and the preparation of the thesis itself has been acknowledged. In addition, I certify that all information sources and literature used are indicated in the thesis.

Signature of Author

Acknowledgements

First and foremost, I would like to thank Professor Eckhard Platen, my supervisor, for providing the opportunity to undertake this PhD and for his consistent and enthusiastic support. I would also like to thank Professor Erik Schlögl and Professor Tony He for their help throughout my research. This thesis would not have been possible without their support and encouragement. Further, I wish to express gratitude to my best friends, Rei Chen, Jan Baldeaux, Hardy Hulley, Boda Kang, Renata Rendek and Nicholas Yap. They have given me lots of good advice on various issues from my research to career development. I am also grateful to the staff and students of the Finance Discipline Group for their support and for providing a friendly atmosphere. Last but not least, I would like to thank my parents and my wife, Li Zeng, for their moral support and undying love. Without them, I would not have been able to accomplish anything.

Abstract

This thesis models commodity prices and derivatives, written on commodity prices, under the benchmark approach. Under this approach, the commodity prices are modeled under the real world probability measure while the corresponding numéraire is the numéraire portfolio (NP), which is the growth optimal portfolio that maximizes expected logarithmic utility. The existence of an equivalent risk neutral probability measure is not required. Under the proposed new concept of benchmarked risk minimization, the minimal price for a nonhedgeable contingent claim is identified, and the fluctuations of the benchmarked profit and loss, when denominated in units of the NP, are minimized. The resulting real world pricing formula generalizes the classical risk neutral pricing formula. The NP will be approximated by a well-diversified stock index. New forward and futures price formulas will be derived, which generalize their classical counterparts. Stylized empirical facts for the dynamics of the NP in a selected commodity denomination will be identified. These lead to a model which falls outside classical no-arbitrage assumptions, but is covered by the benchmark approach. Under this model, some long dated derivatives will be shown to be less expensive than under the classical paradigm.

Contents

List of Figures