

Valuating Weather Derivatives for Wind Energy

Master Thesis
in
Option Pricing

Department of Banking & Finance
University of Zürich

Prof. Dr. Marc Chesney

Author:

Matthias Furrer

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Executive Summary

Problem and Objective

Germany's decision to decommission nuclear power stations and a trend for renewable energy increase the popularity of wind power. However, electricity production with wind power is dependent on favourable wind conditions. This leads to volatile earnings that could have adverse effects on the financial performance of the company and the shareholder value. Wind park operators should consider the risk from lack of wind within their risk management. A weather derivative can offer protection against lost output and volatility in revenues caused by low wind seasons.

In detail, this thesis studies a European put option on the underlying wind speed for contract period between October and March. This is in line with seasonal volatility of wind velocity for Germany that is highest during winter months. Weather options are often capped. The presented put option on wind speed has a cap level that limits the contract payouts. Unfortunately, this option cannot be valued with the traditional Black-Scholes method as its assumptions are violated for the underlying wind speed. Risk-neutral probabilities and portfolio replication are non-applicable as the financial market for wind derivatives is incomplete. The main objective of the following thesis is to value a wind derivative with alternative approaches. In addition, the economic impact of the wind hedge on the electricity company is investigated.

Methodology

In order to derive conclusions on pricing and economic consequences, research is conducted on six wind parks located in Germany. This thesis approaches the valuation in three steps: *First*, the behaviour of wind velocity is studied for each park and nearby weather stations. Limited weather records at the wind farm's location require the use of meteorological weather stations in the neighbourhood that provide historical data over a period of 25 years. The selection of appropriate weather stations is performed by comparing wind speed data from both sources. *Second*, wind speed is simulated with three different methods fed with historical data from weather stations. In details, the historical