HEDGING WITH GENERALIZED BASIS RISK: Empirical Results

OUTLINE OF PRESENTATION

- INTRODUCTION
- MOTIVATION FOR THE TOPIC
- GOALS
- LITERATURE REVIEW
- THE MODEL
- THE DATA
- FUTURE WORK

INTRODUCTION

- Hedging is used to minimize the risks associated with holding an asset/portfolio

- The futures market is an example of a hedge instrument

INTRODUCTION

- Futures contracts defined: a futures contract obliges the seller to deliver an asset at a specified future time (the delivery date) at a random future futures price (at the delivery time). It involves basis risk.
- Futures contracts come from a similar type of agreement known as the forward contract.

INTRODUCTION

- Forward contracts are different from futures contracts as they are untradeable and they do not involve basis risk as the forward price is fixed.
- Basis risk is the risk that the random futures price of an asset will deviate from its market price at the time of delivery.

INTRODUCTION

- Caused by differences in timing, quality and location
- Basis risk is not to be confused with another type of risk known as price risk
- Price risk is the risk that the spot price (market price) of an asset will deviate from its expected value:

$$\tilde{p} = \bar{p} + \sigma\tilde{\varepsilon}$$

INTRODUCTION

- Motivations for an agent to engage in the futures market:

(1)Pure Hedging: associated with risk minimization

(2)Speculation: agent tries to earn speculative profit based on the spot and futures price differential

INTRODUCTION

- In the previous literature the futures price is given by the following formula:

$$\tilde{f} = \beta\tilde{p} + \delta\tilde{\eta}$$

- The major drawbacks of this method is that it assumes that the futures price is a linear function of the market (spot) price and basis risk and that basis risk and price risk are statistically independent

Motivation for the Topic

- It is widely known that most countries in the region face an uncertain environment. Trinidad and Tobago are no exception in terms of the prices it receives for their energy related products. Hedging is a widely known and excepted form of reducing the risks involved in holding an asset and therefore its uncertainty. Hence we choose to empirically examine the natural gas market in an attempt to show how we can reduce uncertainty in this area.

GOALS

(1) Develop alternative ways to model hedging in the futures markets

(2)More specifically we develop a more general framework of risks involved

(3) We relax the statistical independence assumption between the risks involved

(4)We develop a convenient way to empirically measure the impact of risk and other parameters on the optimal hedge

LITERATURE REVIEW

- Holthausen (1979) is the original paper in this area and he introduced a hedging and production model in the absence of basis risk which means he considered the forward market
- He was able to show under what circumstances the agent either over hedges or under hedges or full-hedges his output and the effect of increasing risk aversion on the hedge

LITERATURE REVIEW

- He also found that the firm produces where there MC=b known as the Separation Property
- The Separation Property says that the optimal output does not depend on the probability distributions and preferences; only the amount hedged depends on preferences and distributions

LITERATURE REVIEW

- Paroush and Wolf (1986, 1989, 1992) were the first to introduce basis risk in the literature and therefore were the first to analyze futures markets.
- There analysis showed how basis risk along with other parameters affected the optimal output and hedge of the firm.

LITERATURE REVIEW

- Lapan and Moschini(1994) and Losq(1982) are examples of papers that used output as a parameter
- Lien and Tse (2002) is an example of how the previous literature treated with the structure of the futures price:

$$\tilde{f} = \beta\tilde{p} + \delta\tilde{\eta}$$

LITERATURE REVIEW

- Therefore the futures price is a linear function of the market (spot) price and basis risk and basis risk and price risk are statistically independent
- Alghalith (2005) provided a methodology that can be used to relax the assumptions of the previous literature
- Alghalith (2006) empirically examined the US corn market using this methodology and explored the implications on the optimal output and hedge positions of the firm

The Model

- Profit Function:

$$\tilde{\pi} = \tilde{p}q + \left(b - \tilde{f}\right)h$$

- Given that:

$$\tilde{p} = \bar{p} + \sigma\tilde{\varepsilon}$$

The Model

- We get:

$$\tilde{\pi} = \gamma \bar{p} q + \sigma \tilde{\varepsilon} q + \left(b - \tilde{f}\right) h + a$$

- Objective Function:

$$Max_{q,h} Eu\left(\tilde{\pi}\right)$$

The Model

$$Eu\left(\gamma\bar{p}q + \sigma\tilde{\varepsilon}q + \left(b - \tilde{f}\right)h + a\right)$$

- The maximization problem implies the existence of an indirect utility function V:

$$V\left(\bar{p}, \sigma, \delta, b, \rho, a, \gamma\right) = Eu\left(\tilde{\pi}^{*}\right)$$

The Model

$$= Eu\left(\gamma\bar{p}q + \sigma\tilde{\varepsilon}q + \left(b - \tilde{f}(\tilde{\eta})\right)h^{*} + a\right)$$

- The Estimating Equations:

$$q = \frac{V_{\alpha} + V_{\gamma\bar{p}}\check{p} + V_{\gamma\sigma}\check{\sigma} + V_{\gamma b}\check{b} + V_{\gamma\rho}\check{\rho} + V_{\gamma\delta}\check{\delta}}{(1 + V_{a\bar{p}}\check{p} + V_{a\sigma}\check{\sigma} + V_{ab}\check{b} + V_{a\rho}\check{\rho} + V_{a\delta}\check{\delta})\bar{p}}$$

The Model

$$h^* = \frac{V_b + V_{b\bar{p}}\check{p} + V_{b\sigma}\check{\sigma} + V_{bb}\check{b} + V_{b\rho}\check{\rho} + V_{b\delta}\check{\delta}}{1 + V_{a\bar{p}}\check{p} + V_{a\sigma}\check{\sigma} + V_{ab}\check{b} + V_{a\rho}\check{\rho} + V_{a\delta}\check{\delta}}$$

- Where the coefficients to be estimated are the partial derivatives while the other variables are derived from observed data.

Comparative Statics

- The estimating equations provide a convenient way for us to derive comparative statics results:
- For example: a change the optimal output with respect to a change in the expected price

$$\frac{\partial q}{\partial \bar{p}} = \frac{V_{\gamma\bar{p}}\bar{p} - (\bar{p} + V_{\alpha\bar{p}}\bar{p})V_{\alpha}}{\bar{p}^2}$$

Comparative Statics

- Similarly,

$$\frac{\partial q}{\partial \sigma} = \frac{V_{\gamma\sigma}\bar{p} - V_{a\sigma}V_{\alpha}}{\bar{p}^2}$$

$$\frac{\partial q}{\partial b} = \frac{V_{\gamma b}\bar{p} - V_{ab}V_{\alpha}}{\bar{p}^2}$$

Comparative Statics

$$\frac{\partial q}{\partial \rho} = \frac{V_{\gamma\rho}\bar{p} - V_{a\rho}V_{\alpha}}{\bar{p}^2}$$

$$\frac{\partial q}{\partial \delta} = \frac{V_{\gamma\delta}\bar{p} - V_{a\delta}V_{\alpha}}{\bar{p}^2}$$

Comparative Statics

- In terms of the optimal hedge:

$$\frac{\partial h^*}{\partial \bar{p}} = V_{b\bar{p}} - V_{a\bar{p}} V_b$$

$$\frac{\partial h^*}{\partial \sigma} = V_{b\sigma} - V_{a\sigma} V_b$$

Comparative Statics

$$\frac{\partial h^*}{\partial b} = V_{bb} - V_{ab}V_b$$

$$\frac{\partial h^*}{\partial \rho} = V_{b\rho} - V_{a\rho}V_b$$

$$\frac{\partial h^*}{\partial \delta} = V_{b\delta} - V_{a\delta}V_b$$

The Data

- To empirically estimate the model, we the Henry Hub spot price, the Henry Hub futures price and the quantity of natural gas and the hedged quantity.
- The data is monthly and spans the period March 2000 to March 2010

Future Work

- We will introduce more advanced models in the future to include more forms of risk

THE END