CUSTOMIZED COMMODITY DERIVATIVES; AN ALTERNATIVE TO REDUCE FINANCIAL RISKS ON FARMS.

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Abstract

Customised derivatives are developed for the agriculture industry to decrease the volatility of input or output prices. These derivatives can be attractive for agriculture producers because a substantial part of the business risk in agriculture is caused by fluctuating commodity input and output prices. The aim of the paper is to provide information on customised derivatives, their background and contemporary applications for natural gas procurement in the Dutch horticulture sector. To research the added value of customized commodity derivatives (a maximum price contract and a collar contract) a simulation model is developed. With this model mean and variation of the natural gas costs are calculated and compared with buying on the spot market and a fixed price contract. Our findings show that the use of the maximum price contract in the period 2000-2005 in the Netherlands helps producers to decrease expected costs and lower the variability of natural gas prices as well.

Keywords: customized commodity derivatives, natural gas, horticulture, financial risks

Introduction

Risks can be classified into various types of risk. For most agricultural risks the classification of Hardaker et al. (2004) can be used, who distinguish first between business risks and financial risks. Business risks include production risks, price risks, personal or human risks and institutional risk. The other type of risk, financial risk, refers to the risks related to the way a farm is financed. Price risks are expected to become more important for European agricultural farms because of changing WTO, EU regulation and national policies. Because of the protection of the European market many producers are not used to coping with these price risks.

In the Netherlands, new products are developed by financial institutions (e.g. Rabobank and ABN-AMRO) to decrease the price risks of certain costs. One of these products is customized commodity derivatives.

The aim of this article is to give insight into the value that customized commodity derivatives have for agricultural producers.

In section 2 a short explanation is given about derivatives. In section 3 a model is introduced to compare different alternatives to reduce price risks of natural gas for glasshouses in the Netherlands. In section 4 the obtained results for the period 2000-2005 for a Dutch flower greenhouse are given. In section 5 a list of conditions is offered which ought to be present for the development of additional customised derivatives. Also some suggestions for further research are listed. In section 6 the conclusions are listed.

Customized derivatives

A derivative is an instrument whose characteristics and value depends upon the characteristics and value of an underlying instrument. Derivatives are generally designed to manage or hedge price risk, or to swap cash flows (Hull, 2002).

Some derivatives are standardised and traded on regulated exchanges while others are customised bilateral agreements. An exchange traded derivative is a derivative that is traded on an organised and regulated exchange. These derivatives are most commonly standardised by quantity, grade, delivery location and expiration date. Exchange traded derivatives are typically cleared and settled through the multilateral clearing process used by regulated exchanges.

An example of an exchange traded derivative is a futures contract on natural gas. Exchange traded natural gas contracts are actively traded on organised exchanges such as the New York Mercantile Exchange in New York or the Intercontinental Exchange which is electronic and offered for trading globally. Options traded on such exchanges which settle directly to cash or to a futures contract are also considered exchange traded derivatives.

A customised derivative is one that is designed specifically for a user or a group of users or for a specific application. Customised derivatives are also known as over the counter ('OTC') derivatives. These instruments generally contain some unique characteristics such as the size, grade, delivery location or settlement benchmark, expiration date, pay-off matrix or counter party characteristics. Customised derivatives are generally bilateral and can not be directly offset against other customised or exchange traded derivatives.

An example of a customised derivative would be a contract offered by a gas company to purchase natural gas at a fixed price for the next year designed to meet a customer's requirements. There are numerous other examples of customised derivatives where the supplier customises some aspect of a standardised contract to meet his customer's needs.

Model and data

A stochastic simulation model is developed to compare different strategies for decreasing the volatility of gas prices for greenhouses in the Netherlands.

Four price strategies are compared (see also figure 1):

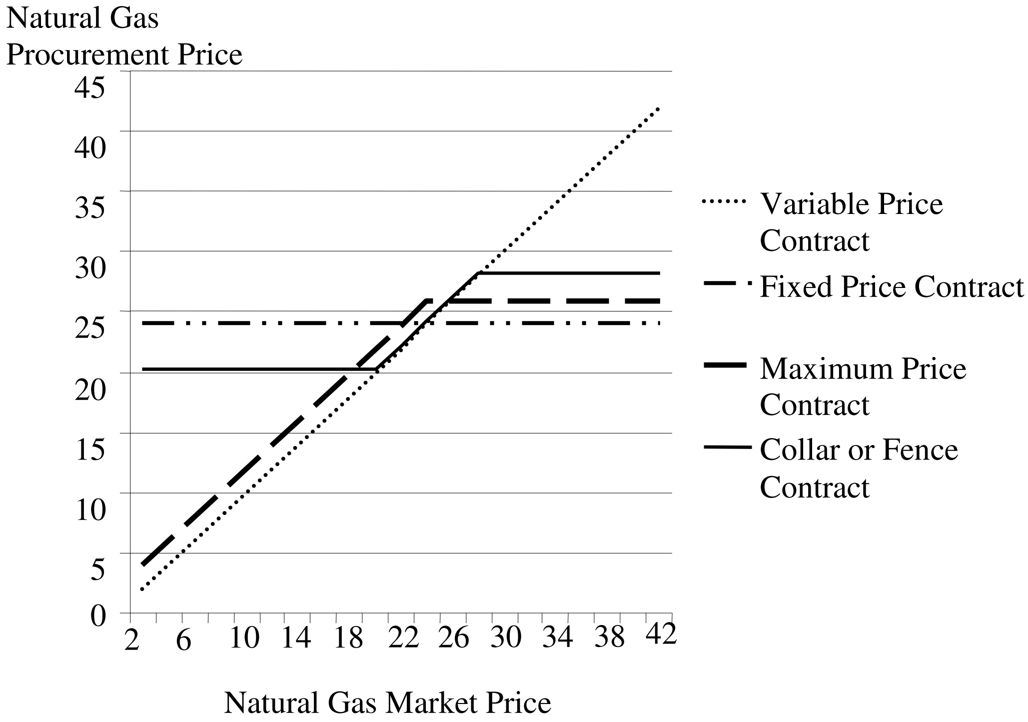
Variable price contract. A variable price contract is a contract where two parties have a relationship to supply and receive a good, but the price floats until the customer takes delivery of the physical commodity. For this case study the Dutch situation, where prices are established each quarter is simulated;

Fixed price contract. A fixed price contract is a contract where the buyer and seller fix the price of a good for a certain period. For this case study the price is fixed for the upcoming calendar year (it is assumed that the market is neither in contango nor in backwardisation);

Maximum price contract. A maximum price contract is a contract where the supplier (or a third party) agrees to charge no more than a predetermined price for a commodity. In this case the buyer will pay a premium up front for the maximum price contract. The maximum price is known as the strike price. If the market price is below the strike price, the greenhouse operator is charged the prevailing market price. However, if the market price is above the strike price, the supplier will only charge the contract maximum price;

Collar contract. A collar (sometimes also called a fence) contract establishes both a maximum price and a minimum price between the supplier and the buyer. If the market price is between the minimum and the maximum prices the user pays the prevailing market price. If the market price is above the maximum price, the user pays only the contract maximum price. If the market price is below the minimum price, the user pays the agreed upon contract minimum price.

Figure 1: Natural gas contract comparison (prices in eurocents per m3).



For pricing the derivatives (maximum price contract and collar price contract) Black's Option Pricing Model for Futures and Forwards is used (Black 1976, see appendix 1).

The maximum price contract utilises an at the money call option. This means that on October 1 of each year, which is the time the derivative is agreed upon by both parties, the average price of the previous four quarters (a proxy for the forward price) and the contract maximum price are the same.

The collar contract strategy uses the purchase of an out of the money call option and the sale of an out of the money put option. In this analysis the collar has a net capital outlay of zero. The purpose of this method of structuring a collar is to create a realistic collar price contract where the derivative premiums are approximately the same for the call option and the put option so that initial capital outlay is approximately zero (premium for the collar is zero).

The price strategies are compared for a fairly typical flower greenhouse in the Netherlands. The characteristics of this farm are listed in table 1.

Table 1: Characteristics of a flower greenhouse in 2005

Production (ha)	1.9
Natural gas usage (m3/m2)	44 (top in January 7 m3 and low in July 1 m3)
Income (€)	1,005,100
Expenses (€)	1,052,600
Profit (€)	(47,500)
Total Energy costs	222,300
Natural gas costs	188,955

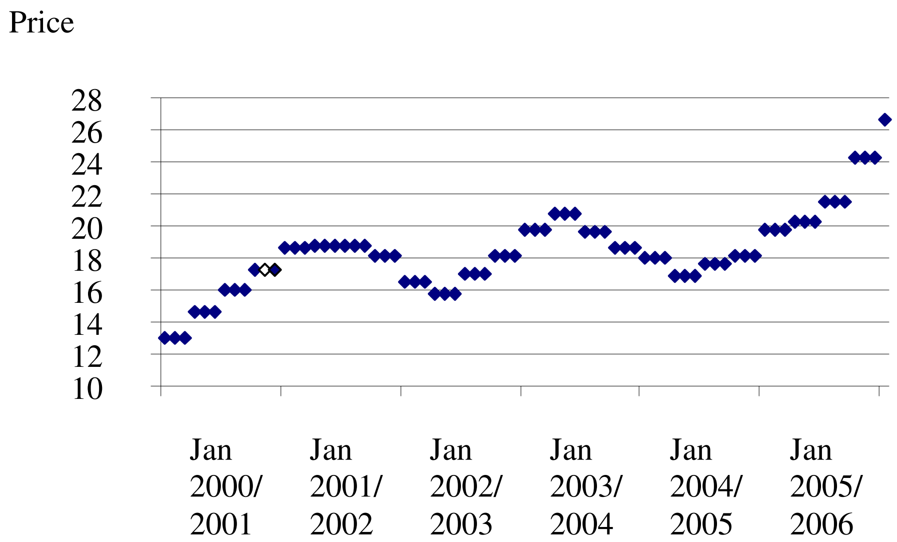
Source: Farm Accountancy Network LEI

Table 1 shows that the greenhouse enterprise has a turn over of about €1 million and a negative profit (loss) of about €50,000, 85 % of the energy costs are costs for natural gas.

The expenses for natural gas constitute more than 20% of the total expenses. Only the labour costs (about 30% of total expenses) are more important.

Figure 2 shows the volatility of the gas prices in the Netherlands in the period January 2000 till January 2006. In this period the gas prices are fluctuating round an increasing trend. In fact the price per m^3 doubled from about 12 eurocent per m^3 in 2000 to 24 eurocent per m^3 in 2005. For the greenhouse enterprise this means an increase of expenses of about 100.000 Euro annually or 10% increase in total costs.

Figure 2: Natural gas price (quarterly prices in eurocents per m3 from 2000 to 2006).



Results

Table 2 shows the results of the historical case study analysis. If the farmer used only variable price contracts for procuring natural gas his average procurement price would have been €8.38 per square meter of production from 2002 through 2005. By enlisting the use of fixed price purchase contracts he would have paid €7.91 per square meter. The maximum price strategy would have resulted expenses of on average €7.72 per square meter and by using collar price contracts €8.02 per square meter. The standard deviation of the returns is an important measure of the riskiness of a strategy. Here we can see that the standard deviation of the procurement strategies using variable price, fixed price, maximum price and collar price are €1.17, €0.61, €0.13, €0.32 respectively.

Table 2 Natural gas cost (€/m2) and standard deviation per price strategy in the period 2000-2005 for a flower greenhouse in the Netherlands

Year	Contract type			
	variable price	fixed price	maximum price	collar price
2002	7.45	8.17	7.62	7.61
2003	8.60	7.42	7.78	8.26
2004	7.50	8.65	7.87	7.92
2005	9.95	7.41	7.60	8.24
Average Cost	8.38	7.91	7.72	8.02
Standard Deviation	1.17	0.61	0.13	0.32

There are two ways to evaluate the four strategies:

Stochastic dominance framework (Hadar & Russell, 1969);
Entrepreneur risk preferences.

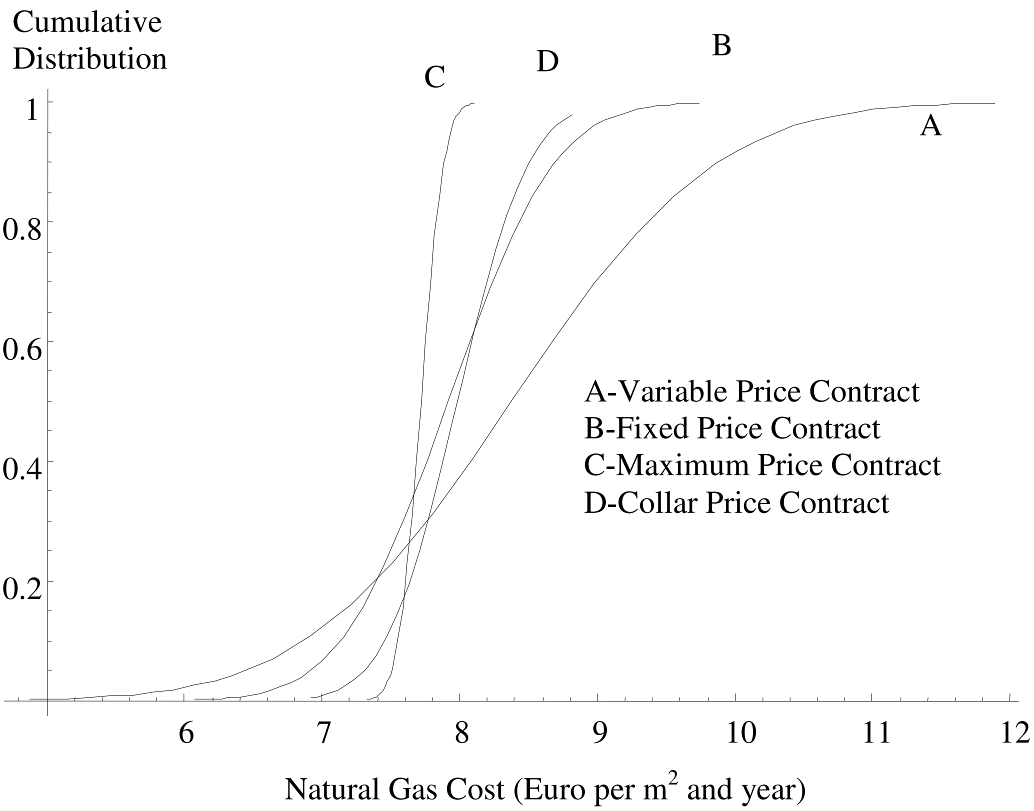
Stochastic Dominance Framework

In this case study we have analysed four years of procurement strategies and derived a mean and a variance for each strategy. If we assume that the distribution of returns for each strategy are normal and follow the mean and variance observed in our case study analysis, we can plot the cumulative distribution function of each strategy (see figure 3).

Stochastic dominance theory can be a useful tool to analyse an entrepreneur's preference among several strategy choices. First order stochastic dominance theory suggests that if all points from a strategy's distribution are to the left of the distribution plot of a second strategy, the first strategy is said to dominate the second. If we have two return distributions with cumulative density functions F(x) and G(x) respectively, then F(x) first order stochastically dominates G(x) if and only if $G(x) \geq F(x)$ for all values of x.

Second order Stochastic Dominance (SSD) can be used to analyse a dominant strategy in the case where the cumulative density function plots of the distributions cross. F(x) is said to stochastically dominate G(x) if its area to the left of G(x) is greater. In this case F(x) is more likely to yield a more favourable result (i.e. a lower procurement price in this case). Here we see that the maximum price strategy is most likely to yield the best natural gas purchase price, thus it can be said that the maximum price strategy is second order stochastically dominant.

Figure 3: Strategy cumulative distribution functions



Entrepreneur Risk Preferences

A risk neutral entrepreneur is one who will select a strategy based on the optimal procurement price (lowest expected costs). In this case the maximum price contract offers the lowest expected procurement price. Therefore, an entrepreneur who is risk neutral will rationally select the maximum price contract strategy in the given case.

A risk averse entrepreneur is one who weights his selection between risk and the likely outcome. Such an entrepreneur's utility function can be viewed as a convex curve where he trades return for risk in a decreasing way. The risk averse entrepreneur would seek the strategy or set of strategies which maximise his utility given his unique risk and return trade-off function. In this case a rational risk averse entrepreneur would also select the maximum price contract.

Possibility For Derivatives And Need For Further Research

Customised derivatives are just beginning to be offered for use in agriculture in the Netherlands. This research shows that there is promise for their use in the horticulture sector for natural gas procurement. It is likely that there are many more applications in other sectors where customised derivatives could be useful in managing commodity price risk inherent in a business. The development of these customised derivative tools will likely require a combined effort by skilled researchers, innovative entrepreneurs and a responsive and committed financial derivative sector.

To develop customised derivatives a number of conditions ought to be present:

Commodity price availability and tradability. The creator of a derivative must have a direct or indirect way to manage the risk inherent with such offering. For example, if there is no trade in a hog futures market but there is very liquid trade in grain and protein products, a company could construct a model where the input price is a combination of grain and soy protein plus a production factor and plus a margin factor to arrive at an approximate live hog value. Using such a model, one may offer live hog derivatives which could be a useful tool for pork producers and processors. This technique is being applied in the agriculture and food industries in other countries. For example, high fructose corn syrup can be purchased based on corn prices plus processing costs plus a margin factor;

- Price volatility. There should be a significant price risk present;
- Price variation should impact farm or firm income. The commodity price volatility should have a noticeable impact on farm or firm income which will incentivise producers and firms to manage the price risk by using customised derivatives;
- The market size should be considered. It is important for derivative creators and sellers to identify markets which meet a minimum size that provides an acceptable possibility to reward them for their efforts. Thus, one must consider the aggregate market size in determining which derivatives to offer;
- There should be willingness by derivative firms and entrepreneurs to experiment and innovate in the realm of financial tools offered and used for commodity purchases and sales.

Suggestions are listed for further research on this topic which may be helpful for the continued commercial development and application of customised derivatives.

- Research could be undertaken to create a modelling tool for entrepreneurs to analyse the value and impact of incorporating the use of customised derivatives into their businesses;
- Case study research utilising actual cases of the use of customised derivatives may be useful for entrepreneurs;
- Further analysis of more exotic derivatives structures may offer additional benefits;
- Research into the business implications of the use of customised derivatives could be helpful;
- Research should be completed on decision tools for determining optimal derivative selection or optimal combinations of derivatives, including considering more detailed analysis of derivative selection under varying entrepreneur risk preferences. Also simulation with different strike prices or collar prices gives insight in the relation between premiums for lowering the risks and the change in volatility of costs or income;
- Research into other implications of using customised derivatives such as cash flow considerations would be insightful;
- Research into the further development of customised derivative tools in other commodities areas would help expand the knowledge and potential development of derivatives in other sectors;
- Research other business models for introduction of derivatives in the market. For example the derivates studied in this paper could be offered by energy companies instead of a bank (the developer of the derivatives).

Conclusions

The horticulture sector in the Netherlands could find significant value by utilising natural gas price derivatives to manage the volatility risk and price risk of natural gas in the period 2000-2005. The cost of natural gas can be reduced through the prudent use of derivatives when compared with a variable price procurement strategy. Furthermore, all natural gas derivative strategies considered here offer less procurement cost volatility in the case study analysis. Using derivatives will reduce volatility of prices and volatility of procurement costs. The elimination of part of these risks has value for some farmers for example in case they need loans for extending the business.

Price Performance

In the studied case, the variable price strategy resulted in a natural gas cost of €8.38 per square meter of production. The fixed price, maximum price and collar price contracts resulted in a cost of €7.91/m^2, €7.72/m^2 and €8.02/m^2, respectively. This research shows that the best natural gas price for the last 4 years would have been achieved using a maximum price contract strategy. Of course these results on historical data are no guarantee that the use of derivatives will realise similar savings for further periods. Normally the lowest mean prices and highest volatility will be expected in the case of a variable price strategy.

Risk Performance

The case study analysis showed that the standard deviation of natural gas costs was €1.17/m^2 for the variable price strategy. The fixed price, maximum price and collar price strategies yielded standard deviations of costs of €0.61/m^2, €0.13/m^2, and €0.32/m^2, respectively. In the case study all derivative contracts were less risky than the variable price contract strategy, with the least risky strategy being the maximum price strategy.

Business Benefits

The savings in natural gas costs observed in the case study in the period 2000-2005, comparing derivative procurement strategies with the variable price procurement strategy, ranged from 5.5% to 8.5% savings in the cost of natural gas. The business impact of incorporating customised derivatives into the procurement and risk management plan of one's business appears to be a substantial reduction in the input cost volatility and approximately a 1% cost savings for the business as a whole. The use of derivatives leads to a strong decrease of volatility which means that the farm income is stabilised. This can lead to lower interest rates for loans or could increase the possibility for extra loans.

References

Black, F., 1976; *'The Pricing of Commodity Contracts'*. In: Journal of Financial Economics 3*;* p 167-79.

Hardarker, J.B., R.B.M. Huirne, J.R. Anderson and G. Lien, 2004; *Coping with riskin Agriculture.* Second edition, CAB International, Wallingford.

Horsager, K., W.H.M. Baltussen and G.B.C. Backus, 2006; *Customised commodity derivatives; the case of natural gas in the Dutch horticulture sector*. Report 2.06.05, LEI, The Hague, The Netherlands.

Hull, J., 2002; *Options, Futures and Other Derivatives.* 5th Edition, Prentice Hall, New Jersey.

http://en.wikipedia.org/wiki/Volatility

Appendix 1 Black's option pricing model for futures and forwards ('BOPM')

$$C = e^{-rt} [F N(d1) – X N(d2)]$$

where: $d1 = (\ln (F/X) + (\sigma^2 / 2t) / \sigma\sqrt{t}$

$d2 = d1 – \sigma\sqrt{t}$

and:
C is the price of the call option,
F is the futures price,
X is the strike price,
t is the time remaining,
σ is the standard deviation of returns or volatility,
r is the risk free rate,
ln denotes the natural logarithm, and
N is the standard normal distribution function.

Assumptions of the BOPM:

There are no transaction costs;
The interest rate remains known and constant;
Prices are log normally distributed;
Volatility is constant over the life of the option.

One of the requirements of the Black's Option Pricing model is a estimation of the future volatility. One method is to look at the current market conditions. Because there is a lack of traded derivatives in the Netherlands another method is used which is based on historical volatility.

Historical volatility can be calculated as:
σ_h = Standard Deviation of $\ln(P_t/P_{(t-1)}) * \sqrt{t}$

where: σ_h is the historical volatility
P_t is the price in period t,
$P_{(t-1)}$ is the previous period's price and,
t is the number of periods in a year
(see http://en.wikipedia.org/wiki/Volatility)

After calculating the historical volatility, we adjust the historical volatility in the following manner to obtain the estimated future volatility:

$\sigma_e = 1.25\ \sigma_h$

where: σ_e is the estimated volatility and,
1.25 is a constant based upon the observation that there is generally a premium for future volatility relative to calculated historically volatility. The 1.25 is an arbitrary value. For commodities the range is 1.1 to 1.3. In the USA's Natural Gas market the future volatility is at the moment about 1.3 times the historical volatility.