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Factors affecting the use of forward pricing methods in price risk management with special reference to the influence of risk aversion

H Jordaan¹ and B Grové²

Abstract

Risk aversion is the primary reason for farmers to use forward pricing methods to hedge against price risk. Previous international research on farmers' forward pricing behaviour found inconsistent results with respect to the relationship between risk aversion and the use of forward pricing methods. Ordinary Least Squares (OLS) regression is used in this research to investigate the relationship between the proportion of maize Vaalharts maize producers are willing to forward price and risk aversion. The quantity decision is modelled conditional on the adoption decision to ensure that the modelling procedure does not force the same variables to influence the two decisions in the same way. Regression results showed that more risk averse farmers are forward pricing a larger proportion of their crop produce. The main conclusion from this research is that the relationship between farmers' risk aversion and the quantity of maize forward priced is consistent with expected utility theory in spite of the fact that farmers need to be less risk averse to adopt forward pricing. Future emphases should be placed on the factors affecting the adoption of forward pricing as risk management tool in order to promote risk management. Especially research that will change farmers' perception about forward pricing is necessary.

Keywords: Forward pricing; risk aversion; farm characteristics; linear regression

1. Introduction

The Comprehensive Africa Agriculture Development Programme (CAADP) of NEPAD is strongly built on agriculture as the engine for overall economic growth in Africa. The vision of a united, non-racial and prosperous agricultural sector is based on three strategic goals: equal access and participation, competitiveness and profitability, and sustainable resource management (NDA, 2001). These three strategic goals are embraced in a strategic plan that was developed for South African Agriculture. The aim of

¹ Graduate student, Department of Agricultural Economics, University of the Free State, PO Box 339, Bloemfontein 9301. E-mail: jordaanh.sci@mail.uovs.ac.za.

² Lecturer, Department of Agricultural Economics, University of the Free State, PO Box 339, Bloemfontein 9301. E-mail: groveb.sci@mail.uovs.ac.za.

the strategy on global competitiveness and profitability is to enhance profitability through sustained global competitiveness in the agriculture sector's input supply, primary production, agro-processing, and agri-tourism industries (NDA, 2001). However, it should be realised that both weather-related and other environmental risks, as well as economic risks, have a significant depressing impact on the level of private investment in the agricultural sector. The depressing effect resulting from these risks hampers the agricultural sector's potential to act as a catalyst for growth. Price risk, amongst others, was identified as a major source of risk during the development of the strategic plan (NDA, 2001) since it may cause acute economic, social, and political consequences (Collier & Dehn, 2001; Timmer, 1995). The effective management of price risk, thus, may prevent, or at least reduce the above consequences, while it is also important to enhance the competitiveness and profitability of agriculture (NDA, 2004). Clearly, effective price risk management is of national importance in South Africa. However, individual farmers too may benefit if they manage price risk effectively since price risk is a substantial component of the overall variability in profit (Groenewald *et al.*, 2003).

Farmers' exposure to maize price volatility has increased since the deregulation of the markets in South Africa (Jordaan *et al.*, 2007). South African maize producers have since the mid 1990's been able to hedge against price risk on the South African Futures Exchange (SAFEX). They can also sell their maize using cash forward contracts³. Shapiro and Brorsen (1988) cited Holt and Brandt who listed numerous studies that show that hedging can reduce risk. Furthermore Shapiro and Brorsen (1988) concluded that research suggests that sufficiently risk averse farmers should participate in forward pricing even if it may lower average prices. In fact, McNew and Musser (2000) argue that risk aversion is the primary motive for farmers to use forward pricing methods. Research amongst irrigation farmers in South Africa shows that the majority of these farmers are risk averse (Botes *et al.*, 1994; Meiring & Oosthuizen, 1993). In light of higher price volatility of maize, the risk averse nature of farmers and the fact that forward pricing is theoretically proven to reduce price risk, risk aversion is expected to increase maize producers' participation in forward pricing. However, results from literature with regard to the relationship between the decision maker's level of risk aversion and the use of forward pricing methods is inconsistent, both internationally and in South Africa. Most researchers found the relationship to be negative (Shapiro & Brorsen, 1988; Goodwin & Schroeder, 1994; Musser *et al.*, 1996; Sartwelle *et al.*, 2000; Jordaan & Grové, 2007), while others found it to be positive

³ The use of both cash forward contracting, and hedging with futures contracts and/or options through SAFEX, are henceforth referred to as forward pricing.

(Isengildina & Hudson, 2001). Above the concern due to the inconsistency in the findings of research, the negative relationship between the use of forward pricing methods and risk aversion is contrary to what is expected from theory. The negative relationship implies that forward pricing is associated with lower levels of risk aversion. Researchers explained the negative relationship by stating that it might be because farmers perceive forward pricing to be a risky marketing alternative (Isengildina & Hudson, 2001; Jordaan & Grové, 2007), or farmers who do not have sufficient knowledge or skills in the use of forward pricing methods may perceive it as something strange and ineffective in price risk management (Jordaan & Grové, 2007).

A possible reason for the inconsistency may lie in the way forward pricing decisions have been modelled over the years. Most researchers modelled the decision whether or not to adopt forward pricing methods (adoption decision), and the decision on the amount of crop produce to be forward priced (quantity decision), as a single decision⁴. Katchova and Miranda (2004), however, argue that the quantity decision should be modelled conditional to the adoption decision to prevent variables from being forced to influence the two decisions in the same way. The objective of this research is to investigate the relationship between risk aversion and the forward pricing behaviour of Vaalharts maize producers by investigating the decision on the proportion of their 2004/05 maize crop respondents were willing to forward price. Following the suggestion by Katchova and Miranda (2004), the quantity decision is modelled conditional to the adoption decision.

The rest of the paper is structured as follows: the data and procedures are discussed next, followed by the presentation and discussion of the results. Conclusions are drawn and recommendations made in the last section.

2. Data and procedures

2.1 Data and characteristics of respondents

Jordaan and Grové (2007) investigated the factors affecting the adoption of forward pricing methods as a price risk management option amongst a sample⁵ of irrigation farmers from the Northern Canal region of the Vaalharts irrigation scheme. The same dataset is utilised in this research. It includes information on the farmers' personal and business characteristics, relative risk aversion as well as their marketing behaviour. The dataset was compiled by

⁴ Typically Multinomial Logit (Sartwelle et al., 2000) and Tobit models (Goodwin & Schroeder, 1994; Musser et al., 1996; Shapiro & Brorsen, 1998; Sartwelle et al., 2000) are used.

⁵ For details about the sample size and the sampling technique that was used refer to Jordaan and Grové (2007).

personally interviewing the farmers by means of a structured questionnaire during October 2005. Fifty of the respondents produced maize during the 2004/05 production season of which 22 participated in some form of forward pricing. Since the aim of this analysis is to identify factors that significantly affect the quantity decision conditional on the adoption decision, only those 22 farmers who participated in some form of forward pricing were analysed further. Although the low number of observations may cause some bias in the results, the results are deemed to be acceptable since the aim is not to predict the actual amount of maize respondents are willing to forward price. The purpose rather is to investigate the direction of the influence of alternative characteristics, especially that of risk aversion, on the level to which farmers use forward pricing methods. Summary statistics of some of the personal and business characteristics of the sub-sample of farmers who have used forward pricing methods are shown in Table 1.

The yield risk premium is used to measure the relative risk aversion of the farmers (Musser *et al.*, 1996). A larger premium indicates that the decision-maker is more risk averse. Table 1 shows that on average the farmers are willing to sacrifice 14.21% of their current yield to obtain a constant yield. However, the premiums vary widely as indicated by the relatively large standard deviation of 12.58%. Based on the average scores of respondents with regard to questions that obtained information on their perceptions, it is interesting that 79% of the respondents indicated that they perceive forward pricing to be an effective marketing strategy. The average score of the farmers' preference for the free market system to a regulated marketing system, however, suggests that they are not too sure which of the two marketing systems they prefer to the other. This may be an indication that, although they feel that forward pricing is an effective marketing strategy, they still do not totally trust the forward pricing market, or they still perceive it to be somewhat of a black box (Jordaan & Grové, 2007). The average age of the farmers in the sample is 51 years while they have on average 23 years of farming experience. They are relatively well diversified in their production practices and receive on average 12% of their total income from off-farm economic activities.

Table 1: Summary of personal and business characteristics of the sub-sample of Vaalharts maize producers who have used forward pricing methods to market their 2004/05 maize crop (n=22)

Characteristics	Mean	Standard deviation
Age (Years)	51.1667	10.1196
Tertiary education (Yes=1/No=0)	0.5417	0.5090
Experience (Years)	23.0652	12.1677
Marketing skills (1-7)	4.3750	0.8754
Off-farm economic activities (%)	12.42	22.45
Insurance (Yes=1/No=0)	0.9167	0.2823
Specialisation (index where 1 = specialisation in one crop)	0.3305	0.1207
Proportion farmland rented (%)	0.1808	0.2438
Centre pivot adoption (Yes=1/No=0)	0.8750	0.3378
Yield risk premium (%) *	14.2083	12.5836
Forward price perception (Yes=1/No=0)	0.7917	0.4149
Free market preference (1-7)	3.9167	2.6361

* The yield risk premium is a proxy for the respondent's level of risk aversion. It is the proportion of the current expected yield that a respondent is willing to sacrifice for the opportunity to produce a crop with a constant yield (Musser *et al.*, 1996).

Looking at the levels to which the respondents used forward pricing methods to market their 2004/05 maize crop leads to an interesting finding. On average respondents indicated that they forward priced about 75% of their crop. That is substantially higher than the forward pricing ratios⁶ found in the majority of the research that investigated the levels to which farmers use forward pricing methods (Shapiro & Brorsen, 1988; Davis & Patrick, 2000; Sartwelle *et al.*, 2000). In all of these studies respondents cash forward contracted less than 30%, and hedged less than 20% of their crops. The higher forward pricing ratio found in this study may be attributed to the inclusion of only adopters of forward pricing methods in this research. From the literature it is not clear whether the other researchers included both adopters and non-adopters when they calculated forward pricing ratios. The low forward pricing ratio found in the literature may be due to the inclusion of the forward pricing ratios of both non-adopters and adopters in their average forward pricing ratios. Considering that optimal hedging research conducted in the US suggest that farmers should forward price between 55% and 90% of their crop to minimise their exposure to price risk (Alexander *et al.*, 1986; Grant, 1985; Myers & Thompson, 1989; McNew as cited by McNew & Musser, 2000), the respondents to this study actually do use forward pricing methods to the prescribed levels.

The discussion of the proportion of maize respondents forward priced concludes the discussion of the data and characteristics of the respondents.

⁶ The forward pricing ratio refers to the proportion of the total crop that is forward priced.

The procedure that was followed to meet the objective of the study is discussed next.

2.2 Procedures

2.2.1 OLS regression of the factors influencing the level of forward pricing

The dependent variable in this analysis is the proportion of the 2004/05 maize crop forward priced by the farmer. Recall, forward pricing includes both the use of cash forward contracting and hedging with futures and/or options through SAFEX. Since the dependent variable in this analysis is continuous, OLS linear regression is used to investigate the factors which influence the decision on the proportion of maize crop the farmer is willing to forward price. The OLS model may be expressed as:

$$Y_i = \beta_0 + \beta_j X_j + \varepsilon$$

Where Y_i is the proportion of his/her crop which farmer i forward priced, β_j the parameters to be estimated, and X_j are the factors which influence the proportion of maize crop the farmer is willing to forward price.

2.2.2 Hypothesised explanatory variables

Since this analysis is performed on a sub-sample of the sample used by Jordaan and Grové (2007), the same variables which were hypothesised to influence the adoption decision in their study were also hypothesised to influence the quantity decision in this study. The hypothesised explanatory variables, and the expected directions of the influence of the respective variables, are shown in Table 2.

Table 2: Variables expected to influence the quantity decision and the expected signs of the influence of the variables on the quantity decision

Variable	Definition	Expected sign
EXP	Number of years of farming experience the respondent has	+/-
MKTSKLL	Respondent's self-rating of his marketing skills relative to that of other farmers in the region (measure on scale from 1 (much lower) to 7 (much higher)).	+/-
OFFECON	Proportion of total income that was generated from off-farm economic activities (%).	+/-
INSUR	Dummy variable scoring 1, if respondent used crop insurance, 0 otherwise	+/-
SPECIAL	Level of diversification (index compiled by summing the squared proportional contributions of all enterprises to the total farm income. A value of 1 indicates the specialisation in the production of 1 crop.)	+/-
CP	Dummy variable scoring 1, if respondent adopted centre pivot technology, 0 otherwise.	+/-
FREEMKTPREF	Rating of respondent's preference for a free market rather than a market regulated by government on a scale from 1 - 7 with 7 indicating a 100% preference for the free market.	+
PROPRENT	Proportion of farmland that is rented (%).	+
EDU	Dummy variable scoring 1 if respondent has some form of tertiary education, 0 otherwise.	+
FWDPERC	Dummy variable scoring 1, if respondent perceives forward pricing to be effective in reducing price risk, 0 otherwise.	+
RISKAVER	Level of risk aversion measured by means of a yield risk premium (Proportion of current expected yield that respondent is willing to sacrifice for opportunity to produce crop with constant yield).	+

Table 2 indicates that the expected direction of the influence of the level of risk aversion (RISKAVER) on the level to which farmers use forward pricing methods to be positive. Such an expectation follows from expected utility theory which leads one to expect that a risk averse farmer will use tools that are available to reduce his exposure to risk (McNew & Musser, 2000). Furthermore Shapiro and Brorsen (1988) argue that farmers who are sufficiently risk averse should use forward pricing methods even if forward pricing result in lower average prices. Clearly there are sufficient reasoning behind the expectation that the relationship should be positive. Table 2 also indicates that the expected directions of the influence of a number of the variables are ambiguous. A farmer who has more years of farming experience (EXP), for example may be in a healthier financial position, and therefore willing to forward price a larger proportion of his crop (Davis, 2005). On the other hand, such a farmer may be more accustomed to the previous regime of market regulation, and the farmer may be expected to forward price at a lower level. Likewise, a farmer who rates his marketing skills (MKTSKLL) higher than that of other farmers is expected to forward price a larger proportion of his crop

(Isengildina & Hudson, 2001) compared to a farmer with a lower perception of his marketing skills. However, a farmer who does not perceive his marketing skills to be up to scratch is likely to use consultation services when making marketing decisions. The consultant may, however, advise the farmer to forward price a larger proportion of his crop. From the above it is clear that these two variables can influence the quantity decision either positively or negatively. The remaining variables with ambiguous expected influences are alternative risk management tools. The use of alternative risk management tools is expected to influence the level to which farmers use forward pricing methods since it influences the overall risk of investing in farming (Bown *et al.*, 1999). The expected direction of the influence depends on whether the alternative risk management tool is used to complement forward pricing (positive relationship), or to substitute for it (negative relationship). The alternative risk management tools considered in this study include off farm economic activities, the use of crop insurance (INSUR), diversification, which is the inverse of specialisation (SPECIAL), and the use of centre pivot irrigation technology (CP).

The last four variables are expected to influence the quantity decision positively. A farmer is expected to forward price a larger proportion of his crop if the farmer has a good perception of forward pricing in price risk management (FWDPERC) (Isengildina & Hudson, 2001). Similarly, a producer who prefers the free market system to a regulated system (FREEMKTPREF) is also expected to forward price a larger proportion of his crop than a farmer who is more in favour of a regulated marketing system. A farmer who is in favour of the free market system may perceive the forward pricing market as an opportunity to generate higher prices (McNew & Musser, 2000). The reason for the positive relationship between forward pricing and formal education (EDU) is that more educated farmers are expected to be more likely to adopt new technology (Goodwin & Schroeder, 1994), and therefore also to forward price a larger proportion of his crop. Finally, it is assumed that only the prosperous farmers will rent additional farmland (PROPARENT). The prosperous farmer is assumed to have a higher level of human capital which will enable him/her to use forward pricing methods to sufficiently high levels.

The discussion of the factors which are hypothesised to influence the quantity decision concludes this section. The next section covers the presentation and the discussion of the results obtained from the regression analysis.

3. OLS regression of the factors affecting the proportion of maize farmers are willing to forward price

The results from the linear regression on the factors which influence the decision of the proportion of maize which a farmer is willing to forward price is shown in Table 3.

Table 3: OLS regression results of the factors affecting the proportion of the maize crop Vaalharts farmers are willing to forward price during 2004/05

VARIABLES	Coefficient	Std Error	t-test	Prob(t)
Intercept	65.2090****	18.4380	3.5370	0.0060
RISKAVER	0.4540*	0.2540	1.7870	0.1080
SPECIAL	-152.1400****	43.9650	-3.4600	0.0070
INSUR	30.8740**	15.5500	1.9850	0.0780
FREEMKTPREF	3.6030**	1.7900	2.0130	0.0750
OFFECON	-0.4390***	0.1390	-3.1530	0.0120
FWDPERC	20.5790**	11.1900	1.8390	0.0990
F-test	6.1680	Number of observations		22
Prob(F)	0.0547	Degrees of freedom		15
R ²	0.7870			
Adjusted R ²	0.6600			

Note: *, **, *** and **** indicates statistical significance at 15%, 10%, 5% and 1% respectively.

Table 3 shows that six⁷ of the eleven hypothesised variables were found to significantly ($p < 0.11$) affect Vaalharts farmers forward pricing decisions. The F-test suggests that these variables jointly are significant ($p < 0.06$). Together the six variables explain 66%⁸ of the variation in the proportion of maize that is forward priced. Important to note is that the estimated coefficients may be bias due to the small sample size and the resulting degrees of freedom. Although the estimated coefficients may be bias, one can still infer important information regarding the direction of influence of the variables that significantly affect farmers forward pricing decisions.

The farmer's level of risk aversion (RISKAVER) has a significant ($p < 0.11$) positive influence on the level to which he is willing to forward price. By implication, given that a farmer adopted the use of forward pricing methods, a farmer who is more risk averse is likely to forward price a larger proportion of his crop compared to his less risk averse counterpart. The positive relationship between risk aversion and the level to which farmers use forward pricing methods moreover is consistent to expectations from expected utility theory.

⁷ These variables were identified through stepwise regression procedures with a threshold significance level of 15%.

⁸ The adjusted R² is interpreted since the adjustment seeks to remove the distortions that may arise due to small sample size (NCSS, 2000).

Important to note is that Jordaan and Grové (2007) found a negative relationship between increasing levels of risk aversion and the adoption of forward pricing methods in price risk management.

Table 3 indicates different signs and hence, directions for the alternative risk management tools under consideration. This implies that some are used complementary to forward pricing (positive relationship), while others are used to substitute for it (negative relationship). According to Table 3, Vaalharts maize producers tend to use diversification ($p < 0.01$), which is the inverse of SPECIAL, and crop insurance (INSUR) ($p < 0.1$) complementarily to forward pricing to manage risk. On the contrary, off-farm economic activities (OFFECON) ($p < 0.05$) substitute for forward pricing as a risk management strategy. A farmer with a larger proportion of his income coming from off-farm economic activities is less exposed to the adverse effect caused by a sudden decrease in the price of maize. Since off-farm economic activities reduce farmers' exposure to price risk, it also reduces their need to manage price risk. From that point of view it is understandable that producers with higher levels of off-farm economic activities forward price at lower levels than those producers whose income is totally dependent on the income they receive from selling their crop. Since respondents tend to use a portfolio of risk management strategies there is an indication that the sample of Vaalharts maize producers are actively managing their exposure to overall risk on their farms.

The remaining variables influence the quantity decision in the direction as was initially hypothesised. Producers who perceive forward pricing to be effective in reducing price risk (FWDPERC) ($p < 0.10$), as well as those who prefer the free marketing system to a regulated marketing system (FREEMKTPREF) ($p < 0.10$), forward price at higher levels than the others. The positive relationship between the level of forward pricing and a good perception of forward pricing as a price risk management tool confirms the argument by Isengildina and Hudson (2001) that farmers will use forward pricing methods if they perceive it to be effective in reducing price risk.

The discussion of the factors that were identified to influence the quantity decision concludes this section. Some conclusions are drawn and recommendations made in the next section.

4. Conclusions and recommendations

The main conclusion from this research is that the relationship between farmers' risk aversion and the quantity of maize forward priced is consistent

with expected utility theory in spite of the finding of Jordaan and Grové (2007) that farmers need to be less risk averse to adopt forward pricing. Thus, although farmers may experience forward pricing as risky, once they have adopted forward pricing methods the quantity that they will forward price is positively related to their level of risk aversion. These results highlight the importance of modelling the quantity of maize forward priced conditional on the adoption decision. These results also confirm the reasoning of Katchova and Miranda (2004) that the direction of influence as well as different factors may influence the decision to adopt and the quantity to forward price differently. An important result from this research is that once a farmer has made the decision to forward price the actual quantity forward priced (75%) is consistent with optimal hedging theory. In light of the results obtained in this research and that of Jordaan and Grové (2007) future emphases should be placed on the factors affecting the adoption of forward pricing as risk management tool in order to promote risk management, especially research that will change farmers' perception about forward pricing is necessary.

The conducted research may be improved in several ways. Modelling the quantity decision conditional on the adoption decision significantly reduced the number of observations that one can include in the statistical analyses which may possibly result in some bias. Therefore researchers should increase their original sample sizes to ensure that the number of respondents that have adopted forward pricing is sufficient to conduct statistical analyses. Since this research was conducted on a sub-sample of the research done by Jordaan and Grové (2007) in Vaalharts, the result should not be generalised to be representative of maize producers in South Africa. Similar research should be conducted in other regions to obtain information on the forward pricing behaviour that are representative for the whole South Africa.

A relatively simple measure of risk aversion (yield risk premiums after Musser *et al.*, 1996) was used to proxy for the level of risk aversion. The research could also be improved by using more sophisticated measures of risk aversion. More sophisticated measures include, among others, absolute risk aversion (ARA) and partial risk aversion (PRA) (Saha *et al.*, 1994; Ferrer *et al.*, 1998). Since this study was conducted on a sub-sample of the study by Jordaan and Grové (2007), it was not possible to obtain relevant information to elicit the respondents' levels of risk aversion following the approaches described by Saha *et al.* (1994) and Ferrer *et al.* (1998). It is, however, recommended that the more accurate measure should be used in future research.

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