

Are Brazilian corn farmers overconfident about prices?

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This paper aims to identify signs of overconfidence among corn producers in south and central-west Brazil. Over the period from October to November 2008, farmers were chosen to answer questions regarding their knowledge of futures markets and price expectations. A large part of subjects responded they do not trade futures contracts because they do not have enough information on the subject. The results show respondents were miscalibrated when estimating directly-stated and the indirectly-stated expected prices. In addition, for certain respondents, subjective variance for corn proves to be significantly less than the market variance. Finally, the paper concludes that the overconfidence effect can partially explain the low use of futures markets by Brazilian corn producers.

Key words: overconfidence, subjective probability, probability elicitation

Introduction

Commodity price is an important variable in determining whether an agricultural activity will be successful or not. Therefore, efficient risk management is crucial for the long-term economic survival of farms, and many instruments exist in the market for this purpose (EGELKRAUT, et al., 2006).

Aguiar (1999) showed that there are at least three strategies which can be used by farmers to manage price risk. They include forward, futures and options contracts. Depending on the farmer's goals, each of these alternatives bring more advantages than

the others. Empirically, while these strategies are known as important management tools in agricultural markets, they are not widely known or used by Brazilian farmers (BORELLA, 2004). In a recent survey, Associação Nacional dos Confinadores (2008) - ASSOCON found that only 4% of the 486 feedlots in the state of Goiás, Brazil, hedge their production at the Brazilian Mercantile and Futures Exchange - BM&F¹. Academically, many studies have already proclaimed the benefits farmers can receive when using these tools, especially in futures markets (MARQUES, MELLO and MARTINES-FILHO (2008), ALVES, DUARTE and LIMA (2008), SILVEIRA and FERREIRA-FILHO (2003), ARBEX and CARVALHO (1998)). However, only a few of them give some explanation for the low use of these tools. Andrade (2004), for example, revealed that transaction costs in the context of the Brazilian futures markets can explain why many corn producers do not trade on BM&F to hedge their production. The same author showed that these costs are, on average, between 2 to 6.5% of the initial value of the contract. He concluded that traders facing cost risk diminish the risk management benefits offered by futures markets and have a similar effect of the basis risk. Furthermore, cost risk can reduce farmers' willingness to hedge. Cruz-Junior, Marques and Martines-Filho (2008) demonstrated that in a downside risk framework sometimes the "true hedge ratio" can be smaller than the traditional one (obtained by the standard mean-variance model framework). In conclusion, more risk-averse cattle producers can hedge a smaller share of their current production simply because they face risk in an alternative way.

¹ According to the Instituto Brasileiro de Geografia e Estatística - IBGE (2008), in 2007, the state of Goiás was the fourth most important cattle producer in Brazil.

Some authors have already sought explanations for the low use of these hedging tools by Brazilian farmers. However, no Brazilian economic literature has been found which gives either empirical or theoretical attention to the relationship between agricultural commodities prices quoted in organized futures markets and the subjective expectation of individuals. No attention has been given to producers' subjective expectation or to their psychological influences in decision making. As discussed by Eales et al. (1990), this issue is of great importance to the validity of many studies that assume that futures price is a proxy for expected price. In addition, this relationship is fundamental to most hedging decisions. For example, if a farmer is optimistic about futures/cash prices, there is no reason for he/she to assume a short position in futures markets. This optimism can be perceived in at least two different ways: futures prices are expected to be higher than the historical mean, and/or, the variance of futures prices are expected to be lower than the historical variance. This optimism is referred to in the literature as overconfidence and can play a major role in explaining why farmers hedge only a small part of their production or do not hedge at all.

The motivation for this paper is to verify if Brazilian corn farmers exhibit any signs of overconfidence about prices, which in turn would provide an alternative explanation as to why they do not hedge in futures markets. To this end, a group of corn producers from south and central-west Brazil were chosen to complete a survey questionnaire. The survey was used to elicit farmers' subjective probabilities regarding expected cash prices. If at least a portion of farmers reveal overconfidence about expected cash prices when compared to futures prices, their behavior could be responsible in explaining farmers' unwillingness to hedge their production with futures markets.

Review of Literature

Overconfident behavior has been cited by many researchers in explaining individual decision-making under uncertainty. Cunningham III et al. (2008), for example, found that men's overconfidence makes them trade stocks more often than women and that consequently, they receive lower prices. Glaser and Weber (2007) found that overconfident investors will trade more than rational investors. Umarov and Sherrick (2005) identified signs of overconfidence among farmers which could explain their crop insurance purchasing decisions. Eales et al. (1990) also found signs of overconfidence among farmers when their subjective probability distributions around futures and options prices were analyzed.

Despite an increasing number of researchers who had summarized their findings as overconfidence, according to Glaser and Weber (2007), there is no precise definition to the overconfidence in the literature on heuristics and biases. Biais et al. (2003) defined overconfidence as a prevalent tendency of individuals to overestimate their skills, the probability of positive outcomes, or the accuracy of their knowledge.

Graham, Harvey and Huang (2005) distinguished two different definitions of overconfidence. On the one hand, according to these authors, within the finance literature, overconfidence is usually defined as overestimating the precision of information regarding the value of a financial security. On the other hand, within the psychology literature, *“overconfidence can mean either believing that the distribution of your knowledge is tighter than it actually is or, believing that your mean skill is higher than it actually is”* (GRAHAM, HARVEY and HUANG, p. 7, 2005).

More precisely, overconfidence can manifest itself in the following forms: *miscalibration, better than average effect and illusion of control*².

Miscalibration

Eales et al. (1990) briefly discussed some reasons as to why individual expectations may not agree with futures and options prices. One of their explanations is that individual probabilities assessments may be miscalibrated with the distribution of actual outcomes. That is, farmers' expectation may not accurately reflect the underlying distribution of prices. Therefore, it is expected that individuals would be overconfident and their subjective probabilities distributions consequently too narrow.

Umarov and Sherrick (2005) explained that miscalibration can be assessed using two different methods. The first is called the confidence interval method. It consists of a list of questions to which the respondents answer and state their confidence in the correctness of their answers. Their confidence levels are then compared to the probability of answering correctly. For example, Biais et al. (2003) used this method to measure the degree of overconfidence of 245 participants in a trading game. They asked the respondents to write down low and high values to general questions such as the age of Martin Luther King Jr. at death, the air distance from London to Tokyo, etc.

The second means of assessing the miscalibration effect is to ask respondents to provide a subjective probability distribution for an unknown quantity/yield/price. This subjective distribution is then compared to the true or historic distribution (objective

² More forms of overconfidence can also be listed here, such as volatility estimates (Glaser and Weber, 2007). However, some of these forms are considered as an alternative definition or part of the forms which were pointed out here.

distribution). If the intervals provided are too tight, the conclusion is that historical volatilities are underestimated and the investor is overconfident. Pease (1992), for example, used this method to elicit subjective corn and soybean yield probabilities from 90 Western Kentucky grain farmers. Previously, Eales et al. (1990) had used the same method to obtain estimates from different farmers groups and elevators in Illinois regarding their grain price expectations. The number of respondents within each group ranged from 14 to 59 people.

De Bondt (1998) asked 45 investors to provide point forecasts of the closing level of the Dow Jones index and their main equity holdings. They were also asked to produce interval estimates (price levels) for which they believed there was only a one-in-ten chance that the equity would turn out higher and lower. The author found that perceived confidence intervals were too narrow relative to the actual variability in prices.

Smith and Mandac (1995) estimated and compared the subjective and objective probability distributions of rice yield for farmers in the Philippines. They solicited responses from 21 farmers in two different rice-growing areas and aimed to analyze whether their objective distributions could be taken as reasonable approximations of their perceptions. Farmers were surveyed before having any prediction of the weather conditions for the current crop season. First, the authors asked the farmers to specify their prediction for lowest and highest yield in the coming season. This range was then divided into five equal intervals. Twenty-five coins (amount of money equivalent to one day of work) were then given to the farmers and they were asked to distribute these coins among the intervals. Farmers were informed that at the end of the season, yields on the plots were going to be quantified and they would receive their previous

allocation of coins, according to the interval which included their realized yield. They found that while the means were similar, the subjective variance was substantially lower than objective variances.

Better-than-average effect

Some researchers suggest that investors can be considered overconfident if they believe they are above average, (i.e. if they judge themselves as better than others with regard to skills or positive personality attributes) (Glaser and Weber, 2007).

Benoît and Dubra (2008) mentioned some research in which the better-than-average effect is described by showing that most people perceive themselves as more intelligent than their average peer, that most business managers rate their performance as better than their average fellow manager or that most high school students rate themselves as more original than the other high school students.

Both Glaser and Weber (2007) and Benoît and Dubra (2008) highlighted the work developed by Svenson (1981) as one of the classical examples of the better-than-average effect. In Svenson's study, subjects were asked about their competence as drivers in relation to a group of drivers. He found that 77% of Swedish subjects felt they were safer drivers than the median, and 69% felt they were more skillful. He still found that 82% of a group of students ranked themselves among the top 30% safest drivers.

Using survey data from 258 Illinois corn farmers, Egelkraut et al. (2006) investigated the relationship between subjective and objective yield measures and their effect on the use of crop insurance for corn. Among their motivation for research was included the claim that, even if insurance premiums were actuarially fair, there was little motivation for farmers to use insurance if their subjective yield distribution was more confident in high yields. Based on the answers to questions regarding farm-level yields

and farmers' perceived relative performance compared to other farmers, the authors found that producers see themselves as better-than-average with respect to yield and their variability.

The work developed by Hyytinen and Pajariten (2005) is another notable example of better-than-average effect in finance. The authors conducted their research with a sample of 393 four-month-old start-up firms in Finland. One of the questions they included in their survey asked entrepreneurs to estimate the probability that their venture would fail and that they would no longer be in business three years from that date. According to their findings, 87% of new entrepreneurs expected to survive at least three years in business, whereas the actual statistical survival rate was around 60% at the time.

Illusion of control

According to Graham, Harvey and Huang (2005), the illusion of control effect can be defined as the tendency to believe that one's personal estimate of probability of success is higher than an objective probability would warrant.

Keh, Foo and Lim (2002) defined the illusion of control effect as a bias in which the individual overemphasizes the extent to which his or her skills can increase performance in situations where chance plays a large role and skill is not necessarily the deciding factor. These same authors mentioned that entrepreneurs often show "*an unusually strong preference for exerting control over their outcomes because they believe they can exert control over people and events*" (KEH, FOO and LIM, p. 131, 2002). Consequently, individuals who exhibit this form of overconfidence are more

likely to underestimate risk because they believe their skills can prevent negative occurrences.

After discussing some forms of overconfidence, Umarov and Sherrick (2005) asked the following question: How reasonable is to expect overconfidence among farmers? They answered that although some forms of overconfidence, such as the better-than-average effect and optimism can be found in various occupations, miscalibration is a different case because it varies among professions. According to Gervais, Heaton and Odean (2002), in the presence of high predictability, repetitive simple tasks, and clear and fast feedback, the individuals are well calibrated. Such is true in the case of bridge players, race bettors, and disabled people (Umarov and Sherrick, 2005). However, if the feedback is slow and noisy, individuals such as managers making a capital investment, for example, will not be well calibrated.

When analyzing the three conditions listed by Gervais, Heaton and Odean (2002), Umarov and Sherrick (2005) concluded that there is empirical evidence that suggests the presence of overconfidence among farmers. The predictability of harvesting outcomes is low, and prices and yield are random variables. The feedback on an initial investment is distant in time and noisy. Furthermore, the decisions farmers make are somewhat complicated, and could obscure learning and lead to overconfidence bias in their judgments. According to Umarov and Sherrick (2005), farming as a profession should lie somewhere between weather forecasting and capital investment decisions.

Method

The survey

During the months of October and November of 2008, a total of 90 corn producers in south and central-west Brazil were surveyed. Respondents from south Brazil consisted of prospective and new clients of a consulting company (Noble Group) and those from central-west Brazil were co-operators of a socioeconomic institute (Instituto Mato - Grossense de Economia Agrícola) or related to the Goiás State University.

Their subjective corn price expectation was obtained in two formats. First, using a direct question, producers' cash price expectations were obtained by simply asking farmers the most likely average price at which they expected to sell a 60 kg corn bag the following March. The second was an indirectly-stated price, based on the probability assignment task. Producers were asked to fill in boxes with the probabilities they believed that the corn price would stay within for each of the listed price ranges, during the following March/July. March and July were selected, first, because they are closest to the harvesting period in south and central-west³ Brazil, respectively. Second, March and July contracts are the most liquid futures contracts traded at the BM&F.

Participation in the survey was voluntary, unassisted and no financial incentive was given to respondents.

The same survey method was used to obtain probability estimates by Clop-Gallart and F. Juárez-Rubio (2007), Egelkraut et al. (2006) and Eales et al. (1990).

³ Only for the state of Mato Grosso. In the state of Goiás, the first crop season is the most important.

The subjective probability distribution and the method for comparing subjective spot prices and futures prices volatilities

A subjective probability can be interpreted “as a decision maker’s degree of beliefs or expectations about the outcome of a nonrepetitive, uncertain event” (GRISLEY and KELLOG, p. 74, 1983). It can be thought of as a translation of someone’s beliefs after using the information available and processing abilities. Moreover, its true value is found to be between zero and one. Considering this final point, while responding to the survey subjects were asked to state “scores” from 0 to 100% to reflect their perceived likelihood of each price range listed in the questionnaire. Pease (1992) defined a “coherence of probability” requirement as the condition of the summation of each price range probability being equal to one (or 100%).

As the aim of this paper is to test for overconfidence based on the miscalibration effect, one must first verify whether the respondents were well calibrated in their answers when estimating directly-stated and indirectly-stated expected prices. To do so, literature proposes using a two-sided t-Student test expressed in the following form:

$$t_{\alpha/2} = \frac{P^I - P^D}{S_{P^I}} \quad (1)$$

Where is P^D the directly-stated price, P^I and S_{P^I} are respectively the indirectly-stated price and the standard deviation calculated from the elicited subjective distribution, and α is the significance level. On one hand, the null hypothesis states that there is no difference between the two elicited prices. On the other hand, the alternative hypothesis states that the respondent can be miscalibrated when directly estimating either a higher or lower price compared to the expected subjective mean of the subjective distribution. Buzby et al. (1994), for example, also analyzed discrepancies

between subjective and historical yield distributions for Kentucky farmers. According to their findings, there is a correspondence between the means of the two distributions, but farmers overestimate their yields and underestimate their risk.

Second, the study must verify whether individuals are miscalibrated when (over)underestimating the variance of spot prices when compared to the historical variance of futures and spot prices. If the subjective variance is smaller than the empirical one (i.e. the perceived distribution of spot prices is tighter than the historical distribution of futures and spot prices) it can be concluded farmers do not expect prices will vary as much they used to⁴.

Under the assumption that the natural logarithm of prices (P_t) is normally distributed with mean μ and variance σ^2 , these parameters were calculated as (Limpert, Stahel and Abbt (2001), Eales et al. (1990)):

$$\mu = e^{\left(\frac{\mu + \sigma^2}{2}\right)} \quad (2)$$

$$\text{var}(P_t) = e^{2\mu + \sigma^2} (e^{\sigma^2} - 1) \quad (3)$$

The variances obtained from survey respondents are monthly based. In order to perform the proposed comparison, means and variances obtained from historical data for futures and spot prices were also calculated as monthly parameters.

According to Berenson and Levine (1999), since it is assumed the variable is normally distributed, the χ^2 test statistic can be used to represent the distribution of the

⁴ Eales et al. (1990) proposed the same type of comparison. However, these authors obtained estimates from respondents regarding their spot price and basis expectations (basis = cash – futures prices). By adding up the expected values of the two variables, they created a subject futures price variable. They also assumed spot price and basis distributions were independent.

variability in the sample data and for testing whether or not the calculated variance (or standard deviation) is equal to a specified value. The test statistic can be calculated as the following:

$$\chi^2 = \frac{(n-1)S^2}{\sigma^2} \quad (4)$$

For a given sample size n (number of filled intervals), the test statistic χ^2 follows a chi-squared distribution with $(n-1)$ degrees of freedom. S^2 and σ^2 are the sample (subject) and the hypothesized population variance (historical), respectively.

The χ^2 test for variance can be either a two-tailed or a one-tailed test, depending on whether the alternative hypothesis is nondirectional or directional. As far as the individuals can be either overconfident or underconfident, Eales et al. (1990) proposed a two tailed χ^2 test to verify differences between the survey and market variances for soybeans and corn prices.

The null and alternative hypotheses are stated as follows:

$$H_0 : S_{subjective}^2 = \sigma_{historical}^2$$

$$H_A : S_{subjective}^2 \neq \sigma_{historical}^2$$

The decision rule is developed as:

$$\text{Reject } H_0 \begin{cases} \text{if } \chi^2 > \chi_U^2 \\ \text{or if } \chi^2 < \chi_L^2 \end{cases}, \text{ otherwise do not reject } H_0.$$

The first condition implies the individual's variance is higher than the market's, from which the conclusion follows that he/she is underconfident. The second condition implies that the variance of the survey respondent is significantly less than the market's variance, what leads to the conclusion that he/she is overconfident.

Data

In addition to the information from the 90 survey questionnaires, futures and spot prices were obtained at BM&F and at Centro de Estudos Avançados em Economia Aplicada – CEPEA⁵, respectively, from January 2004 to October 2008. The nearby contract was used for futures prices. The period was chosen because of spot data availability.

Results

Among the 90 survey respondents⁶, 52 were from southern Brazil (58%). Most were from the state of Rio Grande do Sul (34), followed by Paraná (12) and Santa Catarina (7). In central-west Brazil, most respondents were from Mato Grosso (29), followed by Goiás (8). According to Companhia Nacional de Abastecimento – CONAB (2008), these states are among the top 6 producers in Brazil.

Respondents were also asked to answer additional questions related to their knowledge of futures markets and related issues. A total of 10 respondents answered that they knew about and trade futures contracts at BM&F. Most of the respondents (72) only knew about BM&F but do not trade on it, while the rest (8) did not know about futures markets. The producers who indicated they knew about, but do not trade futures contracts at BM&F were asked to state their reasons for not trading. 75,5% of these producers responded they do not have enough information about trading futures at BM&F, 9 respondents see futures markets as risky (12%), 4 answered they do not trade

⁵ Prices obtained from CEPEA were used as the mean state price for each one of the 5 different states where surveys were applied.

⁶ An example of the survey questionnaire is available upon request.

because it is expensive (5,5%), and only 7% who answered the question claimed they do not trade due to margin calls, because they need advice, or because beginning to trade entails too much bureaucracy.

Subjects were also asked to reveal if they had already sold a part of their next crop. Only 8 producers (9%) said they had already sold a part of it and none of them had sold their entire crop.

When asked about having investments other than those in agricultural markets, 12% (11 respondents) listed alternative investments. Among them, 4 (33.3%) had investments in real estate while others were involved in other activities.

In order to perform the proposed overconfidence analysis, only respondents who were coherent⁷ while listing their estimated probabilities were selected (86 respondents). Three respondents who did not answer this question were eliminated from the analysis, as well as two others who concentrated all their expectations in only one price range. Therefore, 81 respondents were selected for the analysis.

As it was assumed futures and spot prices follow lognormal distributions, the Jarque-Bera test (JB) was also conducted to verify that the natural logarithm of prices is normally distributed. According to table 1, the null hypothesis could not be rejected for the computed values for the JB test, at the 5% level of significance for any of the analyzed series, thus leading to the conclusion that the assumption previously made about the lognormal distribution of prices is reasonable.

⁷ Coherence is defined here in the Pease (1992) sense: elicited subjective probabilities must add up to 1 (100%)

Table 1. Jarque Bera Test for Normality

	Futures	Rio Grande do Sul	Santa Catarina	Paraná	Goiás	Mato Grosso
JB	1.362	1.368	1.345	1.739	3.044	1.362
P-Value	(0.506)	(0.504)	(0.510)	(0.419)	(0.218)	(0.506)

To test if respondents were miscalibrated when pointing out the directly-stated and the indirectly-stated expected prices, the t-Student test was performed. Prices in equation (1) were calculated as the mean prices of their respective lognormal distributions in equation (2) as well as the standard deviation in equation (3). According to the results, at the 5% level of significance, the null hypothesis of equality between the directly and the indirectly-stated prices could not be rejected for only 7 respondents (8.64%). 74 (91.35%) producers revealed themselves as miscalibrated when calculating their expected values. All individuals from south Brazil proved themselves as miscalibrated.

Following Eales (1990), individual subjective variances and historical variance were compared. Calculated chi-squared statistics values were compared to their respective two-sided test statistic (5% level of significance) to evaluate whether individuals were underconfident or overconfident about prices.

Each farmer's subjective variance was compared to the historical variance of his or her respective regional price. 44.44% of farmers revealed themselves as miscalibrated as their subjective variances underestimated the historical variances obtained from regional prices. 28 (44.12%) of them are from southern Brazil and 8 from central-west (28.57%).

When farmer's subjective variances were compared to the historical variance of futures prices, 62 (76.54%) subjects could be considered miscalibrated. 71.69% of central-western farmers and 85.71% of southern farmers expected their subjective variance to be smaller than the historical variance of futures prices.

With the exception of one farmer, all the others who answered he/she knew about and traded futures contracts at BM&F showed themselves as overconfident about the variance of futures prices. Most of the farmers (66%) who answered they knew about but did not trade futures contracts at BM&F because they did not have enough information were also identified as miscalibrated.

Furthermore, two among the eight (25%) farmers who had already sold a part of his/her next crop could be considered as miscalibrated as well as two among those eleven (18%) who said they had an alternative investment than those in agricultural markets.

The results found are in accordance with Eales et al. (1990) and support the hypothesis that corn producers believe spot prices vary less than futures prices. In addition, as some of their subjective variances are smaller than the historical ones, the results indicate signs of overconfidence among farmers.

Conclusions

As a primary work of its kind in the Brazilian literature, this research attempted to discuss and investigate reasons as to why such few corn farmers hedge on futures markets. Moreover, the most important explanation highlighted by this work concerns farmers' perception of variance of spot and futures prices.

The survey applied in south and central-west Brazil showed that only 10% of respondents traded futures at the Brazilian Futures and Mercantile Exchange. Most farmers revealed that they were aware of but did not trade futures contracts. The most important reason for not trading, discovered through the surveys, was that farmers did not have enough information to trade on futures markets.

As argued by many authors, an important factor in determining the type and extent of hedging with options, futures and other risk management tools may be the difference in subjective variances. If farmers perceive variances of spot and futures prices to be lower than they actually are, there may be less incentive for them to hedge on futures markets.

When analyzing differences among subjective and historical spot and futures price variances, evidence was found of disagreement between respondents and the market. Where found, respondents expected lower variances than the market, which points to signs of overconfidence among corn farmers. Differences between directly-stated and indirectly-stated spot prices were also found for most of the farmers, which shows farmers were miscalibrated when evaluating expected prices.

While this research can be considered as novel in the Brazilian literature on futures markets, it is only an initial step of further investigation into the topic. Only when future research investigates multi-period surveys and extends the surveys to a larger number of farmers, can general conclusions be drawn.

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