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The Initial Specification of Viable Futures Contracts: The Use of a New Computational Method of Value at Risk in Iranian Agricultural Commodities Market

S. A. Hosseini-Yekani[1], M. Zibaei[2*], and D. E. Allen[3]

ABASTRACT

The aim of this study is to explore the feasibility of setting up a Commodities Futures Market in Iran. Specifications for the margin requirements, daily price movement limits, the length of expiration intervals, tick sizes and contract size of various potential future contracts are hereby examined. Saffron, pistachio and rice emerge as the three suitable Iranian agricultural commodities. A new computational method of Value at Risk (VaR) optimization model, using a nonparametric sampling approach, is employed to determine the daily margin requirements and daily price fluctuation limits. Expiration intervals are determined by the simulated daily future price with a minimum of volatility. The daily risk free interest rate and the minimum daily average trading value of a participant in the Tehran Stock Exchange (TSE) are used as benchmarks to determine the minimum tick size and contract size for each commodity. These contract specifications are the initially suggested quantities for setting up an agricultural futures market in Iran.

Keywords: Agricultural Futures Market, Contract Specifications, Value at Risk, Sampling Approach, Iran.

INTRODUCTION

The development of an agricultural future exchange is a customary structural policy instrument adopted to help reform and resolve problems encountered in traditional agricultural markets around the world. The history of utilizing such markets dates back to the early 1860's (Du, 2004; Purcell and Koontz, 2003). Prior studies of the history, establishment, and evolution of global agricultural future markets indicates that their introduction has typically been a response to certain economic needs and has frequently removed certain problems and frictions in the markets for commodities. For example Williams *et al.* (1998) provided an excellent assessment of the evolvement of a new future contract. They studied the Chinese Zhengzhou Commodity Exchange Mungbean future contract. The Mungbean future contract was unique for China at the time, as it represented (1) an acknowledgement of market-drive cash market and (2) one of the first future contracts in China.

Important stimulants have traditionally been market failure and inefficiency which cause various forms of difficulties including price-risk or excessive market fluctuations. These have often been the most important motivation for the establishment of these markets, especially in the developing countries (Du, 2004; Purcell and Koontz, 2003).

[1] Department of Agricultural Economics, Sari Agricultural Sciences and Natural Resources University, Sari, Islamic Republic of Iran.
[2] Department of Agricultural Economics, Shiraz University, Shiraz, Islamic Republic of Iran.
[*] Corresponding author, e-mail: Zibaei@shirazu.ac.ir
[3] School of Accounting, Finance and Economics, Edith Cowan University, Western Australia, Australia.

Following this motivation, the Iran Commodity Exchange (ICE) was established in 2005. The limitation is that the contracts are transacted in cash in this exchange. It follows that these contracts cannot be used for hedging by the producers in agricultural market and therefore this cash market cannot play a role in resolving the previously mentioned agricultural market problems (Hull, 2000; Lerner, 2000; Purcell and Koontz, 2003).

The development of an agricultural future market in Iran is a pressing requirement, but it should be remembered that most new future contracts fail (Brorsen and Fofana, 2001). Some studies have shown that probably no more than one-third of future contracts have succeeded (Silber, 1981). The development and introduction of commodity derivatives is an expensive and time-consuming process, especially when it concerns new derivatives (Pennings and Leuthold, 2001). Insight into the characteristics that influence either success or failure of derivatives seems an important consideration in the design of future contracts. Many studies have focused on this issue. For example the work of Williams *et al.* (1998) followed from other researchers noting the necessary conditions for the development of viable future contracts. Also see Gray (1966), Powers (1967), Black (1986), Leuthold *et al.* (1989), Brown *et al.* (1991), Tomek and Robinson (1991), Tashjian (1995), Hieronymus (1996), Harris (1998), Karagozoglu and Martell (1999), Longin (1999), Brorsen and Fofana (2001), Pennings and Garcia (2001), Pennings and Leuthold (2001), Meulenberg and Pennings (2002), Bollen *et al.* (2003), and Pennings and Egelkraut (2003). According to these studies the design of a viable future contract is carried out in several different steps and the optimal choise of agricultural future contract specifications (following a determination of suitable feasible commodities for trading in these markets) has an undeniable role in either success or failure of these contracts.

For example Gray (1966) suggested that future contracts fail because of poorly written contracts and any likely bias in the contracts, in favor of either the buyers or sellers, leads to a boycotting of the future market by large firms, abuse of market power and failure of the contracts to attract speculation. In addition to "commodity characteristics", another issue, important in the identification of successful contract innovations, noted by Black (1986), related to "contract characteristics". This focuses on whether the contract attracts hedgers and speculators and whether it is open to manipulation.

So the aim of the present study is to determine the initial specifications for future contracts for the development of an agricultural future market in Iran. These specifications are specifically determined for saffron, pistachio and rice.

METHODOLOGY

The importance of the specifications of future contracts is dependent upon their success or failure; given the evidence in the prior literature. Thus, in this study, the focus is on a determination of initial levels of margin requirements, daily price limits, expiration intervals, contract sizes and tick sizes for these contracts and for establishing a future market in Iran for saffron, pistachio and rice. These three products are considered as the most important agricultural products in Iran and the most suitable candidates for emerging future markets (Hosseini-Yekani *et al.*, 2009) because of the predominance of export levels as regards saffron and pistachio, and the high level of domestic consumption in the case of rice.

The margin requirement is the most important specification of a future contract which should be attended to first. The margin has a key role determining the security of future trading (Hull, 2000; Purcell and Koontz, 2003). Given there is no payment all the way from the initial trading date up to the delivery date between the buyer and seller of a future contract and given that the prices will likely be changed in the favor of one side of or another the trade, something is somehow required to insure against the default risks of a future contract. The margining system alongside the daily mark-to-market is one of these required mechanisms. The level of margin should be high enough to secure future trading, but a higher margin would mean higher transaction costs. If a very high margin is required it could increase the power of the big market participants and perhaps reduce the likelihood that small players will use such derivatives (Hunter, 1986). So in order to have a successful future contract, the margin should be determined as the minimum required to cover default risks.

Several studies have considered the issue of the optimal margin for future trading from different aspects. For example Figlewski (1984), Gay *et al.* (1986), Hunter (1986), Edwards and Neftci (1988), Warshawsky (1989), Ackert and Hunter (1990), Booth *et al.* (1997), Longin (1999) and Cotter (2001) have concentrated on default risk minimization in determining this optimality. Also Fenn and Kupiec (1993) have studied optimization of the margin level with a view to contract cost minimization.

In order to determine the optimal level of margin to have a suitable function in covering default risks, Value at Risk (VaR) has been employed as a flexible risk measure which is often used as a customary index in the clearing systems of future exchanges. The *VaR* has been defined variedly in literature. *VaR* could be defined as "a loss that will not be exceeded at some specified confidence level" (Hull, 2000). In other words, "the 100a% h-day *VaR* is that number *x* such that the probability of losing *x*, or more, over the next h days equals 100a%" (Alexander, 2001). But formally the *VaR* of a trading loss function ($\zeta_\beta(\Lambda)$) is defined as the β percentile of loss (Λ) distribution function (Gaivoronski and Pflug, 2005), then $\zeta_\beta(\Lambda)$ is the smallest value such that the probability that loss does not exceed this value is bigger than or equal to β (Rockafeller and Uryasev, 2000).

$$\zeta_\beta(\Lambda) = Min\{\zeta \in R : P\{\Lambda \in R : \Lambda \le \zeta\} \ge \beta\} \quad (1$$

Some such future exchanges as the Johannesburg Securities Exchange (JSE) and the Taiwan Futures Exchange (TAIFEX) use a parametric approach and assume a normal distribution for prices to calculate the margin level. Given that the distribution of future prices is not usually normal, this assumption may cause a biased estimation of *VaR* (Van den Goorbergh and Vlaar, 1999; Giot, 2000; Chiu *et al.*, 2006). In order to have less bias in the estimation of *VaR*, a sampling approach is adopted using historical price data without any attached assumption of a specific distributional form or density function instead of the parametric approach.

On the other hand, it is customary to set a daily price movement limit in most future markets in order to prevent large price movements from occurring (Hull, 2000; Purcell and Koontz, 2003). These large price movements might occur as a result of various types of systematic shocks to the markets' supply and demand conditions. Nevertheless, setting price limits should not create an artificial barrier to trading and disturb the normal tendency of price movements in an efficient price discovery process. If these limits are set equal to *VaR* at a high level of β i.e. 99% then not only are large price movements prevented without affecting the normal variation of prices but also the margin at a level of *VaR* of 99% could completely secure the trading by covering the total probable default risks.

There has been a great deal of research undertaken into price limits in the literature on future markets. As examples see: Khoury and Jones (1984), Brennan (1986), Ackert and Hunter (1994), Chance (1994) and Kim and Rhee (1997).

As there is currently no future market existent in Iran, our future prices have to be

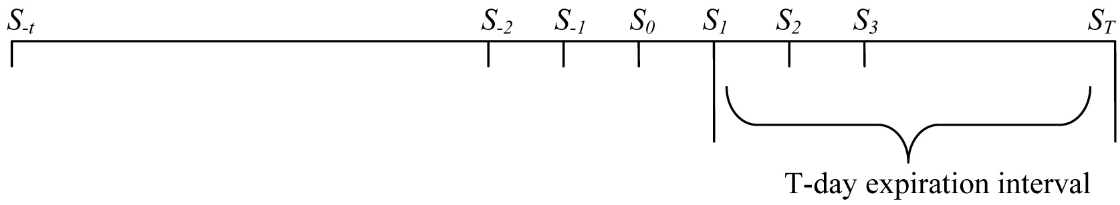

Figure 1. The related spot prices of a future contract with a T-day expiration interval**.**

simulated in order to permit the calculation of VaR in a sampling approach framework.

Figure 1 illustrates the spot prices conditions of a commodity with a T-day expiration interval future contract before and during the expiration interval. In this timeline, S_t shows the level of the spot price of the underlying commodity of a future contract in the t^{th} day of the expiration interval. Then S_{-t} shows the level of this spot price in t days before beginning the expiration interval.

As future prices at each time are determined as the resultant of buyers and sellers expectations about the level of spot prices during the expiration interval, future prices at time t(Ft) could be defined as the expectation of mean value of all spot prices during the expiration interval (Manfredo and Sanders, 2003).

$$F_t = E_t\left[\frac{1}{T}\sum_{i=1}^{T} S_i\right] \qquad (2$$

On the other hand, based on simple arbitrage arguments, the following equation holds for storable commodities (Hull, 2000):

$$E_t(S_K) = S_t e^{c(K-t)} \qquad (3$$

Where K-t is the number of storage days and c is a constant value which involves the total daily current costs (storage, interest, and convenience yield).

According to Equations (2) and (3), the future prices at time t could be written as:

$$F_t = S_t \frac{1}{T}\sum_{i=1}^{T} e^{c(i-t)} \qquad (4$$

Utilizing the eight year monthly spot prices data for saffron, pistachio and rice during 1999 to 2006 obtained from the Ministry of Agriculture of Iran, the monthly future prices of these products in different scenarios of the length of the expiration interval (T) can be calculated from Equation (4).

In order to facilitate the calculation of VaR, in this paper the sample Probability Density Function (PDF) of losses is simulated using the simulated historical future prices without assuming any specific distribution of the loss function. The amount of loss is a function of random future price variable F.

$$\Lambda = f(F) \qquad (5$$

As the target for setting the margins and the daily price limits in the futures market is the covering of the default risk of both sellers and buyers, the amount of loss from the clearing house's point of view in a unit of time t, could be defined as:

$$\Lambda_t = \frac{\left|F_{t+1} - F_t\right|}{F_t} \qquad (6$$

This loss function might be shown at different frequencies i.e. daily, weekly or monthly.

Utilizing the monthly simulated future prices, the amount of monthly loss in the m^{th} month of year y is:

$$\Lambda^M_{y,m} = \frac{\left|F_{y,m+1} - F_{y,m}\right|}{F_{y,m}} \qquad (7$$

Where $F_{y,m}$ shows the future price in the m^{th} month of year y. If Y is the number of total years in the utilized historical data set and 12 is the number of total months in a year, there are $n = 11Y$ scenarios for simulating the sample PDF of monthly losses and Equation (7) showing one of these scenarios in the m^{th} month of year y.

Having obtained the sample PDF of losses, it is possible to calculate the *VaR* at different confidence levels i.e. 99%.

According to the definition, the VaR of losses is the $\lceil \beta n \rceil^{th}$ minimum of all loss scenarios in the sample PDF (Gaivoronski and Pflug, 2005):

$$\zeta_{\beta}^{M}(\Lambda^{M}) = Min^{\lceil \beta n \rceil}\{\Lambda_{1,1}^{M},.........,\Lambda_{y,m}^{M},.........,\Lambda_{Y,11}^{M}\} \quad (8$$

Where $\lceil \beta n \rceil$ is the smallest integer no smaller than βn.

It was argued that daily margin requirement should determine a minimum amount which insures default risks (daily price movement limits). Then, in order to find the initial optimal level of daily margin and price movement limits, one should minimize the daily *VaR* at 99% which is the $\lceil \beta N \rceil^{th}$ minimum of all daily scenarios in the sample PDF of losses:

$$\underset{F}{Min} \quad \zeta_{\beta}^{D}(\Lambda^{D}) = Min^{\lceil \beta N \rceil}\{\Lambda_{1,1}^{D},.........,\Lambda_{y,d}^{D},.........,\Lambda_{Y,263}^{D}\} \quad (9$$

Where $\Lambda_{y,d}^{D}$ is the daily loss in the d^{th} working day of year *y* and could be calculated as:

$$\Lambda_{y,d}^{D} = \frac{\left| F_{y,d+1} - F_{y,d} \right|}{F_{y,d}} \quad (10$$

If 264 is the number of total working days in a year, *N= 263Y* is the number of total daily scenarios in the sample PDF of daily losses.

As in the minimization of the daily *VaR*, there are no estimated values for daily future prices ($F_{y,d}$) and these prices have to be be simulated during the optimization. It has to be considered that the monthly calculated *VaR* corresponding with the monthly loss scenarios using these daily prices ($\Lambda_{y,d}^{M}$) should not be smaller than the calculated $\zeta_{\beta}^{M}(\Lambda^{M})$ in the Equation (8), in order to have an unbiased simulation. $\Lambda_{y,d}^{M}$ could be achieved through Equation (11).

$$\Lambda_{y,d}^{M} = \frac{\left| F_{y,d+22} - F_{y,d} \right|}{F_{y,d}} \quad (11$$

Assuming 264 working days in a year, there are *M= 242Y* scenarios in the sample of monthly losses using daily future prices.

In order to find the solution of Equation (9), as a major contribution in this paper a new computational method of calculating *VaR* is proposed which is more efficient than the previous methods. Solving equation 12 at a confidence level of 99% gives the minimum daily *VaR* at a 99% level which is an indication of the daily margin requirement and daily price movement limit.

$$\begin{aligned}
&\underset{F,\Omega,\Delta}{Min} \quad \zeta_{\beta}^{D}(\Lambda^{D}) = \left[\sum_{j=1}^{N} d_{j}^{D}\varphi(\Omega_{j}^{D})\right]^{-1} \sum_{j=1}^{N} d_{j}^{D}\varphi(\Omega_{j}^{D})\Lambda_{j}^{D} \\
&\sum_{g=1}^{N}\varphi(\Delta_{gj}^{D}) - \Omega_{j}^{D} = \beta N \\
&\Delta_{gj}^{D} - \left(\Lambda_{j}^{D} - \Lambda_{g}^{D}\right) = 0 \\
&\sum_{j=1}^{N} d_{j}^{D}\varphi(\Omega_{j}^{D}) \geq 1 \\
&\left[\sum_{i=1}^{M} d_{i}^{M}\varphi(\Omega_{i}^{M})\right]^{-1} \sum_{i=1}^{M} d_{i}^{M}\varphi(\Omega_{i}^{M})\Lambda_{i}^{M} \geq \zeta_{\beta}^{M}(\Lambda^{M}) \\
&\sum_{h=1}^{M}\varphi(\Delta_{hi}^{M}) - \Omega_{i}^{M} = \beta M \\
&\Delta_{hi}^{M} - \left(\Lambda_{i}^{M} - \Lambda_{h}^{M}\right) = 0 \\
&\sum_{i=1}^{M} d_{i}^{M}\varphi(\Omega_{i}^{M}) \geq 1 \\
&\overline{F_{y}^{D}} = \overline{F_{y}^{M}} \\
&F_{y,d} \geq 0
\end{aligned} \quad (12$$

Where *j= 1, 2,…, N* and *i= 1, 2,…, M* are the number of scenarios in the sample of daily and monthly losses using daily future prices respectively, d_{j}^{D} and d_{i}^{M} are binary (0,1) variables, Ω_{j}^{D}, Ω_{i}^{M}, Δ_{gj}^{D} and Δ_{hi}^{M} are auxiliary variables (in which *g= 1, 2,…, N* and *h= 1, 2,…, M* are indexes that just show the number of scenarios previously given as *j* and *i*) and $\varphi(z)$ is a conditional function such that:

$$\varphi(z) = \begin{cases} 1 & if \quad z \geq 0 \\ 0 & otherwise \end{cases}$$

Also Λ_{j}^{D} and Λ_{i}^{M} are representative variables for $\Lambda_{y,d}^{D}$ and $\Lambda_{y,d}^{M}$ respectively.

$\overline{F_y^D}$ and $\overline{F_y^M}$ are the respectively daily and monthly average future prices in year *y*. The constraint $\overline{F_y^D} = \overline{F_y^M}$ is added to equation 12 in order to have exact simulations of daily future prices and finally the minimum amount of daily *VaR* at 99%.

$$\overline{F_y^D} = \frac{\sum_d^{264} F_{y,d}}{264} \quad (13$$

$$\overline{F_y^M} = \frac{\sum_m^{12} F_{y,m}}{12} \quad (14$$

This new optimization model is much more efficient than the previous methods because it benefits from smaller dimensions. A smaller dimension is a major requirement in the optimization of large scale models (See Appendix for further details.).

Notice that in cases that where there is a local optimum solution, the $\varphi(z)$ function could be produced for the other definable values for different scenarios of such negative *z* values as $\varepsilon \le z < 0$ -where ε has a little absolute value- to achieve smoothing in the model. This method of smoothing is sometimes used in the literature (Alexander *et al.,* 2006; Gaivoronski and Pflug, 2005). However, this method could stray away from the solution for the exact *VaR* in the case of semi-large ε values. Although admittedly the selection of small quantities of ε cannot solve the non-smoothing problem; then in these circumstances, the optimal selection of ε requires trial and error methods.

The other way round this difficulty is via the relaxation of the $\varphi(z)$ function in a relaxed mixed integer nonlinear programming framework using the related solvers. Also in order to choose the best expiration interval for each commodity, Equation (12) was run 21 times for 21 different scenarios of expiration intervals (these scenarios were *T= 2, 3,…, 22* in Equation (4)) and the scenario with the minimal Coefficient of Variation (CV) of simulated daily future prices was selected as the optimal expiration interval. It is assumed that the total working days in each month are 22 days.

After the daily margin, daily price movement limit and the expiration interval, the minimum tick size and contract size of future contracts for saffron, pistachio and rice are considered.

In order to determinate the initial value of tick size of the futures contracts, Figure 2 shows the theoretical relation between the optimum tick size and the transaction costs (Frino, 1997).

As shown in Figure 2, the amount of tick

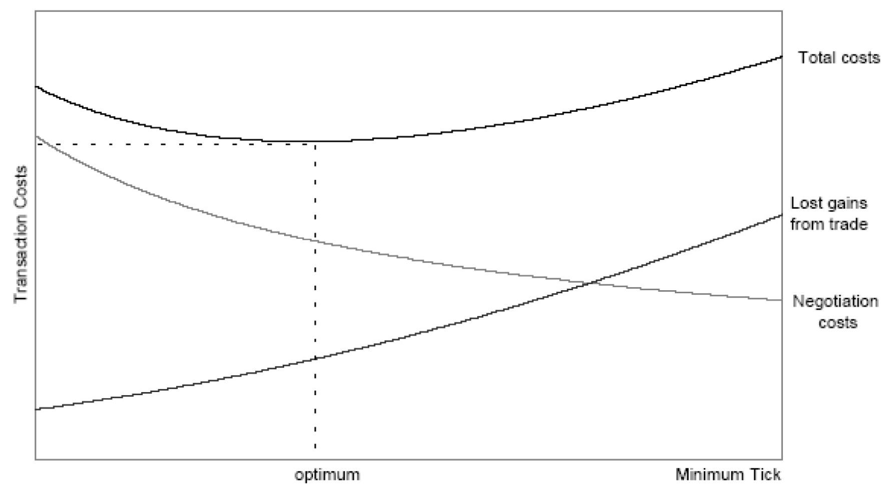

Figure 2. The theoretical relationship between transaction costs and the size of the minimum tick.

size would affect the total transaction costs by the effect on negotiation costs (bargain) and on lost gains from trading. Increasing tick size would decrease the of the negotiation costs by decreasing the price uncertainties. The buyers and sellers confront specific price points for determining the trading prices during the daily price movement limit and by increasing the size of the minimum tick and the result would be to cause a decrease in the negotiation cost.

On the other hand increasing the extent of tick size does not let the buyers and sellers trade at the desired level of commodity prices. This reduction in the traders' abilities to trade at the desired price levels increases transaction costs by increasing the lost gains from trade.

Therefore the optimum level for the tick size of a future contract occurs at the minimum point of total transaction costs. be determined at a level which is not smaller than the risk free interest rate. In other words, setting the initial level of the minimum tick size equal to the level of risk free interest rate would by definition satisfy the attraction of required liquidity to the market.

Finally for a determination of the optimal initial contract size; literature suggests this size to be small enough to let small participants use the market and yet large enough to minimize transaction costs (Karagozoglu and Martell, 1999; Hull, 2000; Purcell and Koontz, 2003).

Given that the Tehran Stock Exchange (TSE) is a customary established market for trading by participants of different size scales in Iran, the minimum daily average trading value of a seller or buyer in this market is taken as an indicator of the smaller potential participants' budget for use of the agricultural futures' market.

$$Contract\ size\,(Kg) = \frac{Minimum\ daily\ average\ trading\ value\ of\ a\ participant\ in\ TSE\,(Rials)}{Average\ prices\,(Rials/Kg)} \qquad (15$$

For some examples of studies of the impact of tick size changes on future markets see: Brown (1991), Chordia and Subrahmanyam (1995), Ahn *et al.* (1996), Frino (1997) and Kurov and Zabotina (2005).

The impact on market liquidity is the most important effect of tick size changes in future markets (Kurov and Zabotina, 2005). A decrease in tick size may increase market liquidity by decreasing the bid-ask spread. Also changing the size of minimum tick may also affect the market depth.

In this study, by necessity, future prices have been simulated and are not the equilibrium prices which result from the forces of market supply and demand. These simulated prices do not show the spread and then price rounding may not show the optimum level of the minimum tick.

The minimum tick sizes should be sufficiently large in order to attract required liquidity (Kurov and Zabotina, 2005). Then the minimum amount of the tick size has to

RESULTS AND DISCUSSION

To determine the initial specifications regarding future contracts for saffron, pistachio and rice in Iran, the first step involved was a simulation of future prices using the available spot prices data from 1999 to 2006 taken from the Ministry of Agriculture of Iran. This simulation was done according to equation 4 for each commodity in 21 scenarios of various length of expiration interval (*T=2, 3,…, 22*). According to the harvesting months of each product; these scenarios for expiration intervals were taken during the months of August, September and November for rice, pistachio and saffron respectively. Also the total daily current costs of these commodities; which are required for the simulation of future prices are calculated as 789×10^{-6}, 241×10^{-6} and 224×10^{-6} respectively for rice, pistachio and saffron.

Table1. The monthly *VaR* 99% of saffron, pistachio and rice in sampling approach using the simulated monthly futures prices corresponding with available monthly spot prices.

Commodity	Monthly *VaR* (%)	Monthly VaR (Rials Kg^{-1})
Saffron	21.45	836430
Pistachio	37.82	20700
Rice	36.33	1815

Following a calculation of the monthly future prices, the sample PDF of monthly losses was simulated for each commodity by Equation (7) in the different scenarios of expiration intervals. Once these sample PDFs of losses are obtained, the monthly *VaR* of 99% could be calculated using equation 8 separately for saffron, pistachio and rice. The values of the calculated monthly VaRs at the 99% levels are presented in Table 1.

The Rials Kg^{-1} equivalents of the *VaR* 99% level in Table 1 are calculated using the average prices of the last year data. Estimations of daily *VaRs* for the selection of the optimal level of margins and daily price fluctuation limits are needed. Monthly *VaRs* have been calculated to set indications in simulating the daily *VaRs*. They have not been directly used in determining the future contract specifications.

Finally running Equation (12) in 21 scenarios of expiration intervals and choosing the most suitable scenario with the minimum level of *CV* gives one the optimum length of expiration interval and the minimum amount of daily *VaR* at 99% which could be used as an estimation of the initial level of daily required margin as well as the price movement limit. These results are presented in Table 2.

As there is not any daily price variation higher than the calculated daily *VaR* shown in Table 2 at a confidence level of 99%, setting the initial amount of margins and daily limits of price fluctuations equal to these amounts for each commodity could serve to secure future trading without affecting the normal trends of prices. The selected expiration intervals in Table 2 are the scenarios where the simulated future prices bear the minimum *CV*. The last column in Table 2 contains the corresponding annual *CV* values.

Also (Figure3a, b and c) illustrate the simulated daily future prices of saffron, pistachio and rice in the best scenarios of expiration intervals during the last 6 years of the sampled data.

The increasing primary trends of 6 year simulated daily future prices in (Figure3a, b and c) are the result of existing price inflation in the agricultural market of Iran. But the annual trends of these effects are different for different years and also for different commodities.

These trends are in balance in the cases of saffron and pistachio (Figures 3a and b). There is no sign of any continuously increasing or decreasing annual primary trend in these two commodities, whilst in the case of rice (Figure 3c) all annual trends are decreasing. A future market with such a strict annual decreasing (or also increasing) primary trend could not be successful and viable.

Table2. The daily *VaR* 99%, length of expiration interval and *CV* of simulated daily futures prices of saffron, pistachio and rice in optimum scenarios.

Commodity	Daily *VaR* (%)	Daily VaR (Rials Kg^{-1})	Expiration Interval (Working day)	Annual coefficient of
Saffron	1.08	42120	9	2.19
Pistachio	1.47	805	5	2.93
Rice	1.20	60	21	1.69

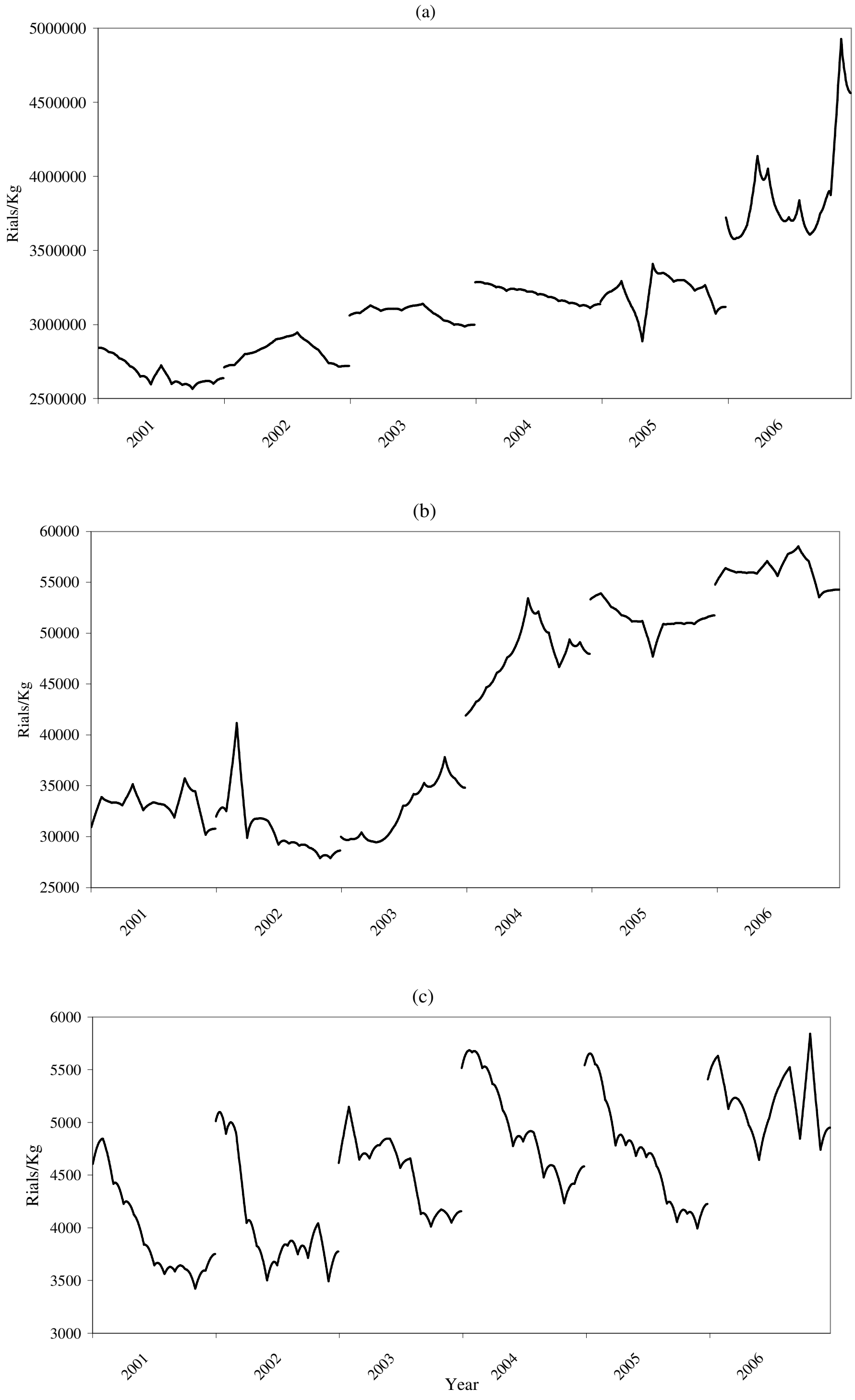

Figure 3a, b and c. The simulated daily future prices of, (a) saffron with 9 working days, (b) pistachio with 5 working day and (c) rice with 21 working day expiration interval during 2001-2006**.**

Table 3. The optimum future contract size and tick size of saffron, pistachio and rice.

Commodity	Contract size (Kg)	Tick size (Rials Kg^{-1})
Saffron	2	750
Pistachio	150	10
Rice	1500	1

These strict trends in the rice future prices show evidence of the non-balanced conditions at different points of time, showing that prices always decrease at the harvest time. The establishment of a future market as a broadly-based, integrated and organized market could help solve these problems.

As described in the methodology, the risk free interest rate in Iran was utilized in order to determine the optimum initial level of the minimum tick size. Using the average price of each considered commodity taken from the last year of price data and taking the annual risk free interest rate to be equal to 7%, the initial optimum tick size values were calculated.

The use of the minimum daily average trading value of a participant in TSE which is equal to about 8 million Rials and utilizing Equation (15), the initial contract size for each product was determined. Table 3 shows the results of the calculation of the optimum tick size and contract size for saffron, pistachio and rice. As the value of one contract for all commodities is taken to be equal to the minimum daily average trading value of a participant in the TSE which was assumed to be the trading power of a small participant, the minimum tick size of all contracts are the same and are equal to 1,500 Rials per contract.

These calculations of the optimal amounts for different specifications for the three mentioned commodities are the initial suggested amounts for the establishment of an agricultural future market in Iran. These initial specifications could be altered following the commencement of future market trading, *via* a study of actual market data which could include an investigation of the likely impacts of the modification of these specifications on trading volume and market quality.

CONCLUSIONS

In this paper an attempt was made to determine the initial specifications of potential future contracts for saffron, pistachio and rice in Iran. The daily margin requirement, daily price movement limit, length of expiration interval, minimum tick size and contract size were the contract specifications considered.

As there is no future market existent in Iran, the monthly future prices of these commodities were simulated in different scenarios for various expiration intervals. These simulated prices were employed to calculate monthly *VaR*s of 99%, the daily future prices and the daily *VaR*s at a 99% level were calculated using a new optimization model for calculating *VaR*. This new computational method of *VaR* calculation is more efficient than the previous methods because of its smaller dimensions. The daily *VaR* 99% is a suitable criterion for the determination of the daily margin requirement as well as price movement limit. Although it is customary to use parametric approaches for setting the margin requirement *via* calculation of the *VaR*, in this paper a sampling approach was employed to more precisely simulate the *VaR* value without recourse to distributional assumptions. By running this model for 21 scenarios of expiration intervals, the one with a minimum level of *CV* was selected as the optimum length of the expiration interval.

The daily risk free interest rate and the minimum daily average trading value of a participant in TSE were used to determine the minimum tick size as well as contract size for each commodity.

Appendix: Details of New Computational Method of VaR Used for Determining the Daily Margin Requirements and Daily Price movement Limits of Future Contracts

For a further descriptions of the new computational method of *VaR* optimization (Equation (12)) in the main body of paper, this appendix contains more details about the model.

The objective function of this model was to calculate the minimum amount of daily *VaR* at a 99% level which is an indication of the daily margin requirement as well as daily price movement limit.

Likewise the fourth constraint of this model is a calculation of the minimum monthly *VaR*. But, while during the simulation of daily future prices to calculate minimum daily *VaR*, the minimum amount of monthly *VaR* might be varied from the realized monthly *VaR* ($\zeta_{\beta}^{M}(\Lambda^{M})$), this constraint doesn't let minimum monthly *VaR* to be smaller than $\zeta_{\beta}^{M}(\Lambda^{M})$.

The first and fifth constraints respectively calculate the auxiliary variables of Ω_j^D and Ω_i^M for each daily and monthly scenario which will be negative for the scenarios with a loss quantity of smaller than daily and monthly *VaR* and a nonnegative value for the other quantities.

The auxiliary variables of Δ_{gj}^{D} and Δ_{hi}^{M} which are the differences between the loss quantities of each two scenarios, calculated in the second and sixth constraints respectively.

Utilizing the third and seventh constraints, the coefficients of daily and monthly loss scenarios, respectively in the objective function and the fourth constraint of model, will be equal to 1 for the corresponding minimum daily and monthly *VaR*s and equal to zero for the others.

This new computational method is more efficient than the previous ones as it carries smaller dimensions. Keeping the introduced notations of this paper, the equation below shows the constraint of calculation of Ω_j in the previous methods (i.e. Gaivoronski and Pflug, 2005).

$$\sum_{s=1}^{\frac{(N-1)!}{(\lceil \beta N \rceil)!(N-\lceil \beta N \rceil-1)!}} \prod_{q=1}^{\lceil \beta N \rceil} \varphi(\Delta_{qsj}) \prod_{r=1}^{N-\lceil \beta N \rceil} \varphi(-\Delta_{rsj}) - \Omega_j = 0$$

The variable (Ω_j) directly calculated the coefficient of loss scenarios in the objective function of the previous methods. The dimensions of this model have drastically been decreased using the binary variable of d_j and conditional function of $\varphi(\Omega_j)$.

This model is a mixed integer nonlinear one that can be solved with such related solvers as ALPHAECP, BARON, DICOPT, LINDOGLOBAL, OQNLP and SBB. For a relaxation of the $\varphi(z)$ function, the COINIPOPT solver in the GAMS environment was employed for an optimization of this model.

Another advantage of this model is that, it is possible to calculate *CVaR*s (Conditional Value at Risk) value of the minimum daily and monthly *VaR*s at the same time. It will be done adding the following constraints to the model:

$$\omega_{\beta}^{D}(\Lambda_{\beta}^{D}) - \left[\left((1-\beta)N\right)^{-1} \sum_{j=1}^{N} \psi(\Omega_j^D)\Lambda_j^D \right] = 0$$

$$\omega_{\beta}^{M}(\Lambda_{\beta}^{M}) - \left[\left((1-\beta)M\right)^{-1} \sum_{i=1}^{M} \psi(\Omega_i^M)\Lambda_i^M \right] = 0$$

Where $\psi(z)$ is another conditional function as below:

$$\psi(z) = \begin{cases} 0 & if \quad z \le 0 \\ 1 & otherwise \end{cases}$$

The quantities of $\psi(\Omega_j^D)$ and $\psi(\Omega_i^M)$ which are the coefficients of loss scenarios in these constraints will be equal to 1 for all scenarios with a loss quantity of no smaller than *VaR*.

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تعیین مشخصات قراردادهای آتی: کاربرد یک روش محاسبه جدید شاخص ارزش در شرایط توام با مخاطره در بازار محصولات کشاورزی ایران

س. ع. حسینی یکانی، م. زیبایی و د. ای. آلن

چکیده

هدف این مطالعه تعیین مشخصات قراردادهای آتی محصولات کشاورزی در ایران به نحوی است که پس از راه اندازی از امکان موفقیت بالایی برخوردار باشند. جهت تحقق این هدف، تعیین میزان سپرده مورد نیاز، حد مجاز نوسانات قیمت روزانه، طول دوره تحویل، حداقل واحد تغییر قیمت و اندازه قراردادهای آتی زعفران، پسته و برنج به عنوان قراردادهای آتی باقوه در ایران مورد بررسی قرار گرفتند. به منظور تعیین مقدار سپرده مورد نیاز و حد مجاز نوسانات قیمت روزانه از یک روش جدید بهینه سازی مدل ارزش در شرایط توام با مخاطره (VaR) با بهره گیری از رهیافت نمونه برداری ناپارامتری استفاده گردید. همچنین طول دوره تحویل، از طریق شبیه سازی قیمتهای آتی روزانه با حداقل مقدار نوسان ممکن تعیین گردید. جهت تعیین مقدار حداقل واحد تغییر قیمت و اندازه قرارداد آتی هر محصول نیز، نرخ بهره بدون ریسک روزانه و حداقل ارزش متوسط معاملات روزانه یک معامله گر در بورس اوراق بهادار تهران (TSE) مورد استفاده قرار گرفت. مشخصات تعیین شده در این مطالعه به عنوان مقادیر اولیه پیشنهادی جهت تاسیس و راه اندازی یک بازار آتی محصولات کشاورزی در ایران ارائه گردیده است.