The use of futures prices and options by Oman to manage wheat import price variability

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Abstract

The objective of this paper is to evaluate whether using financial instruments such as commodity hedging using futures and options would help Oman to improve risk management in wheat imports. Around 61% of wheat imports by Oman during the period covered by this study from 2009 to 2015 were from Australia. The Australian futures were found to be highly correlated with Kansas City Hard Red Wheat (HRW) futures. Employing Kansas City Hard Red Wheat (HRW) futures and options, five simulations were performed involving buying all annual wheat needs in one lot and buying all annual wheat needs in equal monthly installments (spreading risk). Results show that the use of market-based financial risk management tools such as futures and options by Oman would reduce the impact of price volatility. Furthermore, based on the simulations, a combination of futures and options strategies, as well as, buying all annual wheat needs in equal monthly installments (spreading risk) would provide a better protection against price volatility for Oman.

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Key words Financial risk management tools, Price variability, Futures and Options

JEL Classification Codes G13, G15, G32.

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1. Introduction

Oman produces only a fraction of the food consumed in the country, and most of the food, especially grain such as wheat and rice are imported. Based on data made available by Oman Flour Mills[1] and Salalah Mills[2], wheat imports by Oman has risen from nearly 270,000 metric tons in year 2009 to an excess of 1 million tons in both 2014 and 2015. Land and water scarcity are among the leading constraints to agricultural production such that by 2050, Oman is expected to depend solely on wheat grain imports to meet food security needs (Mbaga, 2013 and Mbaga, 2015). Recent volatility in the global crude oil markets has added another dimension to this issue, in that, it has significantly impacted on the capacity of Oman and other countries in the GCC region to meet their grain import needs for food security. Therefore, food security will continue to be one of the important issues occupying policy makers in the region and Oman in particular. According to the National Centre for Statistics and Information (NCSI)[3] by 2040 the population of Oman is expected to reach 4 million—as a result, the burden to meet food security needs especially for grains such as wheat will keep on increasing. Traditionally, Oman has been importing all her food needs for food security using a combination of approaches BUT none of these include financial risk management tools such as futures and options.

One of the greatest challenges facing global grain markets include weather which is both unpredictable and uncontrollable, as well, price volatility and the inability for anyone to predict price. Although price like weather is unpredictable, there are means by which participants in the

[1] http://www.omanflourmills.com/
[2] http://www.salalah-mills.com/company_profile.html
[3] https://www.ncsi.gov.om/news/pages/newsct_20150727083324090.aspx

market can manage price risk and volatility. A close look at the world market for grains reveals the level of price volatility that exists. Over the last five years, for example, (Table 1), Chicago wheat futures (Soft Red Winter Wheat), have seen a high of $9.47/bushel, or $348.00/MT to a low of $4.38 or $161.00/MT.

Table 1: Wheat Price Volatility—Chicago Wheat Futures (Soft Red Winter Wheat)

Year	High ($)	Low ($)	Change($)
2002	4.34	2.56	1.79
2003	4.09	2.73	1.36
2004	4.24	2.83	1.42
2005	3.69	2.87	0.82
2006	5.57	3.21	2.36
2007	10.09	4.12	5.97
2008	13.00	4.55	8.45
2009	6.76	4.29	2.47
2010	8.04	4.26	3.78
2011	8.92	5.72	3.20
2012	9.47	5.90	3.58
2013	8.00	5.99	2.01
2014	7.35	4.66	2.69
2015	6.16	4.51	1.65
2016**	4.89	4.38	0.51

****** Up to 17 March 2016
Average volatility 14 years = $2.97 and average volatility for (2011 – 2015) = $2.62
Source: Chicago wheat futures (Soft Red Winter Wheat)

The average volatility for wheat over those five years was $2.62/bushel, or $96.27/MT, and even higher average volatility of $2.97/bushel, or $109.14/MT for 14 years period (2002 to 2015).

Kansas City wheat futures (Hard Red Winter Wheat) in the past five years (Table 2) has seen a high of $9.91/bushel, or $364.00/MT and a low of $4.38/bushel, or $161.00/MT while the average volatility over those five years was $2.84/bushel, or $104.35.

Table 2: Wheat Price Volatility—Kansas Wheat Futures (Hard Red Winter Wheat)

Year	High ($)	Low ($)	Change($)
2002	4.95	2.71	2.24
2003	4.21	2.95	1.26
2004	4.31	3.12	1.19
2005	3.93	3.10	0.83
2006	5.55	3.68	1.87
2007	10.29	4.33	5.96
2008	13.85	4.90	8.95
2009	7.27	4.54	2.74
2010	8.64	4.55	4.08
2011	9.91	6.32	3.59
2012	9.48	6.14	3.34
2013	8.52	6.33	2.19
2014	8.55	5.50	3.05
2015	6.42	4.40	2.02
2016**	4.82	4.38	0.44

****** Up to 17 March 2016
Average volatility 14 years = $3.09 and average volatility for (2011 – 2015) = $2.84
Source: Kansas wheat futures (Hard Red Winter Wheat)

It is evident from Table 1 and 2 that the international wheat markets are volatile and that the volatility of these markets has and will remain a challenge to all facets of those involved in wheat trade. That is for both producers fearing the lows and buyers/consumers fearing the highs.

Employing innovative market approaches to reduce risks associated with food imports is therefore important (Claessens, S. et al., (1993); Claessens, S. and Varangis, P. (1993); Ederington, L.H. (1979); Faruqee, R, et al,. (1997); Sarris et al., 2005).

Currently, Oman uses no any financial risk management tool in dealing with wheat import.

The objective of this study is to analyze the procurement practices of the government of Oman in order to help determine how and which financial risk management tools (hedge) should be considered by the country in an effort to remove the volatility and uncertainty risk associated with wheat import. This paper is organized into five sections as follows: Section 2 below discusses the methodology of analysis. In section 3 presents the Oman wheat import trends, as well as the data. In section 4 we perform the analysis and present the results of our five simulations. Then lastly in section 5 we summarize our results and provide broad conclusions of this study.

2. Methodology

The function of all market organization is to facilitate coordination of sellers and buyers (Phillips, J., 1966). Coordination has two dimensions, space and time. Futures markets have been developed to facilitate coordination over time to allow buyers and producers of commodities to transfer price formation and uncertainty (risk) bearing to speculators.

Both private and public sectors face a host of risks as they go about conducting their business every day. Fortunately, they have a range of choices available to manage them. However the task of defining realistic choices and specifying their benefits and costs is complex (Tomek and Peterson, 2001). Furthermore, a variety of ways of analyzing risk and financial tools to manage

them exist (Boehlje and Lins, 1998; Bodnar, Hayt, and Marston, 1998). Futures and options are among the leading financial risk management tools available.

Futures market trading is implemented in both public and private sector organizations to manage the uncertainty and volatility of commodity markets over time and space. Following Faruqee, et al., (1997); Sarris et al., (2005) and Sarris (2009), let us assume that the government, in this case, the government of Oman knows that at time 1, which is some months ahead of the present time, it will need to import $\mathbf{Q_W}$ tons of wheat. Therefore the hedging problem can expressed as follows:

$$WIB = P_W Q_W - (FP_1 - FP_O)b - (\Pi - OP)d \qquad (1)$$

Where: WIB = Wheat import bill (import cost)

P_W = Price to pay when ordering the $\mathbf{Q_W}$ amount of wheat needed by the country

Q_W = The amount of wheat needed by the country at time1, some months ahead of the present time.

FP_O = The futures price, observed at the current period, of the commodity for the futures contract expiring closest after the period 1, at which the actual order for imports will be placed.

FP_1 = The price of the same futures contract at time 1.

SP = Strike price

b = The amount of futures contracts (in units of the qty of the product) purchased at the current period

d = The amount of call options contracts purchased also at the current period[4]

Π = The profit from the option in period 1. This profit will be equal to $FP_1 - SP$ if the option is exercised and zero otherwise.

OP = The price of the option

[4] **Note that The call option contract is written on the same futures contract expiring soonest after period 1, and stipulates that if the futures price FP_1 at time 1 is above a strike price SP, determined at the time of the purchase of the option, then the owner of the call option can "exercise" the option and receive the difference FP_1-SP between the futures price at period 1 and the strike price SP.**

Unavailability of price data on FOB and CIF wheat import for Oman made it impossible to implement equation (1) as it is. Therefore a number of simulations are performed utilizing parts of equation (1) as follows:

i. Simulation 1: Equation (2) below is used to simulate what would have happened (in terms of gains and Losses) if Oman had used futures price to hedge wheat imports between 2009 and 2015 by buying all the wheat needed in one lot (buying all wheat).

$$\left(FP_1 - FP_O\right)_b \qquad (2)$$

ii. Simulation 2: Equation (2) above is used to simulate what would have happened (in terms of gains and losses) if Oman had used futures price to hedge wheat imports between 2009 and 2015 by buying one month's worth of expected imports beginning in January and following this with equal purchases every month thereafter.

iii. Simulation 3: Equation (3) below is used to simulate what would have happened (in terms of gains and Losses) if Oman had used a combination of futures and options to hedge wheat imports between 2009 and 2015 buying futures six months before the cash purchase was made.

$$\left(FP_1 - FP_O\right)_b - \left(\Pi - OP\right)_d \qquad (3)$$

iv. Simulation 4: Equation (3) above is used to simulate what would have happened (in terms of gains and losses) if Oman had used futures and options to hedge wheat imports between 2009 and 2015 from the time of purchase until sold to the eventual end-user.

v. Simulation 5: Equation (1) above is used to simulate what would have happened (in terms of gains and losses) if Oman had used futures and options to hedge wheat

imports between 2009 and 2015 by using actual purchases made between February 8, 2009 and October 13, 2015, as provided by Oman Flour Mills and Salalah Mills.

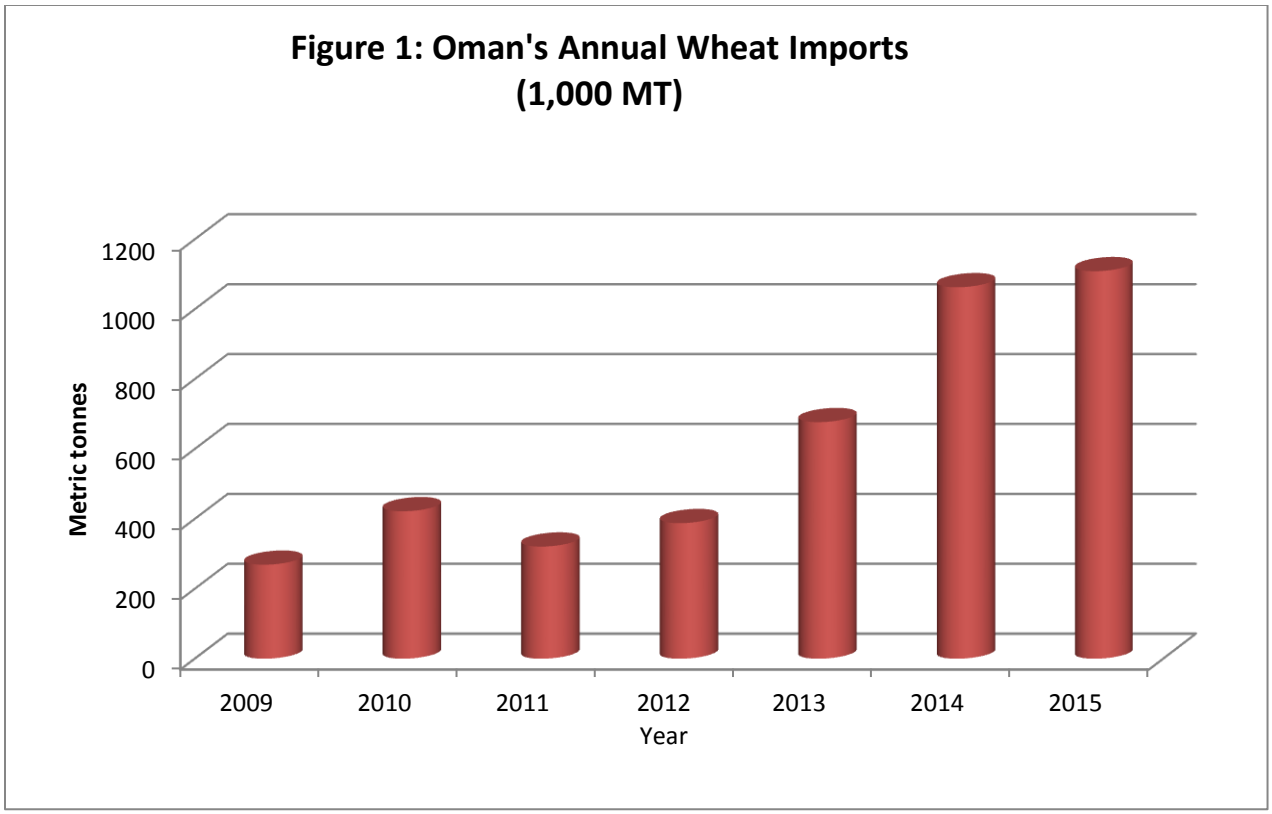
3. Oman Wheat Import Trends and Data for this study

Oman wheat imports have increased significantly in recent years, a trend that is expected to continue because of first, physical constraint of land and water scarcity and secondly, financial constraint related to crude oil price volatility. Data provided by the flour mills indicate annual volume total has risen from nearly 270,000 metric tons in calendar year 2009 to in excess of 1 million tons in both 2014 and 2015 (Table 3 and Figure 1).

Table 3: Oman's Annual Wheat Imports (1,000 MT)

Year	2009	2010	2011	2012	2013	2014	2015
Metric Tons	269	422	321	388	677	1,063	1,109

Source: Oman Flour Mills and Salalah Mills.



Source: Oman Flour Mills and Salalah Mills.

Greater dependence on imported wheat supplies in order to meet domestic consumption requirements suggests a growing need for Oman to manage the potential price risk and volatility associated with these purchases.

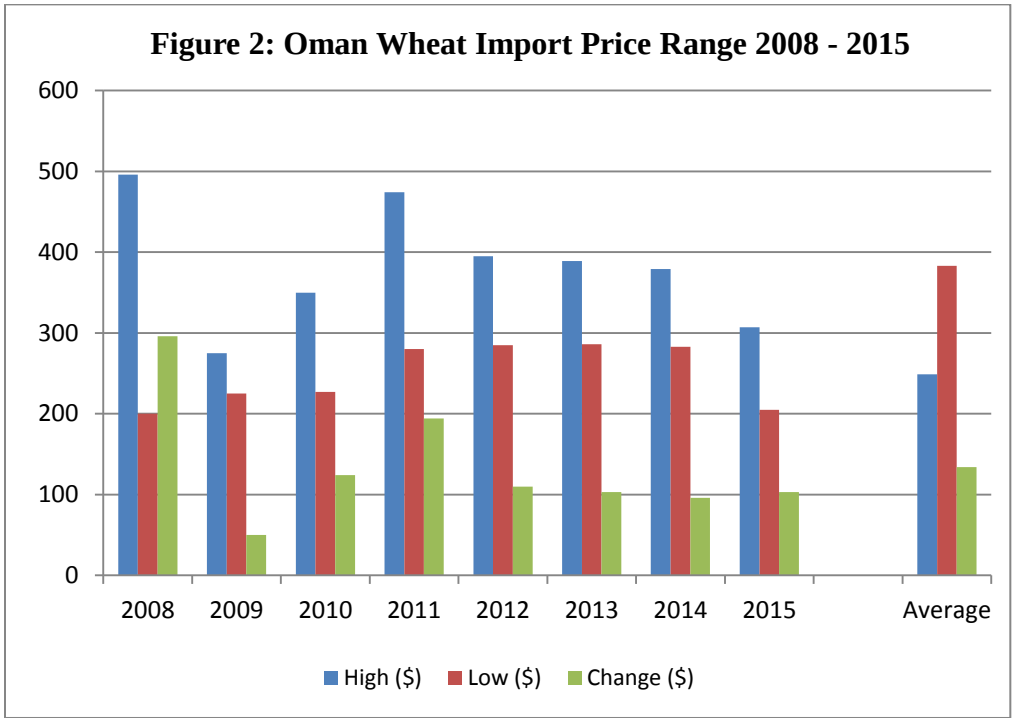
Data on actual delivered prices for each import shipment were not available. Had it been available, this would have allowed a more precise evaluation of cash and futures relationships as well as to account for volatility in ocean freight costs. The Flour Mills did provide ranges for the eight years, from 2008 through 2015 ((Table 4 and Figure 2).

Values varied from a low of $200 per metric ton in 2008 to a high of $496 in that same year. Following first a period of rising prices (2009-2011), values then leveled off during the 2012-2014 period. The latter saw prices range from a low of $280-$285 to a high of $380-$395.

Table 4: Oman Wheat Import Price Range 2008 - 2015

Year	High ($)	Low ($)	Change($)
2008	496	200	296
2009	275	225	50
2010	350	227	124
2011	474	280	194
2012	395	285	110
2013	389	286	103
2014	379	283	96
2015	307	205	103
Average	**249**	**383**	**134**

Source: Oman Flour Mills and Salalah Mills.

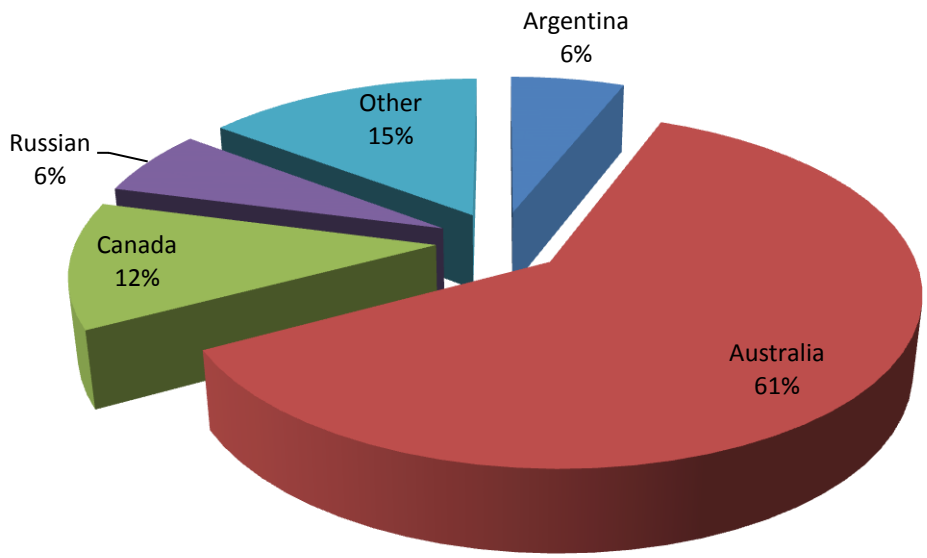


Source: Oman Flour Mills and Salalah Mills.

In 2015, delivered prices weakened with the reported price range declining to $205-$307 per ton. The average for the period varied from a low of $249 to a high of $383, or a range of $134. This degree of price volatility seems to suggest that there may be ample opportunity to better manage the price risk associated with Oman's purchase activities.

Wheat import quantity data provided by Oman Flour Mills and Salalah Mills was for the period from February 8, 2009 through October 13, 2015. The data included information on type and class of wheat, origin, arrival date in Oman and the quantity involved. Information on both FOB and CIF values were unavailable. Total volume imported for the eight years included in this study was 4.2 million tons as shown in Figure 3 and Table 5.

Figure 3: Oman Wheat Import Shares by Origin



Source: Oman Flour Mills and Salalah Mills.

Table 5: Oman Wheat Import Volume in MT 2009 to 2015

Origin	Volume (MT)	Share
Argentina	255,710	6%
Australia	2,599,119	61%
Canada	505,106	12%
Russian	266,289	6%
Other	621,905	15%
Total	4,248,128	100%

Source: Oman Flour Mills and Salalah Mills.

This included approximately 2.6 million tons of Australian wheat; 505 thousand tons of Canadian wheat; 256 and 266 thousand tons of Argentine and Russian wheat and 622 thousand tons from other origins such as Germany, India, Iran, Lithuania, Brazil and the United States. As Figure 3 and Table 5 indicate, around 61% of the total wheat import was of Australian origin.

Based on the origins of the wheat imported by Oman presented above (Figure 3 and Table 5); e.g., Australia, Argentina, Canada and Russia, FOB price data from Agrocharts.com as well as other private sources such as Advance Trading Australia were compiled. Price data was needed to compute correlations in order to establish which future price series is highly correlated with Australian wheat prices—Figure 3 shows that around 61% of the total wheat import by Oman was of Australian origin. Price data included U.S. Soft Red Wheat, U.S. Hard Red Wheat (**Kansas Wheat Futures**), Eastern Australia, Australian Hard (AH), Southern Australia Australian Premium White (APW) and Western Australia (APW), French 10.5% protein wheat and Russian 12.5% protein wheat for the period beginning February 3, 2014 through March 7, 2016. Historical FOB price data prior to that period was not available on a consistent basis. Analysis of these 104 observations found the following correlation coefficients between the various origins and U.S. SRW and HRW prices (see Table 6 below). The table indicates that U.S. HRW (**Kansas Wheat Futures**) generally has a higher correlation coefficient with the

other origins than does U.S. SRW wheat. With the exception of Southern Australia APW, the remaining four origins were found to have coefficients of 88% or greater. These ranged from a low of 83% for Southern Australia APW to a high of 93% for Eastern Australia AH. Both French and Russian wheat had correlation coefficients with U.S. HRW of 90% or higher. Results for SRW were considerably lower and ranged from a low of 65% for Southern Australia APW to 73% and 79% for Western and Eastern Australian wheat, respectively. French wheat carried an 89% correlation and Russian, 91%.

Table 6: Correlation Coefficients—U.S. SRW and HRW with Other Origins

2/3/14 to 3/7/16	East Aus. AH	South Aus. APW	West Aus. APW	French, 10.5%	Russian, 12.5%
U.S. SRW	0.7935	0.6455	0.7271	0.8920	0.9089
U.S. HRW	0.9271	0.8281	0.8831	0.9228	0.9084

Source: Own Calculations

Given t**h**at around 61% of the wheat imported by Oman (Figure 3 and Table 5) was of Australian origin, as well as, had an average correlation coefficient of 0.8794 (Table 6) for the three classes versus U.S. HRW, it was concluded the U.S. HRW futures contract would be most representative as a potential hedging and risk management tool, therefore Kansas City Hard Red Wheat (HRW) futures have been used throughout this study.

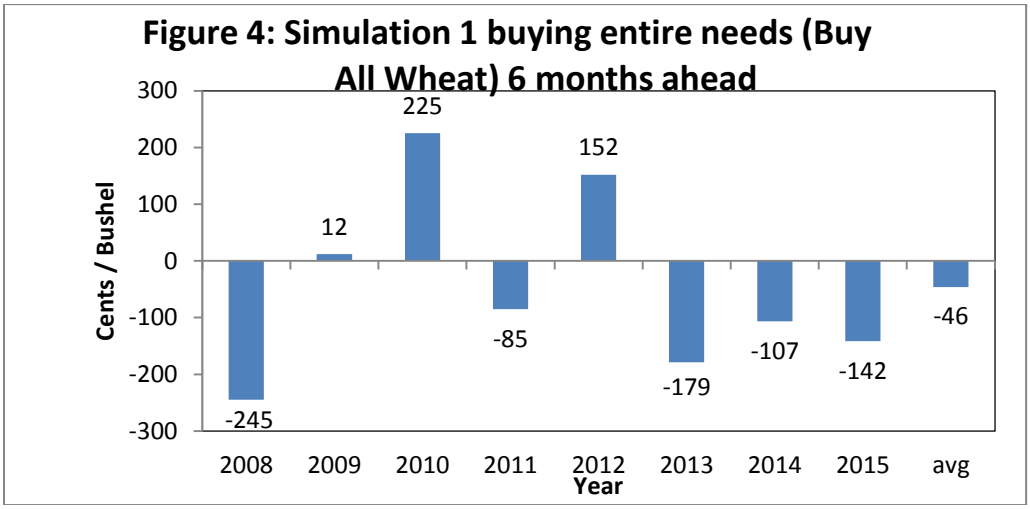
4. Analysis, Results and Discussion

To investigate whether using financial risk management tools will help to reduce risk associated with importing wheat a number of simulations are performed as follows:

I. Buying all wheat needed for the entire year at once

The first simulation consists of buying the near-by futures contract on or about the first of January with the assumption that delivery of the first imported cargo would not be made until

the following June. This was done in order to "lock-in" the effective wheat price for the entire year beginning in June. The quantity of futures purchased could therefore be viewed as 12 times the average monthly import requirements. One twelfth or 1/12 of this amount would then be sold by the buyer (selling the near-by futures) when the vessel arrived in June. A second amount equivalent to 1/12 of the original futures purchase would then be sold when the next vessel arrived in July and so on. The difference between the original futures price and each subsequent futures sale was calculated to determine a gain or loss from the hedging transaction. This procedure was conducted over a period of 8 years from 2008 to 2015 in conformity with the price and quantity data that was availed to us by Oman Flour Mills and Salalah Mills (Table 3 and Figure 1, as well as Table 4 and Figure 2). Results are as presented in Figure 4 and Table 7.



Source: Own calculations based on simulation 1.

Table 7: Gain or Loss from Buying Entire Needs 6 Months Ahead (Cents/bushel)

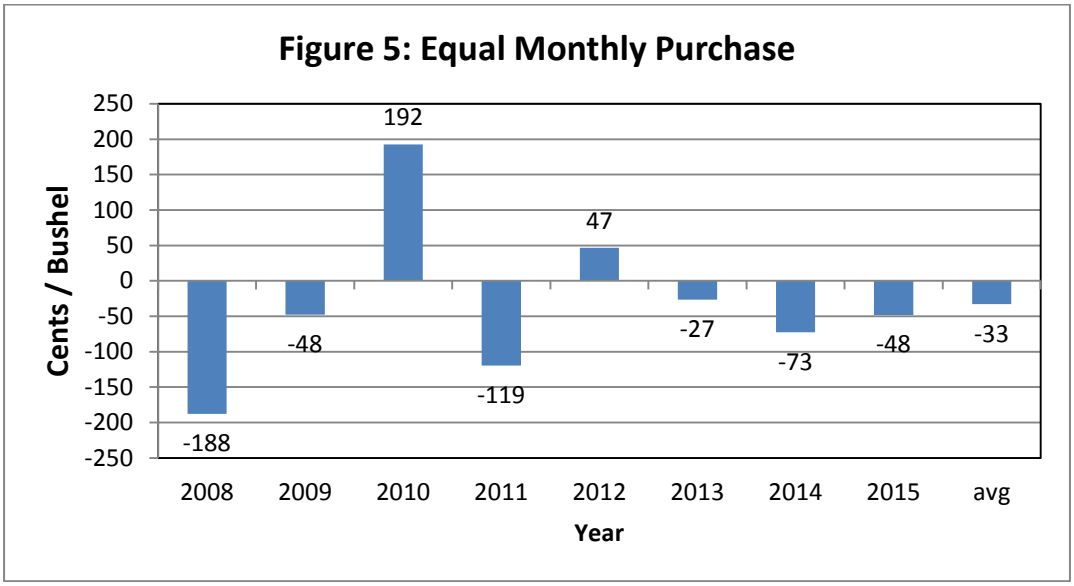
Month	2008	2009	2010	2011	2012	2013	2014	2015	Ave
June	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
July	9.25	-52.75	-67.00	-91.00	-31.00	-130.75	82.00	-65.50	
Aug	-94.50	54.75	63.50	-7.25	251.00	-207.75	-79.50	-128.00	
Sept	-41.25	6.25	168.50	31.75	228.00	-189.75	-82.25	-151.50	
Oct	-137.50	-28.75	201.50	-19.25	226.00	-193.00	-143.00	-139.25	
Nov	-337.00	28.75	167.00	-73.00	219.75	-132.50	-102.75	-150.75	
Dec	-358.00	77.00	141.50	-95.25	224.75	-199.50	-111.50	-164.00	
Jan	-340.75	33.50	262.75	-137.50	190.25	-244.25	-23.50	-146.25	
Feb	-310.00	15.00	320.00	-114.25	144.00	-274.75	-128.00	-153.25	
March	-368.25	15.50	424.50	-114.25	125.75	-212.25	-142.75	-176.50	
April	-313.75	-2.25	267.00	-95.75	72.00	-134.75	-162.25		
May	-359.00	-6.50	370.50	-146.25	67.00	-132.50	-190.50		
June	-284.00	3.00	384.00	-162.25	108.75	-90.50	-195.00		
Ave	-244.56	11.96	225.31	-85.35	152.19	-178.52	-106.58	-141.67	-45.90
$/MT	-$89.86	$4.39	$82.79	-$31.36	$55.92	-$65.60	-$39.16	-$52.05	-$16.87

Source: Own calculations based on simulation 1.

As summarized in Table 7 and Figure 4 above, results of this "Buy All Wheat" simulation shows an average loss of 46 cents per bushel. The range of gains and losses varied from a loss of $2.45 per bushel in 2008 (-$89.86/MT) to a profit of $2.25 (+$82.79/MT) in 2010. In general therefore over the past 8-year period (2008 to 2015) if Oman had engaged in this kind of hedging, the average gain or loss from buying the entire year's import needs in the preceding January would have resulted in an average loss of **$.46 per bushel, or $16.87 per ton (Table 7).**

II. **Equal monthly purchases of wheat beginning in January.**

The second simulation consists of buying one month's worth of expected imports beginning in January and following this with equal purchases every month thereafter. The initial futures purchase was liquidated (selling futures) when the expected cargo arrived in six months. This procedure was repeated in every subsequent month. Rather than buying the entire year's import needs six months in advance (As in simulation 1), this second simulation assumed buying equal amounts beginning six months in advance of expected arrival. A summary of the results is as presented in Figure 5 and Table 8.



Source: Own calculations based on simulation 2.

Table 8: Gain or Loss from Equal Monthly Purchases 1 (cents/bu)

Month	2008	2009	2010	2011	2012	2013	2014	2015	Ave
July	9.25	-52.75	-67.00	-91.00	-31.00	-130.75	82.00	-65.50	
Aug	-225.75	-29.25	113.00	-144.75	198.50	-117.00	-21.00	-59.75	
Sept	-287.25	-57.25	207.50	-83.00	192.00	-21.25	-80.50	-47.75	
Oct	-214.75	-97.75	288.25	-99.00	219.00	-16.75	-176.75	-84.00	
Nov	-283.00	-50.50	218.00	-198.25	243.50	-36.75	-204.00	-13.75	
Dec	-241.00	-113.00	197.25	-236.75	200.75	-52.50	-129.50	-35.50	
Jan	-346.75	-59.00	327.50	-110.25	167.25	-23.00	-44.50	-78.25	
Feb	-215.50	-39.75	256.50	-107.00	-107.00	-67.00	-48.50	-25.25	
Mar	-327.00	9.25	256.00	-146.00	-102.25	-22.50	-60.50	-25.00	
Apr	-176.25	26.50	65.50	-76.50	-154.00	58.25	-19.25		
May	-22.00	-35.25	203.50	-73.25	-152.75	0.00	-87.75		
June	74.00	-74.00	242.50	-67.00	-116.00	109.00	-83.50		
Ave	-188.00	-47.73	192.38	-119.40	46.50	-26.69	-72.81	-48.31	-33.01
$/MT	-69.08	-17.54	70.69	-43.87	17.09	-9.81	-26.75	-17.75	-12.13

Source: Own calculations based on simulation 2.

As summarized in Figure 5 and Table 8 above, results of this "Equal Monthly Purchases (HRW)" simulation shows an average loss of $.33 per bushel (-$12.13/MT) for the 8-year period. The hedging gain or loss in this example ranged from a loss of $1.88/bushel (-$69.08/MT) in 2008, to a profit of $1.92/bushel ($69.08/MT) in 2010.

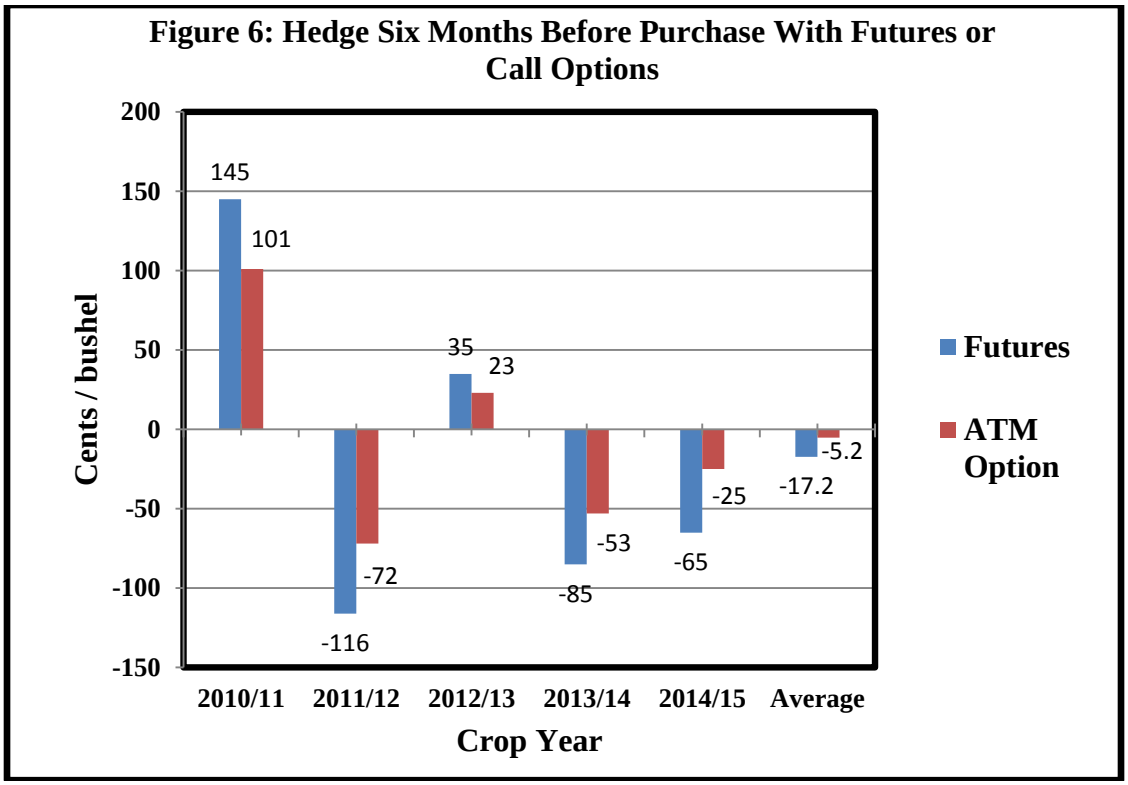
Buying futures in 12 equal monthly installments yielded a 28% or $.129 smaller loss per bushel **at $.33, or $12.13 per ton (see Table 8).** Therefore in this case (simulation 2), the strategy of spreading out price risk over an extended period of time reduces the loss potential compared to the alternative of a single, large purchase. In the next two simulations (simulation 3 and 4) Futures and Option strategies are used for hedging wheat before the cash purchases. Given earlier work (Table 6) established that Sultanate of Oman cash purchases were most closely

correlated with the Kansas City Hard Red Wheat (HRW) contract, Kansas City HRW futures and options were used for all of the simulations (Simulation 3 and 4).

III. Buying futures six months before cash purchases: Futures vs. At the money call options

In this simulation (simulation 3) the futures strategy consisted of buying futures six months before the cash purchase was made. Futures were then sold on the same day a cash purchase was assumed to be made. Equal cash purchases were assumed to be made once a month on the first Thursday of the month. Thursday was chosen (a mid-week day) to avoid possible market volatility around the weekend. This process was repeated for every month during a five crop-year (2010/11 to 2014/15) period.

The option strategy used the same timing as the futures strategy, except at-the-money call options were purchased as a hedge against cash in six months. An at-the-money option is the option with a strike price nearest to the futures price at the time the position is established. At-the-money options are generally very liquid, allowing easy entry and exit of positions. A call option gives the buyer the option, but not the obligation, to establish a long position in the underlying futures market at a predetermined (strike) price. The option strike price used was the at-the-money option at the time the hedge was assumed to be placed, i.e. six months before the cash purchase. The option contract month used was the nearest month after the cash purchase. Results of the two strategies are summarized in Table 9 and Figure 6.



Source: Own calculations based on simulation 3.

Table 9: Hedging Six Months before Purchase Futures vs. At-The Money **Call Options**

Crop Year	Futures Purchase ($)	Futures Sell ($)	Futures Return ($)	Options Purchase ($)	Options Sell ($)	Options Return ($)
2010/11	6.05	7.50	1.45	0.63	1.64	1.01
2011/12	8.71	7.56	-1.16	0.97	0.25	-0.72
2012/13	7.80	8.14	0.35	0.71	0.94	0.23
2013/14	7.97	7.11	-0.85	0.63	0.11	-0.53
2014/15	6.94	6.29	-0.65	0.48	0.23	-0.25
Average	7.49	7.32	-0.17	0.68	0.63	-0.05

Source: Own calculations based on simulation 3.

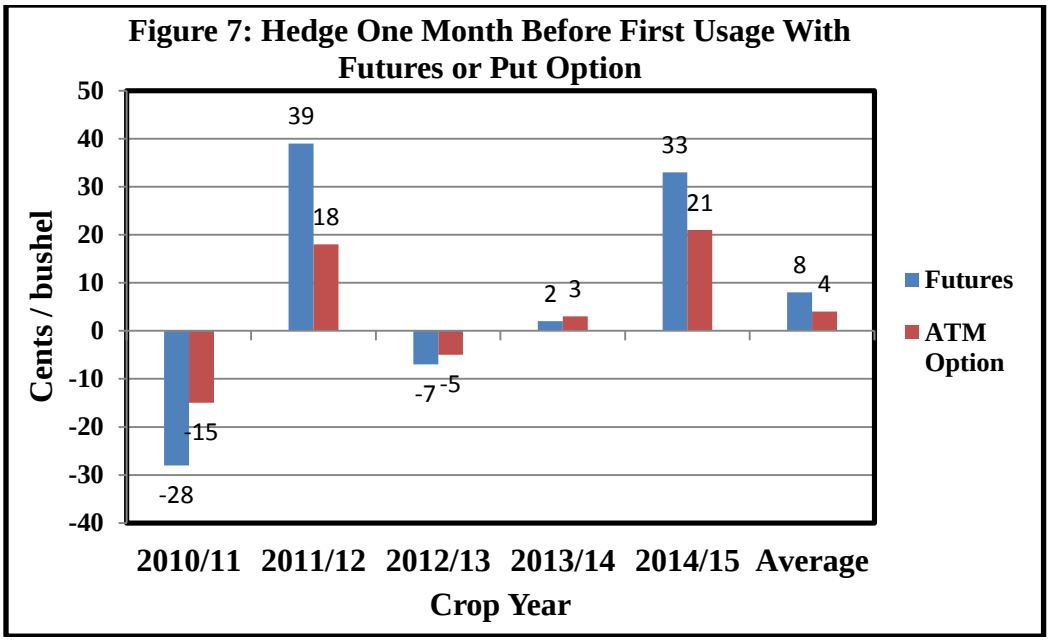
The results as presented in Figure 6 and Table 9 indicates that, on average over the five year period, both hedging strategies would have led to "hedging losses" with futures losing on average $0.17/bushel over the five year study while options lost $0.05/bushel over the same

time. See futures return and option return in the table. However, the results also indicate that both futures and options provide protection during times of rising prices. For example, during the 2010/11 and 2012/13 crop years futures were generally increasing and both the futures and option strategies had positive returns. In addition, options also tend to limit losses as the loss in the option position is limited to the option premium while there is no limit to losses in futures.

IV. Futures and option for hedging wheat from the time of purchase until sold to the eventual end-user.

In this simulation futures and option strategies were used for hedging wheat from the time of purchase until sold to the eventual end-user. For these hedges, the futures strategy consisted of selling futures at the same time the cash purchase was made. It was then assumed it took one month to move the wheat to the eventual user and the wheat was then sold in equal weekly instalments every Thursday over a one month period. This process was repeated for every month during a five crop-year period.

The option strategy used the same timing as the futures strategy, except at-the-money put options were purchased as a hedge until cash sales to the end user. An at-the-money option is the option with a strike price nearest to the futures price at the time the position is established. At-the-money options are generally very liquid, allowing easy entry and exit of positions. A put option gives the buyer the option, but not the obligation, to establish a short position in the underlying futures market at a predetermined (strike) price. The option strike price used was the at-the-money option at the time the hedge was assumed to be placed, i.e. one month before the first cash sale. Results of the two strategies are summarized in table 10 and figure 7.



Source: Own calculations based on simulation 4.

Table 10: Hedging From Purchase to Use Futures vs. At-The-Money Put Options

Crop Year	Futures Purchase($)	Futures Sell ($)	Futures Return ($)	Options Purchase ($)	Options Sell ($)	Options Return ($)
2010/11	7.80	7.52	-0.28	0.57	0.42	-0.15
2011/12	7.23	7.62	0.39	0.50	0.68	0.18
2012/13	8.30	8.23	-0.07	0.48	0.43	-0.05
2013/14	7.12	7.14	0.02	0.34	0.37	0.03
2014/15	5.97	6.3	0.33	0.31	0.52	0.21
Average	7.28	7.36	0.08	0.44	0.48	0.04

Source: Own calculations based on simulation 4.

The results of simulation 4 above (Figure 7 and Table 10) indicate that, on average over the five year period (2010/11 to 2014/15), both hedging strategies would have led to positive results with futures profiting on average $0.08/bushel over the five year study while options would have profited $0.04/bushel over the same time. The results also indicate that both futures and options provide protection during times of rising prices. For example, during the 2011/12 crop year

futures were generally rising and both the futures and option strategies had positive returns. In addition, options also tend to limit losses as the loss in the option position is limited to the option premium while there is no limit to losses in futures.

V. Cash and futures transactions simulated for actual purchases made by Oman between 2009 and 2015.

In this simulation cash and futures transactions are simulated for actual purchases made between February 8, 2009 and October 13, 2015. The Oman Flour Mills and Salalah Mills provided on wheat imports including the arrival dates and quantities during this period (See Appendix I). Price information was unavailable; as a result, to be consistent with the methodology used in the previous simulations above, the results were developed by:

i. Assuming the buying entity purchased an equivalent quantity of near-by HRW futures approximately six months or 180 days in advance of arrival and

ii. Subsequently liquidating the hedge with a futures sale upon arrival of the vessel containing the physical commodity.

iii. Assuming the importing entity desired to avoid the risk of falling prices by selling an equivalent amount of near-by futures upon arrival and then liquidating this position in 30 days using the assumption the wheat would have been sold and/or consumed during that time period. Once the wheat was consumed there would no longer be any price risk/exposure for the buyer.

The terms **"Anticipatory"** and **"Ownership"** are used to describe the two hedges. ("Anticipatory" refers to hedges that were placed in the simulation six months prior to the actual purchase date of the wheat – we purchased wheat futures six months prior to making the actual

cash wheat purchase. "Ownership" refers to the hedges placed on the day the wheat was purchased and priced from the origin through the time the wheat was shipped and then utilized by the country of Oman – wheat is priced, futures are sold then as the wheat is utilized those hedges are lifted/bought back.) Results of each for the seven years examined are summarized in table 10 below.

Table 10: Simulated Anticipatory and Ownership Hedging Results (Metric Tonnes)

Year	Volume	Anticipatory	Ownership	Net	Anticipatory	Ownership	Net
09	268,956	-93,767	10,319	-83,452	-0.35	0.04	-0.31
10	422,449	670,613	-304,751	365,862	1.59	-0.72	0.87
11	320,654	-158,044	18,071	-139,973	-0.49	0.06	-0.44
12	387,759	333,398	-289,510	43,887	0.86	-0.75	0.11
13	677,063	-602,302	144,791	-457,510	-0.89	0.21	-0.68
14	1,062,499	-228,497	253,283	24,786	-0.22	0.24	0.02
15	1,108,749	-452,888	488,782	35,894	-0.41	0.44	0.03
Total	4,248,128	-531,486	320,981	-210,506	-0.13	0.08	-0.05

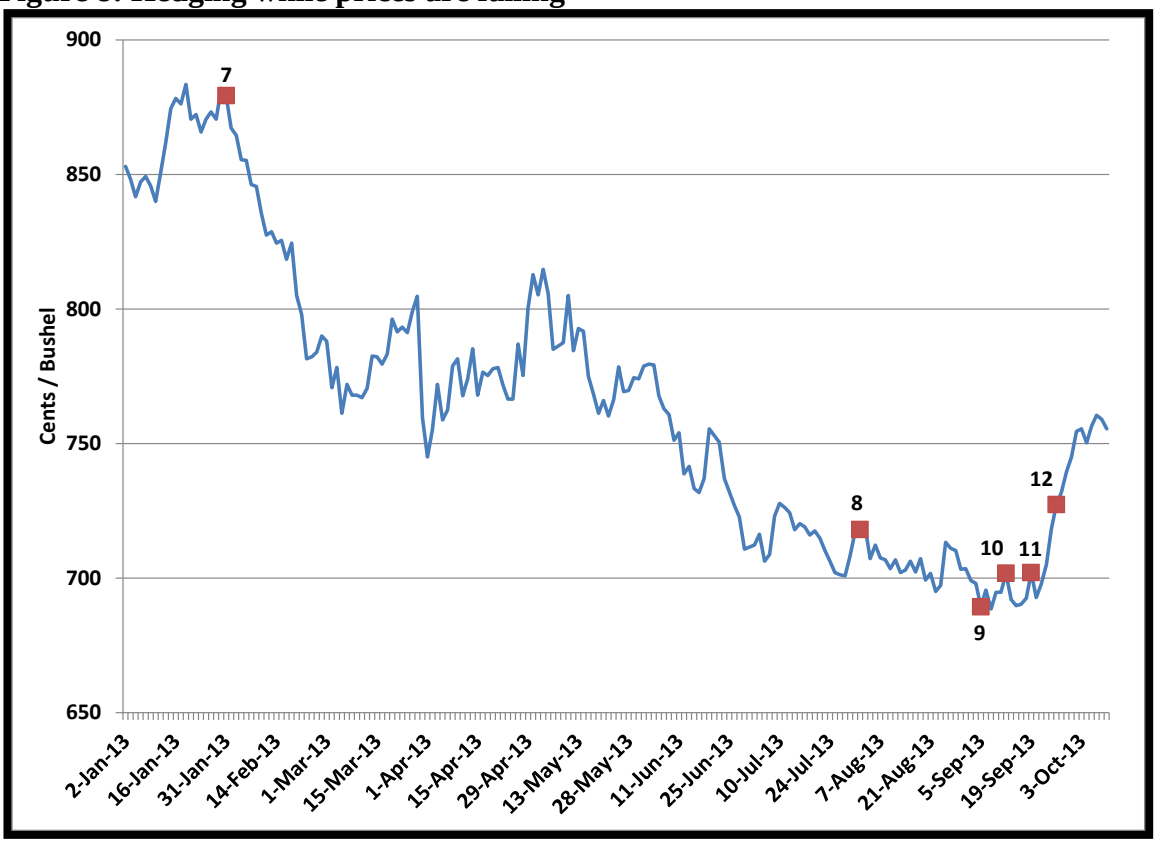
Source: Oman Flour Mills and Salalah Mills wheat purchase data and ProfitX futures and Option data.

Total quantity purchased for the 7-year period (2009 to 2015) was 4.248 million metric tonnes. Annual purchase volume ranged from a low of 269 thousand metric tonnes in 2009 to a high of 1.1 million metric tonnes in the most recent year, 2015. The "Anticipatory" strategy resulted in a 7-year total loss of $531,486; or, a loss of $0.13 per MT on the 4.248 million metric tonnes purchased.

The "Ownership" strategy provided a 7-year gain of $320,981; or a profit of $.08 per metric tonne. Combined, the two strategies yielded a net loss of $210,506. Anticipatory hedge losses are

greatest in declining markets such as 2013, 2014 and 2015 (See Figure 8 for 2013) as the consumer is continually covering the long hedge with a sale upon delivery at a lower price.

Figure 8: Hedging while prices are falling



Particularly note years 2013 and 2015, in Table 10 above, while in 2014, the strategy proved profitable through the mid-May at which time improving U.S. and global weather conditions exerted pressure on futures prices. This suggests that in periods when there intuitively appears to be more down-side risk; an options strategy may be a more appropriate course of action.

5. Summary and Conclusion

Interest in market-based risk management techniques, including the use of commodity futures and options, has grown significantly worldwide in recent years (Lapan., et al., 1991; Faruqee., et al., 1997; Sarris, A. H., 2000; Sarris, A. H. et al., 2005; Zant, W., 2005; Sarris, A. H., 2009). A number of studies have looked at the issue of food security, as well as, strategies to reduce exposure to market volatility through the use of financial instruments to hedge risks (Julian Lampietti et al. 2011; Sadler and Magnan, 2011; Sarris et al., 2005 and Sarris, 2009) in Arab countries and beyond. Different from the previous studies above, this study has utilized fairly basic methodology of hedging and longer data period to provide a fair assessment of possible benefits the government of Oman[5] could realize by enacting a prudent hedging program. Nowadays, true hedging is implemented not only in the private sector, but in both public and private sector organizations to manage the uncertainty and volatility of the global commodity markets. Oman is no exception and would benefit greatly in developing and implementing a hedging program for wheat procurement. It should be noted that an effort to provide the most simplistic analysis and assessment, there may have been some positions in the simulations implemented here that would have been altered, based on market fluctuations that may have resulted in changes in the final results.

A number of simulations have been implemented here whereby the first four (4) simulations involved implementing a hedging system in which futures and options were purchased. The first simulation consisted of buying the near-by futures contract on or about the first of January with the assumption that delivery of the first imported cargo would not be made until the following June. This was done in order to "lock-in" the effective wheat price for the entire year beginning

[5] **Through Oman Flour Mills and Salalah Mills who are the buyers of wheat for the country of Oman**

in June. Results of this "Buy All Wheat" simulation showed an average loss of 46 cents per bushel. The range of gains and losses varied from a loss of $2.45 per bushel in 2008 (-$89.86/MT) to a profit of $2.25 (+$82.79/MT) in 2010. In general therefore over the past 8-year period (2008 to 2015, the period for which we had data) if Oman had engaged in this kind of hedging, the average gain or loss from buying the entire year's import needs in the preceding January would have resulted in an average loss of **$.46 per bushel, or $16.87 per ton.**

In the second simulation, rather than buying the entire year's import needs six months in advance (As in simulation 1), this second simulation assumed buying equal amounts beginning six months in advance of expected arrival. Results of this "Equal Monthly Purchases" simulation showed an average loss of $.33 per bushel (-$12.13/MT) for the 8-year period. The hedging gain or loss in this simulation ranged from a loss of $1.88/bushel (-$69.08/MT) in 2008, to a profit of $1.92/bushel ($69.08/MT) in 2010. Therefore buying futures in equal monthly installments yielded a 28% or $.129 smaller loss per bushel **at $.33, or $12.13 per ton.** Implying, the strategy of spreading out price risk over an extended period of time reduces the loss potential compared to the strategy of making a single, large purchase.

In simulations 3 and 4 futures and options strategies were implemented for hedging wheat before the cash purchases. In simulation 3, the futures strategy consisted of buying futures six months before the cash purchase was made. Futures were then sold on the same day a cash purchase was assumed to be made. Equal cash purchases were assumed to be made once a month on the first Thursday of the month. This process was repeated for every month during a five crop-year (2010/11 to 2014/15) period. The option strategy used the same timing as the futures strategy. ,

The results indicated that, on average over the five year period, both hedging strategies would have led to "hedging losses" with futures losing on average $0.17/bushel over the five year,

while options lost $0.05/bushel over the same period. However, the results also indicate that both futures and options provide protection during times of rising prices. For example, during the 2010/11 and 2012/13 crop years futures were generally increasing and both the futures and option strategies had positive returns. In addition, options also tend to limit losses as the loss in the option position is limited to the option premium while there is no limit to losses in futures.

In simulation 4 futures and option strategies were used for hedging wheat from the time of purchase until sold to the eventual end-user. For these hedges, the futures strategy consisted of selling futures at the same time the cash purchase was made. It was then assumed it took one month to move the wheat to the eventual user and the wheat was then sold in equal weekly instalments every Thursday over a one month period. The option strategy used the same timing as the futures strategy. The results of simulation 4 indicate that, on average over the five year period (2010/11 to 2014/15), both hedging strategies would have led to positive results with futures profiting on average $0.08/bushel over the five year study while options would have profited $0.04/bushel over the same time. The results also indicate that both futures and options provide protection during times of rising prices. For example, during the 2011/12 crop year futures were generally rising and both the futures and option strategies had positive returns. In addition, options also tend to limit losses as the loss in the option position is limited to the option premium while there is no limit to losses in futures.

In simulation five, cash and futures transactions are simulated for actual purchases made by Oman between February 8, 2009 and October 13, 2015. Over the seven years of data provided, there were total hedge losses of $531,486.00 in times where the market had dropped from the time futures were purchased to the time cargoes were purchased and priced. In the seven years of data provided there were $320,981.00 in hedge gains mainly in times where the market rallied

from the time futures where purchased until the cargo was purchased and priced. The net of both equated to a cost of hedging of $210,506.00 on 4.25 Million Metric Tonnes or $0.05 per metric ton. Over that period of time and seeing the extreme volatility in the markets through this period, it is evident that the execution of a true hedging program in the procurement of wheat for the country of Oman would have been advantageous and worth the minimal cost.

Overall, the results show that combining futures and option strategies in hedging wheat from the time of purchase until sold to the eventual end-user would lead to positive results for Oman. Therefore based on the 5 different simulations performed, simulation 4 might be the one that Oman should consider.

The results obtained here should be considered as preliminary / indicative of what would likely happen if Oman engages in any of the hedge strategies simulated for wheat imports. To obtain much more insightful results the country will need to improve data collection and availability. For example in this study we were unable to find data information on both FOB and CIF values. Availability of FOB and CIF data for wheat imports for Oman would have helped to enrich the analysis and lead to much more insightful results.

Furthermore, Oman will need to build capacity in terms of training specialized people who will have the necessary technical skills to do hedging. The Government will also need to decide which institution will be responsible—whether it will be the Ministry of Agriculture, The Public Authority for Stores and Food Reserve or the Oman Flour Mills and Salalah Mills. It may also be more efficient and hence cost effective if ways are found to allow private sector participation in this activity.

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