Success and Failure of Agriculture Futures Contracts

by

N'Zue F. Fofana and B. Wade Brorsen

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The North American Free Trade Agreement (NAFTA) signed among the United States, Mexico and Canada is expected to free markets. Specifically, agricultural prices are expected to reflect efficient allocation of productive resources, and to open up new markets thereby developing the need for new agricultural futures contracts. Factors contributing to the success or failure of futures contracts are unclear (Kolb). However, there is evidence that cash market size, risk reduction ability of the contract, cash price variability, and liquidity costs influence volume of trade and open interest of futures contracts (N'Zue and Brorsen). A successful contract is one that maintains a consistently high volume of trade and open interest (Black). Hence, determining factors contributing to the success of agricultural commodities futures contracts is equivalent to determining factors affecting their (agricultural commodities futures contracts) volume of trade and open interest. Purpose of the present research is to determine factors that contribute significantly to the success or failure of agricultural commodities futures contracts. Past research on success and failure of futures contracts have focused on non-agricultural commodities (Black 1986). N'Zue and Brorsen analyzed factors affecting volume of trade and open interest of agricultural commodities futures contracts. Their study was limited to successful contracts (contracts that are currently traded). They did not account for variables such as the structure of the marketing channel in which the commodities are traded, and the homogeneity characteristics of the commodities considered. The present research extends the study by N'Zue and Brorsen to include commodities without futures markets and also contracts that failed (contracts that existed but are not currently traded).

Data and Procedures

Daily closing prices, cash prices, total volume (VOL_i), total open interest (OI_i), and future price changes for January 1, 1987 to December 31, 1992 were used in the computations of estimates. The contracts

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are daily contracts. The roll-forward day and month is day 15 of previous month. Cash price changes were also computed. The changes in future and cash prices were used to compute weekly future and cash price changes. The data set includes agricultural commodities and livestock as described in table 1.

From the list of criteria considered necessary for selecting commodities and contracts for futures trading (Kolb; Carlton (1984); Sandor (1973); Pierog and Stein (1989); and Gray (1966)) and following Black's argument that exchanges seek to maximize member's utility, the following characteristics were selected as important to the success or failure of agricultural commodities futures contracts:

1) The own hedge contract bearing less risk than the existing cross-hedge contract for commodity i (RR_i).
2) The volatility of the cash market price for commodity i ($PVAR_i$).
3) The liquidity cost of using the own futures market instead of the existing cross-hedge futures market for commodity i ($CLIQ_i$).
4) The size of the cash market for commodity i ($SIZE_i$).

5) The structure of the marketing channel for commodity i ($STRUCT_i$).
6) The homogeneity characteristic of commodity i ($HOMO_i$).

The above characteristics are used as variables important to the success or failure of agricultural futures contracts. These variables are discussed below.

Relative Residual Risk (RR)

The relative residual risk is obtained by regressing the weekly change in cash price on the weekly change of futures price. The coefficient of determination (R-square) of that regression is used as a measure of risk reduction (Black). That is, $(1-R^2)$ is a measure of the risk that remains in a futures contract (residual risk). The relative residual risk is calculated as the ratio of the residual risk of the cross hedge market (alternative market) and that of the own hedge market. The coefficient of this variable is expected to be positive. That is, a relatively high relative residual risk (greater than one) means cross hedging bears more risk than own hedging. If that is the case, the own hedge market would be preferred to the cross hedge market, and contract volume in the own hedge market will increase.

Cash price variability (PVAR)

The cash price variability is obtained by taking the standard deviation of the weekly cash price change and dividing it by the contact size. Literature on futures markets shows a strong, positive correlation between price volatility and trading volume.

Liquidity cost (CLIQ)

Liquidity cost is measured as the average across all active months of the daily trading volume in the cross hedge futures market. This variable is hypothesized to be negatively correlated with trading volume.

Cash market size (SIZE)

The annual production of each commodity was used as a measure of the size of the cash market. The annual production of each commodity was then divided by the contract size of the futures contract of that commodity.

Homogeneity

When a good varies tremendously in quality, its delivery process is impaired. Futures contracts are defined as a legal agreement to buy or to sell a given quantity and quality of a commodity at a specified price at the time the contract is executed (Chicago Board of Trade). A commodity whose quality is subjective or depends on individual taste will not be easy to grade and hence, it will not be suitable for futures trading. Black gives the example of tobacco as another non-traded commodity. Moreover, Hieronymus (1972) argued that commercial units of commodities traded on futures markets must be interchangeable. That is, the commodity must be describable. Thus, homogeneity is an important feature in the success or failure of agricultural commodities futures contracts. It (homogeneity) is subjective. Different degrees of homogeneity exist making it difficult to measure. But it is not because a characteristic is subjective or difficult to measure that, it has to be ignored. For the present research, homogeneity will be measured by the Delphi approach.

The Delphi technique is a group process that allows those individuals who possess the knowledge and ability and may be located in different geographical areas to contribute meaningfully in solving a given problem (Render and Stair, 1988, and Stevenson, 1986). The problem in our case is to measure homogeneity. A scale of one to 10 was developed to rate each commodity (for example, one means the commodity considered is not homogeneous, whereas 10 means that it is). Then a panel of respondents was selected. The respondents were given a questionnaire/survey on which they were asked to rank each commodity using the scale of one to 10. The final Data and detail of the questionnaire/survey can be found in appendix. The mean (μ) and the mean +/- one standard deviation ($\mu \pm \sigma$) of the estimates obtained from the first round were computed. In the second round the respondents were asked to reevaluate their estimates and to give a brief explanation of their new estimate if it is outside the $\mu \pm \sigma$ interval. The procedure was repeated four times and the mean of the estimates of the fourth round was taken as the measure of the homogeneity characteristic (See Shannon for details on the Delphi technique).

Market Structure

The structure of the marketing channel of commodities across all levels can influence the likelihood of success or failure of commodities futures contracts. Indeed, as Gray mentioned in 1966, a contract whose original provisions favor the buyer or the seller enable one side to squeeze the other as the delivery date approaches. Holders of the contract can create squeezes or corners by standing for delivery when the cash commodity is in short supply (as a result of natural disaster or purposeful manipulation) (Black, 1986). That is, market structure is an important factor in the success or failure of futures contracts. Preventing exercise of market power through contract design increases the likelihood of success of futures contracts. Market structure was measured as degree of vertical integration. If multiple handlers and pricing points exist in the market of a given commodity, then the market for that commodity is not vertically integrated. However, if there is unique handler and pricing point then, the market is vertically integrated. For this research, the Delphi approach was used to obtain a measure of the structure of the marketing channels in which the selected commodities are traded.

Model

Because of the inclusion of commodities without futures markets (no trading volume), the simple log linear model used in N'Zue and Brorsen is no longer appropriate. A selectivity model was chosen as an alternative. The selectivity model is defined in a general framework as follows: Suppose we have two variables y^*_t and z^*_t such that

$$y_t = y^*_t \quad if \quad z^*_t > 0; \; y_t = 0 \quad otherwise; \qquad (1)$$
$$z_t = 1 \quad if \quad z^*_t > 0; \; z_t = 0 \quad otherwise.$$

where y^*_t, and z^*_t are generated by the bivariate process

$$\begin{bmatrix} y^*_t \\ z^*_t \end{bmatrix} = \begin{bmatrix} X_t\beta \\ W_t\gamma \end{bmatrix} + \begin{bmatrix} \mu_t \\ v_t \end{bmatrix}$$

$$\begin{bmatrix} \mu_t \\ v_t \end{bmatrix} \sim NID\left(0 \ , \begin{bmatrix} \sigma^2 & \rho\sigma \\ \rho\sigma & 1 \end{bmatrix} \right) \tag{2}$$

and X_t , W_t are vectors of observations on exogenous variables, β and γ are unknown parameter vectors, σ is the standard deviation of μ_t and ρ is the correlation between μ_t and v_t. The restriction that the variance of v_t is equal to 1 is imposed because only the sign of z^*_t will be observed (Davidson and MacKinnon). Equation (1) suggest two types of observations: ones for which both y_t and z_t are observed to be zero and ones for which z_t = 1 and $y_t = y^*_t$. The log-likelihood function for the model in equation (1) is

$$L = \sum_{z_t=0} \log(\Phi(-W_t\gamma)) + \sum_{z_t=1} \log(\frac{1}{\sigma}\phi(y_t - X_t\beta)) + \sum_{z_t=1} \log(\Phi(\frac{W_t\gamma + \rho((y_t - X_t\beta)/\sigma)}{(1-\rho^2)^{1/2}})). \tag{3}$$

Heckman (1976) suggested a simple method for obtaining estimates of equation (3). The method known as the Heckman's two step method is based on the fact that the first equation in equation (1) can be rewritten as

$$y^*_t = X_t\beta + \sigma\rho v_t + e_t. \tag{4}$$

replacing y^*_t by y_t and v_t by its mean conditional on z_t=1 and on the realized value of $W_t\gamma$, we can rewrite equation (4) as

$$y_t = X_t\beta + \rho\sigma \frac{\phi(W_t\gamma)}{\Phi(-W_t\gamma)} + e_t. \tag{5}$$

The quantity $\phi(W_t\gamma)/\Phi(-W_t\gamma)$ is known as the inverse Mills ratio. Equation (5) is referred to as the selection equation. The first step in the Heckman's method is to use an ordinary probit model to obtain consistent estimates of the selection equation. In the second step, equation (5) is estimated by ordinary least squares (See Davidson and Mackinnon and also Greene; Judge et al. for more details on selectivity models). If we let y_t = (VOL_{it} or OI_{it}), W_t = ($SIZE_{it}$, $STRUCT_{it}$, $HOMO_{it}$), and X_t = (RR_{it}, $CLIQ_{it}$, $PVAR_{it}$, $SIZE_{it}$, $STRUCT_{it}$, $HOMO_{it}$) then, we can write equation (5) as function of the variables specified above. The general specification of the models will be:

$$VOL_{it} = f(RR_{it}, CLIQ_{it}, PVAR_{it}, SIZE_{it}, STRUCT_{it}, HOMO_{it}) \quad (6)$$

$$OI_{it} = f(RR_{it}, CLIQ_{it}, PVAR_{it}, SIZE_{it}, STRUCT_{it}, HOMO_{it}) \quad (7)$$

where the subscript i and t refer to commodity and time respectively. The hypothesized signs are

$$\frac{\partial VOL_{it}}{\partial RR_{it}} > 0$$
$$\frac{\partial VOL_{it}}{\partial PVAR_{it}} > 0$$
$$\frac{\partial VOL_{it}}{\partial CLIQ_{it}} > 0 \quad (8)$$
$$\frac{\partial VOL_{it}}{\partial SIZE_{it}} > 0$$
$$\frac{\partial VOL_{it}}{\partial STRUCT_{it}} > 0$$
$$\frac{\partial VOL_{it}}{\partial HOMO_{it}} > 0$$

The same signs are expected for the open interest model.

Empirical Results

The selectivity models were estimated using LIMDEP (Econometric Software). Average daily volume for traded commodities and predicted volume for non-traded commodities were also obtained. Results are summarized in tables 2, 3, 4, and 5. Table 2 presents the mean across year of futures contracts trading volume and open interest of selected commodities in 100 contracts per day, and the cross-hedge market for the selected commodity.

Table 3. presents the parameter estimates of the probit model used in the selectivity regression. The estimates suggest that market size and the degree of vertical integration contribute significantly to the existence of futures markets.

Table 4 Presents the parameter estimates of the selectivity models. All the parameters have the hypothesized signs except the liquidity cost variable in the trading volume model. The risk reduction variable, the cash price volatility and the market size variables are all significantly different from zero.

The selectivity variable (IMR) is not significantly different from zero. This result suggests that selectivity is not an important problem for the data set considered.

The homogeneity variable is significantly different from zero in the trading volume equations. This result suggests that the success of a futures contract is affected by the homogeneity of the underlying commodity.

The degree of vertical integration variable does not have the expected sign. This may result from the beliefs of the panel considered for delphi technique used to measure the degree of vertical integration.

Predicted volume and open interest for non-traded commodities are presented in table 5. Given the difficulty to identify a cross-hedge market for those commodities, the cross-hedge market variable (CLIQ) was assume to be zero. An underlying commodity for which the predicted contract volume and open interest alternate from positive to negative is likely to fail if the contract were traded. Alternatively, a commodity for which the predicted contract volume and open interest are consistently positive is likely to have successful futures contract. From table 5, Broilers, eggs, and milk are likely to have successful contracts if they were traded.

Concluding Comments

A selectivity model was used to determine factors important to the success or failure of agricultural futures contracts. Commodities with and without futures markets were selected. The variables analyzed included (i) a measure of how well the new market is able to reduce risk compared to the existing cross-hedge market; (ii) a measure of the volatility of cash market prices; (iii) a measure of the relative cost of using the existing cross-hedge market versus the new own-hedge market; (iv) a measure of the size of the cash market; (v) a measure of the structure of the marketing channel; and (vi) a measure of homogeneity. Contract's trading volume and open interest for non-traded commodities were predicted. The results suggest that the size of cash market, the homogeneity of the underlying commodity, and the volatility of the cash market prices are important to the success or failure of agricultural futures contracts. Results also suggest that Broilers, eggs, and milk are likely to have successful contracts if they were traded.

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Table 1. Commodities Included in the Study, and Time Period Covered.

Commodities	Period
I. Agricultural Commodities:	
1. Corn	1987-1992
2. Oats	1987-1992
3. Soybeans	1987-1992
4. Soybean Meal	1987-1992
5. Soybean Oil	1987-1992
6. Wheat-Chicago	1987-1990
7. Wheat-Kansas City	1987-1992
8. Cotton	1987-1992
9. Apples	1987-1992
10. Pears	1987-1992
11. Tomatoes	1987-1992
II Livestock:	
12. Live Cattle	1987-1992
13. Feeder Cattle	1987-1992
14. Live Hogs	1987-1992
15. Pork Bellies	1987-1992
III Miscellaneous:	
16. Broilers	1987-1992
17. Eggs	1987-1992
18. Milk	1987-1992

Table 2. Mean Across Year of Futures Trading Volume of Selected Commodities in 100 Contracts per day, and the Cross-Hedge Market for the Selected Commodities.

Commodity	Daily Average Volume	Daily Average Open Interest	Cross-hedge Market
Corn	39821.690	198233.57	Chicago wheat
Oats	1483.600	10178.94	Corn
Chicago Wheat	11939.934	52879.44	Kansas City W.
Kansas City W.	5001.296	26246.45	Chicago wheat
Soybeans	38223.696	108388.03	Soybean meal
Soybean meal	17928.850	65552.82	Soybeans
Soybean oil	17218.320	76919.58	Soybeans
Live cattle	17051.880	79810.52	Feeder cattle
Feeder cattle	2046.830	13771.30	Live cattle
Live hogs	7450.130	28837.63	Live cattle
Porkbellies	4412.420	12871.32	Live hogs

Table 3. Parameter estimates of the probit model used in the selectivity model.

Independent Variables	Dependent Variables: Trading Volume	Open Interest
Size	8.191*	0.000093*
	(2.058)	(2.143)
Struct	2.260*	0.000312*
	(3.480)	(4.020)
Homo	-1.658*	-0.000244*
	(-3.260)	(-3.872)

Numbers in parentheses are t-ratios. * denotes Coefficients significant at 5% probability level

Table 4. Parameter Estimates of the Selectivity Models.

Independent Variables	Dependent Variables: Trading Volume	Open Interest
RR	3.537*	7.997
	(2.104)	(1.096)
PVAR	2.2655*	5.686*
	(4.841)	(3.084)
CLIQ	0.657	-6.989
	(0.676)	(-1.160)
SIZE	1.451*	7.734*
	(5.172)	(5.300)
STRUCT	-2.024*	-6.924*
	(-3.967)	(-2.735)
HOMO	1.510*	5.973
	(2.064)	(1.654)
IMR	-2022.400	36893.000
	(-0.346)	(0.905)
R-Square	0.546	0.525

Numbers in parentheses are t-ratios. * denotes Coefficients significant at 5% probability level, and ** denotes coefficients significant at 10 % probability level. IMR = Inverse Mills Ratio

Table 5. Predicted Volume for non-Traded Commodities.

Year	Commodity	Predicted trading Volume	Predicted Open Interest
1987	Apples	4475.30	-31913.00
1987	Pears	2726.80	-42569.00
1987	Tomatoes	5624.10	-27761.00
1987	Broilers	15443.00	49289.00
1987	Eggs	15726.00	45329.00
1987	Milk	23653.00	66717.00
1988	Apples	4334.00	-32387.00
1988	Pears	2737.30	-42538.00
1988	Tomatoes	5448.50	-28364.00
1988	Broilers	25793.00	94434.00
1988	Eggs	15678.00	45137.00
1988	Milk	23904.00	67554.00
1989	Apples	4417.20	-32105.00
1989	Pears	2748.20	-42500.00
1989	Tomatoes	5865.20	-26965.00
1989	Broilers	15569.00	49869.00
1989	Eggs	15509.00	44457.00
1989	Milk	23761.00	67101.00
1990	Apples	4392.40	-32190.00
1990	Pears	2761.70	-42457.00
1990	Tomatoes	6051.80	-26368.00
1990	Broilers	15650.00	50240.00
1990	Eggs	15557.00	44649.00
1990	Milk	24190.00	68563.00
1991	Apples	4408.80	-32133.00
1991	Pears	2754.40	-42486.00
1991	Tomatoes	6128.80	-26088.00
1991	Broilers	12078.00	50611.00
1991	Eggs	15633.00	44951.00
1991	Milk	24211.00	68634.00
1992	Apples	4411.10	-32127.00
1992	Pears	2754.40	-42486.00
1992	Tomatoes	6149.20	-26037.00
1992	Broilers	12078.00	50611.00
1992	Eggs	15630.00	44945.00
1992	Milk	24556.00	69807.00

Appendix

Final Survey (for homogeneity characteristic)

The objective of this last survey is to obtain definitive rankings. Considering the means and standard deviations computed from the third survey, and the explanations of why some of the commodities are more or less homogeneous, please reevaluate your rankings. Do you confirm the explanations given? why or why not? Circle the number (only one) that, you think, best describes the homogeneity characteristic of the commodity considered.

Commodity	Scale									
	Lowest							Highest	$\bar{x}$	$\bar{x} \pm \sigma$
Corn	2	3	4	5	6	7	8	(9)	**9.0**	**[9.0-9.0]**
Live Cattle	**(2)**	3	4	5	6	7	8	9	**2.0**	**[2.0-2.0]**
Oats	2	3	4	5	6	7	8	9	**9.0**	**[9.0-9.0]**
Wheat-Chi (Soft red)	2	3	4	5	6	7	8	9	**7.0**	**[5.1-8.9]**
Wheat-KC (Hard red)	2	3	4	5	6	7	8	9	**7.5**	**[6.4-8.6]**
Feeder Cattle	2	3	4	5	6	7	8	9	**2.0**	**[2.0-2.0]**
Live Hogs	2	3	4	5	6	7	8	9	**4.25**	**[3.2-5.3]**
Pork Bellies	2	3	4	5	6	7	8	9	**6.25**	**[5.8-6.7]**
Soybeans	2	3	4	5	6	7	8	9	**8.5**	**[8.0-9.0]**
Soybean Meal	2	3	4	5	6	7	8	9	**9.0**	**[9.0-9.0]**
Soybean Oil	2	3	4	5	6	7	8	9	**9.0**	**[9.0-9.0]**
Cotton	2	3	4	5	6	7	8	9	**6.25**	**[4.2-8.3]**
Apples	2	3	4	5	6	7	8	9	**4.25**	**[1.9-6.5]**
Pears	2	3	4	5	6	7	8	9	**4.25**	**[2.5-6.0]**
Tomatoes	2	3	4	5	6	7	8	9	**4.0**	**[2.0-6.0]**
Broilers	2	3	4	5	6	7	8	9	**7.5**	**[7.0-8.0]**
Eggs	2	3	4	5	6	7	8	9	**7.5**	**[6.0-9.0]**
Milk	2	3	4	5	6	7	8	9	**8.5**	**[7.6-9.4]**

Thank you for your time.

Brief explanations of why some of the commodities are believed to be more or less homogeneous:

Live Hogs: Hog marketing practices are changing to reflect the value of fat and genetics. Hence live hogs are more homogeneous than what the actual scale indicates. It should be ranked (6). **(Confirmed by the rest of the panel).**

Pork Bellies: Bellies are priced and graded mainly on weight. Hence, they are more homogeneous than what the actual scale indicates. It should be ranked (7). **(Confirmed by the rest of the panel).**

Cotton: Cotton has an extensive grading system that is, it is relatively homogeneous within these grades. It should be ranked (9). **(Confirmed by the rest of the panel).**

Eggs: Storage time affects value of eggs (They are perishable). The size of eggs may also affect their value. Hence, eggs are less homogeneous than what the actual scale indicates. It should be ranked (5); **(Argument was not confirmed by the rest of the panel).**

Milk: Less homogeneous than what the actual scale indicates because milk differ greatly in quality (skim milk, whole milk, buttermilk, acidophilus ...). It should be ranked (7); **(Argument was not confirmed by the rest of the panel).**

Final Survey (for market structure characteristic)

The objective of this final survey is to obtain definitive rankings. Considering the means and standard deviations computed from the second survey, the explanations of why it is believed that some of the markets are vertically integrated and others are not, and following the given example as a benchmark please reevaluate your rankings. Multiple handlers exist in the wheat market, hence, the **wheat** market is not vertically integrated. It **should be ranked 9**. Multiple handlers do not exist in the broilers market. Hence, the **broilers** market is vertically integrated. It **should be ranked 1**. Do you confirm the explanations given? why or why not? Circle the number (only one) That, you think, best describes the degree of vertical integration of the market considered for the **1987-1992 time period**.

Commodity					**Scale**							
Vertically Integrated					**Not Vertically Integrated**						**x̄**	**x̄±σ**
Corn	1	2	3	4	5	6	7	8	9	10	**8.25**	**[7.9-8.8]**
Oats	1	2	3	4	5	6	7	8	9	10	**7.50**	**[6.4-8.3]**
Live Cattle	1	2	3	4	5	6	7	8	9	10	6.25	**[6.2-7.1]**
Wheat-Chi (Soft red)	1	2	3	4	5	6	7	8	9	10	**9.0**	**[9.0-9.0]**
Wheat-KC (Hard red)	1	2	3	4	5	6	7	8	9	10	**9.0**	**[9.0-9.0]**
Feeder Cattle	1	2	3	4	5	6	7	8	9	10	**8.25**	**[7.4-9.3]**
Live Hogs	1	2	3	4	5	6	7	8	9	10	**5.50**	**[5.2-6.1]**
Pork Bellies	1	2	3	4	5	6	7	8	9	10	**6.00**	**[5.1-7.6]**
Soybeans	1	2	3	4	5	6	7	8	9	10	**6.50**	**[5.4-7.3]**
Soybean Meal	1	2	3	4	5	6	7	8	9	10	**6.00**	**[4.4-6.9]**
Soybean Oil	1	2	3	4	5	6	7	8	9	10	**5.75**	**[4.4-6.3]**
Cotton	1	2	3	4	5	6	7	8	9	10	**6.25**	**[5.9-6.8]**
Apples	1	2	3	4	5	6	7	8	9	10	**4.50**	**[3.7-5.6]**
Pears	1	2	3	4	5	6	7	8	9	10	**5.25**	**[4.2-5.8]**
Tomatoes	1	2	3	4	5	6	7	8	9	10	**4.50**	**[2.4-5.6]**
Broilers	1	2	3	4	5	6	7	8	9	10	**1.00**	**[1.0-1.0]**
Eggs	1	2	3	4	5	6	7	8	9	10	**3.25**	**[2.6-5.4]**
Milk	1	2	3	4	5	6	7	8	9	10	**5.00**	**[4.4-6.9]**

Thank you for your time.

Brief explanations of rankings giving by the panel.
Milk has enough unique prices. Therefore, it is not highly vertically integrated. It should be ranked 7 (not confirmed).
Oats: There are very few oat processors. For example

Quaker oats contracts a large portion of the market. Therefore, the oat market should be ranked 6 (not confirmed).