Intermarket Wheat Spreads

by

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An important element of risk management and speculation in wheat markets is that of intermarket spreads. Hedgers of wheat can and do hedge in at least three different futures markets. Critical to these hedging decisions is the expected change in the intermarket spreads. In addition, a tremendous amount of speculative activity in wheat futures is oriented towards intermarket spreading. Thus, the purpose of this paper is to develop a model and analyze both price levels and spreads between the three principal U.S. wheat futures markets. A quarterly econometric model is developed where price levels are explained by various stock variables. The model is expanded to analyze spreads between markets. In addition, unique attributes of each market are incorporated into the analysis. Of particular importance are variability in quality and the differential impact of government programs across markets.

Several other studies have addressed topics related to the wheat futures markets. The primary thrust of most of the work by Gray has been to emphasize differences and interrelationships between these markets. There are two important points. First, even though the Chicago Board of Trade (CBT) is relatively more speculative and the Minneapolis Grain Exchange (MGE) and Kansas City Board of Trade (KCBT) are more hedging oriented, these markets are critically dependent on each other. That dependence is facilitated through spreading activities. That is, seasonal hedging pressures at the smaller exchanges are reduced because speculative open interest is transfused from Chicago via spreading. In the absence of spreading the price effects of excessive hedging at the smaller exchanges would be much greater. The second point, of particular importance in the past several years, is that these markets are influenced by the differential impacts of government programs. Generally, producers contiguous to the MGE are more participative in government programs than are those in the winter wheat belt, and especially those in the soft red wheat areas. As a result, to the extent that government programs influence prices, the effects will vary across markets. In a recent investigation Gray and Peck examined the details of a drastically inverted market at the CBT. Their results demonstrated the impacts of government programs and relative stocks in both inter- and intramarket wheat spreads.

The effectiveness of hedging various qualities of wheat with each of the wheat futures was analyzed by Wilson (1984). Mean-variance analysis was the methodology using historical variances and covariances for both single market hedges and hedges spread across two or three markets. A legitimate criticism of that study is that the traditional mean-variance approach does not incorporate expected changes in spreads, which are in practice of critical importance and was partly the motivation to the present study. In a more recent study Strohmaier and Dahl developed a model to explain intermarket wheat spreads. They identified that seasonality was an important part of the variability in wheat spreads, but were unable to explain the source of that

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**The authors are Associate Professor of Agricultural Economics at North Dakota State University, and Commodity Analyst, General Mills, respectively.*

seasonality. The model used annual data, and stepwise regression was used to select important explanatory variables amongst a set of supply and demand variables. Intra-year variability was not incorporated in the econometric analysis. In addition, the importance of protein variability was discussed as a possible rationalization of the results but was not incorporated in the model.

This paper is organized as follows. First, the salient differences between the three wheat futures markets are discussed. The empirical model is developed, and results are presented in the second section.

Description of Markets and Important Fundamentals

The three wheat futures markets are highly interdependent but do have several subtle differences of importance. The deliverable grade against the MGE and KCBT wheat futures contracts are hard red spring (HRS) and hard red winter (HRW) wheat, respectively, generally coinciding with the wheat grown in regions contiguous to the markets. The CBT contract however, allows for delivery of soft red winter (SRW), as well as HRS and HRW. Since SRW is the type of wheat grown closest to that delivery market, and being SRW is usually the cheapest wheat, the CBT contract generally is thought to reflect the underlying fundamentals of SRW.

The CBT wheat futures contract nearly always has a disproportionately large share of the open interest. In recent years SRW has comprised about 19 percent of the U.S. wheat production, while HRW and HRS were 50 percent and 16 percent, respectively. However, it is not uncommon for the CBT wheat futures contract to comprise up to 75 percent of the open interest across the markets. Analysis of the composition of open interest indicates the CBT has the largest proportion of speculators, whereas KCBT and MGE have the largest proportion of hedgers. In principal, commercials prefer to place hedges at either the KCBT or the MGE because of the delivery grade. Thus, there is often excessive hedging at the MGE and KCBT. On the other hand, the CBT has a larger hedge carrying capacity and via spreading results in reduced hedging costs at the other two markets. Speculators respond to the hedging pressures and the smaller exchanges resulting in a transfusion of speculation. Alternatively, as a result of the lack of liquidity and associated hedging cost at the smaller exchanges, hedgers of hard wheat in some cases may place their hedges directly at the CBT.

Important supply/demand data for SRW, HRS, and HRW are shown in Table 1. There are several points of interest revealed in this data. First, production of SRW increased relative to that of other classes since the early 1970s and has decreased recently. In 1973/74 SRW comprised 9 percent of total U.S. wheat production and increased to 15 percent in 1985/86. In the interim period SRW production increased to as high as 24 percent. Second, the proportion of exports which were SRW increased from 2 percent in 1973/74 to 17 percent in 1985/86. These effects however have been variable through time. For example, between 1984/85 and 1985/86 exports of all classes decreased, but the rate of decrease varied: HRW -38 percent, HRS -13 percent, and SRW -37 percent. The reason for the disproportionate decline is due largely to the relatively large supply of low protein HRW wheats. Finally, the level of ending stocks for SRW is substantially less than that of the other classes, due in large part to low participation rates, and because inter-year storage is fairly costly for that class of wheat.

The two classes of hard wheats, HRS and HRW, are used primarily in the production of bread products, whereas SRW is used primarily for cookies and crackers. In these products protein level is not important, in fact, lower protein wheat is desireable. HRS wheat is generally the highest in protein and is used for blending purposes, and for hearth bread and hard rolls (Canada Grains Council). HRW wheat is generally lower in protein level. Consequently, wheats are substitutable between classes, but not universally.

Crop year protein levels potentially have an important impact on price levels and spread relationships. Average data for the Kansas and North Dakota crops are shown in Table 2. The HRS crop always has a higher protein level, and is less variable than that of the HRW crop. An important trend developed during the 1980s in that the protein levels for both hard wheats, but, particularly HRW, decreased due to supply response and agronomic practices. For each of the exchanges the protein level for the delivery grade is constant between years, 13.0 and 13.5 percent at the MGE and ordinary at the KCBT. Given that protein levels in any particular year are predetermined, the impact of crop year protein levels on prices and spreads is via the demand factors (i.e., inverse demand). Lower protein HRW wheat results in an increase in demand for HRS wheat, thereby increasing that spread. This effect is generally thought to have an impact on the cash market, but may also influence the futures.

Government programs have pervasive effects throughout the wheat industry. Of particular importance for purposes here is the price effects of the loan rate programs. The potential impact of that program on price levels and spreads depend on participation rates. An important underlying fundamental is that effective participation rates for wheat of each class vary (Table 3). In particular, those of HRS and HRW have always exceeded those for SRW. These differences are due to a number of factors including the fact that much of the growth in SRW production has been from double cropping with soybeans; which generally precludes wheat program participation.

The differential rates of program participation influence price levels, intermarket wheat spreads, and the equilibrium price of storage. Intramarket wheat spreads have generally been less at the KCBT and MGE than the CBT, largely due to the Telser effect and the proportionately larger storage capacity at the KCBT and MGE. The operation of the loan rate program involves participation, entries, and redemption and forfeiture. Consequently, for a market with depressed prices and high participation rates, prices must stay low enough until anticipated free stocks become tight, increasing thereafter to attract redemption. Consequently, prices are influenced by actual and anticipated entries into the program. In addition, Gray (1962) has demonstrated that the effect of the loan rate is to accentuate seasonal behavior of prices.

Empirical Model Development

The primary thrust of the empirical analysis presented here is that of a system of interdependent demand equation. Quarterly data are used so that seasonal effects can be evaluated. Given the short term nature of the analysis, supply of each class of wheat is predetermined. Futures prices for each class are simultaneously determined by interaction of demand factors and supply.

Simple demand functions for the type of wheat traded at each of the futures markets are

(1.1) $Q^M = F^M (P^M, P^K, P^C, X^M)$
(1.2) $Q^K = F^K (P^M, P^K, P^C, X^K)$
(1.3) $Q^C = F^C (P^M, P^K, P^C, X^C)$

where Q^i is quantity demanded, P^i is futures price, and X^i represents all other demand factors. M, K, and C represent the class of wheat traded at the MGE, KCBT, and CBT, respectively. Being Q^i is predetermined at time t, and that in equilibrium these given supplies must be allocated across the various demands (e.g., consumption, exports, government stocks), the above system can be re-written, following Foote, as a reduced form system of equations. This specification is similar to derivation of inverse demand functions for a multi-commodity system. In the reduced form prices are endogenous, and predetermined supplies and X^i are on the right hand side:

(2.1) $P^M = F^{M'} (Q^M, Q^K, Q^C, X^M)$
(2.2) $P^K = F^{K'} (Q^M, Q^K, Q^C, X^K)$
(2.3) $P^C = F^{C'} (Q^M, Q^K, Q^C, X^C)$

Coefficients for the above system can be estimated using single equation least squares techniques.

Since the primary purpose here is the analysis of price, the reduced form coefficients will be interpreted directly, rather than deriving and analyzing structural coefficients. The demand elasticities would equal the reciprocal of the price flexibilities only if the cross-elasticities are zero, which is highly unlikely. The reduced form coefficients represent the total effect of a change in the exogenous variable on the dependent variable, including both the direct impact and the indirect impact through the other markets.

Price spreads between markets were analyzed as the ratio of market prices using the same exogenous variables as in the above reduced form system.[1] Use of ratios is conceptually and empirically preferable to using differences, even though the statistical results using the latter are similar. Each of the exogenous variables is incorporated separately, rather than as a ratio as in Strohmaier and Dahl, primarily to retain generality. Specifically, a variable may be statistically insignificant in explaining a spread, but if included as a ratio (e.g., S^M/S^C) the insignificance would be masked. Secondly, including supply variables as ratios do not explicitly allow differential effects of supply on the price spreads.

Several other exogenous variables and effects were incorporated into the general price level and ratio functions. It is generally well recognized that prices and/or price relationships follow a seasonal pattern (Westcott, Hull, and Green; Strohmaier, and Dahl). In the context of this model, that seasonality must be due to either exogenous shifts in demand, or due to seasonality in the supply or other variables. In order to be general and isolate the source of seasonality, both seasonal intercepts and slope interaction terms were included in the model. Standard statistical tests were conducted to reduce the number of variables in the final specification.

Another important characteristic of the wheat markets is that of protein availability. Indeed, recent premiums for protein are record high reflecting the general world shortage of protein. See Wilson (1983) for an analysis of the effect of protein availability on cash price differences. Normally protein supply is thought to influence cash prices, but then it must also have an influence on futures markets. This influence may take generally one of two forms. The first is to affect hedge pressure at particular markets if, for example, hedgers become concerned about protein availability. Second, is that if due to a protein shortage cash prices increase, futures may increase due to the potential for substitutability and arbitrage. To account for these effects protein availability was included in each equation and the effect was allowed to vary seasonally.

Another important characteristic in the wheat market is the influence of government programs. In particular, the differential rates of participation across wheat regions can result in differential impact in the respective cash and/or futures markets. The effects are nil during periods when prices exceed loan values. However, in several quarters during the late 1970s and more recently when farm cash prices were from 85 to 100 percent of loan values, the differential rates of participation may be important. As prices approach or go below loan value in HRS wheat, the high rate of participation, combined with generally adequate storage, results in massive entries into the program and supports prices. In this area prices may fall below loan value but stay there only temporarily. In recent periods in SRW on the other hand, farm prices fell below loan values and, due likely to the low participation rates and inadequate on-farm storage, stayed at depressed levels for a longer duration. Several different approaches were experimented with to capture these effects. These included: (1) using participation rates as an exogenous variable; and (2) using wheat eligible for program entry as an exogenous variable. In general, the results were inconclusive indicating no obvious direct impact on futures prices.

The effects of differential rates of program participation are captured or reflected in the analysis in several ways. First, a separate equation was estimated for each market. These effects would be partially reflected in the different intercept and slope coefficient. Second, prices at each market were deflated by the respective loan rate (LR) for each class and region contiguous to that market. That is a common approach to easily capture the impacts of government programs (see Westcott, Hull, and Green for example). It is also a very expeditious means to capture the differential impacts across wheat markets which would be reflected in the regression coefficients.[2] Implicitly, as stocks increase, the P/LR ratio asymptotically approaches 1.0 and may intersect that point if stocks are excessively large. For markets and/or times when participation rates are high and stocks are large, the P/LR may never intersect 1.0 and only asymptotically approach it. Alternatively, with large stocks and low participation, the ratio P/LR may very well go below unity. Thus, the effects of differential rates of program participation are reflected in unique slope and intercept coefficients for each market.

The model was estimated assuming a simple partial adjustment process similar to Marsh and to Westcott, Hull and Green. This accounts for an adjustment to desired demand which may take more than one period. To account for several potential nonlinearities all the data was transformed to logs prior to estimation. The final reduced form equations were specified as

(3.1) $P^M_t = F^{M'} (P^M_{t-1}, D_S, S^M_t, S^K_t, S^C_t, PRO^K_t, PRO^M_t)$

(3.2) $P^K_t = F^{K'} (P^K_{t-1}, D_S, S^M_t, S^K_t, S^C_t, PRO^K_t, PRO^M_t)$

(3.3) $P^C_t = F^{C'} (P^C_{t-1}, D_S, S^M_t, S^K_t, S^C_t, PRO^K_t, PRO^M_t)$

(3.4) $P^{MC}_t = F^{S1} (P^{MC}_{t-1}, D_S, S^M_t, S^K_t, S^C_t, PRO^K_t, PRO^M_t)$

(3.5) $P^{MK}_t = F^{S2} (P^{MK}_{t-1}, D_S, S^M_t, S^K_t, S^C_t, PRO^K_t, PRO^M_t)$

(3.6) $P^{KC}_t = F^{S3} (P^{KC}_{t-1}, D_S, S^M_t, S^K_t, S^C_t, PRO^K_t, PRO^M_t)$

where P^i is the quarterly average nearby futures contract at each exchange; $P^{MC}_R = P^M/P^C$; $P^{MK}_R = P^M/P^K$; $P^{KC}_R = P^K/P^C$; D_S is quarterly binary variable, or S = 4, 1, 2; S^i is the free stocks of the type of wheat for each exchange i at the beginning of the quarter; PRO^K and PRO^C is the crop average protein level for HRW and HRS, respectively.

Quarters correspond with the data, where S_1 = January - March, S_2 = April - May, S_3 = June - September, and S_4 = October - December. All prices are divided by relevant loan values for each type of wheat in the regions contiguous to the market. Wheat under CCC or Farmer Owned Reserve were deleted from the stocks, following Westcott, Hull, and Green. The stocks data were specified using several alternatives including: 1) free stocks, i.e., those not under loan or held by FOR or CCC; 2) free stocks and stocks under loan treated as separate variables; and 3) free stocks plus stocks under loan as one variable. Interactions between each of the quarterly dummy variables and stocks and protein were incorporated, which allows for a seasonal differential impact of stocks on prices.

Empirical Results

Several descriptive statisitics of the data are presented prior to presenting the results of the reduced form equation. The historical behavior of the data indicates that the MGE/CBT price ratio has been increasing steadily since 1978 and a similar though less obvious and more sporadic phenomenon has occurred relative to KCBT. The mean ratios and respective ranges and coefficients of variation are as follows:

	Mean	Range	C.V.
MGE/CBT	1.05	.88 - 1.15	7.0
MGE/KCBT	1.04	.95 - 1.13	4.9
KCBT/CBT	1.01	.91 - 1.14	4.0

MGE wheat futures are typically greater than those at the other exchanges. In fact, current values of the MGE wheat futures relative to the other markets is near record high levels.

In order to demonstrate the inherent seasonality in the data, seasonal indexes were derived using X-11 (Final Unmodified SI ratios). These are shown in Table 4 for selected variables together with the results of a test of significance in the seasonality. The results indicate that seasonality in future price levels is significant at the CBT and KCBT, increasing from lows during April-May to highs in October-December. Seasonality in the price ratios also exists except between KCBT and CBT futures. The results indicate CBT and KCBT futures decrease relative to MGE futures after the fourth quarter; or equivalently MGE futures are at a low relative to the other exchange during the fourth quarter and increase thereafter. Free stocks are highly seasonal as expected but it is of interest that the extent of seasonality is much greater for SRW wheat.

The results of the reduced form price level equation are shown in Table 5. Durbin's H statistic indicated that serial correlation was not present so all equations were estimated with OLS. While conducting the empirical analysis, three alternative definitions of stocks were used. The first used "free" stocks of each class which excluded stock under loans and those in the FOR and CCC. The second summed free stocks and stocks under loan. The third treated free stocks and stocks under loan as separate variables. The second approach was selected for presentation here based on the slightly superior empirical results, and that it is generally more consistent with the definition of the dependent variable. It is also consistant with the approach and results of Westcott, Hull and Green. In all cases protein levels of the two classes of wheat were insignificant and deleted from results presented here. In general, the responsiveness of stocks to price varied by season and thus slopes were allowed to vary seasonally.

The coefficients in Table 5 should be interpreted as short run price flexibilities. All have negative signs, as expected, and/or are insignificantly different from zero. The coefficients are nearly always greater during the third quarter, which coincides with the harvest period. For example, the effect of HRS stocks in MGE futures changes from .02 in the first quarter to -0.42 during the third quarter. Of particular interest is the overwhelming importance of HRS stocks not only on MGE futures, but also on futures prices at the other exchanges. In fact, it is the single most important stock variable. Another important observation is the general lack of significance in stock levels at other exchanges. Signs are generally correct but few have t-ratios greater than 1.0.

The results in Table 4 indicated that seasonality in price levels was significant for both CBT and KCBT wheat futures, but not for MGE futures. The reduced form equations indicate that several of the seasonal dummy variables are significant at MGE and CBT, implying an inherent shift in demand throughout the year. The total effect of seasonality can be evaluated using the $\partial P^i/\partial D_s$ which includes the effect of stocks on prices. Therefore, seasonality in price levels is due to inherent demand shifts, seasonality in stocks, and price responsiveness to stocks which varies quarterly.

The estimated equations for the price ratios are shown in Table 6. All equations were estimated using OLS except those where ρ is reported; for those autoregression procedures were used. Preliminary analysis indicated that where stocks variables were significant, the response was constant across quarters. Therefore, seasonal interactions were not used with stock variables. However, in general, when protein variables were significant the response did vary by quarter and the model was constructed accordingly. The models for each ratio were estimated with and without the significant stock variables and two models for each are shown in Table 6.

For the MGE/CBT price ratio the stocks variables were not significant and were deleted in model two. Both protein levels for the HRS and HRW crop were significant and their impacts varied throughout the year. Increases in HRS crop protein levels results in an increase in MGE futures relative to CBT and this impact is greatest during the first and third quarter. Increases in HRW crop protein levels results have a negative impact on the price ratio, decreasing MGE futures relative to CBT. This impact is only significant during the third and fourth quarter.

Stock levels were not significant in explaining MGE/KCBT futures price ratios. Crop protein levels however were significant and have a similar impact as in the MGE/CBT price ratio. HRS crop protein levels however had a greater impact during both the third and fourth quarter. Protein levels for the HRW crop were only significant during the third quarter.

Stock variables were very important in explaining the KCBT/CBT price ratio. Decreases in HRW (SRW) stocks resulted in an increase (decrease) in the price ratio, as expected. The coefficients are approximately equal and opposite. HRS crop protein levels were not significant but those for HRW were during the fourth quarter. Decreases in HRW crop protein results in an increase in KCBT futures relative to CBT futures.

Seasonality in price spreads or ratios is an important element of hedging and spreading and is confirmed in results in Table 4. The results presented in Table 6 can be used to assess whether that seasonality is inherent, or related to other fundamentals. The intercept dummy variables were significant only to a limited extent, indicating the observed seasonality is due to either: 1) seasonality in stocks or 2) seasonality in responsiveness to protein levels of the hard wheat crops.

Conclusions and Limitations

An important feature of the wheat futures markets is that of intermarket spreads, having implications for both hedgers and speculators. The purpose of this study was to conduct an empirical analysis of factors influencing both price levels and spreads between the three U.S. wheat futures markets.

The results of the reduced form price level equations indicated that wheat fundamentals are reflected across the futures markets, not necessarily reflecting those of the indigenous wheat. Protein availability in the HRS and HRW crops were not significant in explaining price levels. Stocks of each class were important to varying degrees. One result of interest is the overwhelming significance of HRS wheat stocks across all three wheat futures markets.

Market interrelationships were evaluated using price ratio equations. Stocks were important in explaining price ratios only in the case of KCBT/CBT futures prices. All other market relationships were influenced by protein availability, even in the case of KCBT/CBT. It is undoubtedly for these reasons that the MGE futures is currently abnormally high relative to the other markets. Observed seasonality in price spreads is due in part to inherent shifts in demand, but more important is the seasonality in stocks and the responsiveness to protein availability which varies quarterly.

There are several limitations/extensions of the approach used in this study, which provide impetus for extensions. First, an important extension would be to link cash market behavior to each futures market. By doing so the impacts of protein availability would be easier defined. Also, the impact of different rates of program participation on price spreads could be incorporated via cash market influences. This of course, would require a more complex specification, but would provide a better understanding of the price determination process and intermarket relationships. Second, the use of a quarterly model is adequate for purposes of conducting an interseasonal equilibrium analysis. However, most spreading and hedging decisions are based on a time horizon of lesser duration. Therefore, a natural extension would be to develop a model which incorporates intraquarter fundamentals, and technicals. By doing so one could incorporate factors important to intermarket wheat relationships such as availability of deliverable stocks, exports, and exchange effects (e.g., liquidity) all of which tend to influence shorter term movements in prices.

Footnotes

[1]In general the specification is not dissimilar from that of Marsh who used 'cost of gain' analysis to explain price differences in the livestock market.

[2]The alternative approach would be to endogenously determine the net rate of entries into the nine-month loan program for each market. Preliminary analysis using this approach was conducted but was not pursued because it was beyond the scope of this paper.

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TABLE 1. WHEAT CLASS: MARKETING YEAR SUPPLY/DEMAND VARIABLES, 1975/76 TO 1985/86

Year	Production			Export Demand			Ending Stocks		
	HRW	HRS	SRW	HRW	HRS	SRW	HRW	HRS	SRW
	(million bushels)								
1973/74	961	328	161	775	245	27	170	87	23
1974/75	883	293	273	510	130	136	225	104	37
1975/76	1,055	327	331	581	160	165	376	116	61
1976/77	978	412	337	418	124	181	606	250	72
1977/78	997	399	349	535	156	197	632	335	71
1978/79	830	380	189	610	232	95	423	320	27
1979/80	1,092	369	309	725	217	154	440	285	40
1980/81	1,181	312	442	701	188	299	541	257	38
1981/82	1,112	464	678	754	205	460	538	346	60
1982/83	1,243	492	590	679	239	325	754	408	74
1983/84	1,198	323	504	704	221	222	745	314	74
1984/85	1,251	409	531	717	183	253	717	371	64
1985/86	1,230	460	368	445	160	160	949	495	60

TABLE 2. CROP PROTEIN LEVELS: KANSAS AND NORTH DAKOTA, 1973 TO 1985[1]

Year	Kansas HRW	North Dakota HRS
1973	11.1	14.6
1974	11.4	15.2
1975	11.4	14.1
1976	11.7	14.3
1977	12.5	14.5
1978	12.0	13.6
1979	12.1	13.7
1980	12.3	14.7
1981	13.2	14.2
1982	11.4	14.0
1983	11.3	14.4
1984	11.6	14.1
1985	11.6	13.8

[1]Source: Miscellaneous publications, Department of Cereal Chemistry, North Dakota State University, Fargo.

TABLE 3. PROGRAM PARTICIPATION RATES BY WHEAT CLASS[1]

Year	HRS	HRW	SRW
	(percent)		
1974	100	100	100
1975	100	100	100
1976	100	100	100
1977	100	100	100
1978	76	84	21
1979	62	73	9
1980	100	100	100
1981	100	100	100
1982	65	45	21
1983	96	90	54
1984	73	66	24
1985	79	65	45

[1]Derived from state data for principal producing states for each class.

TABLE 4. SEASONAL INDEXES FOR SELECTED VARIABLES[1]

	January-March	April-May	June-September	October-November
Price levels				
MGE	99.8	98.7	101.5	100.9
CBT	100.5	97.0	100.0	102.6
KC	100.6	97.0	99.8	102.6
Price ratios				
MGE/CBT	99.0	101.3	101.0	98.3
MGE/KCBT	98.9	101.3	101.3	98.2
KCBT/CBT	100.0	99.9	99.5	99.9
Free stocks				
HRS	75.0	49.0	159.0	114.0
SRW	60.0	34.0	193.0	115.0
HRW	77.0	48.0	164.0	115.0

[1]F-test for significance of stable seasonality in the time series.
*Indicates significance at the 10 percent level.

TABLE 5. PRICE LEVEL REDUCED FORM EQUATIONS

	MGE		KCBT		CBT	
Int.	4.75	(2.07)[1]	3.45	(1.40)	3.61	(1.52)
D4	-1.95	(0.70)	-1.00	(0.34)	-0.97	(0.34)
D1	-5.18	(2.06)	-4.04	(1.50)	-4.33	(1.67)
D2	-5.00	(2.15)	-3.84	(1.53)	-4.17	(1.74)
DEP_{t-1}[2]	0.85	(17.40)	0.87	(16.20)	0.85	(16.60)
HRS stocks						
D1	0.02	(0.17)	0.05	(0.34)	0.05	(0.39)
D2	0.04	(0.28)	0.05	(0.29)	0.07	(0.43)
D3	-0.42	(2.00)	-0.31	(1.36)	-0.43	(1.79)
D4	-0.19	(1.00)	-0.12	(0.61)	-0.15	(0.75)
HRW stocks						
D1	0.05	(0.28)	0.05	(0.23)	0.12	(0.60)
D2	-0.03	(0.19)	-0.05	(0.30)	-0.04	(0.30)
D3	-0.19	(0.47)	-0.12	(0.28)	-0.02	(0.04)
D4	-0.14	(0.52)	-0.16	(0.55)	-0.13	(0.47)
SRW stocks						
D1	-0.01	(0.09)	-0.003	(0.02)	-0.08	(0.74)
D2	0.05	(0.64)	0.09	(1.10)	0.11	(1.32)
D3	-0.12	(0.98)	-0.11	(0.85)	-0.14	(1.10)
D4	-0.11	(1.12)	-0.10	(0.90)	-0.15	(1.39)
R^2	0.96		0.94		0.94	
D.H.	0.64		0.64		0.57	

[1]Figures in ( ) are t-ratios.
[2]Lagged dependent variable.

TABLE 6. PRICE RATIO REDUCED FORM EQUATIONS

	MGE/CBT				MGE/KCBT				KCBT/CBT			
	1		2		1		2		1		2	
Int.	0.36	(0.31)[1]	0.63	(0.58)	-0.07	(0.06)	0.11	(0.11)	1.77	(3.50)	2.77	(3.19)
D4	0.96	(0.67)	0.84	(0.67)	0.004	(0.00)	-0.01	(0.01)	0.007	(0.53)	0.53	(0.84)
D1	-1.84	(1.28)	-1.89	(1.36)	-0.42	(0.36)	-0.39	(0.35)	0.01	(0.56)	-0.47	(0.76)
D2	2.18	(1.50)	1.71	(1.21)	2.23	(1.87)	2.11	(1.83)	0.01	(0.37)	0.09	(0.15)
DEP_{t-1}[2]	0.79	(8.26)	0.75	(9.01)	0.88	(7.23)	0.84	(8.61)	0.65	(6.11)	0.53	(4.22)
Protein HRS												
D1	0.78	(2.26)	0.71	(2.21)	0.31	(1.10)	0.28	(1.10)				
D2	-0.19	(0.56)	-0.16	(-0.53)	-0.34	(1.22)	-0.34	(1.34)				
D3	0.62	(1.90)	0.55	(1.76)	0.55	(2.08)	0.52	(2.09)				
D4	0.43	(1.31)	0.39	(1.23)	0.46	(1.75)	0.45	(1.81)				
Protein HRW												
D1	0.21	(0.78)	0.20	(0.89)	0.12	(0.60)	0.11	(0.61)			0.007	(0.96)
D2	-0.38	(1.59)	-0.30	(1.55)	-0.25	(1.41)	-0.23	(1.47)			-0.22	(1.25)
D3	-0.37	(1.59)	-0.37	(1.80)	-0.31	(1.76)	-0.31	(1.85)			-0.19	(1.00)
D4	-0.57	(2.33)	-0.56	(2.56)	-0.23	(1.24)	-0.23	(1.39)			-0.40	(2.14)
HRS stocks	0.03	(0.74)			.009	(0.36)						
HRW stocks	-0.05	(-1.64)			-0.016	(0.67)			-0.06	(2.48)	-0.06	(2.91)
SRW stocks	0.01	(0.67)							0.04	(2.61)	0.06	(3.24)
R^2	0.87		0.87		0.80		0.81		0.75		0.78	
D.H.	0.05				0.19		0.31		0.22		0.47	
ρ			-0.23									

[1]Figures in ( ) are t-ratios.
[2]Lagged dependent variable.