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## Empirical testing of alternative price spread models in the South African maize market

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### ABSTRACT

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Reduced-form price spread models have been recently utilized by Wohlgenant and Mullen, and Thompson and Lyon to evaluate the economic factors affecting the marketing margins for agricultural products. Drawing on Gardner, Heien, Buse and Brandow, Waugh, Tomek and Robinson, and others they specify alternative retail-farm price spread models and attempt to determine which best fit the data in the context of underlying theoretical rationale.

This paper continues in the spirit of Wohlgenant and Mullen, and Thompson and Lyon by evaluating alternative specifications of the retail-farm price spread for white maize in South Africa. However, several important differences do remain. Wohlgenant and Mullen analyzed the price spread for beef using annual data, while Thompson and Lyon modeled the price spread for oranges using weekly data. The time period under consideration can be expected to affect the choice of model because fixed markup rules that might be evident using a short-run period of analysis (e.g., Thompson and Lyon) become untenable over the long run with underlying supply and demand shifts. In this paper, monthly data, which may be interpreted as an intermediate-run period, are used along with dichotomous supply–demand shifters. In addition, Brorsen et. al. have shown that price uncertainty affects the price spread in the marketing channels of agricultural commodities. Thus, the analysis in this paper extends the framework of Wohlgenant and Mullen, and Thompson and Lyon to include measures of price risk. Finally, like Brorsen et. al. this study pertains to the grain market, while Wohlgenant and Mullen, and Thompson and Lyon studied the marketing margin for non-storable commodities.

## BACKGROUND

The basic starchy staple consumed among low-income consumers in South Africa is mealie pap, a porridge made of maize meal. With the exception of time periods when production is abnormally low, only white maize is used to produce maize meal in South Africa. Per capita consumption of maize meal has fallen over time, but rapid population increases caused total consumption to increase slowly between 1968 and 1980 (see Fig. 1). After a peak during the 1983/1984 marketing year, total consumption fell dramatically. Empirical evidence is sketchy, but it appears that white maize is an inferior product (income elasticity between  $-0.25$  and  $-0.30$ ) and has a low own price elasticity ( $-0.10$  to  $-0.15$ ) (Van Zyl, 1985). Although white maize and bread appear to be substitutes, the estimated cross elasticities are low (Van Zyl, 1985).

Preference shifts within categories of maize meal have also occurred over time. The two highest priced categories, super and special maize meal, are more highly processed and contain less fibre and chaff than the two lower priced categories (sifted and unsifted maize meal). Increases in income lead to relative increases in the consumption of super and special maize meal, especially when the income change occurs as a result of rural-to-urban migration. Thus, although per capita consumption of maize

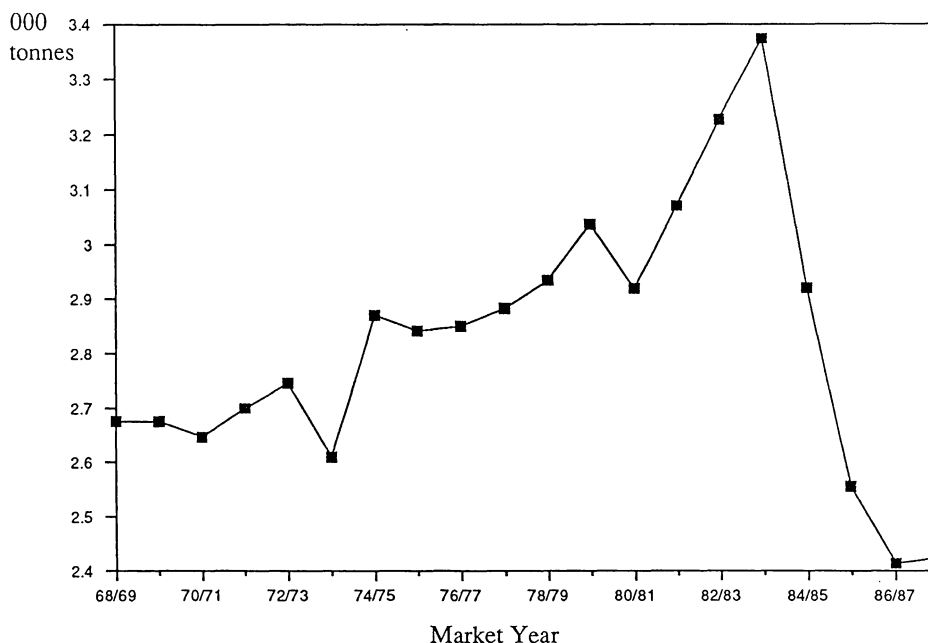


Fig. 1. Domestic consumption of white maize and products.

meal is falling over time due to a negative income effect, consumption is also shifting to more processed forms that have a lower nutritional value. As a result, the production of by-products has increased and is a more important component of the activities of millers.

Various forms of intervention affect the markets for maize and its substitutes. The South African Maize Board controls various aspects of the white maize market by setting farm producer (selling) and maize milling (buying) prices each year. The Maize Board is responsible for export sales which in recent years have resulted in prices well below domestic prices. Since the 1987 marketing year, the Maize Board has covered 'export losses' by increasing the margin between the farmer selling and miller buying prices. Increases in the Maize Board margin have coincided with relatively high rates of general price inflation and substantial increases in the costs of agricultural product processing.

The pricing structure employed by the South African Maize Board is enforced through a one-channel marketing system. The producer price is fixed immediately prior to the harvest season. This price is determined after consideration of expected production and use, and becomes a base for the selling price to millers, after allowance for Board operational costs (financing, storage, etc.) The margin between the selling price of the Maize Board and the producer realized price is thus fixed. The selling price to millers is determined from negotiations between the millers and the Maize Board, which occur each year.

The maize milling industry is highly concentrated. Although precise data on the structure of the milling industry are not available, it appears that two firms account for over 50% of the market share. Several other firms contribute an additional 10–15% of production, so a conservative estimate places the four-firm concentration ratio at about 65%. The remainder of the industry is comprised of small private and cooperative firms with regional distribution programs.

The food retailing sector is also highly concentrated. Three retailers account for about 70% of the retail food market with the remainder served by small privately owned cafe's (the South African equivalent of a local independent mom and pop store). The large millers market maize meal on a national basis and emphasize brand identification. They dominate the market for maize meal in the retail chains, while the smaller millers are more successful in selling a generic form of product through small local distributors.

The magnitude of the price spread for white maize has been a highly controversial issue in South Africa. Because maize meal accounts for an important component of the diet of low income consumers, changes in the size of the marketing margin are quite visible and elicit strong response

from consumer advocates. Nutrition, especially among the young and elderly components of the population, is an important social issue and unjustified increases in the price spread of an important food staple could have important adverse effects on an already stressed component of the population.

#### MODELS OF THE RETAIL-FARM PRICE SPREAD

With a fully specified supply-demand model of an agricultural sector it is possible to include economic factors that affect the price spread (e.g., see Arzac and Wilkinson, 1979). In many countries adequate data to construct a full supply-demand model or to evaluate changes in the components of a marketing margin over time may not be available. In addition, as in the case of South African maize, government intervention in price setting may preclude the effective estimation of such a model. As an alternative, reduced form price spread models can be applied. The data needs are minimal and, as illustrated by Thompson and Lyon (1989), the effects of policy and economic shifts can be directly evaluated through inclusion of dichotomous shift variables.

The time periods used in the analysis may be an important factor in determining the appropriate form. With short time periods managers of agricultural processing and food retailing firms might be expected to rely on fixed premia pricing rules and utilize price changes from below in the marketing chain as pricing signals. This could produce the reactive price spread behaviour described by Heien (1980). With longer time period, however, managers might be expected to adjust the pricing structure to be consistent with market equilibria as described by Gardner (1975). The empirical evidence tends to provide support to the notion that the choice of time period is important. Using annual data, Wohlgenant and Mullen (1987) showed that the data did not support the models consistent with fixed pricing rules, while the weekly analysis of Thompson and Lyon (1989) supported the use of fixed markup rules. This evidence is weak, however, because the studies pertain to different commodities and market circumstances, and different lengths of run in margin behavior.

Choice of the appropriate price spread model is not always clear, either from a theoretical or an empirical perspective. Gardner (1975) has demonstrated in the context of a perfectly competitive model that it is inappropriate to assume that a simple markup pricing rule will depict the relationship between the farm and retail price of an agricultural product. This is because retail and farm level prices each are determined by their own demand and supply conditions. In addition, the magnitude of the price spread will be affected by the elasticity of substitution between the agricul-

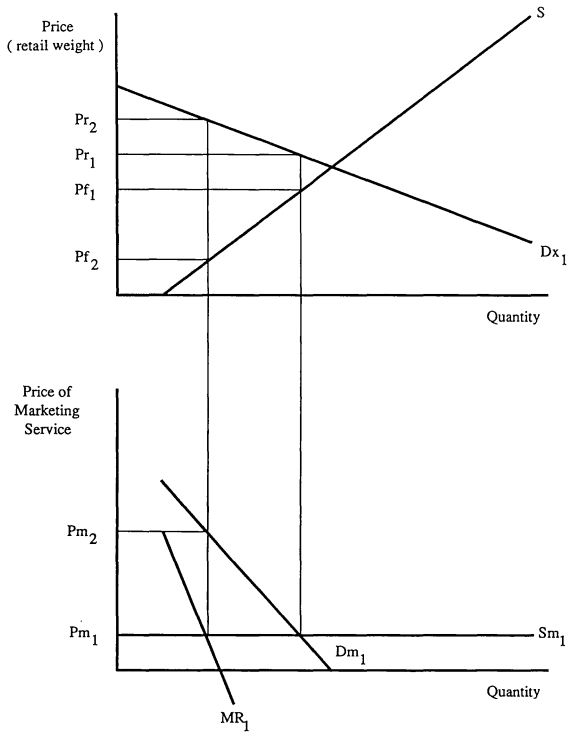


Fig. 2. Competitive and monopoly solution of price spread model.

tural commodity and marketing services, plus supply and demand conditions for firms that provide services in the marketing sector. However, in empirical analyses it is common to assume that a specific form of retail-farm price relationship holds (e.g., Freebairn and Rausser, 1975; Arzac and Wilkinson, 1979) and Heien (1980) has shown that for some cases this may be a reasonable assumption. Fisher (1981) developed a graphical model of price spreads which illustrates the market behavior described by Gardner (1975).

Adaptation of Fisher's model to the case of monopoly pricing in the marketing sector is demonstrated in Fig. 2. This abstracts from the monopoly position enjoyed by the Maize Board and assumes that firms in the marketing sector are able to effectively collude to realize the monopoly solution. Development of a bilateral monopoly model and/or consideration of the many potential oligopoly outcomes that could arise from imperfect collusion in the marketing sector are beyond the scope of this paper (other than to point out the potential range in outcomes discussed below).

Figure 2 replicates Fig. 1(c) in Fisher (1981), with an extension to the case where firms in the marketing sector are able to collude and set a

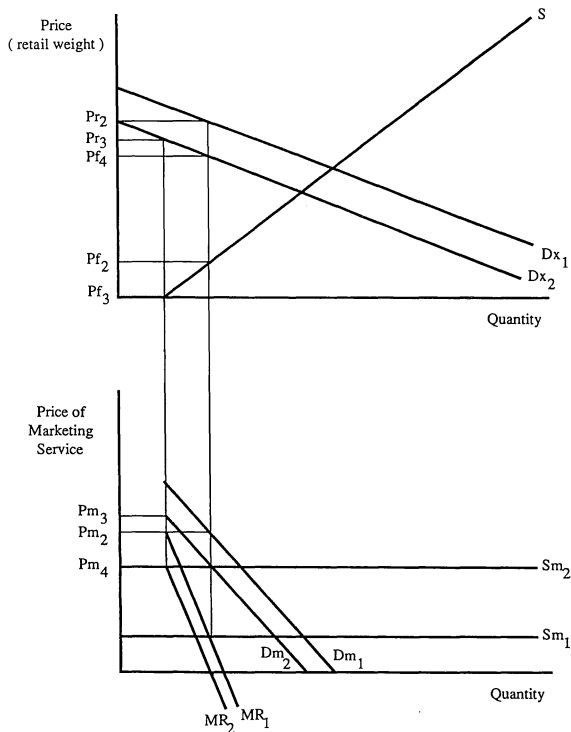


Fig. 3. Effects of demand and marketing cost shifts.

monopoly price for marketing services. Under the competitive case the farm-retail price spread is determined by the intersection of the demand ( $Dm_1$ ) and supply ( $Sm_1$ ) of marketing services, resulting in  $Pm_1$  as the price of marketing services and  $Pr_1 - Pf_1$  as the price spread. The monopoly solution equates marginal revenue ( $MR_1$ ) and marginal cost ( $Sm_1$ ). The price of marketing services under monopoly is set at  $Pm_2$ , which equals the price spread ( $Pr_2 - Pf_2$ ) determined from the vertical distance between retail demand ( $Dx_1$ ) and farm supply ( $S$ ).

Figure 3 graphically illustrates the effects of decreases in retail demand and increases in the cost of marketing services, relative to the monopoly solution from Fig. 2. A downward shift in retail demand to  $Dx_2$  lowers the demand for marketing services to  $Dm_2$  and marginal revenue to  $MR_2$ . Any increase in marketing costs beyond  $Sm_2$  results in a negative farm price. Thus  $Pm_3$  is a limit on the ability of monopolist marketing firms to depress the farm price of the agricultural commodity and extract monopoly profits. However, if marketing firms were forced to price competitively under the new cost ( $Sm_2$ ) and demand ( $Dm_2$ ) conditions the price would be  $Pm_4$ , with a price spread of  $Pr_2 - Pf_2$ . Thus,  $Pm_4$  and  $Pm_3$  are the results of two

extreme forms of pricing behavior with presupposed structural shifts in retail demand and marketing costs. Conceivably, through the power of the Maize Board, producers could counteract a non-competitive marketing industry and prevent firms from setting the price of marketing services at the monopoly level, thereby forcing down the price of marketing services from  $Pm_3$  towards  $Pm_4$ .

### *Design of statistical models*

Wohlgenant and Mullen (1987) describe three general price spread models. The markup model (Waugh, 1964) relates the retail-farm margin to the retail price and marketing costs, while in the price of marketing services model (Tomek and Robinson, 1981) the marketing margin is a function of the quantity of agricultural product entering the marketing system and marketing costs. The relative model (Gardner, 1975) has the marketing margin as a function of the retail price, marketing costs and the quantity marketed. Wohlgenant and Mullen suggest that it is preferable to enter quantity marketed as an interaction variable (interacted with the retail price). Thompson and Lyon (1989) also consider a fourth model based on the one proposed by Buse and Brandow (1960) but, as shown by Wohlgenant and Mullen, this can be considered a special form of the relative model. In this paper, we adopt this interpretation and do not differentiate the Buse and Brandow model from the relative model. Of the three models, only the relative model allows for simultaneous shifts in supply and demand, so Wohlgenant and Mullen argue that it is a preferred specification for many applications.

### *Data and empirical specification*

The retail-farm price spread was computed as the difference between the monthly retail price of a five kilogram package of maize meal and the monthly farm price of white maize. The quantity of white maize marketed for each month is published by the Maize Board. The expected sign for the quantity variable is positive. This is an imperfect farm supply variable (but the only one available) because it does not account for temporary market flow restrictions which may be imposed by the Maize Board or marketing firms. In addition, imported or stored white maize could periodically enter the marketing system.

Marketing costs were not directly available on a monthly basis. Discussions with market participants indicated that labour and energy costs were two important categories. Although data were not available to construct a time series of these two categories, the Production Price Index (PPI) was



available in two forms. The PPI's for natural gas and electricity and in aggregate were available on a monthly basis. The PPI for gas and electricity was used as a proxy for energy costs and the aggregate PPI was used to proxy the costs of all marketing inputs. Wohlgenant and Mullen (1987) used a similar proxy in their analysis.

Brorsen et al. (1985) show that marketing risk is directly related to the price spread and that a distributed lag or moving average specification of past prices could be used as a measure of price risk. Maize millers and food retailers are required to hold product in storage while performing their marketing functions. In addition, the Maize Board can alter its domestic and external marketing practices, thereby influencing price formation in the South African market. The effects of these market adjustments, which may not be reflected in the product supply variable (as discussed above) should be reflected in the price risk variable. Several different forms of the price risk variable were used. Following Brorsen et al. (1985), an annual measure of absolute and relative price risk, based on a distributed lag of the past twelve monthly price changes, was specified as:

$$\text{RISKA} = 12 \text{ DIFF} + 11 \text{ DIFF}(-1) + 10 \text{ DIFF}(-2) + \dots + 1 \text{ DIFF}(-11)$$

where DIFF is the monthly price change and the number of lags is shown in parentheses. The relative version of this variable (suggested by Brorsen et al. as the preferred measure) was constructed by dividing the absolute price risk, calculated as above, by the annual average maize price. Maize marketing firms in South Africa typically hold stocks for less than one year so a quarterly version of the price risk variable was specified as:

$$\text{RISKQ} = 0.4 \text{ DIFF} + 0.3 \text{ DIFF}(-1) + 0.2 \text{ DIFF}(-2) + 0.1 \text{ DIFF}(-3)$$

The sign of the risk parameter indicates behaviour towards risk in the marketing system. Positive coefficients are consistent with 'decreasing absolute risk averse' behaviour (see Brorsen et al. for discussion) so that increased price instability would be reflected in larger margins. Price risk can also affect the sign of the marketing cost variable. Brorsen et al. show theoretically that under conditions of risk, marketing cost increases can lead to positive, negative or zero changes in price spreads.

Two dichotomous variables were defined to account for specific events that occurred during the time period under study. Thompson and Lyon (1989) utilized the same approach to account for policy changes in the U.S. orange market. One variable (D8287) takes a value of zero for the market years 1982/83 through 1986/87 (the South African market year runs from May to April) and one thereafter. Beginning with the 1987/88 market year the Maize Board adopted a new pricing policy whereby losses on export sales were reflected in a lower net or blend price received by farmers. Prior

to this policy, these losses were effectively covered out of government revenues. It is expected that this variable will be positive.<sup>1</sup> The second dichotomous variable (D8385) takes a value of one for the 1983/84 and 1984/85 market years and zero otherwise. During these two years, severe drought reduced white maize production to roughly half of normal production levels. As a result, both white and yellow maize were blended during those two years to satisfy the demand for maize meal. The expected sign of this variable is negative.

An omission in the model specification is the lack of an inventory (storage) variable. The inventory of maize fluctuates considerably during the year. Normally, 90–95% of the annual sales of white maize is marketed by producers during the months of May, June and July. Unfortunately, inventory data are only available on an annual basis. Thus, this effect is not directly included although, as indicated above, it is hypothesized that inventory effects are partially transmitted into the model through the price risk variables.

All price-related variables were deflated using the monthly Consumer Price Index. Thus, RMPDEF is the deflated retail maize price, MIMAR is the deflated retail-farm price spread, and PPIPOR is the deflated production price index for natural gas and electricity costs. The deflated aggregate production price index (PPIALR) was also used in the analysis but, because the resulting implications did not differ, these results are not presented in detail here.

Complete data series for all variables were available beginning with the 1982/83 marketing year and ending in December 1988. The three general models were specified as follows:

$$\text{MIMAR} = a_0 + a_1 \text{RMPDEF} + a_2 \text{PPIPOR} + a_3 \text{RISK}_i + a_4 \text{D8287} + a_5 \text{D8385} + e_1 \quad (1)$$

$$\text{MIMAR} = b_0 + b_1 \text{QUANT} + b_2 \text{PPIPOR} + b_3 \text{RISK}_i + b_4 \text{D8287} + b_5 \text{D8385} + e_2 \quad (2)$$

$$\text{MIMAR} = c_1 \text{RMPDEF} + c_2 \text{PRQ} + c_3 \text{PPIPOR} + c_4 \text{RISK}_1 + c_5 \text{D8287} + c_6 \text{D8385} + e_3 \quad (3)$$

<sup>1</sup> Notice that inclusion of this variable helps defer one criticism suggested by a referee. It can be argued that a better representation of the marketing margin would link the Board selling price to the retail price. This is true. However, a primary purpose of the one-channel marketing system in South Africa is to regulate the entire maize marketing chain between the farm and consumer. By including the Maize Board component of the margin in the analysis it is possible to evaluate the impact of a major shift in policy such as occurred in the 1987/88 market year.

TABLE 1

Econometric results of price spread models

Model	Equation No.	Intercept	RMPDEF	QUANT	PRO	PPIPOR	D8287	D8385	MOVAVA	MOVAVQ	RELMOA	RELMOQ	$\rho$	$R^2$	F
Markup	1a	-45.04 (51.36)	0.93 <sup>a</sup> (0.18)	-	-	-15.98 <sup>b</sup> (9.03)	11.35 <sup>a</sup> (4.00)	-12.42 <sup>a</sup> (2.98)	0.00066 (0.015)	-	-	-	0.81 <sup>a</sup> (0.075)	0.94	177.12 <sup>a</sup>
	1b	-32.08 (53.38)	0.87 <sup>a</sup> (0.19)	-	-	-15.59 <sup>b</sup> (9.04)	10.97 <sup>a</sup> (3.98)	-12.50 <sup>a</sup> (2.98)	-	-	1.08 (4.35)	-	0.82 <sup>a</sup> (0.075)	0.94	177.32 <sup>a</sup>
	1c	-47.56 (38.61)	0.91 <sup>a</sup> (0.12)	-	-	-12.86 (7.85)	11.17 <sup>a</sup> (3.90)	-12.23 <sup>a</sup> (2.81)	-	0.02 (0.27)	-	-	0.83 <sup>a</sup> (0.062)	0.94	198.08 <sup>a</sup>
	1d	-46.73 (38.74)	0.91 <sup>a</sup> (0.12)	-	-	-12.87 (7.85)	11.13 <sup>a</sup> (3.90)	-12.24 <sup>a</sup> (2.81)	-	-	-	7.28 (75.03)	-	0.83 <sup>a</sup> (0.062)	0.94
Price of marketing Services	2a	168.62 <sup>a</sup> (36.01)	-	$4.03 \times 10^{-5}$ <sup>a</sup> ( $1.63 \times 10^{-5}$ )	-	-10.18 (10.02)	9.02 <sup>b</sup> (4.52)	-12.98 <sup>a</sup> (3.18)	0.072 <sup>a</sup> (0.0056)	-	-	-	0.98 <sup>a</sup> (0.044)	0.94	159.22 <sup>a</sup>
	2b	170.72 <sup>a</sup> (34.02)	-	$3.92 \times 10^{-5}$ <sup>a</sup> ( $1.60 \times 10^{-5}$ )	-	-10.37 (9.83)	9.25 <sup>a</sup> (4.43)	-13.02 <sup>a</sup> (3.13)	-	-	19.80 <sup>a</sup> (1.50)	-	0.97 <sup>a</sup> (0.045)	0.94	165.96 <sup>a</sup>
	2c	185.02 <sup>a</sup> (29.63)	-	$3.03 \times 10^{-5}$ <sup>b</sup> ( $1.76 \times 10^{-5}$ )	-	-13.44 (10.01)	4.93 (4.95)	-15.02 <sup>a</sup> (3.54)	-	1.79 <sup>a</sup> (0.16)	-	-	0.97 <sup>a</sup> (0.038)	0.91	127.73 <sup>a</sup>
	2d	185.78 <sup>a</sup> (29.61)	-	$2.95 \times 10^{-5}$ <sup>b</sup> ( $1.76 \times 10^{-5}$ )	-	-13.67 (9.99)	4.94 (4.94)	-15.00 <sup>a</sup> (3.53)	-	-	-	493.08 <sup>a</sup> (45.01)	-	0.97 <sup>a</sup> (0.038)	0.91
Relative	3a	-	0.72 <sup>a</sup> (0.075)	-	$1.52 \times 10^{-7}$ <sup>a</sup> ( $5.82 \times 10^{-8}$ )	-15.27 <sup>b</sup> (8.42)	8.67 <sup>a</sup> (3.72)	-12.93 <sup>a</sup> (2.93)	0.013 <sup>b</sup> (0.0079)	-	-	-	0.85 <sup>a</sup> (0.068)	N.A.	194.29 <sup>a</sup>
	3b	-	0.71 <sup>a</sup> (0.075)	-	$1.52 \times 10^{-7}$ <sup>a</sup> ( $5.79 \times 10^{-8}$ )	-14.14 <sup>b</sup> (8.41)	8.78 <sup>a</sup> (3.71)	-12.93 <sup>a</sup> (2.92)	-	-	4.03 <sup>b</sup> (2.18)	-	0.85 <sup>a</sup> (0.067)	N.A.	196.14 <sup>a</sup>
	3c	-	0.72 <sup>a</sup> (0.059)	-	$1.32 \times 10^{-7}$ <sup>a</sup> ( $5.39 \times 10^{-8}$ )	-15.79 <sup>a</sup> (6.62)	7.84 <sup>a</sup> (3.61)	-13.10 <sup>a</sup> (2.77)	-	0.31 <sup>b</sup> (0.17)	-	-	0.86 <sup>a</sup> (0.054)	N.A.	210.88 <sup>a</sup>
	3d	-	0.73 <sup>a</sup> (0.059)	-	$1.32 \times 10^{-7}$ <sup>a</sup> ( $5.39 \times 10^{-8}$ )	-15.73 <sup>a</sup> (6.61)	7.85 <sup>a</sup> (3.61)	-13.10 <sup>a</sup> (2.87)	-	-	-	85.64 <sup>b</sup> (47.82)	-	0.86 <sup>a</sup> (0.054)	N.A.

<sup>a</sup> Significant at 95% level of confidence.<sup>b</sup> Significant at 90% level of confidence.

The variable *RISK* refers to the various forms of the risk variable where *i* indicates annual ( $RISK_A$ ) or quarterly ( $RISK_Q$ ) distributed lag measures of risk. Notice that equation (3) is specified without an intercept as suggested by Wohlgenant and Mullen (1957). All equations were estimated using ordinary least squares on the linear form of the variables. Initial testing showed very low values of the Durbin–Watson statistic so the Cochrane–Orcutt technique was used to correct for first order autocorrelation. The values of the autoregressive term  $\rho$  are included in the econometric results. The variances of the residuals were inspected for heteroscedasticity, but none was apparent.

Equation (1) is the markup model, equation (2) is the price of marketing services model, and equation (3) is the relative model. In addition to the results presented here, all three models were estimated with *PPIALR* replacing *PPIPOR* and also without the two dichotomous variables. The estimated coefficient values and significance tests were almost completely consistent with the results using the fully specified models reported in this paper.

## EMPIRICAL RESULTS

Table 1 presents the complete empirical results for the three price spread models. Results are presented for all four price risk measures. Accordingly, (1a) through (1d) refer to the markup model, (2a) through (2d) refer to the price of marketing services model, and (3a) through (3d) refer to the relative model.

### *Basic results*

The results for the markup model are somewhat mixed. The intercept is always negative and non-significant. The deflated retail maize price (*RMPDEF*) enters all four versions statistically significant and with a value of approximately 0.9. Marketing costs (*PPIPOR*) are always negative and significant in two of four cases. The two dichotomous variables (*D8287*, *D8385*) enter significantly and with the expected signs while none of the risk variables are significant. Across the different specifications the parameter values are quite stable.

The price of marketing services model also performs in a mixed fashion. The intercept is always significant and positive as is *QUANT*. *PPIPOR* is always negative but never in a significant fashion. As was the case in the markup model, the two dichotomous variables always enter with expected signs although *D8287* is significant in only two of four cases. All four risk measures enter the equations as positive and significant.

The relative model is the most consistent of the three and provides the best results. RMPDEF and PRQ (the price-quantity interaction variable) are always positive and significant, marketing costs (PPIPOR) are always negative and significant, the two dichotomous variables have their expected signs and are always significant, and the four risk measures are positive and significant. Parameter values are highly stable across the four versions of this model. This model was also estimated with an intercept but it was never significant and the other coefficients were qualitatively the same in value and significance.

In aggregate, the parametric stability of the various models (and forms of each model) is quite impressive. The only sign reversal is in the case of the intercept and none of the negative intercepts in the markup model were statistically significant. The parameters of RMPDEF, QUANT, PRQ, PPIPOR, D8287, and D8385 remain highly stable in value and exhibit no sign reversals. This was also true when the aggregate marketing cost variable (PPIALR) was specified in place of PPIPOR.

In addition, in order to evaluate the fragility of the estimates the three models were also estimated by systematically excluding  $RISK_j$ , D8385, and D8287 so that the basic forms of the three theoretical models could be evaluated. The signs and values of the explanatory variables in these more limited forms were highly similar to the results presented in Table 1. However, standard errors tended to be higher so PPIPOR and QUANT were not significant in the markup and price of marketing services models.

The autoregressive term  $\rho$  always enters the equations in a significant and positive fashion (ranging between values of 0.81 and 0.98) indicating positive autocorrelation. The three models were also estimated with one-period lagged values of MIMAR and RMPDEF replacing the autoregressive term. Both of these variables entered significantly indicating that lagged values of the price spread (MIMAR) and retail prices (RMPDEF) tend to affect current levels of the price spread. Although the values of the other parameters were quite consistent with the results reported in Table 1, the lagged variables were highly collinear with other variables resulting in inflated standard errors. Utilization of an autoregressive term is a method of accounting for lagged variables but avoiding the incidence of multicollinearity. The autoregressive term  $\rho$  may be interpreted as a proxy for the lagged effects of MIMAR and RMPDEF.

## DISCUSSION

Because none of the models is a special case of the others it is not possible to utilize traditional nested testing procedures to choose among the alternatives. Thus, Wohlgenant and Mullen (1987) and Thompson and

Lyon (1989) relied on non-nested procedures as selection criteria. Wohlgenant and Mullen found that the data fitted all three models equally well based on traditional hypotheses-testing criteria (all variables were significant and with anticipated signs) but the non-nested procedures unambiguously suggested that the relative model was preferred. On the other hand, Thompson and Lyon's econometric results were less clear, as the sign and significance of several variables were not consistent across model specification. Furthermore, the non-nested testing did not result in an unambiguous choice of model. Recall that Wohlgenant and Mullen utilized annual data while Thompson and Lyon presented results based on weekly data.

In situations where it is impossible to choose on theoretical or customary grounds between models, statistical choice criteria such as non-nested procedures are appropriate. However, in some market situations it is not clear that one model should be chosen with the exclusion of others. For example, the time period of the data would appear to be an important consideration. In the short-to-medium-term (weekly, monthly, or quarterly data for most agricultural commodities) the marketing sector might be expected to utilize fixed markup rules *and* also respond to underlying economic forces. In a longer-term scenario, such as analyzed by Wohlgenant and Mullen, responses consistent with economic supply and demand equilibria would be expected and the importance of fixed markup rules to be diminished. Essentially, in the long run it is possible to respond to supply and demand information but, as detailed by Heien (1980), fixed decision criteria may be reasonable in the short-run. Furthermore, the substitution of marketing services (i.e. milling) for agricultural products also involves a longer run response.

In this study, the parameter values and significance tests are highly consistent across alternative specifications. However, only in the case of the relative model are all estimated coefficients statistically significant. Signs are as expected and firms exhibit decreasing absolute risk averse behaviour (recall that under conditions of price risk the sign of the marketing cost variable is ambiguous). In the price of marketing services model, marketing costs are never significant and the D8287 is not significant in two cases. Marketing costs are not significant in two versions of the markup model and the price risk variables are always nonsignificant. The philosophy behind the markup model is that cost increases are passed on up the marketing channel as they occur (or perhaps with lags). Thus a negative coefficient of marketing costs does not lend strong support to the markup model.

Although the results appear to favour the relative model over the price of marketing services and the markup models, this is not a strong result.

When the *J*-test (see Wohlgemant and Mullen) was applied to the data it was not possible to choose between the alternatives. However, as argued above this might be anticipated when monthly data are used. A non-nested test with more power might indicate dominance of one model over the others but there is a danger that this would lead to an arbitrary selection (arbitrary in terms of using statistical criteria in lieu of adequate theoretical or a priori evidence) that does not reflect the underlying economic circumstances.

In this study there are institutional and empirical reasons to suspect that the choice between models is, in fact, indeterminate. From an institutional perspective, the tendency for marketing firms to utilize fixed markup rules in the short run is well known, but these rules must be adjusted to account for competitive pressures over the longer run. The autoregressive term serves as a proxy for lagged values of *MIMAR* and *RMPDEF*. But these terms suggest that *lagged* values of the price spread and retail price are important factors in determining *current* price spreads. This suggests evidence of fixed markup rules in the pricing decisions of marketing firms and may indicate administered pricing, which would not be inconsistent with the market structure. Inventory control and management is often utilized by firms in order to maintain administered prices. However, supply and demand factors also clearly influence the size of the price spread, as implied by the significance of the other variables in the models. Marketing firms may utilize fixed markup rules to guide the determination of margins but they must also respond to economic forces and competitive pressures.

As of the 1987/88 marketing year, when the Maize Board adopted the policy of internalizing losses in sales to export markets, the losses in these sales would not be borne completely by the taxpayer and consumer, but would be shared. In effect, this meant that the price received by farmers would be lower (other things the same) in order to pay for lower prices received in export markets. The dichotomous variable (*D8287*) entered into the markup and relative models in a significant and positive manner.

The dichotomous variable to account for the severe drought years (*D8385*) was expected to have a negative effect because agricultural supply shifts to the left, increasing farm level prices and decreasing the margin. Again, this variable always entered with the correct sign and in a significant manner. It should be emphasized that the comparative statics of these shifts measured by the dichotomous variables are not necessarily straight forward. Gardner (1975) discusses the conditions under which they may be derived graphically and when mathematical methods must be used. Two of the general mathematical results are especially important for this study. First, Gardner (p. 402) derives the result that a farm product supply shift to the left will always decrease the margin. Thus the sign of *D8385* is clearly

expected to be negative as estimated here. Second, Gardner (p. 405) derives the impact of a price control policy for the agricultural product. Specifically, a production control program that raises the farm level price will unequivocally narrow the retail-farm level price spread. The converse is also true – the relaxation of the price control system will increase the margin. This expectation is entirely consistent with the situation surrounding the design of the variable D8287. The fact that this variable enters the equation in a significant and positive manner reinforces the observation that maize producers, through the Maize Board, have significantly changed the pricing policy in recent years. The level of price support provided through Maize Board pricing policies appears to have declined in recent years. Thus the public position taken by the Maize Board that the pricing system is moving more toward a free market system is supported by our empirical results.

The results appear to be consistent with other circumstances underlying the market. In particular, the negative and significant sign for marketing costs implies that cost increases reduce the marketing margin. As indicated earlier this is consistent with the behavior of marketing firms under conditions of risk. It is also consistent with declining demand for the final product (see Figure 1 and supporting discussion) combined with a shift from a monopoly to a competitive pricing system in the marketing sector as illustrated in Fig. 3.

Price risk appears to affect the retail-farm price spread for white maize. Higher levels of price risk, measured as absolute or relative distributed lags of price changes are transmitted into increased price spreads for white maize. As suggested by Brorsen et al. (1985, p. 527), marketing firms (and also consumers) can also benefit from price stabilization policies. Agricultural policy makers in South Africa have expressed a commitment to a more market-oriented pricing system for agricultural products. However, if the traditional highly regulated marketing board system evolves into freely moving prices increases in marketing margins can be expected due to marketing firms response to increased agricultural input price risk.

A weakness of this empirical study (and the others cited above) is the failure to address issues such as by-product use and inventory control. By-products can be an important factor influencing the net profitability of marketing firms, because a highly profitable market for by-products could result in cross-subsidization of conventional markets. Similarly, regulatory constraints or evolution to more competitive pricing policies of milling firms, as discussed in an earlier section, could create incentives for a more diversified final product portfolio. The increased percentage and range of by-products associated with the growth of the highly processed segment in the South African maize meal market may be illustrative.



Inventory and other market effects appear to be especially problematic. Although data limitations precluded direct modeling of their monthly impacts in this study, a more complete market evaluation would include analysis of the proportion of marketed maize milled each month, other alternative uses, and inventories held by marketing firms.<sup>2</sup> Detailed study of these facets of the market would permit subsequent researchers to analyze more thoroughly the pricing structure of the marketing chain. However, the basic approach applied above, augmented with dichotomous variables and price risk measures, uncovers a great deal of information. Given that knowledge of the marketing system and components of the price spread between agricultural commodities and final consumer products are often not adequate, especially in developing countries, much additional information can be gained from an empirical evaluation of price spread models.

#### SUMMARY

Recent research has investigated the nature of marketing margins for agricultural commodities using reduced-form price spread models. Data are often not available for direct evaluation of the components of marketing margins over time or for estimation of a supply–demand model of the marketing system, so this approach provides a tractable methodology. The primary emphasis in recent studies has been placed on using statistical criteria, in the form of non-nested testing procedures, to choose among alternative models. This paper, however, takes the viewpoint from an institutional perspective that ambiguity may characterize the system in which price spreads are observed. This may especially be the case when short- or medium-term data are used in the analysis. This suggests that future research might wish to address the selection of price spread model for one particular commodity, but over different length time periods for the data.

Application was made to the price spread for white maize in South Africa. White maize is used to make maize meal, which is a principle staple food, especially for low income consumers. The statistical analysis lent cautious support to the relative model. However, the autocorrelation term used in the monthly analysis appears to proxy past levels of the marketing margin and retail prices of maize meal, indicating that fixed markup rules may also be used in the pricing decisions of marketing firms. Thus, the empirical results suggest that ‘confounding’ influences caused by a mixture

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<sup>2</sup> We are grateful to a referee for this suggestion.

of fixed markup rules and reaction to underlying economic forces typify monthly price spread behaviour in the South African white maize marketing system.

Following Brorsen et al. (1985) measures of price risk were included in the price spread equations. In the price of marketing services and relative models higher price risk was associated with higher margins. Thus, our data drawn from the South African grain marketing sector confirm findings for the U.S. system reported by Brorsen et al. As South Africa moves to a more free-price orientation in agricultural policy, positive effects on marketing margins might be expected. With a highly concentrated food production and distribution complex, this may lead to more visible public concerns about competition and pricing policy. This would also appear to have implications for other countries in Africa that may be contemplating the relaxation of one-channel marketing systems, especially in the case of basic subsistence commodities.

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