DETERMINANTS OF THE MAIZE BOARD-MILLER MARKETING MARGIN IN SOUTH AFRICA : 1977-1993

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Determinants of the Maize Board - Miller (MBM) marketing margin for the period 1977-1993 (period defined by data limitations) are identified for a mark-up model using Three-Stage Least Squares Regression (3SLS) and Principal Component Analysis. The MBM margin was positively related to the real miller white maize meal selling price, real variable processing costs, and a change in Maize Board pricing policy after 1987.

BEPALERS VAN DIE MIELIERAAD-MEULENAARSBEMARKINGSMARGE IN SUID-AFRIKA : 1977-1993
Bepalers van die Mielieraad-Meulenaars (MRM)-bemarkingsmarge vir die tydperk 1977-1993 (tydperk afgebaken deur databeperkings) word geïdentifiseer vir 'n bruto winsmargemodel met gebruik van Drievoudige Kleinstekwadrate (DKK) en Hoofkomponentontleding. Die MRM marge is positief verbind met die reële witmieliemeel-meulenaarsverkoopprys, reële veranderlike verwerkingskoste, en 'n verandering in die Mielieraad se prysbeleid na 1987.

INTRODUCTION

Maize is the most important field crop in South Africa comprising 45% of all arable land and accounting for 40% by value of all field crops. White maize is milled to produce maize meal which forms the staple food for the majority of the population (Cownie, 1992). The size of the marketing margin between the farm and retail prices of maize, and changes in the margin, are thus important economic policy issues. Faminow and Laubscher (1991) evaluated alternative specifications of the marketing margin for white maize in South Africa for the period 1982-1988. Using a relative price model (Gardner, 1975), they found that the margin was positively associated with real retail maize price, a real production price index, the quantity of white maize marketed, price risk and two dichotomous variables to account for maize producer price policy change (1987/88 marketing year) and drought (1983/84 and 1984/5). Their work, however, did not consider the size, or causes of, individual components of this margin. This paper therefore analyses determinants of the Maize Board-Miller (*MBM*) margin component using a mark-up model. Trends in miller structure and the *MBM* margin since 1977 are first outlined. Empirical models of the *MBM* margin determinants for 1977-1993 (data limited) are then estimated using Three-Stage Least Squares (3SLS) and Principal Component Analysis. Policy implications and areas for future research are discussed in the conclusion.

1. MILLER STRUCTURE AND MAIZE MARKETING MARGINS IN SOUTH AFRICA SINCE 1977

1.1 Miller Structure

The South African Maize Milling Industry during 1977-1993 was dominated by about five large millers, each processing over 100 000 tons of maize per annum. The number of small millers (processing less than 1000 tons per annum) more than doubled between 1989/90-1993/94, from 101 to 251. The number of new "*bosmeulens*" (small non-registered mills) increased by more than 500 (joint processing capacity about 1,25 Mt) in the 1994/95 season, due mainly to their being able to bypass official channels and so avoid paying the current levy of R185 per ton on maize purchases from the Maize Board (Payne *et al.*, 1994).

The three largest firms in the industry (three firm concentration ratio - CR3) accounted for 52% of the market in 1977/78 and 47% in 1993/94. Although there has been a relative decline in the level of concentration over the study period, concentration is still relatively high.

1.2 White Maize Marketing Margins since 1977/78

A marketing margin, assuming purely competitive conditions, is "the price of a collection of marketing services that is the outcome of the demand for and supply of such services" (Tomek & Robinson 1990:108). Marketing services include processing, packaging, transportation and retailing of the product. A marketing margin thus represents the difference between the price of an equivalent unit of product at two different marketing levels. For this study, the absolute Maize Board Miller (*MBM*) marketing margin equals Miller selling price per ton of white maize milled (P_M) less the Maize Board selling price of an equivalent unit of product (P_{MB}).

This study assumes fixed product proportions, whereby one ton of maize meal at miller selling price is converted using an accepted conversion factor (80 percent extraction) to an equivalent tonnage at the producer level (Elliott, 1994). That is, 1,25 ton of raw maize is equivalent to 1 ton of maize meal. The actual nature of a marketing margin may be difficult to determine, since most food products undergo a complex transformation from the farm to the consumer and different products require different marketing services (Tomek and Robinson 1990). For example, if the supply curve for marketing services has a positive slope, the price of such services would rise as demand increases, resulting in a higher margin with increased production. This may be unrealistic as economies of scale in providing marketing services could lead to a negatively shaped supply curve for marketing services, at least over some range (lower margins with increased production). Marketing margins will change with changes in factor prices, the quantity and quality of services contained in the final product and the efficiency with which services are provided.

Figure 1 shows a real *MBM* margin in South Africa rising from about R98 per ton to R228 per ton since 1977. Between 1977/78-1986/87, both real Maize Board (P_{MB}) and Miller selling prices (P_M) rose, but since 1986/87 both P_M and P_{MB} have declined. The margin has, however, risen overall due to P_{MB} declining faster than P_M. Possible reasons include increased demand for services, higher real variable costs (such as wages and electricity) per ton of milled maize or costs being passed on because of market

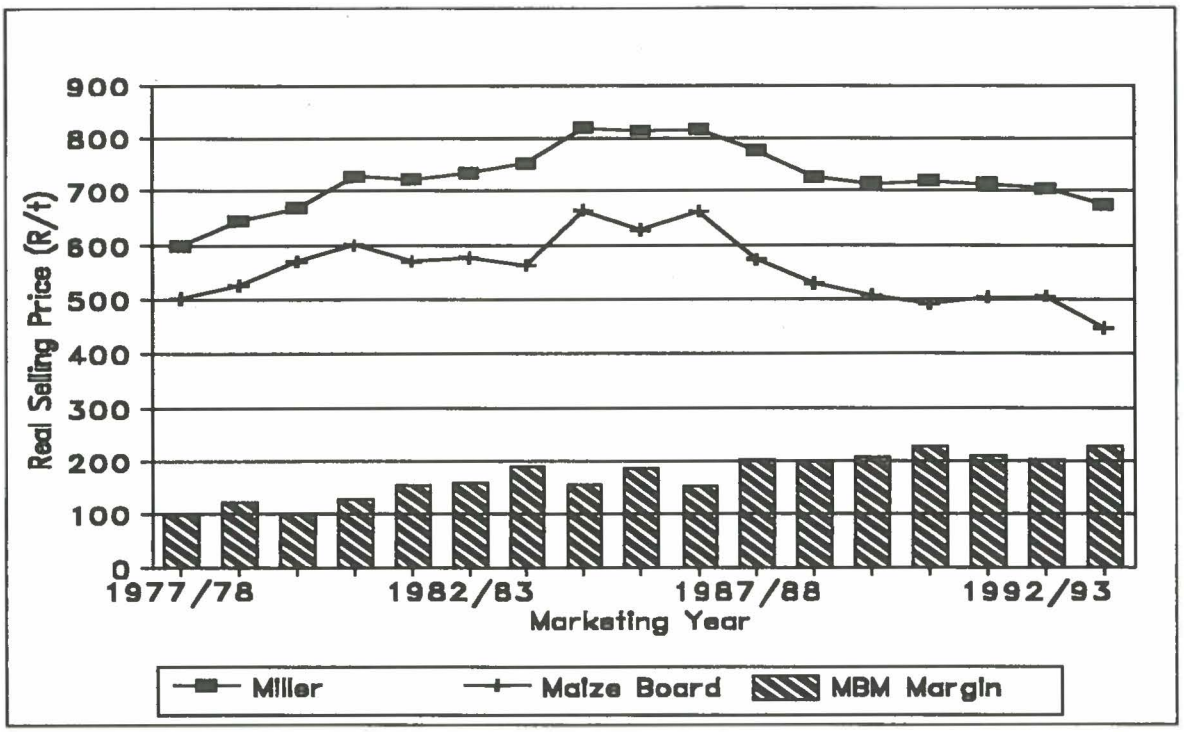

Figure 1: Trend in real Maize Board-Miller White Maize Margin 1977-1993 (1990 = 100) (Central Statistical Services 1994; Directorate Agricultural Economic Trends, 1995)

concentration amongst millers. Another factor could be the Maize Board's new pricing policy since the 1987/88 marketing year, whereby losses on export sales were reflected in a lower real net producer price - and hence lower real P_{MB} to millers - despite a higher nominal levy.

2. EMPIRICAL MODEL OF DETERMINANTS OF THE MAIZE BOARD - MILLER MARGIN

The *MBM* margin better reflects the maize grain distribution and processing system in South Africa during 1977-1993 than the Farm-Miller margin would, as the Maize Board was officially the sole buyer, seller and importer of maize over this period. The producer price was fixed by the Board prior to the harvest season, taking into account expected production and use, and thus set a base for P_{MB}, after allowance for the Board's operating costs (financing, storage, etc.). Assuming that millers use a combination of constant percentage mark-ups and absolute margins (George and King, 1971), the *MBM* margin model is:

$$MBM = b_1RMP + b_2RTVCOP + b_3D1 \quad (1)$$

where *MBM* = Real Maize Board-Miller margin (R per ton), *RMP* = Real miller white maize meal selling price (R per ton), *RTVCOP* = Real total miller variable cost of production (R per ton), and *D1* = Dummy variable for 1987 Maize Board policy change (*D1* = 0 for 1977-1986 and 1 for 1987-1993). It is expected that *MBM* would be positively related to *RMP*, *RTVCOP* and *D1*.

Input and output price data for the empirical model were collated from the Maize Board (1994), Central Statistical Services (1994), Directorate Agricultural Economic Trends (1995) and the Millers Association (1994). The scope of the study is limited, as only 17 years of aggregate mill data for the period 1977-1993 were available on an annual basis. All price data are deflated to real terms using the Consumer Price Index, CPI (1990=100) (Directorate Agricultural Economic Trends).

3 RESULTS

3.1 Correlation coefficients

The *MBM* margin was positively correlated (0.2934) with *RMP* at the 15 percent level of significance. It was also significantly positively correlated with both *RTVCOP* (0.9003) and *D1* (0.8031) at the 1 percent level. Multicollinearity may be a problem as *RTVCOP* and *D1* were significantly positively correlated (0.8108) at the 1 percent level.

3.2 Regression Models

The initial MBM margin model estimated from a system of equations including a maize demand equation and the margin model by 3SLS was (RATS, 1995):

$$MBM = \underset{(1,1500)^{ns}}{0,0732}RMP + \underset{(1,9900)^{*}}{1,6264}RTVCOP + \underset{(1,9600)^{*}}{35,5172}D1 \quad (2)$$

where adjusted R^2 = 81,63 percent, t-values are in parentheses and * and *ns* indicate statistically significant at the 10 percent level and non-significant, respectively.

The model fits the data well (81,63 percent of the variation in *MBM* is explained), but the lower than expected statistical significance of the *RTVCOP* and *D1* coefficients

probably reflects multicollinearity between these variables. An output price risk proxy variable similar to that used by Brorsen *et al.*(1985) and Faminow and Laubscher (1991) was tried in the model, but omitted due to a statistically insignificant coefficient. Input price risk effects are probably captured by *D1* accounting for the 1987 Maize Board producer price policy change (see above).

Principal components (PC's) extracted from the *standardized* explanatory variables to purge multicollinearity and restate the regression coefficients in original scale form (Chatterjee and Price, 1977) are shown in Table 1. The first two PC's were retained for the margin model as they explain about 96 percent of the variation in the data (the third PC captured the linear relationship between *RTVCOP* and *D1* which was the source of the multicollinearity).

The standardized *MBM* margin, *ZMBM*, is first regressed on PC_1 and PC_2:

$$ZMBM = 0{,}6736PC_1 + 0{,}1383PC_2 \qquad (3)$$

The *ZMBM* could also be estimated by 3SLS regression on the standardized explanatory variables as per equation (4):

$$ZMBM = \beta_1 ZRMP + \beta_2 ZRTVCOP + \beta_3 D1 \qquad (4)$$

This implies that the β coefficients in equation (4) can be estimated from equation (3) coefficient estimates and the PC_1 and PC_2 loadings in Table 1 as per the set of expressions in equation (5) (Chatterjee and Price, 1977):

Table 1 Principal Components Extracted for *MBM* Margin Model

Variable	Principal Component		
	PC_1	PC_2	PC_3
ZRMP	0,13416	0,95279	-0,27239
ZRTVCOP	0,71492	0,09729	0,69241
ZD1	0,68622	-0,28763	-0,66811
Eigenvalue	1,825	1,056	0,119
Percentage variation	60,84	35,19	3,97

$$\begin{aligned}\beta_1 &= (0{,}13416 \times 0{,}6736) + (0{,}95279 \times 0{,}13832) = 0{,}22216\\ \beta_2 &= (0{,}71492 \times 0{,}6736) + (0{,}09729 \times 0{,}13832) = 0{,}49503 \qquad (5)\\ \beta_3 &= (0{,}68622 \times 0{,}6736) + (-0{,}28763 \times 0{,}13832) = 0{,}42246\end{aligned}$$

The t-values and significance levels for these standardized parameter estimates are found by dividing the coefficients by their standard errors which are obtained from equation (6) as:

$$\text{Var}(b_i) = \sum_{i=1}^{2} (\text{PCLoading})^2 * \text{Var}\, a_i \qquad (6)$$

where the variances of the α_i are estimated by :

$$Var(\alpha_i) = \frac{1 - \sum_{i=1}^{2} \lambda_i \alpha_i^2}{(n - k - 1)\lambda_i} \qquad (7)$$

where λ_i = Eigen value, α_i = coefficient estimates for PC_1 and PC_2 in equation (3), n = sample size, and k = the number of PC's retained.

The t-values for the standardized coefficients are equivalent to those for the variables in original scale since the correlations of the variables are unaffected by scaling (Chatterjee and Price, 1977). Furthermore, the β's can be transformed back into their original scale (*b*'s) by multiplying them by S_{MBM}/S_{Xi}, the standard deviation of the *MBM* margin divided by the standard deviation of the given explanatory variable. This gives the *MBM* margin model in original scale (free of multicollinearity) as:

$$MBM = -69.3623 + 0.15817RMP + 1.74096RTVCOP + 35.2464D1 \qquad (8)$$
$$\qquad\qquad (2.2900)^{**} \qquad (8.8500)^{***} \qquad (7.0000)^{***}$$

where t-values are in parentheses and ** and *** indicate statistical significance at the 5 percent and 1 percent level, respectively.

Compared to equation (2) which is in the same units, the t-values have improved substantially so that all coefficients are now highly significant. The constant term in the model is calculated to correct for the normalization process in determining the principal component loadings and does not affect the underlying theoretical assumption of fixed proportions. The regession coefficients in equation (8) are biased as some information was lost by dropping PC_3, but they have more precision than the 3SLS estimates in equation (2) (Chatterjee and Price, 1977:175).

4 CONCLUSIONS

Study results are limited by the small sample size (17 years) and lack of firm specific data. The maize milling industry is characterized by entrenched concentration (CR3 ratio of 0,47 for the 1993/94 season) and firm specific data are needed to provide more in depth conclusions from empirical work. The Maize Board-Miller (*MBM*) marketing margin during 1977-1993 was positively related to the real miller white maize selling price, real miller variable costs and the Maize Board producer price policy change in 1987/88, with real variable costs being the main determinant. A decrease in the real consumer price of maize meal could possibly be achieved by reducing real processing costs, particularly with the removal of fixed administered prices of inputs (like electricity) and moderation of real wage demands in negotiations between trade unions and millers. The 1987 Maize Board price policy change captured the effect of input price risk on the *MBM* margin, implying that changes in maize pricing policies were an additional source of risk for maize millers. Local maize producer price deregulation in 1995 will create market price risk which farmers, millers and retailers will need to manage. Increased use of forward contracting and futures contracts to hedge portions of maize crops and maize orders for milling is likely. Research to overcome limitations of the above model is in progress to adapt work by Schroeter and Azzam (1991) to assess whether or not concentration ratio levels in the maize milling industry reflect some miller oligopoly power over the real white maize meal selling price, which may have partly contributed to the rising real Maize Board-Miller marketing margin.

NOTE

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REFERENCES

BRORSEN, B.W., CHAVAS, J.P., GRANT, W.R. & SCHNAKE, L.D. (1985). Marketing margins and price uncertainty : The case of the U.S. Wheat Market. American Journal of Agricultural Economics, Vol.67:521-528.

CENTRAL STATISTICAL SERVICE (1988). Census of Manufacturing. Central Statistical Service, Pretoria.

CENTRAL STATISTICAL SERVICE (1994). Personal correspondence. Central Statistical Service, Pretoria.

CHATTERJEE, S. & PRICE, B. (1977). Regression Analysis By Example. John Wiley and Sons, New York.

COWNIE, P.J. (1992). The Maize Industry - Quo Vadis? AFMA Forum, Pilanesberg Conference Centre, Sun City, Bophuthatswana. Maize Board. Pretoria.

DIRECTORATE AGRICULTURAL ECONOMIC TRENDS. (1995). Abstract of Agricultural Statistics, Government Printer, Pretoria.

ELLIOTT, M. (1994). Personal communication. Senior Economist, Maize Board, Pretoria.

FAMINOW, M.D. & LAUBSCHER, J.M. (1991). Empirical testing of alternative price spread models in the South African Maize Market. Agricultural Economics, Vol.6:49-66.

GARDNER, B.L (1975). The farm-retail price spread in a competitive food industry. American Journal of Agricultural Economics, Vol.57:339-409.

GEORGE, P.S. & KING, G.A. (1971). Consumer Demand for Food Commodities in the United States with Projections for 1980. Giannini Foundation Monograph No.26, University of California, Berkeley, 1971.

GUJARATI, D.N. (1988). Basic Econometrics. 2nd Edition, McGraw Hill, New York.

MAIZE BOARD (1994). Data collection. Maize Board. Pretoria.

MILLERS ASSOCIATION (1994). Data collection. Millers Association. Johannesburg.

PAYNE, T., WIXLEY, J. & REINECKE, P. (1994). Food and Commodities Confidential of Southern Africa, November.

RATS (1995). Regression Analysis of Time Series Data: Version 2.2. VAR Econometrics, Doan Associates.

SCHROETER, J. & AZZAM, A. (1991). Marketing margins, market power and price uncertainty. American Journal of Agricultural Economics, Vol.73:990-999.

SPSS (1995). Statistical Package for Social Sciences: Release 4.0. SPSS Incorporated.

TOMEK, W.G. & ROBINSON, K.L. (1990). Agricultural Product Prices. Third edition. Cornell University Press, Ithaca.

VAN ZYL, J. & NIEUWOUDT, W.L. (1990). Maize marketing in the future. Unpublished Paper.