The Effects of Market Reform on Maize Marketing Margins in South Africa: An Empirical Study

by

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1. Introduction

Throughout the world, the major share of staple food costs to the consumer is typically accounted for by marketing costs. The maize-based agricultural economies of Southern Africa are no exception: in most of the region, farm-gate maize prices account for roughly 30 to 40 percent of the total value of commercial maize meal. This implies that cost reduction in the marketing system can transmit potentially major benefits to both consumers and farmers.

In South Africa, starting in the mid-1980s, internal pressures from within the maize industry led to a series of reforms designed to reduce government's role in the sector and rely increasingly on market forces. Prior to these reforms, maize meal prices and marketing margins for millers and retailers were among the highest in the Southern Africa region (Jayne et al., 1999). In 1997, maize and maize meal prices were deregulated after decades of price control by the government. This article determines the effect of market reform on the size of maize milling/retail margins in South Africa. This objective is addressed by estimating alternative models for representing structural change in monthly maize milling/retailing margins, applying alternative estimation processes, and time-periods. The next section presents the marketing margins models estimated in the analysis. Then the data and variables used in the models are described, the estimation procedures used explained, and the model results interpreted. The paper concludes with an overall summary of key findings and identifies salient issues for future research on maize marketing and food security in South Africa.

2. The Model

Agricultural economists have developed various models of agricultural marketing margins beginning with Waugh (1964) and Gardner (1975). Tomek and Myers (1993) show how many of these models produce quite similar reduced form specifications (see also Lyons and Thompson, 1993). We start with a general reduced form data generating process of monthly maize marketing margins:

$$MM_t = X_t^* \beta_i^* + U_t \qquad (1)$$

here, MM_t is the difference between the retail price of maize meal and millers' purchase price of maize grain in month *t*, modified by grain-to-meal extraction rates. We refer to this margin as the "wholesale-to-retail" margin. X_t^* includes all exogenous variables affecting this marketing margin, and U_t is an identically and independently distributed error term.

Not all of the X_t^* variables can be identified because of the lack of observable data. Therefore $X_t^* \beta_i^*$ can be re-written as:

$$X_t^* \beta_i^* = X_t \beta_i + H_t \alpha_i \qquad (2)$$

where X_t contains the observable data and H_t the unobservable data. We can now write the data generating process as:

$$MM_t = X_t \beta_i + V_t \qquad (3)$$

where

$$V_t = H_t \alpha_i + U_t \qquad (4)$$

is the Wold representation of the stochastic component of $H_t \alpha_i$ and U_t. Any deterministic mean, trend, or seasonal component of $H_t \alpha_i$ can be incorporated in the intercept, trend or seasonal component of X_t.

The variables in X_t would normally include exogenous components of marketing costs (e.g. labor wages, transport rates, etc) as well as exogenous factors commonly found in structural models of maize supply and demand, such as rainfall, categorical variables to account for potential seasonality, and macroeconomic variables. Time trends are often included as regressors to account for slow-moving processes such as changes in technology. Finally, we must develop a representation of marketing and pricing deregulation to measure its impact on margins. Assuming a linear relationship between the marketing margin and the independent variables, equation (3) can be expressed as:

$$MM_t = \delta_0 + \mathbf{X}_t \beta_i + \delta_1 REFORM_t + \delta_2 T_t + \Sigma^{11}_{m=1} \gamma_i \mathbf{D}_{mt} + v_t \qquad (5)$$

The exogenous explanatory variables contained in the **X** vector include: labor costs lagged by one period; real exchange rates between the Rand and the US dollar, modified by differential inflation rates; an index of macroeconomic risk lagged one period; and a rainfall index based on the relevant maize growing season. T is a time trend to capture slow-moving trends, **D** is a vector of eleven monthly dummy variables, and REFORM is a variable capturing structural change in the maize marketing system. The simplest representation of REFORM is a categorical variable taking on a value of zero during the pre-reform period and a value of one afterward. The coefficient δ_1 measures the difference in mean marketing margins between the pre-reform and post-reform periods. All prices were adjusted by the 2000 consumer price index.

Alternate specifications can allow for changes in both the mean level of margins over time as well as the trend in the margins between the two periods. One such specification is:

$$MM_t = \delta_0 + \mathbf{X}_t \beta_i + \delta_1 REFORM_t + \delta_2 T_t + \delta_3 REFORM(T_t - T_R) + \Sigma^{11}_{m=1} \gamma_i \mathbf{D}_{mt} + v_t \qquad (6)$$

Equation (6) is a piecewise linear regression model imposing the restriction that there be no discontinuous change in margins at the point of market reform (T_R). In this model, the estimated margin prior to market reform reduces to:

$$E(MM_t) = \delta_0 + \mathbf{X}_t \beta_i + \delta_2 T_t + \Sigma^{11}_{m=1} \gamma_i \mathbf{D}_{mt} \qquad (7)$$

where the monthly trend in the level of the margins is δ_2 and the intercept is δ_0. After reform, REFORM=1 and hence the estimated milling/retailing margin at time *t* is:

$$E(MM_t) = (\delta_0 + \delta_1 - \delta_3 T_r) + \mathbf{X}_t \beta_i + (\delta_2 + \delta_3) T_t + \Sigma^{11}_{m=1} \gamma_i \mathbf{D}_{mt} \quad (8)$$

We examined the potential non-stationarity of the data, which could lead to problems of I(1) cointegration. In conducting Augmented Dickey-Fuller tests for unit roots on the inflation-adjusted prices and other variables in the model, we rejected the hypothesis of unit roots at the 5% level for wholesale-to-retail margins, the real exchange rate, and the rainfall index, and at the 1% level for real wage rates and exchange rate volatility.

3. Data and Variable Construction

Milling/retail margin (MM): The wholesale-to-retail marketing margin is a processing plus retailing margin. The formula used to estimate the wholesale-to-retail maize margin, following Jayne, et al. (1994), is:

$$MM_t = P_{rt} - P_{wt} * z + [(z-1)*P_{bt}] \qquad (9)$$

where P_{rt} equals the retail price of maize meal at time *t*, P_{wt} is the wholesale price of the maize grain at time *t*, *z* represents the average extraction rate of 1.80 tons of grain used to produce one ton of meal, and P_{bt} is the value of the residual maize by-product that is sold to agro-industries as input. In the margin computations used in this analysis, *z* is 1.8 and P_{bt} is approximated as 70% of the wholesale maize price in month *t*, based on information from sources in the maize milling industry.

Exogenous variables: The average wages and salary measures for the manufacturing sector within South Africa, as well as e*xchange rate and CPI data* come from Statistics South Africa. *Real exchange rate volatility is defined as the* squared deviation between the current and lagged exchange rate values, $(E_t - E_{t-1})^2$. A rainfall index, weighted by the share of maize production by province, is available from the South African Weather Service. The weather index is constant within each marketing year and varying across marketing years.

Marketing and price policy change: To examine the robustness of our findings, we report two alternative methods of modeling the structural change that accompanied full price deregulation of maize and maize meal products in May 1997. These alternate models were (a) the inclusion of an intercept shift variable equaling zero before May 1997 and one afterward, as in equation (5); and (b) a piecewise linear regression approach restricting a discontinuous change in margin levels at the time of reform, as in equation (6).

Estimation Period: To examine the sensitivity of model results to recent events in Southern Africa, we estimate equations (5) and (6) using both the full sample period (May 1976 to September 2003) and a truncated sample period, May 1976 to April 2001. The latter sample period is used to the possibility that the results could be affected by the 2002/03 drought and episodes of substantial exchange rate volatility, which occurred near the end of the full sample period for which data is available.

4. Estimation Procedure

When Ordinary Least Squared (OLS) method of estimation is applied to both our reduced form linear equations, it was found that the wholesale-to-retail margin model exhibited both serially correlated error terms and heteroskedasticity. We used two alternate procedures to correct for this. First, when error autocorrelation was found to be AR(1), serial correlation was modeled and corrected for through a weighted least squares AR(1) procedure, Feasible General Least Squares estimation.

We estimated the equation by the standard Prais-Winsten method of estimation, providing standard errors that are robust to heteroskedasticity. The resulting Feasible General Least Squares estimators are asymptotically efficient and all the standard errors and test statistics from the Prais-Winsten method are asymptotically valid.

When serially correlated errors were found to be AR(2) or higher, we use the Newey-West (NW) serial correlated robust inferences after OLS. The NW procedure has become more popular in recent years because it is intended to provide standard errors that are robust to fairly arbitrary forms of serial correlation and heteroskedasticity (Wooldridge, 2000). The serial correlation-robust standard errors are typically higher than the usual OLS standard errors when there is serial correlation. Lag length selection procedures indicated a need for up to two lags for the May 1976-April 2001 estimations and up to four lags for the May 1976-September 2003 period.

5. Results

The first column of Table 1 presents the results of the OLS/NW estimation results for equation (5), in which the categorical variable REFORM measures the change in mean wholesale-to-retail margins after price deregulation in 1997. Most notably, the deregulation variable has a highly significant positive coefficient, indicating that the conditional mean of the maize mill/retail margin increased after the deregulation of prices by R358 per ton during the May 1997 to April 2001 period, and by R470 per ton during the May 1997 to September 2003 period. These figures represent a 29 and 40 percent increase over mean inflation-adjusted milling/retailing margins during the 1976 to 1997 period of controlled pricing. Over and above this finding, the results in Table 1 also show a very gradual upward trend in maize processing/retail margins over the entire sample period of roughly 1 Rand per month.

Table 2 shows the piecewise linear regression results of equation (6). This model allows for a shift in the mean level of milling/retailing margins as well as a shift in the rate of growth of the margin. The OLS/Newey-West and FGLS estimations show again a fairly consistent picture with respect to the effects of maize market reform on maize milling/retailing margins. Both sets of models, after computing standard errors robust to serial correlation, show statistically insignificant immediate effects on the margin after the initiation of price decontrol and market reform, with coefficient estimates ranging from -49 to +245 Rand per ton. However, all of the models presented in Table 2 show a steep increase over time in the mill/retail margin.

The monthly increase in the margin ranges from R9.52 per ton for the May 1976-September 2003 OLS/NW estimation, to R16.71 and R15.34 per ton for the OLS/NW and FGLS estimations for the May 1976-April 2001 sample period. This implies a steady increase in the conditional mean of the mill/retail margin of 388 to 551 Rand per ton after a three-year period – a 29 to 42 percent increase over mean mill/retail margins during the Phase 1 and II periods in which prices were controlled. The finding of a rising trajectory in maize mill/retail margins is statistically significant across all models at the 99.5 level of statistical significance or higher.

By contrast, trend growth in the mill/retail margin prior to price decontrol was very close to zero in the OLS/NW runs, and +1.79 Rand per ton per month in the FGLS estimation for the shorter sample period. This contrasts markedly with the estimated sharp increase in the size of the mill/retail margin after the 1997 decontrol of maize meal prices.

To simulate the dynamics of maize meal price movement under the counterfactual policy conditions of continued price control, we predicted Pr using equation (9), based on model results from equation (5) OLS with Newey-West corrected standard errors over the full sample period (simulation 1), and from equation (6) (simulation 2). In both simulations, the variable REFORM was set to zero over the entire sample period. Figure 1 plots the price movement of actual maize meal retail prices against the two simulated retail price series. Both simulated ‘‘no reform/no price decontrol’’ prices show a close tracking of actual prices during the pre-control period, and then show that historical prices rose substantially above the simulated prices starting with the decontrol of maize meal prices in 1997.

From the results of these alternative model specifications, estimation techniques, and sample periods, a consistent picture emerges. The implementation of market reform and price decontrol has led to an increase in real retail maize meal prices. While our statistical results do not reveal the reason for the rise in margins after the decontrol of maize marketing and pricing, these results are consistent with descriptive analyses by Chabane (2002), Watkinson and Makgetla (2002), and Diamant (2003) indicating high levels of concentration in the milling and especially the retailing stage of the food system. Given the importance of maize meal in the diets of South African consumers, further investigation of the causes of rising real maize marketing margins and of options to efficiently reduce these margins would be of great importance for the food security of the poor.

6. Conclusions

Summary

This study determines the effect of price decontrol of maize meal prices in 1997 on the maize milling/retailing margins in South Africa. To assess the robustness of our findings, we applied two alternate model specifications of market reform using two different sample periods and two different estimation techniques.

In virtually all models, the results indicate that inflation-adjusted margins accruing to millers and retailers has risen 29 to 42 percent between 1997 and 2003, after controlling for disturbances in weather, wages, exchange rate levels and volatility. Furthermore there appears to be a rising trend in the margin size over time. Simulations indicate that the deregulation of maize meal prices has caused a 16 to 20% increase in the mean retail price of maize meal since 1997. Maize meal prices in South Africa remain the highest of all maize producing countries in the region, even though mean wholesale prices in South Africa are relatively low compared to its regional neighbors. Following on widespread concerns about the competitiveness of the food industry in South Africa (see COSATU, 2002; and Watkinson and Makgetla, 2002), the study indicates the need for more detailed understanding of how market structure, public policies and/or practices of marketing firms may be affecting competition and possible barriers to entry for new milling and retailing firms.

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Table 1: Maize Milling/Retailing Margins, Equation (5), OLS with Newey-West (NW) Serial Correlation-Robust Standard Errors

	-- Sample period --					
Variables	**May 1976 – April 2001**			**May 1976 – September 2003**		
	OLS	NW lag(1)	NW lag(2)	OLS	NW lag(1)	NW lag(4)
Rainfall index	-0.049	-0.049	-0.049	0.008	0.008	0.008
	(-0.567)	(-0.466)	(-0.394)	(0.080)	(0.053)	(0.038)
$Wages_{t-1}$	0.171	0.171	0.171	0.029	0.029	0.029
	(3.384)**	(2.157)*	(1.879)	(0.557)	(0.343)	(0.244)
ER Volatility $_{t-1}$	-183.597	-183.597	-183.597	-178.417	-178.417	-178.417
	(-0.834)	(-1.195)	(-1.160)	(-3.079)**	(-4.231)**	(-3.882)**
RER $_{t-1}$	-27.761	-27.761	-27.761	-58.306	-58.306	-58.306
	(-3.370)**	(-2.734)**	(-2.284)*	(-6.450)**	(-3.212)**	(-2.277)*
Trend	1.336	1.336	1.336	1.034	1.034	1.034
	(5.259)**	(5.287)**	(4.538)**	(3.746)**	(2.191)*	(1.562)
Reform	**358.038**	**358.038**	**358.038**	**480.59**	**480.59**	**480.59**
	(8.587)**	**(3.799)****	**(3.186)****	**(9.138)****	**(4.666)****	**(3.165)****
June	32.045	32.045	32.045	35.672	35.672	35.672
	(0.692)	(1.023)	(1.173)	(0.622)	(0.887)	(1.223)
July	23.597	23.597	23.597	31.735	31.735	31.735
	(0.509)	(0.523)	(0.587)	(0.553)	(0.550)	(0.747)
Aug	10.262	10.262	10.262	30.282	30.282	30.282
	(0.218)	(0.204)	(0.200)	(0.524)	(0.532)	(0.607)
Sept	-29.402	-29.402	-29.402	5.115	5.115	5.115
	(-0.628)	(-0.575)	(-0.560)	(0.088)	(0.086)	(0.086)
Oct	-36.053	-36.053	-36.053	-45.1	-45.1	-45.1
	(-0.772)	(-0.700)	(-0.680)	(-0.773)	(-0.766)	(-0.758)
Nov	-55.465	-55.465	-55.465	-55.354	-55.354	-55.354
	(-1.177)	(-1.080)	(-1.035)	(-0.941)	(-0.957)	(-0.941)
Dec	-96.043	-96.043	-96.043	-79.156	-79.156	-79.156
	(-1.973)	(-1.515)	(-1.443)	(-1.309)	(-1.178)	(-1.115)
Jan	-199.427	-199.427	-199.427	-63.496	-63.496	-63.496
	(-3.132)**	(-2.208)*	(-1.977)*	(-0.832)	(-0.710)	(-0.565)
Feb	-59.833	-59.833	-59.833	-63.477	-63.477	-63.477
	(-1.281)	(-1.413)	(-1.392)	(-1.089)	(-0.997)	(-1.161)
Mar	-67.886	-67.886	-67.886	-76.320	-76.320	-76.320
	(-1.465)	(-1.794)	(-1.910)	(-1.317)	(-1.190)	(-1.571)
Apr	-88.543	-88.543	-88.543	-64.772	-64.772	-64.772
	(-1.894)	(-2.258)*	(-2.273)*	(-1.111)	(-1.270)	(-1.462)
Constant	665.554	665.554	665.554	1419.162	1419.162	1419.162
	(3.668)**	(2.012)*	(1.732)	(6.517)**	(3.839)**	(2.678)**
DW	0.2770			0.2926		
R^2	0.7939			0.7309		
Observations	299	299	299	328	328	328

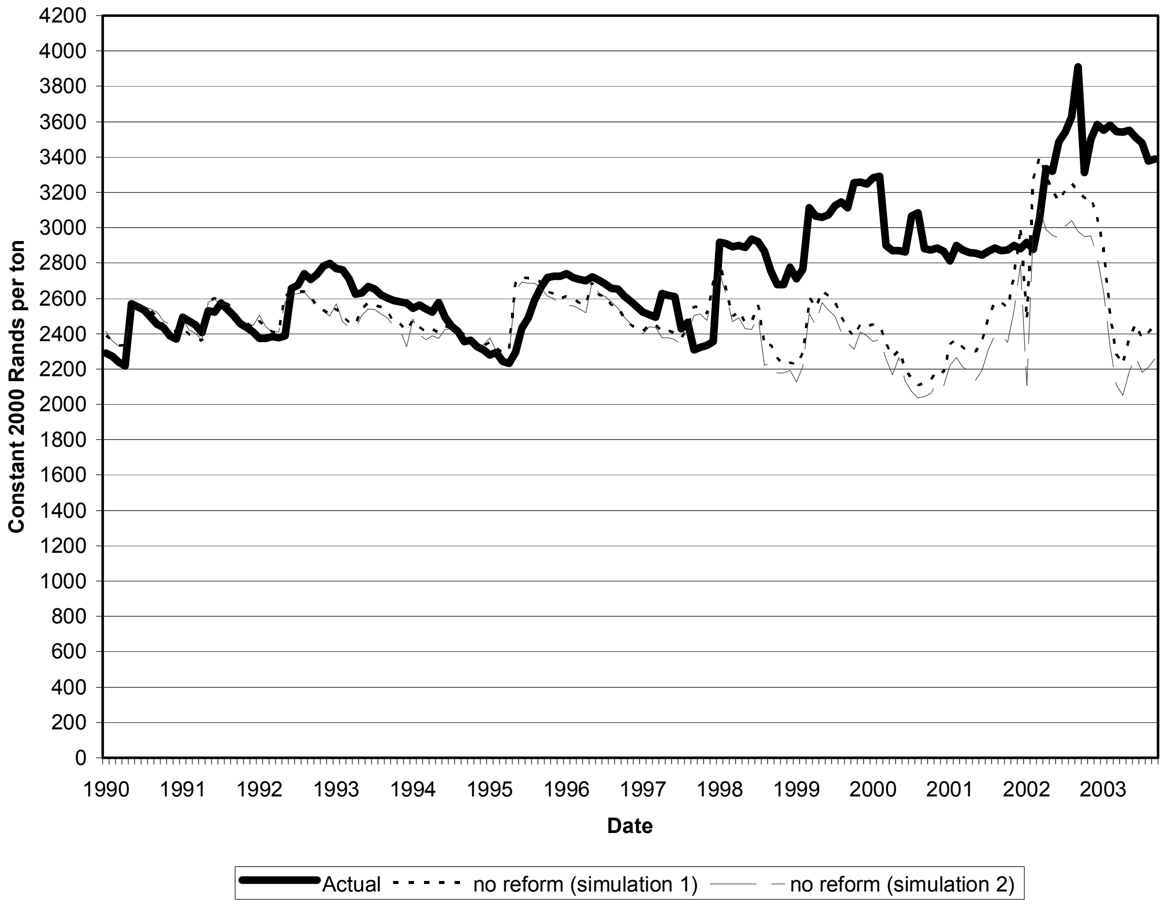
Note: * = 5% level of significance, and ** = 1% level of significance

Table 2: Maize Milling/Retailing Margins, Equation (6), OLS with Newey-West Serial Correlation-Robust Standard Errors and FGLS Estimation

Variables	May 1976 – April 2001			May 1976 – September 2003		
	OLS	NW lag(1)	FGLS	OLS	NW lag(1)	NW lag(4)
Rainfall Index	-0.175	-0.175	0.188	0.164	0.164	0.164
	(-2.373)*	(-1.655)	(-1.125)	(1.712)	(1.214)	(0.885)
Wages $_{t-1}$	0.077	0.077	0.033	0.107	0.107	0.107
	(1.987)*	(1.425)	(1.525)	(2.212)*	(1.593)	(1.224)
ER Volatility $_{t-1}$	-36.670	-36.670	-57.246	-193.025	-193.025	-193.025
	(-0.197)	(-0.248)	(-0.802)	(-3.649)**	(-3.914)**	(-3.412)**
RExch $_{t-1}$	-48.096	-48.096	-25.146	-91.813	-91.813	-91.813
	(-6.675)**	(-8.306)**	(-3.017)**	(-9.913)**	(-5.455)**	(3.974)**
Trend	0.983	0.983	1.790	-0.115	-0.115	-0.115
	(4.533)**	(4.721)**	(3.625)**	(-0.397)	(-0.270)	(-0.202)
Reform	**65.111**	**65.111**	**-49.590**	**245.243**	**245.243**	**245.243**
	(1.461)	**(0.696)**	**(-0.641)**	**(4.350)****	**(2.400)***	**(1.698)**
Reform*(T_t-T_{253})	**16.712**	**16.712**	**15.344**	**9.519**	**9.519**	**9.519**
	(10.708)**	**(5.269)****	**(3.229)****	**(7.956)****	**(4.017)****	**(2.862)****
June	31.097	31.097	25.302	37.824	37.824	37.824
	(0.796)	(1.007)	(1.767)	(0.723)	(1.072)	(1.441)
July	24.640	24.640	19.397	32.164	32.164	32.164
	(0.630)	(0.622)	(0.916)	(0.614)	(0.651)	(0.851)
Aug	17.876	17.876	18.362	21.465	21.465	21.465
	(0.451)	(0.446)	(0.797)	(0.407)	(0.433)	(0.482)
Sept	-18.808	-18.808	-19.143	-3.999	-3.999	-3.999
	(-0.476)	(-0.470)	(-0.709)	(-0.076)	(-0.081)	(-0.080)
Oct	-30.844	-30.844	-29.736	-45.380	-45.380	-45.380
	(-0.783)	(-0.739)	(-1.063)	(-0.852)	(-0.846)	(-0.837)
Nov	-47.497	-47.497	-42.797	-62.483	-62.483	-62.483
	(-1.195)	(-1.129)	(-1.504)	(-1.163)	(-1.191)	(-1.162)
Dec	-76.365	-76.365	-64.796	-98.870	-98.870	-98.870
	(-1.857)	(-1.542)	(-2.166)*	(-1.789)	(-1.617)	(-1.529)
Jan	-121.806	-121.806	-81.067	-128.528	-128.528	-128.528
	(-2.247)*	(-1.839)	(-2.173)*	(-1.834)	(-1.686)	(-1.438)
Feb	-66.442	-66.442	-60.414	-72.730	-72.730	-72.730
	(-1.686)	(-1.628)	(-1.890)	(-1.367)	(-1.258)	(-1.455)
Mar	-86.772	-86.772	-81.854	-84.164	-84.164	-84.164
	(-2.217)*	(-2.148)*	(-2.622)**	(-1.592)	(-1.470)	(-1.925)
Apr	-99.523	-99.523	-90.656	-80.616	-80.616	-80.616
	(-2.522)*	(-2.578)*	(-2.967)**	(-1.515)	(-1.828)	(-2.115)*
Constant	1283.599	1283.599	1186.304	1444.232	1444.232	1444.232
	(7.844)**	(6.110)**	(8.776)**	(7.267)**	(5.096)**	(3.739)**
DW	0.3138		1.9940	0.3790		
R^2	0.8538			0.7767		
Observations	299	299	299	328	328	328

Note: * = 5% level of significance, and ** = 1% level of significance

Figure 1. Maize Meal Retail Prices: Actual vs. Simulated Under No Price Decontrol: January 1990 to September 2003



Notes:
Simulation 1: estimated retail price of maize meal assuming that market reform/price decontrol did not occur (generated from mill/retail margins based on equation 5 using the Newey-West lag(4) method of estimation).

Simulation 2: estimated retail price of maize meal if market reform/price decontrol did not occur (generated from mill/retail margins based on equation 6 using the Newey-West lag(4) method of estimation).

In both cases, the variable REFORM was set to zero throughout the entire period from May 1976 to September 2003.