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Price Integration of Oils and Oilseeds

P. Nasurudeen and S.R. Subramanian*

INTRODUCTION

Oilseeds and edible oils hold a key position in the Indian economy. Its contribution to the gross domestic product (GDP) was 4 per cent and it accounted for 10 per cent of the total value of agricultural commodities produced during 1991-92. Oilseeds and edible oil economy of India has been characterised by an overall shortage in supply even with the record production of 18.28 million tonnes of nine major oilseeds in 1991-92. With an increase in domestic production the country is on the threshold of attaining self-sufficiency in oilseeds. Most of the oils are substitutable in their uses and certain oils need pre-treatment. The substitutability of oils is basically influenced by their prices. The prices of all oils are interrelated and have certain degree of integration.

Earlier studies on price analysis reported that there existed price integration in agricultural products. Price correlation analysis was used to measure the market integration of agricultural commodities (Cummings, 1967; Harris, 1979; Jasdanwala, 1966; Jhala, 1984; Lele, 1971; Raju and Von Oppen, 1982). Pricing efficiency has been estimated based on the degree of price correlation between commodities and markets over space and time. The validity as well as utility of correlation coefficients as a measure of market integration was often questioned (Harris, 1980; Blyn, 1973). In some cases the correlation coefficient was found to be high even though there was no contact between these markets or periods (Lundahl and Petersson, 1982). Blyn (1973) and Harris (1980) argued that the correlation coefficient is an inadequate measure of market or price integration. It was proved by Blyn (1973) that even for well integrated markets the correlation coefficient need not be high. Ravallion (1983, 1986) used bivariate correlation or regression model of spatial price differentials for a tradable good which avoided the inferential dangers of received methods using static price correlations. Tomek (1980) and Leavitt *et al.* (1983) computed price-pair differentials and constructed a first difference equation to assess the pricing behaviour of Alberta pork market over time.

The dynamic bivariate regression model was used to estimate the short-run price adjustment. The long-run price adjustment was measured through error correction model (Palaskas and Harris, 1991). Bessler and Schrader (1980) tested the causal relations among prices by Granger causality test. The price linkage and price transmission were studied through Wolfram's asymmetry model (Ward, 1982). Temporal ordering between price series was computed by lead-lag relationship which indicates the strong and weak causality (Adamovicz *et al.*, 1984). Koyck's distributed lag model was used to test market integration of groundnut (Narasimhan, 1983). The price interrelationships among oils and oilseeds was estimated by Koyck's distributed lag model (Narasimhan *et al.*, 1985).

This paper attempts to study the price adjustment between oils and oilseeds. The price adjustment among oils and oilseeds can take place at two stages. At the first stage the price adjustment can reach when the price of oil and oilcake got fixed the price of its own seed, since oil and oilcake are derived from its seed. Thus in this stage the weighted sum of oil and oilcake prices fixes the price of oilseed price. In the next stage, price of all oils responds

* Assistant Professor, Department of Agricultural Economics and Director, Centre for Agricultural and Rural Development Studies, respectively, Tamil Nadu Agricultural University, Coimbatore- 641 003.

to change in the price of each oil. With the above hypothesis the analysis was carried out to estimate the price relationship at two stages: (*i*) Vertical integration - integration of seed price to price of its oil and cake and (*ii*) Horizontal integration - integration between price of different oils.

THE MODEL

To test the temporal ordering of oil and oilseeds price, Koyck's distributed lag model (Koyck, 1954) was used due to its superiority over correlation analysis. Koyck's basic model is explained below:

$$P_{it} = \alpha + \beta_0 P_{jt} + \beta_1 P_{jt-1} + \ldots\ldots\ldots\ldots + \beta_k P_{jt-k} + U_t \quad \ldots.(1)$$

where P_{it} is the price of i-th oil/oilseed in t-th period and α and β are parameters. Assuming that the βs are of same sign and decline geometrically, then it follows as

$$\beta_k = \beta_0 \lambda^k \quad \ldots.(2)^1$$

$k = 0, 1, \ldots\ldots\ldots$

where λ is such that $0 < \lambda < 1$ as the rate of decline of the distributed lag and $(1 - \lambda)$ is the speed adjustment. Equation (2) explains that each successive β is numerically less than each preceding β, implying that as one goes back into distant past the effect of lag on P_{it} becomes progressively smaller. If λ is close to 1 the slower is the rate of decline in β_k. If $\lambda = 0$, the more rapid is the decline in β_k. With the assumption of non-negative values for λ, Koyck rules out the βs from changing sign and $\lambda < 1$, lesser weight has been assigned to the distant βs than the current ones and the sum of the βs which gives the long-run multiplier finitely, namely,

$$\sum_{k=0}^{\infty} \beta_k = \beta_0 \left(\frac{1}{1-\lambda} \right) \quad \ldots.(3)^2$$

As a result of equation (2) the infinite lag model (1) can be written as

$$P_{it} = \alpha + \beta_0 P_{jt} + \beta_1 \lambda P_{jt-1} + B_2 \lambda^2 P_{jt-2} + \ldots. + \mu_t \quad \ldots.(4)$$

The model is still not amenable to easy estimation since there remains a large number of parameters to be estimated and the parameter λ enters in a highly non-linear form. By lagging equation (1) by one period, it becomes

$$P_{it-1} = \alpha + \beta_0 P_{jt-1} + \beta_1 \lambda P_{jt-2} + \beta_2 \lambda^2 P_{jt-3} + \ldots.. + U_{t-1} \quad \ldots.(5)$$

Multiplying equation (5) by λ

$$\lambda P_{it-1} = \lambda \alpha + \beta_0 \lambda P_{jt-1} + \beta_1 \lambda^2 P_{jt-2} + \beta_2 \lambda^3 P_{jt-3} + \ldots. + \lambda U_{t-1} \quad \ldots.(6)$$

and subtracting equation (6) from (4)

$$P_{it} = \alpha + \beta_0 P_{jt} + \lambda P_{it-1} + \upsilon_t \quad ....(7)$$

where $\alpha = \alpha(1-\lambda)$, $\upsilon_t = (U_t - \lambda U_{t-1})$ a moving average of U_t and U_{t-1}. In a sense multicollinearity is resolved by replacing P_{jt-1}, P_{jt-2}, ... by a single variable P_{it-1}. The β gives the short-run price adjustment corresponding to a unit change in j-th price. The long-run adjustment is measured through equation (3), i.e., $\beta_k = \beta_0 / (1-\lambda)$. Similarly, the number of days required to realise 90 per cent adjustment was estimated by

$$0.09\beta_k = \frac{\lambda^n - 1}{\lambda - 1} \quad ....(8)$$

where 'n' is the time period. Here it is 365 days.

The estimate form is given in equation (7). The error term υ_t possesses ordinary least squares (OLS) properties.

The horizontal and vertical integration of oils and oilseeds were tested with the following equations.

$$P_{it} = \alpha + \beta_0 P_{jt} + \lambda P_{it-1} + \upsilon_t \quad ....(9)$$

$$P_{ist} = \alpha + \beta_0 P_{it} + \mu P_{ict} + \lambda P_{ist-1} + \upsilon_t \quad ....(10)$$

where P_{it} is the price of the oil on t-th day, P_{jt} is the price of j-th oil on t-th day, P_{it-1} is the price of i-th oil on t-1 day. P_{ist} is the price of i-th oilseed on t-th day, P_{ist-1} is the price of i-th oilseed on t-1 day. P_{ict} is the price of i-th oilcake on t-th day and $\alpha = \alpha(1-\lambda)$.

Positive signs are expected for β and λ in horizontal integration (9) and negative sign for α and positive signs for β, λ and μ in vertical integration (10). Under perfect competition long-run adjustment in seed price with oil and cake price should be closer to the proportionate content of oil and cake in the respective oilseed. Therefore, β_k is expected to be equal to the conversion ratio of oil and cake in the oilseed.[3]

Ten oils, i.e., groundnut, soyabean, castor, linseed, seasame, safflower, niger, cottonseed, coconut and rice bran oil for which data are available are taken for analysis of horizontal and vertical price integration. Bombay market was selected for this study due to its prominence in the marketing of oils and oilseeds in India. Daily wholesale price of oil, oilseeds and oilcakes were collected for one year (October 1993 to September 1994) from the daily issues of *The Economic Times* and *The Financial Express*. Bombay acted as terminal market and also price setter for the entire national market because of concentration of traders, speculators, and consumers (industrial users). Once the prices are decided in Bombay market they filter down to the lower level markets. This study was based on only one market-year data and so the linkages observed may or may not be representative of other years. Similarly, since this study was conducted for only one market the linkages observed need to be verified with respect to other markets.

HORIZONTAL INTEGRATION

Koyck's distributed lag model was used to test the integration of oil prices. Separate regressions for each oil was estimated in linear functional form. The results are presented in Table I. Durbin-Watson 'h' statistic estimated for each oil showed that it is well within the accepted level and the R^2 ranged between 0.74 and 0.92.

TABLE I. REGRESSION RESULTS OF INTEGRATION OF OIL PRICES (HORIZONTAL INTEGRATION)

Dependent variable	Explanatory variable (oil price)	α	β coefficient		Coefficient		R^2
			β	't' value	λ	't' value	
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Groundnut oil price	Soyabean	-6.211	0.8080**	15.654	0.3369**	9.447	0.87
	Castor	35.011	0.5231**	11.142	0.5153**	14.937	0.83
	Linseed	-84.351	1.1458**	16.331	0.3295**	9.472	0.88
	Sesame	-100.128	0.9866**	10.749	0.4725**	12.369	0.83
	Safflower	-30.028	0.8302**	16.099	0.3210**	9.007	0.87
	Niger	477.104	-1.1996**	-14.041	0.4077**	11.652	0.86
	Cottonseed	39.181	0.6608**	16.534	0.3096**	8.743	0.88
	Coconut	224.141	24.8860**	18.471	0.6293**	18.471	0.79
	Rice bran	10.787	0.5073**	3.286	0.7146**	19.575	0.75
Soyabean oil price	Groundnut	32.450	0.5437**	21.960	0.2313**	8.398	0.86
	Castor	53.476	0.6587**	20.224	0.2404**	8.253	0.85
	Linseed	-61.236	1.0903**	24.709	0.1709**	6.416	0.88
	Sesame	-91.679	1.0369**	16.146	0.2913**	8.941	0.81
	Safflower	8.598	0.5716**	14.286	0.3334**	9.896	0.78
	Niger	425.175	-1.0159**	-16.401	0.3248**	10.515	0.81
	Cottonseed	56.150	0.6648**	30.633	0.1129**	4.825	0.92
	Coconut	373.975	-0.4271**	-17.750	0.2883**	9.462	0.82
	Rice bran	-45.618	1.3083**	10.368	0.4177**	11.496	0.74
Castor oil price	Linseed	-61.115	1.8083**	16.762	0.583*	1.798	0.74
Linseed oil price	Groundnut	-74.6071	0.3912**	22.653	0.2307**	8.782	0.87
	Soyabean	-64.349	0.5598**	24.431	0.1720**	6.533	0.88
	Castor	77.2996	0.3088**	11.496	0.4278**	13.012	0.74
	Sesame	-4.6010	0.5352**	10.730	0.4189**	12.099	0.77
	Safflower	-50.414	0.4771**	17.853	0.2588**	8.415	0.83
	Niger	304.968	-6.1230**	-12.827	0.3896**	11.931	0.76
	Cottonseed	-94.797	0.4104**	20.504	0.2011**	6.809	0.85
	Coconut	229.680	-2.0179**	-10.253	0.4444**	13.040	0.74
	Rice bran	-27.124	0.7125**	7.244	0.4673**	12.059	0.81
Sesame oil price	Groundnut	-104.308	0.2935**	18.043	0.2666**	9.889	0.80
	Soyabean	-98.123	0.4044**	18.151	0.2342**	8.397	0.80
	Castor	120.508	0.4062**	21.600	0.2121**	8.464	0.84
	Linseed	-65.607	0.4311**	12.414	0.3396**	10.872	0.77
	Safflower	-86.265	0.3347**	13.702	0.3112**	10.164	0.78
	Niger	-312.548	-0.5499**	-13.663	0.3309**	11.066	0.76
	Cottonseed	-118.654	0.2915**	15.801	0.2645**	8.922	0.76
	Coconut	-257.469	-0.1955**	-11.634	0.3548**	11.191	0.82
	Rice bran	-63.541	0.6449**	7.588	0.3923**	10.756	0.77
Safflower oil price (Kardi)	Groundnut	-46.531	0.4917**	20.561	0.3124**	11.301	0.89
	Soyabean	-34.435	0.4850**	12.965	0.4415**	13.516	0.82
	Castor	-54.662	0.3070**	8.863	0.5761**	17.885	0.77
	Linseed	-21.675	0.8096**	16.234	0.3612**	11.541	0.86
	Sesame	-35.483	0.6798**	10.419	0.4940**	14.357	0.79
	Cottonseed	-63.177	0.3893**	13.110	0.4250**	12.765	0.83
	Coconut	-179.001	-0.1646**	-6.679	0.6293**	19.407	0.74
	Rice bran	12.030	0.6463**	5.336	0.6176**	17.037	0.78

(Contd.)

TABLE I *(Concld.)*

Dependent variable	Explanatory variable (oil price)	α	β coefficient		Coefficient		R^2
			β	't' value	λ	't' value	
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Niger oil	Groundnut	-269.500	-0.2818**	-15.810	0.2603**	8.592	0.83
	Soyabean	-252.341	-0.3295**	-14.557	0.3260**	11.221	0.81
	Castor	224.727	-0.2866**	-12.558	0.3452**	11.071	0.79
	Linseed	-247.026	-0.3785**	-11.423	0.3909**	12.792	0.77
	Sesame	-261.136	-0.4311**	-11.116	0.4091**	13.615	0.77
	Safflower	-246.543	-0.3021**	-12.896	0.3553**	11.805	0.79
	Cottonseed	-256.760	-0.2935**	-17.879	0.2717**	10.047	0.85
	Coconut	-70.691	-0.1707**	-10.866	0.4105**	13.513	0.76
	Rice bran	-223.024	-0.6361**	-10.185	0.4867**	17.720	0.75
Cottonseed oil price	Groundnut	-11.327	0.8726**	33.828	0.0132**	2.456	0.84
	Soyabean	-55.066	1.2073**	46.727	0.0100**	2.458	0.91
	Castor	31.937	1.0217**	26.046	0.0187**	2.836	0.76
	Linseed	-146.931	1.5922**	32.155	0.0138**	2.469	0.83
	Sesame	-199.704	1.7039**	21.821	0.0232**	3.132	0.78
	Safflower	-46.237	1.0474**	22.538	0.0167*	2.278	0.77
	Niger	-718.790	-1.8800**	28.225	0.0136*	2.183	0.79
	Coconut	-575.951	0.7231**	25.639	0.0149*	2.232	0.77
	Rice bran	-165.788	2.7880**	17.636	0.0211**	2.472	0.80
Coconut oil price	Groundnut	-244.023	0.2442**	5.493	0.6263**	18.824	0.79
	Soyabean	-438.946	0.7150**	12.207	0.4326**	13.064	0.86
	Castor	-416.758	0.7015**	12.159	0.4091**	11.750	0.86
	Linseed	-315.000	0.5379**	6.789	0.6035**	18.748	0.80
	Sesame	-365.451	0.6893**	7.519	0.5948**	19.004	0.81
	Safflower	-215.522	0.2358**	4.399	0.6747**	22.226	0.78
	Niger	9.392	-0.7473**	-7.456	0.5704**	16.957	0.82
	Cottonseed	-397.395	0.5541**	12.308	0.4354**	13.299	0.86
	Rice bran	-428.866	1.5520**	10.942	0.5624**	20.462	0.85
Rice bran oil price	Groundnut	-50.143	0.0846**	8.289	0.4897**	16.351	0.89
	Soyabean	-48.684	0.1577**	11.974	0.4007**	13.722	0.75
	Castor	-54.410	0.1241**	9.941	0.4547**	15.428	0.92
	Linseed	-35.506	0.1885**	10.044	0.4425**	14.791	0.74
	Sesame	-26.967	0.2017**	8.762	0.4602**	14.928	0.90
	Safflower	-45.049	0.1188**	8.650	0.4693**	15.382	0.90
	Niger	-135.047	-0.2196**	-9.783	0.4577**	15.492	0.92
	Cottonseed	-58.859	0.1299**	12.638	0.3792**	12.960	0.76
	Coconut	-138.683	0.1083**	12.618	0.3936**	13.734	0.78

** and * Significant at 1 per cent and 5 per cent level respectively.

Short-run and long-run price adjustment coefficients and the average number of days required to realise 90 per cent of long-run price adjustment are presented in Table II. The results revealed that the price of groundnut oil influenced the prices of all other oils except castor oil. Castor oil price was influenced only by linseed oil price since linseed oil and castor oil are substitutable in industrial uses. Coconut oil price had an impact due to the price changes of groundnut, soyabean and castor oil. Niger oil price showed a negative relationship with the prices of all other oils.

TABLE II. SHORT-RUN, LONG-RUN PRICE ADJUSTMENTS, NUMBER OF DAYS REQUIRED TO REALISE 90 PER CENT OF LONG-RUN PRICE ADJUSTMENT AT BOMBAY MARKET

Oil price (1)		Groundnut (2)	Soyabean (3)	Castor (4)	Linseed (5)	Sesame (6)	Safflower (7)	Niger (8)	Cotton (9)	Coconut (10)	Rice bran (11)
Groundnut oil price	S		0.8069	0.5231	1.1458	0.9866	0.8302	-1.1990	0.6608	24.8860	0.5073
	L		1.2200	1.079	1.7080	1.8700	1.2227	-2.0243	0.9675	67.1324	1.7775
	N		3.00	4.12	2.98	3.794	2.92	3.37	2.89	5.39	7.00
Soyabean oil	S	0.5437	-	0.6587	1.0903	1.0369	0.5716	-1.015	0.6648	-0.4271	1.3083
	L	0.7073	-	0.8671	1.3150	1.4631	0.8575	-1.504	0.7494	-0.6001	2.2468
	N	2.60	-	2.63	2.41	2.82	3.00	2.96	2.25	2.81	3.43
Castor oil	S	-	-	-	1.8083	-	-	-	-	-	-
	L				4.3360						
	N				4.79						
Linseed oil	S	0.3912	0.5598	0.3088	-	0.5352	0.4771	-6.1230	0.4104	-2.0179	0.7125
	L	0.5085	0.6761	0.5397		0.9210	0.6427	-10.0312	0.5137	-3.6319	1.3375
	N	2.60	2.42	3.50		3.44	2.70	3.28	2.50	3.60	3.75
Sesame oil	S	0.2935	0.4044	0.4062	0.4311	-	0.3347	-0.5499	0.2915	-0.1955	0.6449
	L	0.4001	0.5280	0.5155	0.6528		0.4859	-0.8219	0.3963	-0.3030	1.0612
	N	2.73	2.61	2.54	3.03		2.90	2.99	2.72	3.10	3.29
Safflower oil	S	0.4917	0.4850	0.3070	0.8096	0.6798	-	-0.8002	0.3893	-0.1646	0.6463
	L	0.7150	0.8683	0.7243	1.2673	1.3430		-1.4655	0.6770	-0.4440	1.6901
	N	2.90	3.58	4.73	3.13	3.95		3.66	3.50	5.40	5.23
Niger oil	S	-0.2818	-0.3295	-0.2866	-0.3785	-0.4311	-0.3021	-	-0.2935	-0.1707	-0.6361
	L	-0.3809	-0.4893	-0.4437	-0.6217	-0.7296	-0.4686		-0.4030	-0.2896	-1.2392
	N	2.70	2.97	3.09	3.28	3.38	3.10		2.75	3.39	3.90
Coconut	S	0.2442	0.7150	0.7015	0.5379	0.6893	0.2358	-0.7473	0.5541	-	1.5520
	L	0.6534	1.261	1.1872	1.3570	1.7011	0.7249	-1.7395	0.9832	-	3.5466
	N	5.35	3.53	3.38	5.04	4.94	6.15	4.65	3.54		4.57
Cotton	S	0.8726	1.2073	1.0217	1.5922	1.7039	1.0474	-1.8800	-	0.7231	2.788
	L	0.8843	1.2195	1.0412	1.6145	1.7440	1.0650	-1.9059		0.7340	2.8585
	N	2.03	2.02	2.03	2.02	2.05	2.03	2.02		2.02	2.04
Rice bran	S	0.0846	0.1577	0.1241	0.1885	0.2017	0.1188	-0.2196	0.1299	0.1083	-
	L	0.1657	0.2631	0.2276	0.3381	0.3736	0.2239	-0.4059	0.2092	0.1786	
	N	3.92	3.34	3.67	3.59	3.71	3.77	3.69	3.22	3.29	

Notes: S = Short-run price adjustment.
L = Long-run price adjustment.
N = Number of days required to realise.
90 per cent of long-run price adjustment.

The number of days required for price adjustment showed that it was as low as two days for cottonseed oil-niger oil, cottonseed oil-linseed oil, and cotton seed oil-soyabean oil, and as high as seven days for groundnut-rice bran oil. It could be inferred that all oil prices had interacted within a short period for its price adjustment and the maximum number of days required to realise 90 per cent of long-run price adjustment was only one week. So the Bombay market for oils and oilseeds is well integrated with the characteristics of perfect market condition.

VERTICAL INTEGRATION

The oilseed price formation was tested by using Koyck's distributed lag model. Linear functional form was used for estimating the oilseed price formation. The estimates are presented in Table III. All the estimated coefficients (β, λ, μ) are statistically significant except β in cottonseed price formation. This showed that a major portion of cottonseed was not used for oil extraction and it was mostly directed for use as cattle feed. The price increase in cottonseed oil was deleterious to its seed price. One rupee increase in 10 kg of cottonseed oil will decrease the price of 10 kg of cottonseed by Rs. 0.67. In the case of oilcakes μ for soyabean and coconut showed negative signs which revealed that a large portion of these cakes was not used for oil extraction. This might be because they are at high demand for export as oil meal and cattle feed. Durbin-Watson 'h' test showed that the autocorrelation was within the accepted level for all oilseeds.

TABLE III. REGRESSION ESTIMATES FOR VERTICAL INTEGRATION OF OILSEEDS

Dependent variable (price)	β coefficient			Coefficient		Coefficient		R^2
	α	β	't' value	μ	't' value	λ	't' value	
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
1. Groundnut	618.9571	0.3003**	28.414	0.0515**	2.638	0.0618**	3.402	0.95
2. Soyabean	892.1427	0.2340**	5.894	-0.0157	-0.512	0.0137**	2.305	0.88
3. Castor	62.4385	0.1377**	8.683	0.1830**	5.276	0.1809**	5.755	0.88
4. Linseed	94.2250	0.3621**	19.632	0.3310**	3.117	0.2068**	6.899	0.86
5. Sesame	-152.2232	0.2041**	6.298	0.1390**	9.953	0.2491**	7.102	0.85
6. Safflower	253.0743	0.1189**	10.075	0.0926**	6.482	0.6023**	13.708	0.84
7. Niger	1747.5235	0.2516**	5.321	0.1662	1.972	0.3086**	9.189	0.80
8. Cottonseed	264.6920	-0.6700	-0.594	0.0757**	7.308	0.3609**	11.426	0.85
9. Coconut	1632.2350	0.4127**	35.150	-0.9494	-1.179	0.0547**	3.025	0.93
10. Rice bran	27.9500	0.6173**	3.104	0.1842	1.421	0.1783**	6.282	0.80

** Significant at 1 per cent probability level.

Short-run and long-run price adjustment coefficients and the number of days required to realise 90 per cent of long run adjustment were also worked out and the results are furnished in Table IV. The long-run price adjustment coefficients, i.e., β_{kj} were not nearer to the conversion ratios of oil and cake. This implied that there existed imperfection in seed price formation. It also indicated that intra-market seed prices were influenced by exogenous factors and oilseeds were traded for some other purposes other than oil extraction. Price adjustment was quick for soyabean and slow in safflower. For a rupee change in groundnut oil price (10 kg) groundnut kernal realised Re. 0.30 (for 10 kg) on the same day and Re. 0.32 realised for the same kernal in 2.13 days, i.e., in the long run. The oilseed market at Bombay adjusted itself quickly for all oilseeds revealing the characteristics of perfect competition in price formation of oilseeds.

TABLE IV. SHORT-RUN AND LONG-RUN ADJUSTMENTS AND NUMBER OF DAYS REQUIRED TO REALISE 90 PER CENT OF LONG-RUN ADJUSTMENT FOR OILSEEDS' PRICE RESPONSE IN BOMBAY MARKET

Price of oilseeds P_{it} (1)	Independent variable (2)	Short-run adjustment (3)	Long-run adjustment (4)	Number of days required to realise 90 per cent of long-run adjustment (5)
Groundnut	Oil-	0.3003	0.3200	2.13
	cake	0.0515	0.0548	
Soyabean	Oil-	0.2340	0.2372	2.03
	cake	0.0570	0.0580	
Castor	Oil-	0.1377	0.1681	2.44
	cake	0.1830	0.2234	
Linseed	Oil-	0.3621	0.4565	2.52
	cake	0.3310	0.4173	
Sesame	Oil-	0.2041	0.2781	2.66
	cake	0.1390	0.1851	
Safflower	Oil-	0.1189	0.2989	5.02
	cake	0.0926	0.2328	
Niger	Oil-	0.2516	0.3639	2.89
	cake	0.1662	0.2404	
Cottonseed	Oil-	0.6700	1.0483	3.12
	cake	0.0757	0.1184	
Coconut	Oil-	0.4127	0.4366	2.11
	cake	0.5940	0.5220	
Rice bran	Oil-	0.6172	0.7512	2.43
	cake	0.1843	0.2243	

Price interaction for all oils presented in Table V showed the directional influence of price of each oil on the other. Based on the interactions it could be inferred that price of industrial oil (coconut, linseed, safflower, castor) influenced the price of edible oils. This implied that in the short run edible oil is substituted for industrial purposes but not vice versa. This is quite plausible since edible oils are easily adoptable after some pre-treatment for industrial uses. But industrial oils are generally not acceptable for edible purposes even after treatment. Though some industrial oils are used in the manufacture of vanaspati their share is marginal. Consumers do not change their preferences frequently in the short run. Groundnut oil, soyabean, linseed, sesame, safflower, niger, cottonseed and coconut oil showed bidirectional relationship. Castor oil showed unidirectional relationship with all oils except linseed oil where the relationship is bidirectional.

TABLE V. DIRECTIONAL INTERACTIONS OF OIL PRICES

Bidirectional			Unidirectional		
Groundnut	<->	Soyabean	Castor oil	->	Groundnut
Groundnut	<->	Linseed	Castor oil	->	Soyabean
Groundnut	<->	Sesame	Castor oil	->	Niger
Groundnut	<->	Safflower	Castor oil	->	Sesame
Groundnut	<->	Niger	Castor oil	->	Safflower
Groundnut	<->	Cottonseed	Castor oil	->	Cottonseed
Groundnut	<->	Rice bean			
Linseed	<->	Castor			
Linseed	<->	Sesame			
Linseed	<->	Soyabean			
Soyabean	<->	Sesame			
Soyabean	<->	Safflower			
Soyabean	<->	Niger			
Soyabean	<->	Cottonseed			
Soyabean	<->	Coconut			
Soyabean	<->	Rice bran			
Linseed	<->	Safflower			
Linseed	<->	Niger			
Linseed	<->	Coconut			
Linseed	<->	Rice bran			
Sesame	<->	Safflower			
Sesame	<->	Niger			
Sesame	<->	Cotton			
Sesame	<->	Coconut			
Sesame	<->	Rice bran			
Safflower	<->	Niger			
Safflower	<->	Cottonseed			
Safflower	<->	Coconut			
Safflower	<->	Rice bran			
Niger	<->	Cottonseed			
Niger	<->	Coconut			
Niger	<->	Rice bran			
Cottonseed	<->	Coconut			
Cottonseed	<->	Rice bran			

CONCLUSION

The analysis of prices of oils and oilseeds in Bombay market revealed the nature of price integration between oilseeds and oils. The assumption of complete oil price integration could not be fully accepted. Price integration in most cases was bidirectional except in castor oil. The contemporary belief of influence of groundnut oil price on all edible oil prices was also established. The results of vertical integration confirmed the hypothesis that changes in oilseed price is linked to changes in its oil and cake price. The vertical integration in oilseed price was much quicker as compared to horizontal integration in oil prices. The Bombay oilseed market showed the characteristics of perfect market condition by its quick adjustment to price changes.

NOTES

1. Sometimes this is also written as

$$\beta_k = \beta_0 (-\lambda) \lambda^k \qquad \lambda = 0, 1, ...$$

2. This is because

$$\Sigma \beta_k = \beta_0 (1 + \lambda + \lambda^2 + \lambda^3 + ... + \lambda^k) = \beta_0 \left(\frac{1}{1 - \lambda} \right)$$

since the expression in the parenthesis on the right side is an infinite geometric series whose sum is $\left(\frac{1}{1-\lambda}\right)$ provided

$0 < \lambda < 1$. If β_k is as defined in equation (1)

$\Sigma\beta_k = \beta_0(1-\lambda)/(1-\lambda) = \beta_0$

thus assuming that the weights $(1-\lambda)\lambda^k$ sum to one.

3. While applying Koyck's transformation, certain features should be noted. It started with a distributed lag model but ended up with an autoregressive model because P_{it-1} and P_{iat-1} appear as explanatory variables in equation (9) and (10) respectively. The appearance of P_{it-1} and P_{iat-1} is likely to create some statistical problems. P_{it-1} and P_{iat-1} are stochastic. The error term is $\upsilon_t = (u_t - \lambda u_{t-1})$, it results in serial correlation of error term. The presence of lagged explanatory variable violates Durbin-Watson 'd' test. Therefore, we have to test the serial correlation by Durbin-Watson 'h' test.

$0.9\ \beta_k = \frac{\lambda^k - 1}{\lambda - 1}$ which is medium lag which explains 50 per cent time adjustment; hence, we have to multiply it by two to get full adjustment, which is considered as 90 per cent price adjustment in this paper.

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