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THE SUPPLY OF COMMERCIAL STORAGE FOR AMERICAN CHEESE

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The use of public funds to remove dairy products from commercial markets for the purpose of increasing milk prices paid to farmers was authorized with enactment of the Agricultural Adjustment Act in 1933 (9,chap.6). Purchases of selected storable dairy products, cheese, nonfat dry milk, and butter, by the Commodity Credit Corporation (CCC) have been made to increase the price that farmers receive for their milk. In the early years, until 1949, a strict 'support price' was targeted and, if the market price fell below the support price, the Secretary of Agriculture was directed to purchase products until the support price level was attained. In 1949, a new act gave the Secretary the flexibility to vary the support price target within a range.

The original enabling legislation incorporated the concept of 'parity' in determining the target price of milk, parity being defined as the relationship of the current ratio of prices received to prices paid to some base period ratio of prices received to prices paid. The current average price of milk, the current index of prices received, and the current index of prices paid were used to determine a 100% parity price which was then adjusted by a target parity level to determine a support price level. In 1981, in the face of mounting government stocks, Congress cut the link with parity, and also went back to the single target support price instead of a range. In determining the announced purchase prices for storable dairy products, the CCC considers manufacturers' marketing margins (make allowances) and expected product yields, as well as support price targets.

In addition to making offers to purchase the three storable commodities, the CCC also offers these same commodities for resale, when it has sufficient levels of stocks. Sales for restricted use, namely the sale of nonfat dry milk for domestic use as animal and poultry feed have been substantial at various time. Even though unrestricted sales have been small, it is generally agreed that the availability of such stocks provides a price stabilizing influence.

The CCC announced sales price of American cheese for unrestricted use is determined in such a way so as to recover for the CCC "at least a season's average storage and other costs" (3,p.29). While market prices for American cheese have, at times departed substantially from the announced CCC purchase price, the tendency has been for the market price to remain close to the support price, relative to the announced CCC sales price.

The current situation of relatively large government inventories and the accompanying high treasury costs have elicited a number of proposed policy responses. It seems clear however, that any changes which the federal executive branch and legislature are likely to support will necessarily be directed toward reducing the federal government's current role in acquiring and holding stocks of storable manufactured dairy products. While milk producers and dairy product consumers have been directly and indirectly affected by the manufacturers' marketing margins (make allowances) and expected product yields, as well as support price targets.

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This paper relies upon Holbrook Working's elucidation of the price of storage (11), to specify a conceptual model which is used in the analysis of the commercial storage behavior of economic agents active in the wholesale markets for American cheese. The purpose of this model is to derive quantitative information about this behavior.

THEORY OF THE PRICE OF STORAGE

Working's treatment of the price of storage as a necessary return rather than simply a cost and his conclusion that the practice of hedging gives potential holders of a commodity a precise, or 'at least a good approximate ' (11, p.28), index of the return to be expected from storing the commodity, forms the basis for the conceptual model presented below. In his theory, 'the price of storage is not quoted directly, but must be derived by taking the difference between quoted prices of wheat for two different dates of delivery...'(11,p. 28). In the proposed commercial stocks behavioral model for American cheese, the returns to storage will not be measured as differences between two futures contract prices at a single point in time, as suggested by Working, but rather the difference between the current product price and the current government announced purchase price. Working's theory also accommodates the notion that a zero, or even a negative, return to storage can elicit positive storage activity due to the holding of 'convenience stocks'.

Labys (6) elaborates on the inventory behavior of market participants by partitioning their motives for holding inventories into three classes: 1) transaction motives, 2) precautionary motives, and 3) speculative motives. Transaction, or 'stock-out', motives include the need of stocks to meet production goals, to avoid production delays, and to provide continuity in production. Precautionary or 'coverage' motives involve desires on the part of storers to provide stable prices. Speculation enters this scheme as the supply price of storage and determines what levels of inventory will be held in the aggregate. Manufacturers or processors will increase or decrease their inventory levels to the point where their their marginal inventory holding costs equals the rate at which they expect the commodity price to appreciate (10,p.34).

Transactions motives for storage activity are the subject of a great deal of literature in the field of operations research and industrial engineering (1,5,7,8). In its simplest form, interest is in determining the 'economic order quantity' (EOQ), the amount which should be ordered during each order cycle. In minimizing, C, the cost per order cycle, it is assumed that all order sizes are equal and that there is an 'ordering charge',A, incurred each time an order is placed. Further, there is a constant demand per unit of time for the product, D, and there is a constant unit storage cost, H. Replenishment is assumed to occur instantly. Under these restrictive assumptions, the problem is to minimize storage and ordering cost per unit of time over some fixed time interval.

$$C = (A * \frac{D}{EOQ}) + (\frac{EOQ}{2} * H)$$

$$\frac{\partial C}{\partial EOQ} = \frac{-AD}{EOQ^2} + \frac{H}{2} = 0$$

$$EOQ = \sqrt{\frac{2AD}{H}}$$

This is variously known as the 'EOQ' formula, the 'Wilson-Harris' formula, the 'economic lot size', and the 'square root law'. It can be seen that as the order charge A, increases, EOQ increases; as the rate of demand D, increases, EOQ increases; and as the unit storage cost, H, increase, EOQ decreases.

The EOQ indicates that

> 'inventory should increase only in proportion to the square root of sales. In other words, if sales of some item double, inventory should not be doubled - it should increase to much less than 200 percent of its original amount' (1,p.10).

Of course, many variants of the above determination of minimum cost order quantities and resultant average inventories have been proposed as different assumptions about the parameters and behavioral relationships are made. Most of these, however, take as the point of departure the simple inventory determination model presented above.

THE CONCEPTUAL MODEL

Transactions motives for storage are hypothesized to be related to the amount of product passing through commercial channels. As the amount of wholesale product flow rises, transactions storage supply will not rise proportionally, but will rise in proportion to the square root of product flow. Speculative motives for storage are hypothesized to be related to the relative difference between the current market and future expected prices. As the difference between current market prices and announced purchase prices increases, suppliers of storage will have incentives to reduce their holdings of product in storage in expectation of price depreciation. Precautionary motives involve a mix of product flow and price appreciation causality. As flow increases, the total stocks necessary to 'cover' purchased product price changes increase, given a fixed sale product price. However, as expected sales product prices increase, the less are the precautionary stocks which are necessary to cover the change in the total value of inputs which would result from a change in the input product price. As the opportunity cost of holding more liquid funds, the interest rate, increases, less stocks will be held.

The conceptual model used in this paper is:

$$CS_t = f(CD_t, EP_t, C_t)$$

where CS_t = commercial stocks of American cheese in period t

CD_t = wholesale sales of American cheese in period t

EP_t = expected price appreciation of stocks of American cheese in period t

and C_t = opportunity cost of holding stocks of American cheese.

EMPIRICAL RESULTS

Based on the conceptual model, variables corresponding to the ideal variables in the conceptual model were chosen for use in the empirical analysis. These include:

GOVTPC: The U.S. grade A or higher announced price for Cheddar cheese in 40-60 lb. blocks at standard moisture (cents/lb.).

MKTPC: The simple average of monthly prices paid f.o.b. Wisconsin assembly points for American cheese, 40 lb. blocks (cents/lb.).

PRODC: The U.S. total production of American cheese (thous. lbs.).

COMMSC: Ending commercial stocks of American cheese (mil. lbs).

I: Annualized interest rates on 90 day Treasury bills.

CPI: Consumer price index, 1967=100.

Quarterly observation of these variables over the period 1968-1983 were obtained from appropriate publications or were generated from monthly data by taking sums or by calculating simple averages. All prices were converted to real terms (*'s) by dividing them by the CPI for each quarter. The interest rate, I, was converted to real terms, I^*, by the following transformation (4):

$$I^* = \left\{ \frac{1+I}{1+F} - 1 \right\} \times 100$$

where;

I^* = real interest rate,

I = nominal interest rate,

and F = inflation rate.

American cheese production is used as a proxy variable for wholesale sales. Sales of cheese by manufacturers to assemblers and intermediate handlers for cutting, wrapping, and further processing are assumed to be directly related to production.

The mathematical specification used to estimate commercial stocks response parameters for American cheese is:

$$\begin{aligned} COMMSC_t = \beta_0 + \beta_1 \sqrt{PRODC_t} + \beta_2 I_t^* \\ + \beta_3 S^{23} * (MKTPC_t^* - GOVTPC_t^*) \\ + \beta_4 (MKTPC_t^* - GOVTPC_t^*) \end{aligned}$$

where S^{23} is a zero-one variable representing the second and third quarters.

It is expected, from the EOQ formula derived above, that β_1 will be positive. Commercial stocks are hypothesized to be directly related to the squareroot of production. The coefficient β_2 represents the response of commercial stocks to opportunity costs. As such, it is expected to be negatively related to the level of commercial stocks. β_4

represents the speculative response of commercial stocks to differences between the current market and announced purchase price, which is intended to represent speculative expectations. β_4 is expected to be negative, i.e., since market prices tend toward the purchase price, the further they depart from the purchase price, the lower are speculative expectations. Cheese sales and market prices are seasonal, with higher levels of sales and prices in the fourth and first quarters of each year. As such, β_3 is expected to be positive. In the second and third quarters, commercial stock will be higher, given the same levels of prices.

The above mathematical formulation was estimated using OLS (2). The results were:

	Variable	Coefficient	t-statistic
β_0	CONSTANT	-19.08	-.49
β_1	$\sqrt{PRODC}$	.55	10.04
β_2	I^*	-14.98	-7.17
β_3	$S^{23}*(MKTPC^*-GOVTPC^*)$	6.96	2.73
β_4	$(MKTPC^*-GOVTPC^*)$	-3.32	-2.26
	$\bar{R}^2 = .70$		D.W.=.77

This estimated equation exhibits significant autocorrelation, as indicated by the very low Durban-Watson (DW) statistic. It was re-estimates assuming a first-order autoregressive specification by the use of non-linear regression. The results of this estimation were:

	Variable	Coefficient	t-statistic
β_0	CONSTANT	17.48	1.13
β_1	$\sqrt{PRODC}$	.40	5.80
β_2	I^*	-7.30	-2.46
β_3	$S^{23}*(MKTPC^*-GOVTPC^*)$	7.54	4.58
β_4	$(MKTPC^*-GOVTPC^*)$	-2.69	-1.83
θ		.76	8.18

$\bar{R}^2 = .83$ D.W. = 1.62

where θ = first order autocorrelation coefficient.

The estimate of β_1, the responsiveness of wholesale commercial stocks to the squareroot of cheese production attained the expected positive sign and was significant at less than 1%. β_1 indicates that a change of 1 unit in the squareroot of 1,000 pounds of cheese production will result in a positive 400,000-pound change in commercial storage. An alternative measure of the relative likely importance of the estimated coefficient, in terms of the observed variation in the explanatory variables is to calculate the expected percent change in the dependent variable, relative to its mean, resulting from a one standard deviation change in the explanatory variable. For β_1, this would be 10.9%. A one standard deviation change in the squareroot of cheese production would result in a 10.9% change in commercial cheese stocks at the mean.

The estimate of β_2, the responsiveness of commercial stocks to the real rate of interest attained the expected negative sign and was significant at less than 2%. β_2 indicates that a change of one percentage point in the real rate of interest (such as from .25 to 1.25) will have a negative impact of 7.3 million pounds of commercial storage. A one standard deviation change in I^* will have a 5% negative impact on commercial stocks of American cheese.

β_4, the responsiveness of commercial stocks to the difference between market and CCC purchase prices, attained the expected negative sign and was significant at less than 10%. A change of one cent in the difference between the real market price and CCC purchase price is estimated to result in a negative 2.7 million pounds change in commercial stocks. A one standard deviation change in this difference is estimated to have a 2.7% negative impact on commercial stocks. The seasonal adjustment for expectations, β_3, also attained the expected positive sign and was significant at less than 1%. Its value indicates that a change of one cent in the difference between the real market and CCC purchase prices will result in a positive 7.5 million pound change in commercial stocks. The net impact of a one cent change in the second or third quarter being a positive 4.9 million pounds. A one standard deviation change in the second or third quarter would have a 5% positive net impact.

Commercial American cheese storage interests appear to respond strongly to transactions, opportunity cost, and speculative motives. Government policy actions, however, have limited the importance of speculative response by keeping market prices relatively stable and by effectively bounding these price differences to be less than the cost of storage.

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