Price Volatility in Dairy Markets: A Story of Stocks?

by

Rob Weaver and William Natcher

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Practitioner's Abstract

The role of private, government and total stocks as determinants of price volatility in the dairy markets is analyzed based on monthly price data (U.S. geographic area average). Results reported here find no strong evidence that changes in beginning stock levels or beginning stock change have played a substantial role in contributing to price volatility in butter, cheese, or non-fat dry milk markets analyzed. These results are notable given substantial changes in government policy impacting these markets during the sample period. Each market was dominated by government purchases of stocks to manage the price. It follows by definition that these periods price induced ending period government stocks. However, this paper considered evidence concerning the hypothesis that when such government stock transactions were terminated, prices may have become more volatile. To focus on a possible causal role of stocks, we focus on beginning stocks and their role in determining prices formed later in time. We find no role played by the levels of beginning stocks and very little evidence of a role played by changes in beginning stocks as determinants of volatility in monthly average key dairy complex prices. These results must be interpreted within the context of several caveats. First, monthly averaging and geographic averaging of prices may obscure important variation that would reflect evidence of a role of stocks. Second, data analyzed may contain systematic errors that occur a role for stocks.

Introduction

Economists would predict that the current level of volatility in price is related to the level of stocks, at least sometimes. Further, most economists would define price volatility as the unanticipated change in price, and note that only under very peculiar conditions is this measurable by the historic variation of prices. The standard commodity-pricing model supports the hypothesis that intertemporal arbitrage such as storage reduces the volatility of cash prices to a level that reflects the volatility of the unanticipated portion of shocks to fundamentals in that commodity's markets. In this sense, it should not be unexpected that government management of arbitrage, in an otherwise free and informed market setting, can only reproduce what the market can achieve left alone, though at increased cost, see Helmberger et al. or more recently Netz (1995). As a result of private, competitive arbitrage, the impacts of unanticipated shocks are dampened as they are spread forward, spatially, and even vertically.

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Recently, Chambers and Bailey (1996) formalized this theory by providing an approach to modeling price fluctuations for storable commodities. Their model suggests *ceterus parabis* that price volatility and opening stock levels are inversely related. Thus, high levels of volatility should correspond to low initial stock levels and vice versa.

The relevance of price volatility is highlighted by press and extension coverage of temporal variation in commodity prices, see e.g. AgriFinance (1997); Yonkers and Dunn (1996). Much of this coverage has suggested that volatility would or has dramatically increased as a result of F.A.I.R[1]. Indeed, cash prices appear to have varied over a wider range during recent years, see Figure 1. However, as Weaver and Natcher (1998) showed variation over time does not imply change in time varying volatility. In fact, their results showed that volatility had not changed markedly for grain commodities despite F.A.I.R. and dramatic reduction in government stocks. They note, however, that the data show that reforms in trade policy as well as government budget constraints did lead to reduction of government managed stocks, as well as private sector stocks, resulting in significant decreases in stock-to-use ratios for many commodities over a period starting in the mid-1980s. This is highlighted for dairy in Figure 2. From these graphics it is clear that stocks generally began to decline sharply in 1986 to a new equilibrium level that was found in about 1989. Both commercial and government cheese stocks followed this trend. In contrast, butter stocks reverted to previous highs by 1993 and declined sharply thereafter. Nonfat dry milk (NDM) stocks show no sign of dramatic trend or change. For grains, Weaver and Natcher (1998) noted F.A.I.R. appears to have simply formalized an adjustment already accomplished.

Nonetheless, for many commodities, attention continues to focus on the hypothesis that "price volatility" has increased due to reduction in government stocks and other government interventions, e.g. as incorporated in the 1996 Federal Agriculture Improvement and Reform (F.A.I.R.) Act. In this paper, we reexamine the role stocks in dairy price volatility. We extend the work of Weaver and Natcher (1998) by investigating the relationship between monthly inventory levels and price volatility of various dairy products over a thirty-year period. Our focus is on price volatility rather than historic variation or a historic volatility (based on calculation within a rolling window of variance or standard deviation). The latter is difficult to interpret given nonstationarity of price series and due to the *ad hoc* nature of the selection of a window during which measures of variance are calculated, see Weaver and Natcher, 1999. Instead, we examine the roles of stocks as determinants of time varying conditional variance. We explore various parametric functional forms for the conditional variance specification.

Parametric modeling of conditional variance has been employed in a broad spectrum of applications to explore various relationships between volatility and exogenous variables. For example, this approach has been used extensively in the financial literature to explore the relationship between trading volume and returns volatility. (see e.g. Jones et al. (1994), Najand and Yung 1991). Jones et al. showed that the positive volatility/volume relationship in the equity cash markets is attributed to the number of transactions rather than the size of the trade. Najand

[1] The Act reformed U.S. agricultural policy in place since the 1933 Agricultural Adjustment Act. F.A.I.R. removed many of the crop specific interventions leaving market conditions to dictate crop allocation, storage, and trade. The Act eliminated the safety net historically granted to farmers by discontinuing income support deficiency payments and target prices. The Act also ended the Farmer Owned Reserve (FOR) eliminating publicly held stocks for many commodities (Stuart and Runge 1996).

and Yung explored the Treasury-bond futures market and find a positive volatility/volume relationship. Another application of this approach was implemented by Beller and Nofsinger (1998) who introduced a seasonal variable in the conditional variance to determine if stock return volatility possesses a seasonal component. Their results suggest that there are differences in monthly volatility and the distinction can be attributed to firm size.

A further extension of this literature by Shively (1996) investigated the role of historic prices, current production, and storage in price variability in the Ghana maze market. Shively's results suggest that economic reform in Ghana significantly contributed to price volatility and played a greater role than did severe production shortfalls. Specifically, prices and price volatility in Ghana increased during years of economic reform while the severe drought of 1983 failed to explain observed increases in price volatility.

A Reminder of the Theory of Storage and Price Volatility

The determination of current price and the moments of future prices can be examined within a multitude of alternative specifications, see e.g. Deaton and Laroque (1992) among other standard references. Focusing on a pure cash situation, the physical balance condition can be written for any time period as:

1) $$z_t + (1-\delta)S_{t-1} = D(p_t) - v_t + S_t$$

where z_t is the current exogenous and price inelastic supply, v_t is a random demand shock, S_t represents carry-out storage, S_{t-1} represents carry-in storage, and $D(p_t)$ is price responsive demand for current utilization. The left side of equation (1) therefore represents the exogenous quantity supplied available at any period t while the right side represents the price responsive quantity demanded. Adding an intertemporal arbitrage rule to 1) to determine carry-out, by recursion of 1) from a terminal horizon and inversion, equilibrium price level as well as the moments of future prices can be derived. Defining the conditional price variance as $h(p_t|p_{t-1})$, this process motivates a negative relationship between storage and volatility. For example, Deaton and Laroque (1992) show that conditional variance is positively related to past price level:

2) $$\frac{\partial h(p_t \mid p_{t-1})}{\partial p_{t-1}} \geq 0$$

Pairing this with the intuitive result that past price p_{t-1} is inversely related to past carry-in (e.g. S_{t-2}), suggests that conditional volatility is inversely related to past carry-in. That is,

3) $$\frac{\partial h(p_t \;\; p_{t-1})}{\partial p_{t-1}} \frac{\partial p_{t-1}}{\partial S_{t-2}} \leq 0$$

To move toward empirical implementation, we note that the current price level can be decomposed to anticipated and unanticipated portions. To retain focus on the costs of price volatility, we focus on the volatility of the unanticipated portion. By definition, volatility of the anticipated portion will induce economic adjustment, though because it is anticipated the adjustment will be efficient. To proceed, if for the i^{th} commodity we write: $p_{it} = p_{it-1} + R_{it}$ where p_{it-1} is interpreted as the anticipated portion of price, then our interest lies in R_{it} measurable by

dp_{it}. If R_{it} is orthogonal to p_{it-1}, then $h(p_t|p_{t-1}) = h(p_{t-1}) + h(R_{it})$. Our interest lies naturally in $h(R_{it})$, not necessarily $h(p_t|p_{t-1})$ which obscures $h(R_{it})$ with the anticipated, in fact known, $h(p_{t-1})$.

Empirical Approach

We begin by specifying the conditional mean of the change in price as an AR process. That is, defining $R_{it} = dp_{it}$ we specify the conditional mean as:

$$4) \qquad R_{it} = \beta + \sum_{j=1}^{p} \phi_j R_{it-j} + \varepsilon_{it} \qquad \varepsilon_{it} \sim N(0, h_{it})$$

R_{it} is the change in the price of commodity i in month t. The right hand side term represents an autoregressive process of order p, $AR(p)$, and is included to capture movement in the conditional expected innovation in prices. The error's conditional variance is specified as following some form of GARCH(p,q) process (see Engle (1982), and Engle and Bollerslev (1986)), e.g.

$$5) \qquad h_{it} = \alpha_i + \gamma_i S_{it-1} + \sum_{j=1}^{q} \rho_{ij} \varepsilon^2{}_{it-j} + \sum_{j=1}^{p} \rho_{ij} h^2{}_{it-j} + \mu_{it} \qquad \mu_{it} \sim i.i.d(0,1)$$

where S_{it} is a vector of current stock levels and other structural determinants of the time varying conditional variance. For example, $S_{i\,t}$ can be interpreted as a scalar representing the total stock held both commercially and non-commercially. The above model allows for several alternative specifications depending on how stocks are included: a) total stocks, b) government stocks only, c) commercial stocks only.

Volatility in Dairy Prices

In this paper, we focus on monthly data to allow for consideration of the impacts of stock changes. Our data consists of monthly price and storage observations for various dairy products. These include non-fat dried milk (NFD), grade AA butter, and American cheese. The storage data is disaggregated into stocks held commercially and by government and therefore affords the opportunity to individually investigate the relationship between private and public inventories and price volatility. All price and storage data were obtained from the AMS/USDA. The series for NFD milk was not available during 1982, so results are reported for the sample 1/83-12/98. For other series, the sample period is 1/70 - 12/98. Data sources are noted in Table A-1.

We begin by considering the performance of price levels over the sample period. As illustrated in Figure 1, a significant spike occurred in the American cheese and NFD milk markets in late 1988. In both markets, by the opening of 1990, the price reverted nearly to past levels, though only briefly, and spiked again in mid 1990, reverting again in early 1991. Thereafter, substantial variation in American cheese prices continued, while NFD milk prices appeared to settle between 1993 and the opening of 1996. Similar variation of Grade AA butter prices did not begin until 1995. While possibly not apparent in Figure 1, each of these price series is characterized by seasonality.

Inspection of these graphics suggests that concern for temporal variation in prices is substantiated by history, however, the relevance of that temporal variation as a measure of price volatility is debatable, see Weaver and Natcher (1998). Our interest in the unanticipated portion of price (measured by change in price) is also clearly justified. At any point in time, we suggest that interest lies in the conditional mean and variance in the unanticipated portion of price. We measure this unanticipated portion as the price difference.

Figure 2 presents time series of stock variables. Total stocks of NFD milk (for human consumption) vary substantially over time. Commercial holdings varied within a range of a 100,000 lbs. while government stocks were more erratic. NFD milk government stocks spiked in 1987 and again in late 1990 through the fall of 1992. Butter stocks were dominated by government stocks, reflecting a steady build up between the late 1980's and spring 1995. Again, commercial stocks were relatively more stable in their variation over time. Cheese stocks have historically been dominated by American cheese stocks held commercially with the exception the late 1980's period. Commercial stocks as in the case of other product forms are relatively stable with variation limited to a range of about 25% of their long term average. Stock outs in these products are not estimable from the available data, and are not a subject of this paper. However, Figure 2 graphics suggest that for NFD milk, government purchases have moved inversely with commercial stocks, suggesting that when commercial stocks are low, government stocks are available. Similar results do not hold for butter stocks. Prior to 1995, government stocks were at very high levels, thereafter, total stocks are dominated by commercial stocks. While government stocks disappeared, commercial stocks expanded. While this expansion of private stocks did not achieve levels comparable to past government holdings, levels of typical past commercial stocks were achieved.

Empirical Results

To begin our analysis of this data, we consider the nonparametric characteristics of our data series. Figure 3 reports results that confirm that each of the price series is slightly skewed, and not likely to be normal in distribution.[2] Skewness varies across price series. Cheese prices appear to be negatively skewed, while NFD milk and butter are positively skewed. However, kurtosis results suggest that tails of cheese and NFD milk are not much thicker than normal.[3] Nonetheless, the null of normality is rejected by the Jarque-Bera test statistic.[4] Table 1. presents results for stationarity tests. While the price levels are nonstationary, the innovations that are of interest in our modeling of volatility are stationary. For a measure of stocks we focus on beginning stocks to ensure that we have temporal exogeneity between stocks and prices. Similar stationarity results hold for stocks. While they are nonstationary in levels, stationarity in differences could not be rejected. We begin by identifying the optimal lag length of the AR portion of the conditional mean model based on the SIC criteria. Table 3 reports results that suggest considerable persistence in mean of innovations in prices. It is interesting to note that this persistence is relatively greater for product form markets for which government stocks were a relatively more dominant proportion of total stocks, see Figure 2.

We began with estimation of the model expressed in equation 5), and found the level of stocks to be insignificant for each the commodity forms. We next generalized our interest to consider the role of changes in stocks as signals of adjustment in market conditions. We report here results based on the following model in absolute value of changes in stocks:

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[2] The skewness of a symmetric distribution is zero. Values other than zero represent a skewed distribution . For example, if skewness is positive then the upper tail of the distribution is fatter than the lower tail.

[3] The kurtosis of a normal distribution is 3 and therefore, values in excess of 3 suggest the tails of the distribution are fatter than a normal.

[4] The Jarque-Bera test statistic is a test for normality. Under the null hypothesis of normality, the statistic is distributed χ^2 with 2 degrees of freedom.

6) $$h_{it} = \alpha_i + \gamma_i \, | dS_{it-1} | + \sum_{j=1}^{q} \rho_{ij} \varepsilon^2{}_{it-j} + \sum_{j=1}^{p} \rho_{ij} h^2{}_{it-j} + \mu_{it} \qquad \mu_{it} \sim i.i.d(0,1)$$

Tables 4-6 report results for the GARCH specification that includes a measure of the absolute value of changes in stocks.

For cheese, we report estimates for American cheese prices based on American cheese stocks. Recall that government stocks represented a small proportion of total stocks except through the 1980s. Results indicate that change in itself of commercial stocks is a positive and significant determinant of the conditional variance of the price innovation. However, the estimated parameter is very close to zero and very small relative to the estimated conditional variation. It is also clear from the results that the cheese price innovation follows a GARCH process. Estimated results are consistent with the interpretation that conditional variance adjusts with inertia (the GARCH(1) coefficient is .87). By comparison, the role of unanticipated shock to the innovation (ARCH(1)) is relatively small (.1230).

For Grade AA butter, Table 5 reports that similar results are found, despite the substantially higher proportion of total stocks in this market accounted for by government stocks. Again, the ARCH and GARCH terms are statistically significant indicating a greater role for persistence in adjustment of the conditional variance than to response of the conditional variance to shocks to the innovation in volatility. Private commercial stocks are found to have statistically significant positive role. Interestingly, government stocks are found insignificant and with a zero parameter when considered separately. This suggests that changes in government stocks did not impact volatility in the unanticipated portion of price, however, private stocks appear to have played a role in positively contributing to that volatility.

Finally, for manufacturer's and government NFD milk stocks Table 6 indicates that the absolute change in stocks is not found to play a significant role in determining conditional volatility. For this product form, we find no GARCH process, though do find evidence of a significant ARCH process. This indicates inertia in adjustment to shocks in unanticipated volatility.

To confirm the roles of stocks reported in Tables 4-6, Tables 7 reports results for a GARCH(1,1) without inclusion of a stocks variable. Results are generally robust to exclusion of the change in stocks.

Figure 4 reports the estimated conditional variances over time based on model 6). These figures re-iterate concern over price volatility. In all three cases, we find that the estimated conditional variance has both increased significantly since 1995 and appears to have increased in variation. For butter, the records of substantial volatility begins in 1995, while for American cheese and NFD milk, earlier periods of substantial volatility are evident.

Our specification 6) explored the hypothesis that the extent of change in stocks induced a symmetric impact on volatility of the unanticipated portion of price. Thus, equal magnitude increases and decreases in stocks resulted in identical change in volatility. To explore the role of the level of stocks as well as the asymmetry in the relationship between changes in stocks we relax our initial model to allow for asymmetric response to change in stocks as follows:

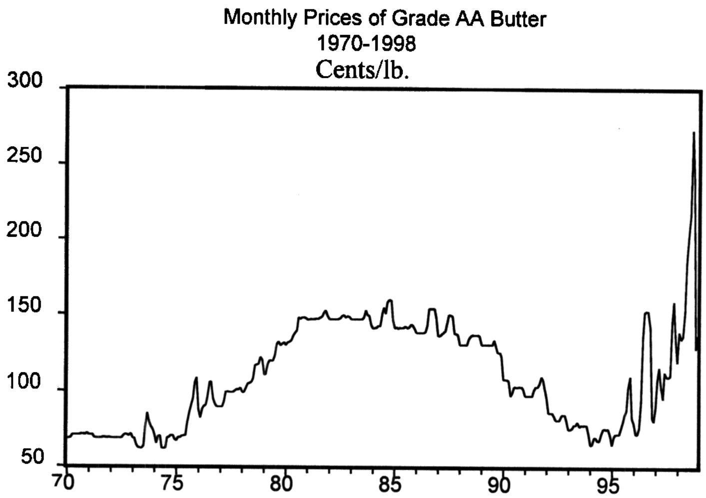
7) $$h_{it} = \alpha_i + \gamma_{i1} S_{it-1} + \gamma_{i2} S_{it-2} + \sum_{j=1}^{q} \rho_{ij} \varepsilon^2{}_{it-j} + \sum_{j=1}^{p} \rho_{ij} h^2{}_{it-j} + \mu_{it} \quad \mu_{it} \sim i.i.d(0,1)$$

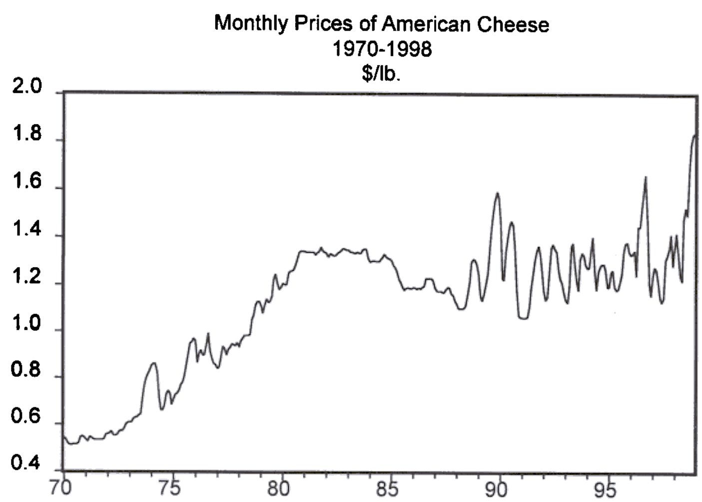
Note that when $\gamma_{i1} = \gamma_{i2}$, the results are consistent with the hypothesis that it is the change in stocks that is related to volatility. Results from this model are reported in Tables 8-10. For cheese Table 8 indicates the coefficient and its significance for total natural cheese stock levels are not robust suggesting that indeed the coefficient reported in Table 4 was very close to zero. Other results for cheese and butter are robust. These results are consistent with the conclusion that it is the magnitude of change in beginning stocks that signals changes in price volatility.

Conclusions and Directions for Future Research

This paper explored evidence of a role of stocks in the determination of price volatility in the dairy markets. Results reported here find no strong evidence that changes in beginning stock levels or beginning stock change have played a substantial role in contributing to price volatility in butter, cheese, or non-fat dry milk markets analyzed. These results are based on monthly data and do not comment on relationships that may exist in daily or other more frequently sampled data. Results are based on beginning stocks to ensure that the stocks analyzed are known before the price levels or changes analyzed are determined. Given the dominant role of systematic price oriented government stock management, use of current price and current or closing stock changes would leave begging the question of whether price change causes stock change. Based on the data analyzed here, we assured ourselves that current or closing price changes could not have been a causal determinant of beginning period stock levels or changes. Further research will reconsider these same issues incorporating the possibility of changes in regimes within the sample period, changes in advertising, and health related information flows.

Figure 1: Price Levels





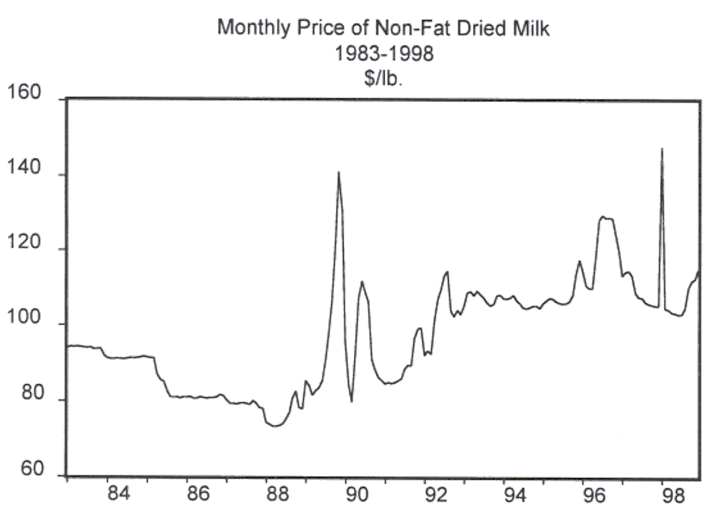
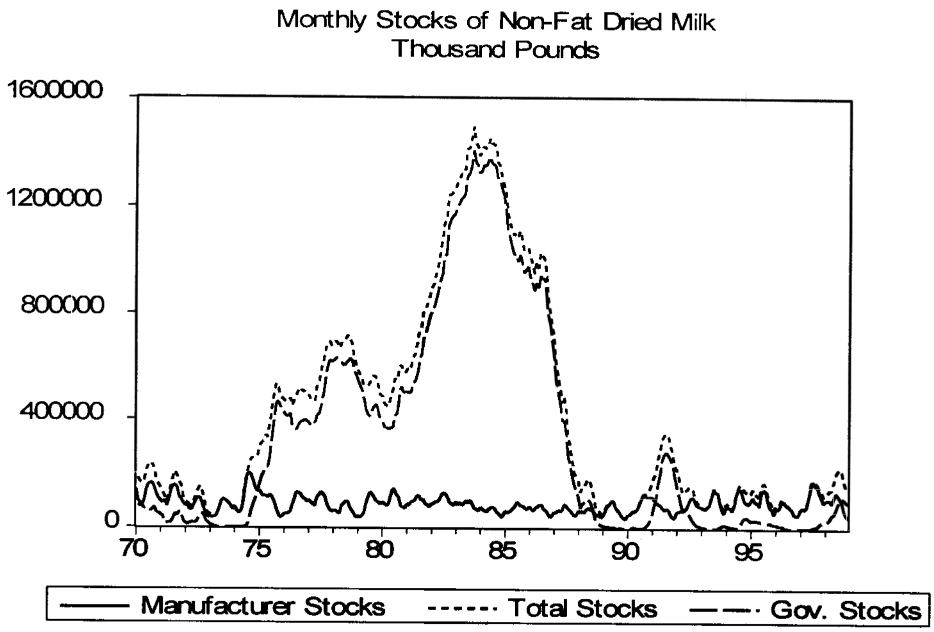


Figure 2: Stock Levels



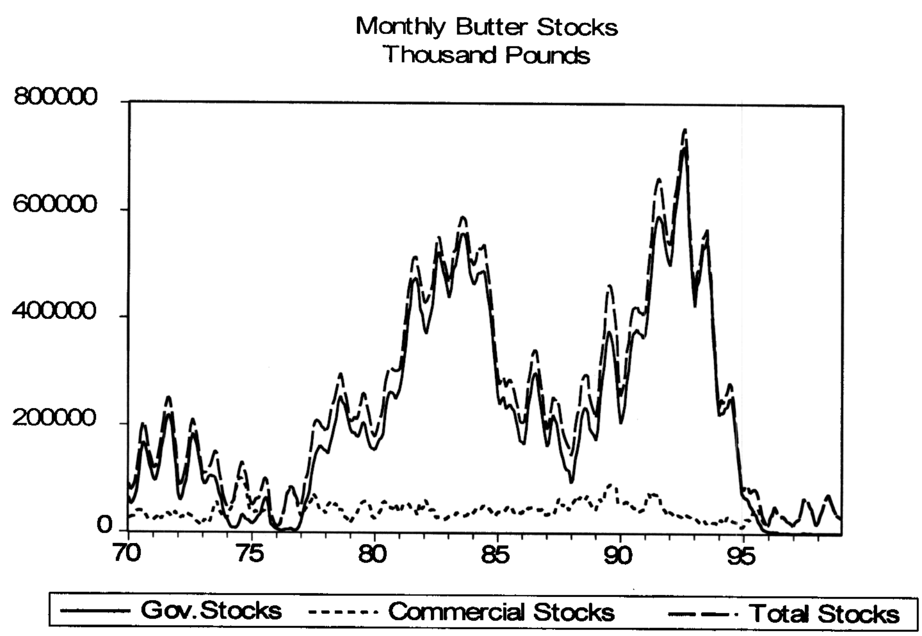
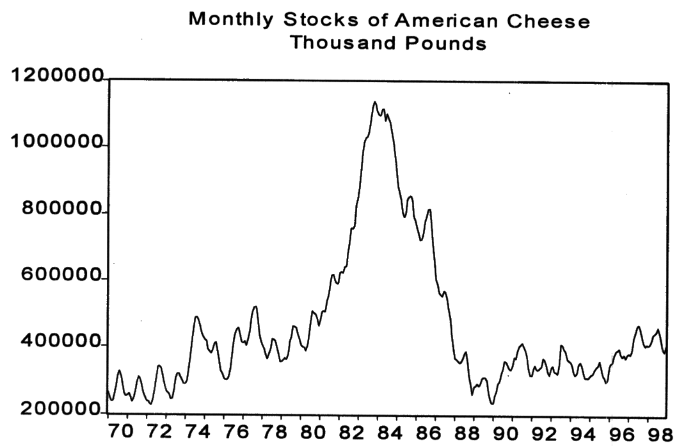
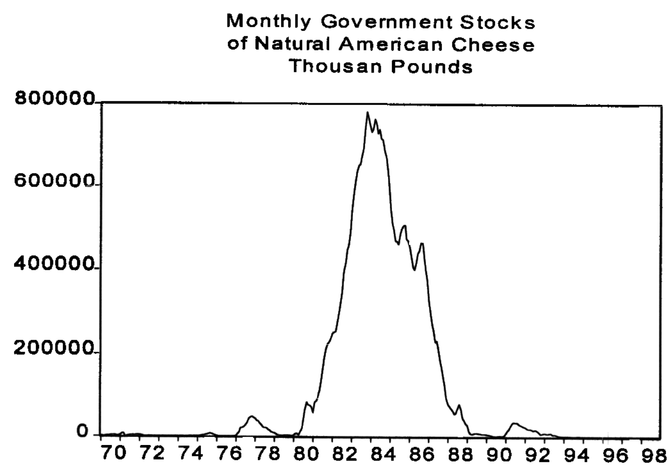


Figure 2 continued: Stock Levels





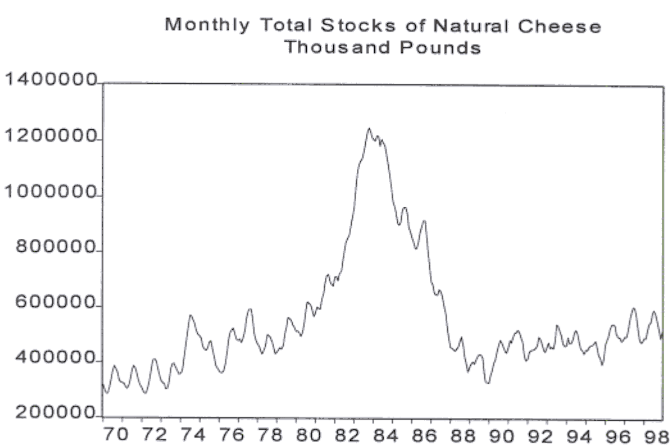


Figure 3: Descriptive Statistics of Price Levels

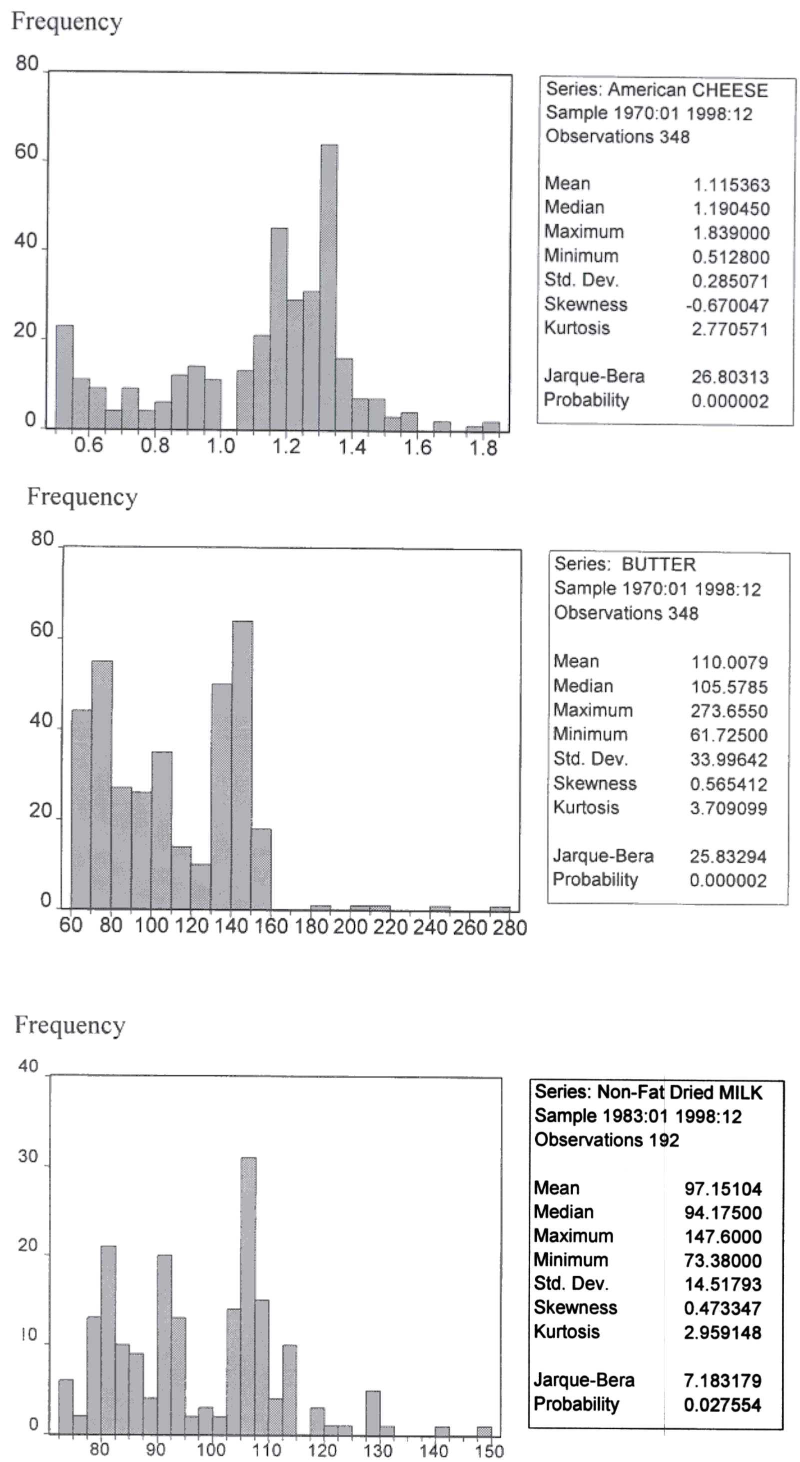


Figure 4: Monthly Conditional Variance Estimates (Based on a GARCH(1,1) Model no Stocks)

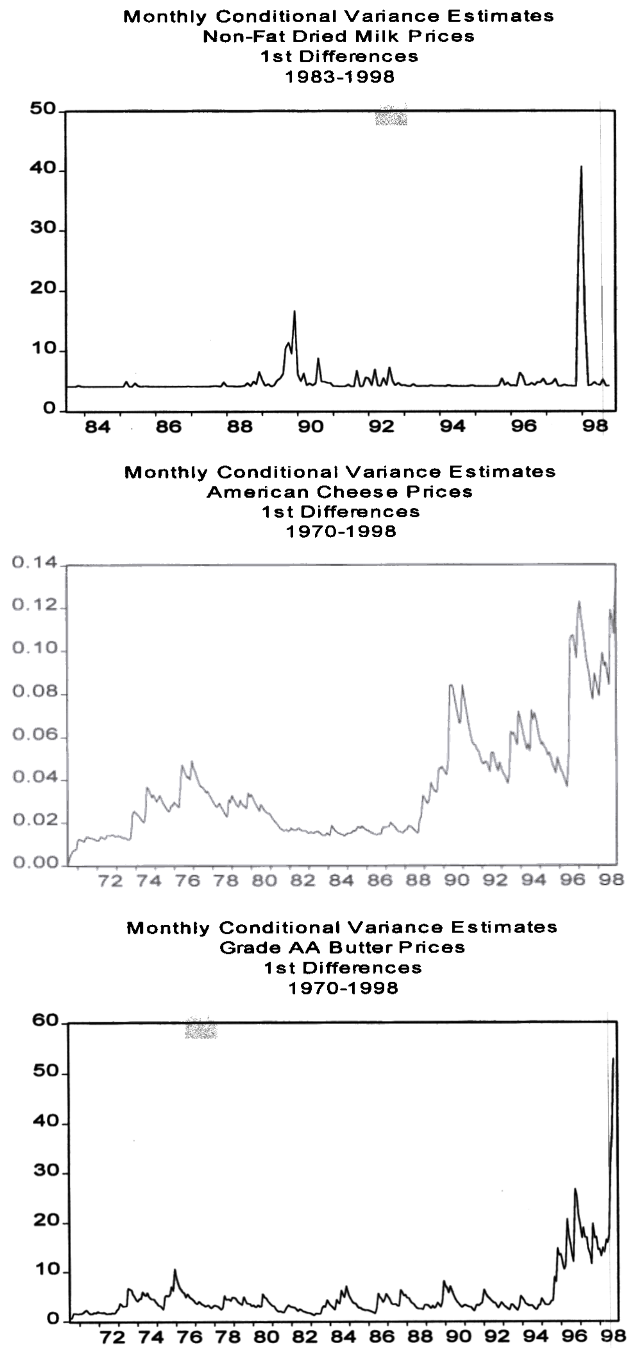


Table 1: Unit Root Test Results Based on Price Variables

Commodity	Price Levels			1st Difference		
	Estimate	*T- Value*	*Result*	*Estimate*	*T- Value*	*Result*
American Cheese	-.0316	-1.8453	Unit Root	-1.6612	-4.5861	Stationary
Non-Fat Dried Milk	-.0521	1.2933	Unit Root	-2.2692	-3.5713	Stationary
Grade AA Butter	-.0141	-.9473	Unit Root	-2.0406	-4.8119	Stationary

Table 2: Unit Root Test Results Based on Stock Variables

Commodity	Stock Levels			1st Difference		
	Estimate	*T- Value*	*Result*	*Estimate*	*T- Value*	*Result*
Commercial Butter	-.0888	-2.5066	Unit Root	-2.6272	-6.5856	Stationary
Government Butter	-.0091	-1.9539	Unit Root	-.3252	-3.5587	Stationary
Non-Fat Dried Milk (Human)	-.1097	-2.6844	Unit Root	-2.4733	-7.0015	Stationary
Total Natural Cheese	-.0084	-1.9029	Unit Root	-.3954	-3.6269	Stationary
Commercial American Cheese	-.0080	-1.9085	Unit Root	-.3610	-3.5076	Stationary
Government American Cheese	-.0055	-2.1742	Unit Root	-.1696	-2.6906	Stationary

Table 3: Conditional Mean Model Specification Based on First Differences*

	American Cheese		Non-Fat Dried Milk		Grade AA Butter	
	Parameter	*T- Value*	*Parameter*	*T- Value*	*Parameter*	*T- Value*
AR(1)	.4127	7.875	-.1002	-1.367	.2899	5.217
AR(2)	-.2408	-4.591	-.0989	-1.381	-.5638	-8.679
AR(3)			-.2068	-2.942	.2033	2.820
AR(4)			-.2334	-3.252	-.1777	-2.315
AR(5)			-.1740	-2.369	-.3323	-4.433
AR(6)					-.1902	-2.517

*Optimal lag structure determined by minimizing the SIC criteria.

Table 4: American Cheese GARCH(1,1) Estimates with Exogenous 1st Difference Stock Variables

	American Cheese					
	Total Natural Cheese Stocks		Gov. American Cheese Stocks		Com. American Cheese Stocks	
	Parameter	*T-Value*	*Parameter*	*T-Value*	*Parameter*	*T-Value*
ARCH(0)	.0000	.0000	.00001	2.4165	.0000	.0000
ABS[(D)STOCK]	.0000007	3.5170	.0000	.0000	.0000007	3.6065
ARCH(1)	.1264	4.9079	.1298	4.5021	.1230	5.0694
GARCH(1)	.8736	33.9243	.8553	27.9714	.8770	36.1554

Table 5: Grade AA Butter Price GARCH(1,1) Estimates with Exogenous 1st Difference Stock Variables

	Grade AA Butter					
	Commercial Stocks		Government Stocks		Total Stocks	
	Parameter	*T-Value*	*Parameter*	*T-Value*	*Parameter*	*T-Value*
ARCH(0)	.0000	.0000	1.2714	3.2961	1.1462	1.6600
ABS[(D)STOCK]	.0002	3.3932	.0000	.0000	.000005	.2155
ARCH(1)	.2991	6.0256	.3019	5.1684	.2972	4.7907
GARCH(1)	.7009	14.1172	.6655	11.4254	.6708	10.5831

Table 6: Non-Fat Dried Milk Price (Human Consumption) GARCH(1,1) Estimates with Exogenous 1st Difference Stock Variable

	Non-Fat Dried Milk					
	Manufacturers Stocks		Government Stocks		Total Stocks	
	Parameter	*T-Value*	*Parameter*	*T-Value*	*Parameter*	*T-Value*
ARCH(0)	17.0989	8.6920	17.0989	8.6917	17.0989	8.6901
ABS[(D)STOCK]	.0000	.0000	.0000	.0000	.0000	.0000
ARCH(1)	.4472	3.0486	.4472	3.0488	.4472	3.0416
GARCH(1)	.0000	.0000	.0000	.0000	.0000	.0000

Table 7: GARCH(1,1) Estimates Based on Optimal Conditional Mean

Price:	American Cheese		Non-Fat Dried Milk		Grade AA Butter	
	Parameter	*T- Value*	*Parameter*	*T- Value*	*Parameter*	*T- Value*
ARCH(0)	.0000	2.4161	17.099	8.6918	1.2713	3.2645
ARCH(1)	.1298	4.5038	.4472	3.0444	.3019	5.0735
GARCH(1)	.8553	27.9734	.0000	.0000	.6655	11.2168

Table 8: American Cheese GARCH(1,1) Estimates with Exogenous Stock Variables (S_{t-1}, S_{t-2})

	American Cheese					
	Total Natural Cheese Stocks		Gov. American Cheese Stocks		Com. American Cheese Stocks	
	Parameter	*T-Value*	*Parameter*	*T-Value*	*Parameter*	*T-Value*
ARCH(0)	.000006	2.4165	.000014	2.4165	.0000	.0000
STOCK(1)	.0000	.0000	.00000	.00000	.00000002	2.3648
STOCK(2)	.0000	.0000	.00000	.00000	.0000000	.0000000
ARCH(1)	.1297	4.5033	.12976	4.5026	.1094	5.2547
GARCH(1)	.85534	27.9303	.85534	27.9749	.8905	42.7617

Table 9: Grade AA Butter Price GARCH(1,1) Estimates with Exogenous Stock Variables (S_{t-1}, S_{t-2})

	Grade AA Butter					
	Commercial Stocks		Government Stocks		Total Stocks	
	Parameter	*T-Value*	*Parameter*	*T-Value*	*Parameter*	*T-Value*
ARCH(0)	.0000	.0000	1.2714	3.28825	1.27139	3.27578
STOCK(1)	.00002	3.044822	.00000	.00000	.00000	.00000
STOCK(2)	.00000	.000000	.00000	.00000	.00000	.00000
ARCH(1)	.2664	5.3149	.30187	5.12078	.30187	5.03997
GARCH(1)	.7358	14.8058	.66553	11.34469	.66553	11.19735

Table 10: Non-Fat Dried Milk Price (Human Consumption) GARCH(1,1) Estimates with Exogenous Stock Variables (S_{t-1}, S_{t-2})

	Non-Fat Dried Milk					
	Manufacturer's Stocks		**Government Stocks**		**Total Stocks**	
	Parameter	*T-Value*	*Parameter*	*T-Value*	*Parameter*	*T-Value*
ARCH(0)	.0000	.0000	17.0989	8.6916	17.0991	8.6914
STOCK(1)	.0000	.0000	.0000	.0000	.0000	.0000
STOCK(2)	.0002	8.5345	.0000	.0000	.0000	.0000
ARCH(1)	.5270	3.4092	.4472	3.0403	.4473	3.0411
GARCH(1)	.0000	.0000	.0000	.0000	.0000	.0000

Table A-1 Commodity Prices and Data Sources

Commodity	Sample Period	Units	Source
American cheese price, barrel, Wisconsin assembly points	1970-1998	$/lb.	USDA/AMS
Grade AA butter price, Chicago	1970-1998	Cents/lb.	USDA/AMS
Wholesale price of nonfat dry milk for human food	1983-1998	$/lb.	USDA/NASS/Dairy Products

Table A-2 Commodity Stocks and Data Sources

Commodity	Sample Period	Units	Source
Commercial Butter Stocks	1970-1998	Thousand Pounds	USDA/NASS/Cold Storage
Government Butter Stocks	1970-1998	Thousand Pounds	USDA/NASS/Cold Storage
Manufacturer's Stocks of Non-Fat Dry Milk for Human Food	1970-1998	Thousand Pounds	USDA/NASS/Dairy Products
Total Natural Cheese Stocks	1970-1998	Million Pounds	USDA/NASS/Cold Storage
Government Natural American Cheese Stocks	1970-1998	Thousand Pounds	USDA/NASS/Cold Storage
Manufacturer's American Cheese Stocks	1970-1998	Million Pounds	USDA/NASS/Cold Storage

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