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Abstract

In the early 1990's, after four decades of relying on government authorized minimum price supports and the required public stockholding necessary to achieve price risk management, the United States dairy industry began a journey toward a shift to a market clearing equilibrium system. In this new era the forces of supply and demand determine product prices and changes in those prices. With this market clearing system comes in increase in the volatility of product prices and the risk associated with this volatility. A potentially important component of this new structure is the development of an operational futures market for selected milk and dairy products. In June of 1993 the Coffee, Sugar, & Cocoa Exchange (CSCE) introduced a contract on Cheddar Cheese. The Chicago Mercantile exchange began trading a cheese contract in October of 1997. Today there are contracts covering cheese, butter, nonfat dry milk and raw milk. As the production of cheese represents over one-third of the use of raw milk in the United States this contract has the potential of serving as an important price risk management tool. An important question to be addressed is whether or not the speculative trading activity on these contracts will increase or decrease spot price volatility. This study investigates this question for the CSCE cash cheese market. The results suggest that the trading on the futures market for Cheddar Cheese, has not increased the cheese spot market price volatility and therefore provides additional support for the continued development of the futures market as a price risk management tool by the dairy industry.

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Introduction

Dairy producers and processors of dairy products in the United States have historically paid little attention to the volatility of spot-market prices. Since 1949 Federal Legislative price support policy has set a floor and ceiling around cash market price. This policy worked directly on the product markets of cheese, nonfat dry milk powder, and butter. By serving as the demander of the last resort, the Commodity Credit Corporation purchased these products and maintained sufficient publicly held stocks that unanticipated shocks to market price were exceedingly rare, occurring only during times of general disarray in the overall agricultural economy. This system survived to the late 1980's and then began to lose influence as the taxpayer price-tag became unsupportable. With the minimum support prices frozen in place the price stabilizing product stocks have all but disappeared and along with their shrinkage has come increased spot price volatility in the dairy markets.

Today the economic landscape has changed dramatically. Since 1991 effective minimum price supports no longer exist and the 1996 Farm Bill sets in motion a plan to dismantle the actual legislative foundation of the price support program. The Agricultural Marketing Service and Commodity Credit Corporation no longer function as the public stockholding and price stabilizing agency for dairy producers, processors, wholesalers and retailers. These groups now face the challenge of finding effective mechanisms for the management of price volatility. One such mechanism is the emerging futures markets for milk, cheese, butter and nonfat milk powder. An important question to which we must turn our attention considers whether or not trading activity on these new futures markets can or will function as effective spot-price stabilization mechanisms in lieu of minimum price supports.

Research Objectives

This research will build on two concepts relating futures markets and spot price volatility that have appeared in the literature. First is the theoretical work pioneered by Holbrook Working in 1960 where he takes up the question: "Does the introduction of futures trading make the underlying commodity price more or less volatile?" Volatility can be typically thought of as the variance of price changes. This question has been addressed with respect to the onion market (Working, Gray); for the cattle and pork markets (Powers); and for live cattle (Taylor and Leuthold) with the general conclusion that futures trading does not increase spot market volatility. In general the research methodology used in these studies has been to examine the "before", and "during" spot price variance to determine if it has increased or decreased under the without and with futures regimes.

In more recent years this question has been addressed in the equities markets using more sophisticated methods for measuring price change variances. For example, Holmes considers this question for the FTSE Eurotrack 100 futures contract which traded on the London International Financial Futures Exchange June 1991 to June 1992. Holmes used the now familiar Bollerslev Generalized Autoregressive Conditional Heteroscedasticity (GARCH) technique to examine the relationship between information and price volatility. The main conceptual

underpinning of the approach taken by Holmes is based on the work of Ross who demonstrates that in a no-arbitrage world the variance of price change (volatility) will be equal to the rate of information flow into the market. With this view it is possible to conclude that an increase in information flow into the spot market which results in increased volatility, while uncomfortable for market participants, is an efficient preferred state to one where stabile prices represent sluggish information flows.

While the Holmes-Ross approach looks at the variance of spot price changes to draw conclusions there is another line of inquiry which attempts to isolate, in a fundamental way, the influence of futures trading on spot price volatility. This work was advanced by Danthine (1978) and Anderson and Danthine (1983) and has its roots in the concepts of normal backwardization and contango first discussed by Keynes(1930) and Hicks (1946). By applying the theory of the supply of storage (Brennan, 1960), along with the price of storage (Working, 1949, 1962) and rational expectations and efficient markets (Bray, 1981), they have provided a basis for a positivist approach to the futures-spot price volatility question.

The efficient markets equilibrium approach has been extended by Kawai (1983) and Driskill, McCafferty and Sheffrin (1991). Kocagil (1997) has extended the DMS work to include producers, inventory holders, processors, and final consumers and has addressed the volatility issue within the construct of a simultaneous stochastic rational-expectations model of futures- and spot-price determination and applied it to the metals markets. Within the context of this stylized model Kocagil derives the stochastic process which drives futures prices and in so doing provides an empirically testable condition for an increase in speculative intensity to destabilize spot prices.

The stylized model set out by Kocagil can be used as a representation of the cheddar cheese market, and form the basis for a test of that increased speculative intensity has a stabilizing effect on spot cheese prices. As stated by Kawai; "If the demand disturbance is the primary random element in the [cheese] commodity market then the introduction of a futures market will tend to stabilize [cheese] spot prices; whereas if the [cheese] inventory demand disturbance is predominant, a futures market tends to be price-destabilizing ... ".

Research Procedures

The question of the influence of futures activity on cheese spot price volatility will be addressed along the approach taken by Kocagil in extending the work of DMS. This approach addresses the question of spot price volatility by estimating the parameters of the stochastic futures price process as derived by Kocagil and then to calculating a sufficient stability condition. The key features of the Kocagil model includes four principal economic agents: (a) producers, (b) inventory holders, (c) processors and (d) final good consumers. Spot and futures prices are determined in a simultaneous equilibrium which is characterized by: (1) uncertainty of consumer demand, (2) fluctuating storage costs and (3) uncertainty in the price spread between the raw and processed goods. All agents maximize quadratic in profit expected utility functions

and operate in a mean-variance economy. The rational expectations equilibrium solution provides an estimable expression for the stochastic futures price process and a stability condition:

$$f_t = \pi_0 + \pi_1 f_{t-1} + (1-\pi_2)C_t + \pi_4 \varepsilon$$

$$\lambda\beta^2\left[\left(\frac{\pi_1-\pi_2}{\pi_2-1}\right)(1+\pi_1)^2 + 2\pi_1 + \pi_1^2\right] \geq 1$$

$$\Omega \geq$$

The first expression above is the rational expectations equilibrium futures price stochastic process, which is derived as a solution to the complete model. In this equation the current period futures price (f_t) is a function of the futures price lagged one period and the a variable which reflects the cost of storage (C_t). {For a complete derivation of this equation see Kocagil}. The second expression relates the parameters of this process to the condition that an increase in speculative intensity in the futures market will result in an increase in spot price volatility. This condition, i.e., $\Omega \geq 1$ will obtain if the predominate disturbance in the market derives from the inventory demand shocks and not consumer demand. On the other hand if $\Omega < 1$ then the opposite is true. Thus by estimating the parameters of the futures price stochastic process Kogacil demonstrates that we can arrive at a testable condition that speculative intensity in the futures markets will either increase or reduces spot price volatility.

Empirical Analysis

The data used in this analysis consist of the weekly cheese spot price over the period 1990 to April 1998. The spot cheese price is represented by the National Cheese Exchange (NCE) series as reported by Dairy Market News Service of the United States Department of Agriculture through April of 1995 and then Chicago Mechantile Exchange price thereafter. The futures price used in the analysis is the settlement price on the Friday trading day for the period June 1993 through February 1998. The cost of storage is represented by the weekly 90 day T-Bill rate as reported by the St-Louis Federal Reserve.

Descriptive Statistics

The descriptive statistics for the spot cheese price variability are listed in Table 1 and graphically illustrated in Figure 1. Table 1 reports the statistics for the time period which precedes the beginning of trading of futures contracts on the CSCE and CME and the period of concurrent spot and futures trading. In the prefutures period the average price change was 0.08 percent with a variance of 3.69 percent. During the futures trading period this average change was -0.012 percent with a variance of 3.75 percent. Inspection of Figure 1 shows a price change pattern which exhibits large changes occurring together and small changes bunched together. The time-series pattern does not show any trend in weekly spot prices over the period.

Table 1. Descriptive Statistics for Week to Week Price changes in the Cheddar Cheese Spot Market

Cheddar Cheese Spot Price Pre Futures Trading		Cheddar Cheese Spot Price Concurrent Futures Trading	
Mean	0.0832601	Mean	-0.012451213
Sample Variance	3.69339436	Sample Variance	3.757828794
Kurtosis	9.059009465	Kurtosis	13.77869108
Skewness	1.37585352	Skewness	1.190005089
Minimum	-6.990569674	Minimum	-7.660139359
Maximum	10.95433721	Maximum	13.56406531
Number of weeks	179	Number of weeks	251

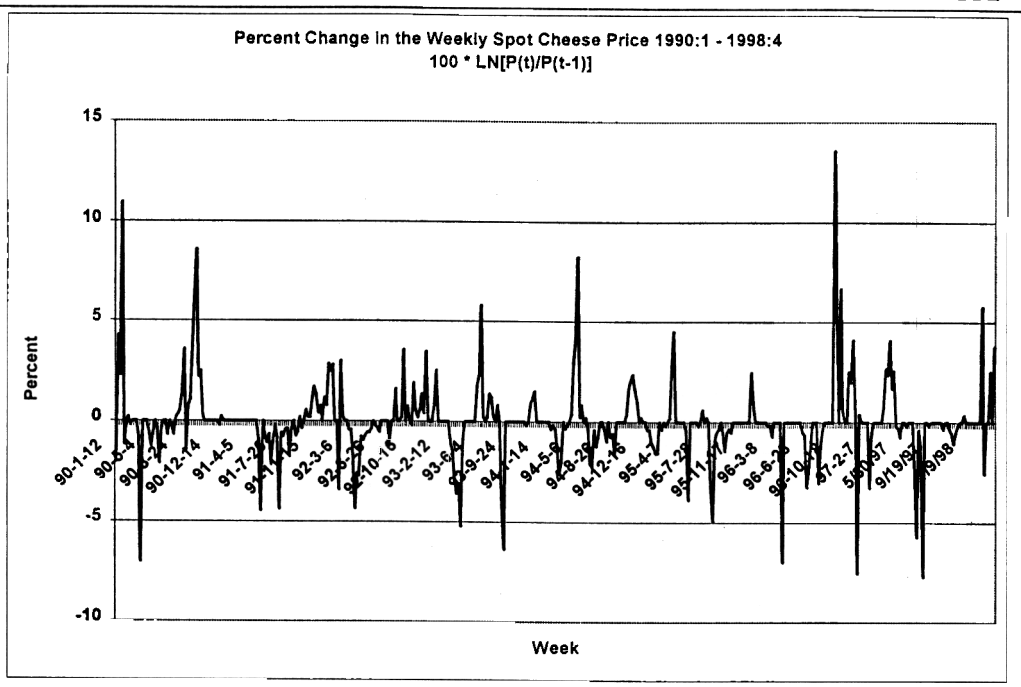

Figure 1. Cheddar Cheese Spot Price Volatility

Cheddar Cheese futures contract trading activity

The trading volume and open interest for the cheddar cheese contract recorded on Friday of each week on both the CSCE and CME markets is depicted in Figures 2 and 3. Figure 2 shows an initial trading volume in excess of 300 contracts (each contract represents 10,500 pounds of cheddar cheese) which diminishes to less than 100 contracts through September of 1997 and then increases with the trading on the CME contract. Figure 3 depicts the reported open interest on each Friday of the week. Open interest increased on the CSCE contract and then waned until the trade began using the the CME contract in October of 1997. After that time open

interest has increased to over 1,000 contracts reaching a high of 1,200+ at the end of the time period. These figures clearly depict an unsettled trading activity on the cheddar cheese contract.

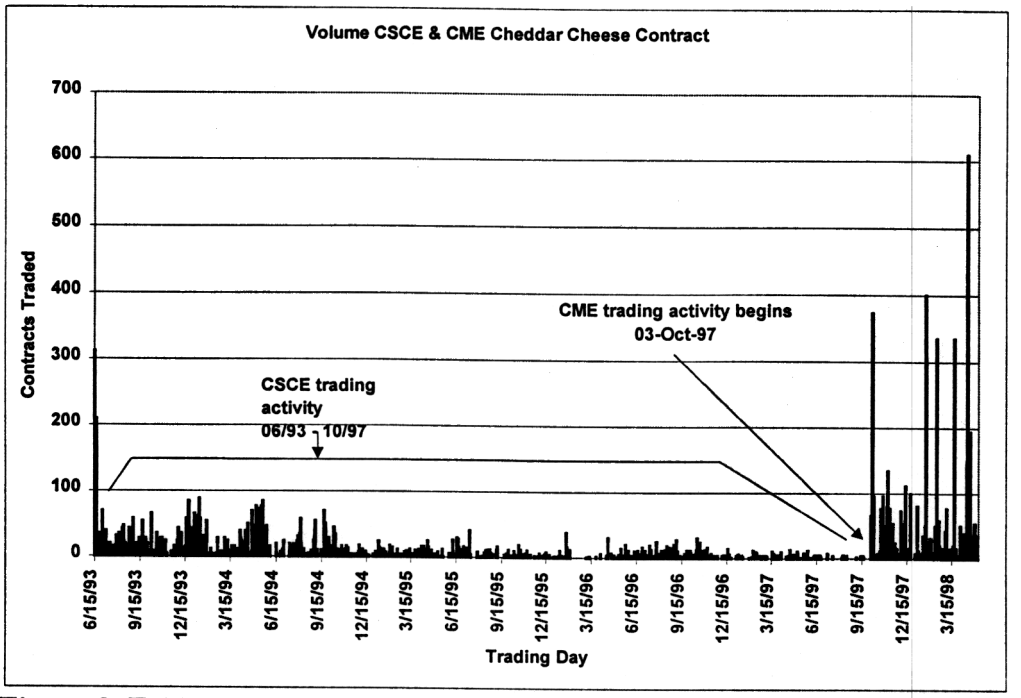

Figure 2. Friday trading volume on the cheddar cheese contract, CSCE and CME.

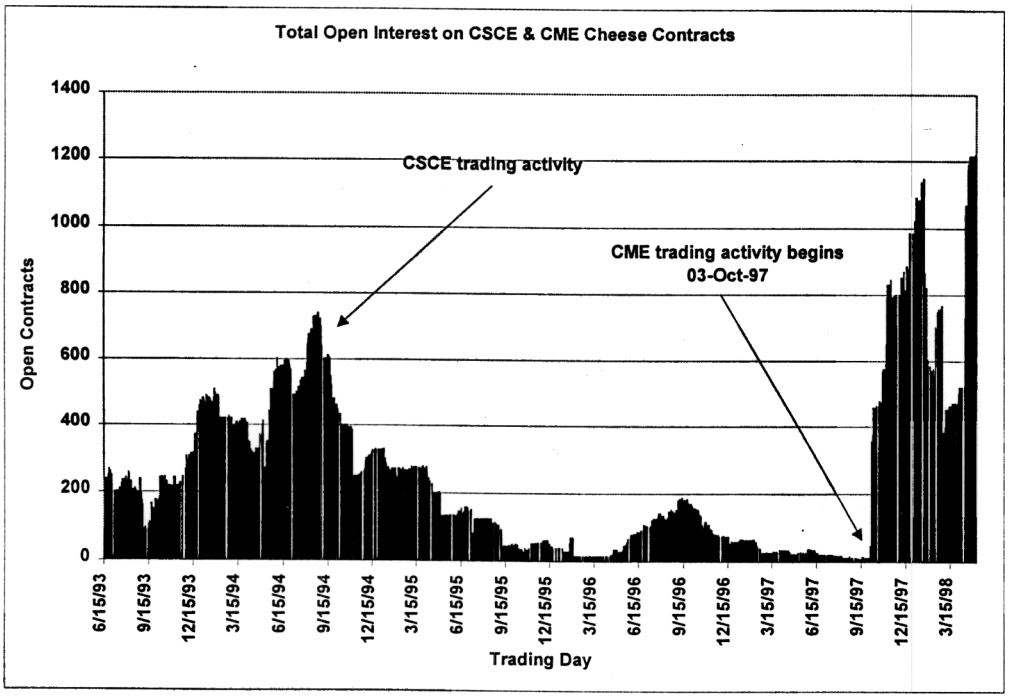

Figure 3. Friday trading open interest on the cheddar cheese contract, CSCE & CME.

The futures price stochastic process estimates

The futures price stochastic process estimated parameters are presented in Table 2. The estimated standard errors are small and the parameter estimates appear to be reasonable magnitudes. These parameter estimates allow the calculation of the critical Ω value which is strictly less than one in magnitude.

Table 2. Futures Price Stochastic Process Estimates.

Valid cases:	251	Dependent variable: Futures Price				
Missing cases:	1	Deletion method:				Listwise
Total SS:	1.591	Degrees of freedom:				248
R-squared:	0.894	Rbar-squared:				0.893
Residual SS:	0.168	Std error of est:				0.026
F(2,248):	1049.295	Probability of F:				0.000
Durbin-Watson:	1.922					
Variable	Estimate	Standard Error	t-value	Prob >|t|	Standardized Estimate	Cor with Dep Var
CONSTANT	0.025642	0.115231	0.222528	0.824	---	---
f(t-1)	0.951051	0.020761	45.808696	0.000	0.951634	0.940607
C(t)	0.221951	0.046827	4.739820	0.000	0.098465	-0.008109

The required parameters are: $\pi(1)=0.95105076$ $\pi(2)=0.77804914$
$V(\pi(4)U(t)=0.00067816$

The calculated critical Omega (Ω) value is: 0.02273621 < 1.0

Therefore this analysis supports the conclusion that increased speculative activity on the cheddar cheese futures market has not increase spot price variability. The implication to be drawn from this analysis is that the predominate source of spot price variability is introduced from the final consumer demand sector and given this it follows that increased activity on the cheddar cheese futures contract will not be a source of increased spot price volatility.

Conclusions and Implications

Participants in the U.S. dairy industry developed their market acumen over a long period of time which was characterized by stabile market prices provided by a mandated support price and large public stocks. This market has changed significantly beginning in the late 1980's and accelerating in the 1990's. Reduction of the support price to a level that is not effective and the concomitant elimination of the large stocks of dairy commodities has brought with it significant change in the volatility of the dairy product markets. Market prices are now free to move over a much wider band than possible in the past. As a mechanism for managing this increase price volatility futures contracts have been developed and are actively being traded on the Coffee, Sugar, and Cocoa Exchange, and the Chicago Merchantile Exchange. With this futures market

trading activity will come the question as to whether or not speculative activity on these contracts will increase the volatility of spot market prices. This analysis suggests that this will not be the case and in fact, increased activity on the futures markets may well result in less spot market volatility. This analysis suggests that the spot market price volatility for cheddar cheese is driven by random shocks emanating from the demand side of the cheese market and not from the inventory management side of the cheddar cheese market. Because of this, trading activity on the cheddar cheese futures contract will provide an increase in information flow to the spot market about future demand shifts and will attenuate the impact of unanticipated demand shocks to the cheddar cheese spot market price.

Limitations and further research

This research provides evidence that increased trading activity on the cheddar cheese futures contract will not be a cause of increase cheddar cheese spot market price volatility. There are, as with all research, a number of caveats. The first of course is the assumption that the stylized rational expectations model adequately captures the principal economic characteristics of the cheddar cheese market. Clearly the condition $\Omega < 1$ relies critically on this assumption. Second, the futures market data used in this analysis represents a completely new contract being trading in an economic arena that is not at all used to unfettered markets and free price discovery. Because of this newness this analysis should be considered preliminary and further work in this area is encouraged as more data becomes available and increased trading activity occurs on the futures contract. Additionally this research only addresses the issue of price volatility in the cheddar cheese spot market. Additional work needs to be done on the other primary storable dairy commodities of butter and nonfat milk powder, for which there are also futures contracts available for trading.

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