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Abstract

Cash Market Tests of the Weak Form Efficient Market Hypothesis

The efficient market hypothesis can have important policy implications concerning the quantity and quality of market information publicly provided on agricultural commodity markets. This study explores appropriate methodology and some empirical tests of the weak form efficient market hypothesis applied to cash markets, rather than to commodity futures markets.

Linda Cox is a Research Assistant, Department of Agricultural Economics, Texas A & M University. She holds an M.S. degree from Montana State University.

Thomas L. Sporleder is Professor, Department of Agricultural Economics, Texas A & M University. He received his Ph.D. from The Ohio State University in 1968 and was a Visiting Research Scholar in the U.S. Department of Agriculture during 1975. He currently serves as a member of the Food Advisory Committee, Office of Technology Assessment, U.S. Congress.

Jean-Paul Chavas is Assistant Professor, Department of Agricultural Economics, Texas A & M University. He received his Ph.D. in 1978 from University of Missouri.

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Cash Market Tests of the Weak Form Efficient Market Hypothesis

by

Linda Cox, Thomas L. Sporleder, and Jean-Paul Chavas*

Information concerning the economic value of goods and resources is required to achieve allocative efficiency. The efficiency of a market, in part, hinges on how rapidly and accurately market prices reflect both privately and publicly held information.

The efficient market hypothesis has its roots in finance. A (security) market is efficient if prices "fully reflect" all available information and if no traders have monopoly access to information relevant to price formation (Fama, p. 383-385). Since the area of relevant information is so vast, empirical work has concentrated on the adjustment of prices to one or more of three information subsets. Weak form tests consider only the information contained in historical prices. If historical prices contain information relevant to price formation, the market is not efficient in the weak form sense. No abnormal profits can be made from speculative trading based on past prices. Semi-strong form tests concern whether prices effi-

*Research Assistant, Professor, and Assistant Professor, respectively, Department of Agricultural Economics, Texas A & M University. Technical article number , Texas Agricultural Experiment Station.

ciently adjust to information publically available. Finally, strong form tests center on whether certain traders have monopolistic access to any information relevant to price formation.

Agricultural futures market prices have been empirically tested for weak form market efficiency be Stevenson and Bear, Leuthold, Cargill and Rausser, Working, Kendall, and Houthakker. Each of these studies employed the random-walk model as the basis for weak form tests of the efficient market hypothesis. The random-walk model states:

$$E[R_{j,\ t+1} \mid \Phi_t] = E[R_j]$$

where $R_{j,\ t+1}$ is the return of commodity j at time t + 1 and Φ_j denotes the information set available at time t. The random-walk model implies that return changes must be serially independent. These studies found some evidence of dependency in commodity futures prices. However, no study reported a clear, compelling case for dependency. The only studies that examined price movements in cash markets were those by Kendall and Houthakker. The cash prices were tested using the random-walk model exactly as the futures prices were tested. Little evidence of price dependency was found in cash market prices, indicating weak form market efficiency.

Methodology for Testing Cash Prices

This study evaluates movement in cash market prices for corn, grain sorghum, and feeder cattle. These markets are interdependent. The feed grains are substitutes for one another in feeding cattle. Of course, the derived demand for the feed grains is only partially determined by their input use in the production of cattle. However, these markets were specifically chosen for the analysis because of their partial interdependency.

Cash Price Problems

Cash prices are affected by storage costs, seasonality trends and perhaps long term cycles. For the most part, futures prices are not. If storage costs are constant throughout the year, changes in corn and sorghum prices should increase linearly between harvests due to storage costs. After the next harvest, prices drop. Other factors, such as the cattle cycle are expected to affect feeder prices.

Variables that account for trends and cycles cannot be observed as regularly as cash market prices. Because these variables affect cash market prices, the effects of the unobservable factors must be removed from each price series before the random-walk model can be used to test for weak form market efficiency.

If all the effects of cycles and trends are removed, then any price changes left in the series represents a random shock. This random shock is the result of a change in supply and/or demand conditions. This allows an investigation into the manner in which information is reflected in historical prices. Supply and/or demand conditions change, which cause market prices to change. These price changes may take time to occur and this adjustment time reflects market efficiency in a weak form sense.

Cycle and Trend Removal

If for each time period, t, the time series, Y_t, can be predicted almost perfectly using $(Y_{t-1}, Y_{t-2}, Y_{t-3}, \ldots\ldots,)$ then Y is a long memory series. If a plot of $(Y_1, \ldots., Y_T)$ reveals an obvious, predictable shape, such as a linear or seasonal trend, Y is a long memory series. A periodogram of the various frequency components in the series also indicates long memory if it exhibits a high dynamic range or a large ratio of the highest to the lowest value (Newton, p. 1).

A white noise or no memory series is one made up of independent, random variables. Predictive models are not useful in the case of a no memory time series. If the behavior of a specific time series can be described by a random-walk model it is a no memory series (Parzen, pp. 4-6).

A time series possessing anything between perfect predictability and no predictability is a short memory time series. Time series analysis works best on a short-memory series because then the effects of random shocks to the series can be analyzed. Therefore, if any perfectly predictable trend in the series indicates long memory, the time series must be transformed to reduce it to a short-memory series. The predictable part of the series can be subtracted, leaving the unpredictable portion to be analyzed (Parzen, pp. 4-6).

In order to determine if a series is short memory or not, a spectral representation of the data may be used (Newton, p.1). However before a spectral representation of a series can be developed, the series must exhibit covariance stationarity. Covariance stationarity implies: (a) the expected value for Y_t is constant for all t; and (b) the covariance matrix of $(X_{t1}, \ldots, X_{tn})$ is the same as the covariance matrix of $(X_{t1 + n}, \ldots, X_{tn + h})$ of indices (t1, ...,tn) and all h such that t1, t2, ... t1 + h, t2 + h, ..., tn + h are contained in the index set (Nerlove, Grether and Carvalho, pp. 206-207). A series can be transformed into a stationary series by successive differencing (Box and Jenkins, p.74). However, a stationary series is not a sufficient condition for a short memory series.

A plot and periodogram must be examined to determine whether differencing has reduced a series to short memory. If the plot reveals no cyclic patterns, it is assumed none is present in the series. If the periodogram of the various frequency components does not exhibit high dynamic range, then the series is assumed to be short memory (Newton, p. 1). It then can be tested for weak form market efficiency using the random-walk model. If long memory is detected in the series, further differencing is appropriate until the series is transformed to short memory. However, if successive differencing will not transform a series to short memory, power, and regression filter transformation are appropriate (Parzen and Newton, 1981).

The Data

Price series examined in this study were average weekly prices from 1972 to 1980. Price volatility has increased in agricultural commodity markets since the early 1970's. Before the time, large government held grain stocks kept grain prices close to price support loan rates. This increased price volatility is especially apparent in feed grains because government policies have been "successful in stabilizing prices of feed grains over the period from 1960 to 1971" (Robinson, p. 770).

In Texas, most sorghum, corn and feeder cattle are produced in the Panhandle area. The major auction for feeder cattle in this area is Amarillo. Therefore, the average weekly cash prices of 400 lb feeder cattle in Amarillo comprise the data base for Texas feeder cattle prices. These prices were obtained from Texas Livestock Market News; corresponding prices of sorghum and corn were obtained from Texas Cash Grain Prices. Sorghum and corn prices are from the Panhandle, including the area north of the Canadian River. Average weekly cash prices for sorghum and corn in the Kansas City market were taken from Grain Market news.

Results

These markets were tested for weak form market efficiency. First differencing of each price series produced stationary and short memory series. Texas grain sorghum and corn prices from north of the Canadian River are abbreviated GSN and CN, respectively. The Texas 400 lb. feeder cattle prices are designated T4. The Kansas City grain sorghum, corn, and 400-500 lb. and 500-600 lb. feeder cattle prices are abbreviated KCGS, KCC, KC5, and KC6, respectively.

The cash price series of each commodity was examined to determine whether price changes are random or follow some pattern of serial dependence. Spectral analysis is used to test randomness of each price series. An autoregressive model which best explains the variation in the series also is fit to each series. The order of the autoregressive model was choosen using a CAT (Criterion Autoregressive Transfer Function) criteria proposed by Parzen and Newton (1981). The number of significant coefficients in the autoregressive model determines the amount of serial dependence in the series.

Both the Texas and Kansas City sorghum price models include one significant price coefficient (Table 1). The Texas price coefficient is positive; the Kansas City coefficient is negative. Although this sign difference indicates a difference between variation in the Texas and the Kansas City price cycles, neither market is more efficient than the other in the weak form sense. The negative sign on the Kansas City price coefficient indicates it over adjusts while the Texas price converges downward or upward after information indicates supply and/or demand conditions have changed. The relative magnitude of the two coefficients indicates that the Kansas City price over adjusts by the same amount that the Texas price adjusts downward.

The Texas corn price model contains three lagged price variables with significant coefficients on the first two. The Kansas City corn price model contains four lagged price variables with significant coefficients on the first and the fourth. Texas corn prices can be predicted using price differences from two previous periods while Kansas City corn price prediction requires price differences from four previous periods. Thus, the Texas corn market is more efficient than the Kansas City corn market in the weak form sense. Both models have coefficients that alternate in sign, starting negative. This

Table 1. Autoregressive Models Indicating Own Price Relationships

Variable	ΔP_t [a]	ΔP_{t-1}	ΔP_{t-2}	ΔP_{t-3}	ΔP_{t-4}	ΔP_{t-5}	ΔP_{t-6}	ΔP_{t-7}	ΔP_{t-8}	ΔP_{t-9}	ΔP_{t-10}	ΔP_{t-11}
GSN	.112*											
	(.046)											
CN	-.203*	.114*	.080									
	(.046)	(.047)	(.046)									
KCGS	-.129*											
	(.046)											
KCC	-.236*	.018	.036	-.108*								
	(.046)	(.047)	(.047)	(.046)								
T4	.042											
	(.049)											
KC5	.612*	-.348*	.208*	-.126*	.091	.047	.118*					
	(.049)	(.057)	(.059)	(.060)	(.059)	(.057)	(.049)					
KC6	.486*	-.241	.048	-.056	.034	-.051	.169*	.031	-.080	.010	.087	
	(0.49)	(.054)	(.057)	.057)	(.058)	(.064)	(.069)	(.075)	(.075)	(.070)	(.058)	

*Indicates significance at 95% level, standard errors are in parentheses.

a/ $\Delta P_t = P_t - P_{t-1}$

indicates that both prices over adjust to new information and then must re-adjust.

The Texas 400 lb feeder cattle price model has no significant coefficients (Table 1). The Kansas City 500 lb feeder cattle price model has seven price coefficients, with significance indicated on the first four and the seventh. The Kansas City 600 lb feeder cattle price model has 11 price coefficients, with significance indicated on the first, second, and seventh. Texas 400 lb feeder cattle market prices are efficient in the weak form sense while, Kansas City 500 and 600 lb feeder cattle markets are not. The Kansas City markets were expected to be more efficient than the Texas markets. Both Kansas City models alternate in sign, starting positive. This indicates over adjustment, then re-adjustment to new information in these markets.

Conclusions

Since the variation in Texas 400 lb feeder cattle prices can be explained by a cumulative autoregressive model of order zero, T4 is random. Because the other price series are short memory and exhibit significant serial dependence, the Texas 400 lb feeder market is efficient in the weak form sense. The Texas sorghum and corn markets and Kansas City sorghum, corn, and feeder cattle markets are not efficient in the weak form sense.

This study is a preliminary examination of the efficient market hypothesis applied to cash markets. There are additional difficulties in the examination of cash markets relative to futures markets due to storage, trends, and cycles. However, the potential public policy implications of efficient markets justify further investigation of cash markets and attempts to improve the methodology for doing so.

Public policy considerations are particulary important in cash markets for agricultural commodities since the federal government provides market information. Results of tests on efficient cash markets could assist in decisions concerning the quantity and quality of market news publicly financed.

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