DEPENDENCE IN COMMODITY PRICES: A COMMENT

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Peterson, Ma, and Ritchey (1992), hereafter PMR, analyze the statistical properties of *cash* prices for 17 commodities. Their results are consistent with other studies which have found autocorrelation in commodity prices. For a literature review, see Tomek and Myers (1993). This author fears, however, that the introductory and concluding remarks of the PMR article may mislead those readers who are unfamiliar with commodity markets. This note is intended to clarify the characteristics of commodity price behavior and the implications of these characteristics for the conclusions drawn. Agricultural markets are emphasized here, but most of the comments are equally applicable to other commodities. The important point is that cash prices for commodities should not be expected to follow a random walk. Thus, this model is not a useful benchmark for measuring the efficiency of cash markets for commodities.

COMMODITY MARKETS

Looking at graphs of commodity price movements over time, one is immediately struck by the positive autocorrelation. Formal time-series analyses of daily data confirm that prices are indeed highly autocorrelated and are not normally distributed. The variances of

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distributions of price changes appear to be autocorrelated, i.e., heteroscedastic. The interesting questions relate to the reasons for this behavior. Inventory holding and transactions costs are factors that create dynamic behavior, though they are not the only sources of dynamics.

Many agricultural crops are produced annually but consumed throughout the year, giving rise to inventory holding. Even livestock commodities, which are produced continuously, often have seasonality in output. Stock holding can be important for nonagricultural commodities as well. Thus, the available supply (stocks) relative to demand influence both intrayear and interyear commodity price behavior, and since stocks must be nonnegative, prices and inventories have a nonlinear relationship.

Several consequences follow. Prices typically have a seasonal component, implying intrayear autocorrelation. Given the nature of producers' and inventory-holders' responses to changes in expected prices and the nonlinear effects of carryover from one year to the next, prices also can be autocorrelated when observed at yearly frequencies, moving from high to low prices and back again, e.g., Deaton and Laroque (1992) and Williams and Wright (1991).

In appraising transactions costs, one must appreciate the complexity of commodity markets and the associated price discovery processes. Many reasons exist for shocks to expectations. Agricultural supply is subject to the vagaries of diseases, pests, and weather and is spread over geographic space. Production and distribution of commodities can be threatened by political instability and strikes. Commodities contain a variety of desirable and undesirable attributes, and the supplies of and demands for these attributes change. Prices also vary because the specific terms of trade for transactions differ. Thus, commodity prices are influenced by numerous variables; information about the factors determining prices comes from many sources; and this information changes frequently and unexpectedly.

Information is appraised by a variety of price discovery mechanisms, including bargaining between individuals, simple acceptance of bids without bargaining, trading on organized auctions or exchanges, and using formulas in contracts. Often, a commodity, like fed cattle, is priced by more than one mechanism (on central markets, by individual negotiation, and by using a formula based on the carcass value of the slaughtered animal). Further, with the passage of time, marketing and pricing mechanisms change in importance. Central markets play a much

reduced role in establishing prices in the United States now than in the past.

Two implications can be drawn from this discussion of price discovery. First, transactions costs, broadly defined, are important in commodity markets, and these transactions costs imply autocorrelated prices. It is costly to obtain relevant information and then to act on it. A literature, which has come to be called noisy rational expectations, suggests that the cost of acquiring and acting on new information means that prices in a competitive market will not follow a random walk, e.g., Grossman and Stiglitz (1980) and Sunder (1992). Persistence in price behavior can occur in rational markets.

A second implication relates to how data are collected, reported, and interpreted. With changes in the way commodities are marketed and priced, it has become increasingly difficult (costly) to report prices with the same degree of accuracy. In the past, the Agricultural Marketing Service, U.S. Department of Agriculture could station reporters at central markets and their reports were an accurate reflection of a large volume of trading. This is no longer true. The volume of sales on central markets is small relative to total sales.

Reported prices may represent actual transactions, bid and asked prices, or a reporter's perceptions of the market (most often the latter). Price reports for privately negotiated trades must be secured on a voluntary basis and in dispersed markets. The reporter cannot easily examine the particular lot of the commodity and verify that the information is accurate. For a good, but brief discussion of cash price quotations see Paul (1985, pp. 288–289).

Prices quoted for choice steers, for example, cover a range of individual transactions between buyers and sellers, with varying quality and other differences in the terms of trade (Schroeder, et al., 1993). It is not possible to identify an opening or closing price, or bid–ask spreads. A range of prices is reported which is intended to be representative of the transactions that occurred during that day, e.g., for yield grade 2–4, 900–1,100 pound choice, slaughter steers in Iowa–Southern Minnesota. All of the foregoing is very much in contrast to organized market places like the New York Stock Exchange.

To summarize, good reasons exist for commodity prices to be autocorrelated. These reasons include the dynamics of supply and demand for commodities and the dynamics associated with transactions costs as prices respond to new information.

IMPLICATIONS FOR PRICE ANALYSIS

How does the foregoing discussion relate to the PMR article? One issue, requiring clarification, is the heavy emphasis in PMR's article on the random walk model, both in the literature cited and as a foundation for measuring market efficiency. The literature cited in their introduction relates to securities and futures prices, not to cash prices for commodities. The transfer of the ideas in this literature to commodity markets is not straightforward. Indeed, the literature on commodity prices, especially in the last 10 years, is about why such prices are not random walks.

Under specialized circumstances, price changes for commodity *futures* contracts might equal a random error, which has no autocorrelation (as cited in PMR). Futures prices are anticipatory prices for a relatively homogenous product, the contract, established at a central market place, which is usually quite competitive and which often has small transactions costs (Working, 1958). But the random walk hypothesis is a rather narrow characterization of price behavior even for futures markets, e.g., Irwin, Krukemyer, and Zulauf (1993). PMR do cite papers that discuss why the random walk hypothesis may not be applicable to speculative price series, but the literature cited mostly misses the main attributes of commodity markets.

A simple way to characterize a commodity price series is as

$$P_t = S_t + e_t$$

where

S = the systematic component

e = the random component

t = time (say, days)

Both components of P can be modeled in a variety of ways (and have been), but it is unlikely that the systematic component can be adequately modeled as lagged price alone, $S_t = P_{t-1}$. As noted above, S is composed of a mixture of factors representing seasonality, distributed lag effects, and longer cycles, and transactions costs are likely an important source of short-run persistence in price behavior.

PMR use differences (of the logarithms of prices) in their analysis. The differences are apparently taken over daily, weekly, or 4-week intervals (but adjusted for weekend or holiday effects). Thus, the PMR model is analogous to the equation above, with S modeled as a single price lagged either 1 day, 1 week, or 4 weeks and assuming the error

term has a constant variance. In the context of the earlier discussion, it is unlikely that the resulting difference would have no systematic behavior nor that variance of the error is homoscedastic. Indeed, Deaton and Laroque found second-order autocorrelation in the (deflated) annual prices of 13 commodities. (Also see citations in Tomek and Myers.)

Perhaps the most remarkable part of PMR's results is that deviations from a random walk are not larger. The evidence (PMR, Table 1) against the random walk hypothesis appears strongest for the 1-day lag and weakest for the 4-week lag, which is consistent with short-lived persistence of information cost effects, as implied in the noisy expectations literature. Given the seasonality and longer "cycles" which appear to exist in commodity prices, it is surprising that more evidence of autocorrelation is not found. (PMR do mention cobweb effects as one explanation of their results, but it is not the point emphasized in the conclusions.)

A second type of concern, though not the central point of this comment, relates to the data and techniques of analysis. The sample period, 1969–1987, contains a transition in 1972–1974 from a period of stable to a period of highly variable prices for most commodities, e.g., Hudson, Leuthold, and Sarassoro (1987). This raises a question about the sensitivity of the results to the selection of the sample period. Also, given evidence that the variances of price changes are autocorrelated, heteroscedastic-consistent variance ratio tests might yield different results.

A related concern is whether the quality of the prices used in the analysis is adequate for the purposes of the PMR article. The authors' state (p. 433) that "the daily prices in the sample are obtained from dealer's offering quotes or ask prices." Appendix B indicates that these data are from the *Wall Street Journal,* and the *Journal* states that the prices are closing prices. But careful perusal suggests that some series are "averages." It may be that many of the prices represent a market reporter's estimate for a particular quality and location (as discussed above).

Prices reported for central markets are based on few or no transactions on some days of the week. For example, most transactions on the Omaha hog market occur on Mondays and Tuesdays. Interestingly, the authors exclude Monday returns because of their concern about weekend effects. But, with few or no transactions, Thursday and Friday price reports may not be much more meaningful than the lack of prices for Saturdays and Sundays. One is left to wonder about the interpretation of the analyses based on the daily changes.

The third general issue relates to the conclusions drawn. One must be extremely cautious in concluding that commodity markets are inefficient in the sense that significant unrealized profits exist, which traders can exploit if they develop appropriate forecasting models. Perhaps models of price differences with predictive power can be developed, but this does not necessarily translate into profitable transactions, given the costs of developing the models, obtaining correct information, and making the corresponding transactions. Stated another way, it does not make sense to talk about the efficiency of cash markets without discussing the reasons for persistent behavior and whether this systematic behavior merely reflects normal returns to storage, information gathering, etc.

Moreover, stable estimates of autocorrelation parameters, useful for forecasting, may be difficult to obtain. Time-series processes are subject to structural change through time; and, as noted, evidence exists that structural change did occur in the 1972–1974 period [Hudson, Leuthold, and Sarassoro (1987)]. Further, the estimated autocorrelations may not be the same from one day of the week to another, simply because of the nature of the price data. For instance, the nature of persistence in price behavior on the Omaha hog market may not be the same from Monday to Tuesday as it is from Thursday to Friday.

CONCLUSION

PMR state (p. 431) that "These results indicate that many daily commodity prices appear not to react to unexpected information in a rational fashion..." and conclude (p. 439) that "...there is a component, independent of the underlying fundamentals, that can be used to predict future [cash] prices. This implies the possibility of market irrationality..." Readers should treat these statements with skepticism. The systematic patterns more likely reflect market fundamentals and transactions costs in complex markets. In this sense, they are rational.

While commodity markets are probably efficient, at least on average, one can still ask about the relative roles of the public and private sectors in providing information. Historically, the federal government in the United States has played an important role in data collection in commodity markets; but as commodity markets have become more complex, the cost of maintaining a given level of information (the cost of sampling the population of transactions) has grown [Tomek (1980)]. More research is needed about the benefits of improving the public collection of data relative to the costs of doing so.

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