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DO WHOLESALE RED MEATS MARKETS OPERATE IN DISEQUILIBRIUM?

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ABSTRACT

DO WHOLESALE RED MEATS MARKETS OPERATE IN DISEQULIBRIUM?

Forward formula pricing in wholesale red meats markets cause transactions quantities and prices to be determined at different times. Use of purchase limits in meat retailing is symptomatic of disequilibrium marketing. Price analysis on specific cuts indicates short-run disequilibrium but aggregation problems prevent reliable estimation of demand functions.

DO WHOLESALE RED MEATS MARKETS OPERATE IN DISEQUILIBRIUM?

The question posed by the title of this paper is important because of the economic importance of the red meats industry and because of the long-standing controversy over its marketing and pricing procedures. Much if not most red meats are wholesaled by means of a forward formula pricing system using prices reported by the "Yellow Sheet," a private price reporting service (Williams). Both forward formula pricing and the Yellow Sheet have been accused of being noncompetitive and causing price distortions, but studies have not found that price levels, profitability, and other indicators of market performance differ from that expected under the competitive norm (Williams). Previous studies have hypothesized that wholesale red meat markets were equilibrium markets affected by noncompetitive forces. This paper examines the proposition that these markets actually operate in disequilibirum. Disequilibrium is an attractive paradigm for red meats, because it accounts for behavior that is difficult to reconcile with equilibrium, namely the quasi-rationing that is sometimes practiced at the retail level. Better understanding of the underlying mechanisms in this market may provide a better basis for research on ways to improve its pricing performance without impairing its operational efficiency, which seems quite high.

Forward Formula Marketing

Most beef, perhaps 75 to 90 percent of total volume, and much pork is sold on a forward formula basis whereby forward contracts specify quantities of individual meat cuts to be delivered from a few days up to a week or so hence. Everything is specified in these contracts but the price. A price formula is negotiated in the contract as so many cents per pound over or under the Yellow Sheet price quote. However, this formula applies to the price quoted on the date of delivery of the contract rather than the date it was signed (National Provisioner, October 28, 1978, p. 113). These price quotes are determined in an ostensibly open, competitive spot market for red meats. However, because so much of total meat volume is sold by formula, and because the wholesale markets are not for beef and pork *per se* but rather for a sizeable number of individual cut and box specifications, these spot markets are very thin and serve mainly to provide quotes to support formula transactions (Williams).

Even though forward formula contracts are of short duration, there is clearly an information gap between most of the markets' transactions and the prices at which these transactions are valued. Contractual delivery dates and the prices at which they are valued coincide, but decisions as to the quantities being transacted were made previously and so have no direct bearing on current price levels. Current price is unlikely to have much effect on current supplies of red meat, because livestock slaughter is largely predetermined with respect to the week-to-week time frame in which the wholesale red meat market operates. Current demand can influence price in the thin spot market, but its effect in the far larger forward formula market is to influence transactions levels for future delivery. Under these circumstances it is difficult to see how price can fulfill the market clearing role assigned to it in the equilibrium market model.

Disequilibrium Markets

Disequilibrium markets are markets in which the *tatonnement* process of price adjustment after a shift in either demand or supply can not operate rapidly enough to re-establish equilibrium within a measurable time interval after the shift. In continuous time, equilibrium requires instantaneous price adjustment, but in discrete time the rate need not be instantaneous, merely "sufficiently" rapid. Specifying price adjustment as a partial adjustment to an imputed moving equilibrium (PAMEQ), an approach developed by Bowden (pp. 75-83), allows the rate of price adjustment to be treated as a testable hypothesis with something less than infinite rates needed in order to find in favor of equilibrium.

A simple PAMEQ model with predetermined supply is as follows:

(1) $D_t = D(P_t, X_t)$

(2) $P_t = \theta P_{t-1} + (1-\theta)P_t^*$

(3) $Q_t = \mathrm{Min}(D_t, S_t)$

where X_t represents exogenous variables affecting demand, P_t^* is the equilibrium price needed to equate D_t and S_t, P_t is observed price, and Q_t is observed transactions. The parameter is interpreted as a "coefficient of friction" on price adjustment, such frictions being attributed to institutional pricing rules, slow propogation of market information, and the like. Natural boundaries for the value of are $0 \leq \theta < 1$, with 0 representing the null hypothesis of full adjustment to equilibrium.

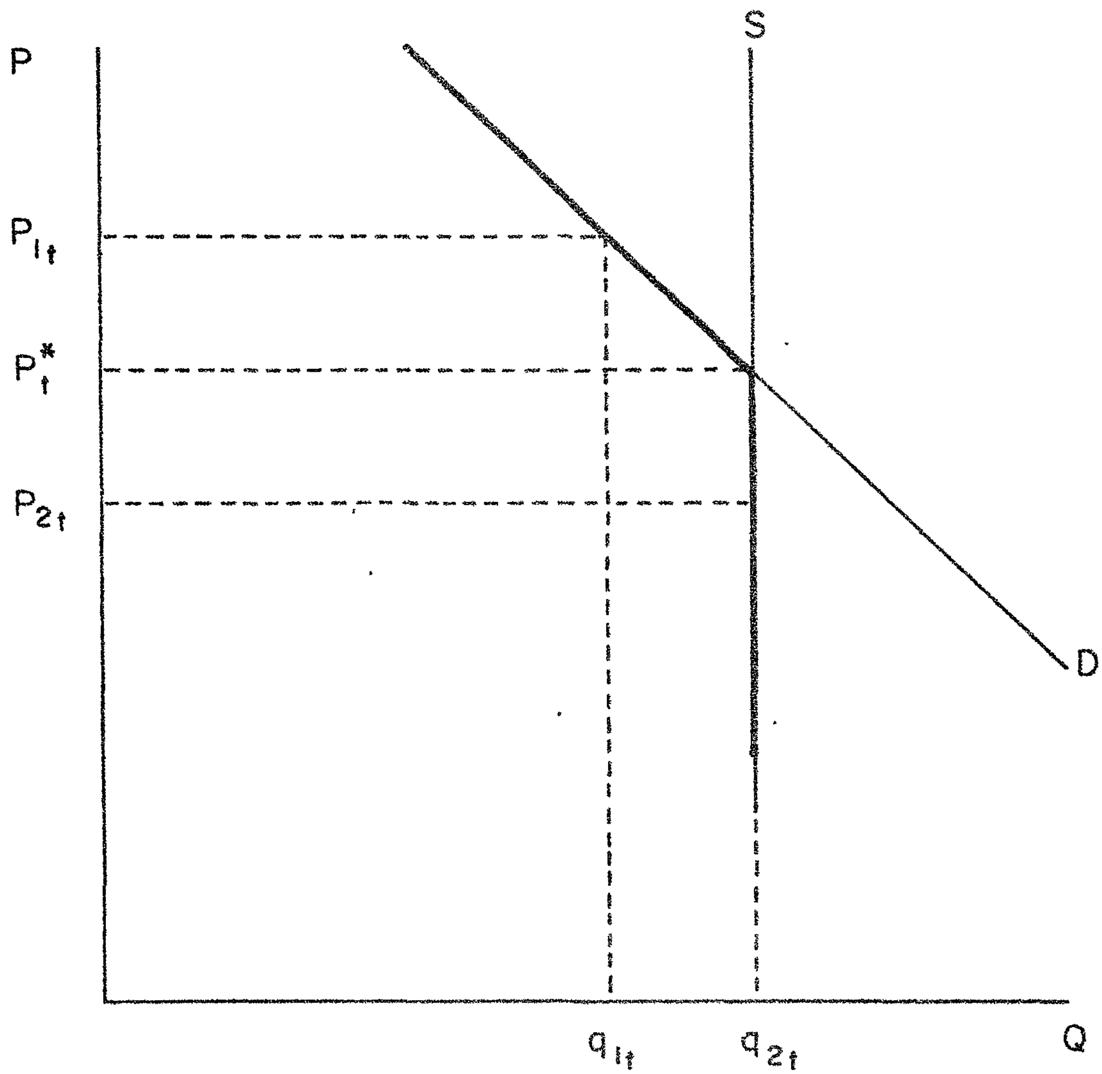
The observed transactions function (3) was developed by Fair and Jaffee. Its implications for the observability of quantities demanded and supplied are illustrated in Figure 1. At prices above equilibrium, consumers can not be induced to take more than say, q_{1t}, even though suppliers offer q_{2t}. With predetermined supply, forced storage or discarding is implied. Discarding takes place in fresh fruit and vegetable Federal marketing orders, but cold storage facilities are available for temporary storage of red meats, so meat packers could store under disequilibrium conditions. Observed transactions in the wholesale market would approximate quantities demanded under disequilibrium at prices above equilibrium.

On the other hand, supply becomes the short side of the market at below-equilibrium prices. *Ex ante* quantities demanded exceed quantities supplied, and since withdrawals from storage are not necessarily forced in order to balance quantities, it may be that not all consumers will be satisfied under these conditions.

Quasi-rationing and Meat "Specials"

Some kind of rationing scheme is implied under the excess demand regime at prices below equilibrium. To be practical, the scheme should be easy to implement when the market moves into an excess supply state and just as easily suspended when it moves into an excess demand state. In fact something like this occurs in the ordinary practice of meat retailing. Meat "specials" are often accompanied by purchase limits. Such limits are informal and easily surmounted by consumers willing to take the trouble to do so, but they do seem to be expressions of sellers' judgements that quantities demanded may exceed

Figure 1. Disequilibrium Market with Predetermined Supply.



quantities available at the offered price. Such practices fit in nicely with the idea of disequilibrium but are very difficult to reconcile with equilibrium markets.

Empirical Models and Analysis

Models used in the analysis follow the outlines laid out previously. Two general meat models, one equilibrium and one disequilibrium, are estimated with respect to weekly average prices of individual cuts of beef and pork. Due to space limitations, results for only one cut, choice boxed beef strips, are reported here. Unfortunately, comparably specific quantity data are not available. Instead, quantities supplied are weekly FIS meat production data for beef and pork with no cuts detail. Quantities demanded are imputed disappearances after estimated changes in cold storage stocks are accounted for. These changes are estimated by interpolation between monthly observations of these data. (Only quarterly stocks data were available for a period in 1982, exacerbating the interpolation problem.) This interpolation introduces serial correlation into the weekly estimates of both cold storage stocks and quantities demanded. Also, since quantity estimates are aggregated across all cuts, prices for specific cuts are only indirectly related to much of the transactions represented in the quantity data.

Despite these obvious difficulties, it was decided to retain the sharper focus on prices given by individual cut and weekly price data rather than to use aggregates of price and longer periods which have more reliable quantity data. Specific cuts and short time periods seem to characterize the environment in which the wholesale meat markets operate.

The equilibrium model is as follows:

(4) $D_{it} = D(P^*_{it}, X1_{it})$

(5) $P^*_{it} = P(K_{it}, X2_{it})$

(6) $K_{it} = S_{it} + K_{it-1} - D_{it}$

where $X1_{it}$ = substitute meat prices for the ith meat and per capita income, and $X2_{it}$ = interest rates (Federal funds rates), lagged cold storage stocks for the ith meat, and seasonal dummies. The price function is an inverted stocks function. Prices are designated with an asterisk to indicate that they are assumed to be at equilibrium in this specification.

The corresponding disequilibrium model is

(7) $D_{it} = D(P_{it}, X1_{it})$

(8) $K_{it} = K(P_{it}, X2_{it})$

(9) $P_{it} = \theta P_{it-1} + (1-\theta)P(X1_{it}, X2_{it})$

(10) $Q_{it} = \text{Min}\ [(D_{it} - K_{it} + K_{it-1}), (S_{it} + K_{it} - K_{it-1})]$

Equation (9) is Bowden's PAMEQ function transformed on to observable variables since, in general, P^*_{it} is unobservable in the disequilibrium model. Equation (10) is Fair and Jaffee's short-side transactions function modified to account for stocks.

Standard two stage least-squares parameter estimates of the equilibrium model using choice boxed beef strip pieces are shown in

Table 1. These prices are published in the National Provisioner as weekly summaries of Yellow Sheet reports. Estimates are based on weekly data for the years 1979-1983. Sample separation techniques are needed to identify observed quantities as representing either quantities demanded or supplied in the disequilibrium model. These methods have been derived by Bowden (pp. 181-186) for the PAMEQ model and result in a modified two stage least-squares procedure for the demand and stocks functions in the disequilibrium model. His method is used to estimate these parameters. Prices are estimated by OLS from the transformed PAMEQ function in equation (9). Disequilibrium model parameter estimates are also shown in Table 1.

Conclusions

Interpretations of the results depends in part upon one's methodological stance concerning the disequilibrium hypothesis. If one is willing to entertain the possibility that markets can operate out of equilibrium, then this analysis provides evidence that wholesale red meat markets, or at least the market for boxed beef strips, are doing so. The estimated value of the "friction coefficient" in the PAMEQ price function is 0.92 with a standard error of 0.03. The ordinary t-test is applicable to this function and yields a t-value of 30, which indicates that the null hypothesis of equilibrium should be rejected. If, however, one holds that equilibrium is the only paradigm for market analysis, then this result will not be persuasive. At the same time, however, some other explanation for the measured persistence in the price series will need to be found. Autocorrelation in the equilibrium version of the price

Table 1. Parameter Estimates for Equilibrium and Disequilibrium Beef Models[a,b]

Equilibrium Model

$$D_t = \underset{(26)}{312} - \underset{(.10)}{.16}P^*_t + \underset{(.15)}{.49}\,PorkP_t + \underset{(.41)}{.48}\,BroilP_t + \underset{(1.79)}{7.81}\,Inc_t$$

$R^2 = .19$ Autocorrelation = .17 $F = 14.20$

$$P^*_t = \underset{(8.3)}{209.0} + \underset{(.70)}{.14}\,K_t - \underset{(.31)}{.55}\,Int_t - \underset{(.69)}{.26}\,K_{t-1} + \underset{(3.3)}{29.6}\,Qtr2 + \underset{(3.5)}{34.1}\,Qtr3 - \underset{(4.3)}{3.4}\,Qtr4$$

$R^2 = .64$ Autocorrelation = .83 $F = 67.79$

Disequilibrium Model

$$D_t = \underset{(29)}{327} - \underset{(.09)}{.34}\,P_t + \underset{(.16)}{.61}\,Pork\,P_t + \underset{(.43)}{.81}\,BroilP + \underset{(1.88)}{7.44}\,Inc$$

$R^2 = .26$ Autocorrelation = .18 $F = 16.49$

$$K_t = \underset{(5)}{10} - \underset{(.02)}{.02}\,P_t - \underset{(.10)}{.12}\,Int_t + \underset{(.01)}{.98}\,K_{t-1} - \underset{(1.09)}{2.15}\,Qtr2 - \underset{(1.21)}{2.04}\,Qtr3 + \underset{(.94)}{4.49}\,Qtr4$$

$R_2 = .99$ Autocorrelation = .76 $F = 6522.53$

$$P_t = \underset{(33.6)}{63.4} + \underset{(.03)}{.92}\,P_{t-1} - \underset{(.04)}{.04}\,PorkP_t - \underset{(.09)}{.04}\,BroilP_t - \underset{(1.22)}{.04}\,Inc_t - \underset{(.14)}{.13}\,Int_t - \underset{(.02)}{.02}\,K_{t-1} + \underset{(1.42)}{3.00}\,Qtr2 - \underset{(1.60)}{1.39}\,Qtr3 - \underset{(1.40)}{4.30}\,Qtr4$$

$R^2 = .94$ Autocorrelation = .06 $F = 339.16$

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[a]Standard errors in parentheses.

[b]Variable identification. QD_t = quantity demanded, mill. lbs. carcass weight, P_t = choice boxed beef strips (all prices in cents per pound); $PorkP_t$ = fresh pork price; $BroilP_t$ = broiler price; Inc_t = per capita personal income, current dollars, K_t = cold storage stocks, mill. lbs.; Int = Fed funds interest rate, %; Qtr2, Qtr3, Qtr4 – dummy variables for the 2nd, 3rd, and 4th quarters of the year.

function is 0.83. Is this autocorrelation without economic content, or can some explanation for it be found within the framework of the equilibrium model? This seems to be a methodological issue of some importance.

Quantity data problems cause unsatisfactory estimates of demand in both the equilibrium and disequilibrium models and in the stocks function in the disequilibrium one. All one can say for the demand functions is that the parameter signs seem sensible. They hold out the hope that better data would yield better results. A slightly better fit is obtained in the disequilibrium model version of the demand function, but not much should be made of this. More interesting is the increase in parameter values for own-price and substitute meat prices. This is the kind of improvement that is to be expected if the sample separation involved in disequilibrium procedures is able to reduce the slurring of demand estimation across both excess demand and excess supply regimes.

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