SP-81-10 July 27, 1981

# A TEACHING TOOL FOR MAKING ELASTICITY RELEVANT

by

Karen P. Mundy
David E. Kenyon

David E. Kenyon, Professor of Agricultural Economics, Virginia Tech.

Karen P. Mundy, Research Assistant in Agricultural Economics at Virginia Tech.

## ABSTRACT

This paper explains the self-learning unit, "Forecasting Hog Prices Using Elasticities." It discusses the format of the self-learning unit, its forecasting ability, and its strengths and limitations for teaching a practical application of elasticities.

Printed at AAEA meetings Clemson University, July 26-29, 1981.

A Teaching Tool for Making Elasticity Relevant

The concept of elasticity is taught from the principles through the upper level of agricultural economics courses, but students have a difficult time understanding the concept and its relevance. A great deal of the difficulty students encounter with this concept centers around the failure of most texts to demonstrate any potentially useful applications. In reviewing text books written for undergraduate agricultural marketing courses, only two have been found that give a practical application for elasticities. Dahl and Hammond in Market and Price Analysis use a relatively unimportant agricultural commodity, lamb, to illustrate how own price, the price of substitutes, and income affect the quantity of lamb consumed. Elasticities are used to compute the change in consumption. The graphical analysis is such that distinctions cannot be made easily between movement along the demand curve and a shift in demand. The second text that makes use of a practical application is Purcell's Agricultural Marketing: Systems, Coordination, Cash, and Futures Prices. Purcell uses beef in his example and forecasts price, but it is based on a shift in demand and the supply side is essentially ignored.

To meet this deficiency in current textbooks, a self-learning unit entitled "Forecasting Hog Prices Using Elasticities" has been developed. The main objective of the self-learning unit is to demonstrate how elasticities can be used to forecast hog prices up to 5 months into the future. Another objective is to reduce class time spent in reviewing demand and its relationship to elasticity. This was considered necessary due to the composition of the agricultural

marketing classes at Virginia Tech. Nearly two-thirds of the students in these classes are not agricultural economics majors. Many of them took principles their freshman year and waited until their junior or senior year before taking agricultural marketing. Hence, the necessity for review. This paper reports on how the self-learning unit is designed, how well this procedure forecasts prices, and the value of this particular teaching tool.

## Design of Self-Learning Unit

The 34-page long self-learning unit presents the material such that the student reads an explanation, works an example based on the explanation, and is given an answer so that he can check his work before proceeding to the next section. The first three sections are primarily designed to provide a review of the relationships between movement along a demand curve, a shift in demand and own price, cross, and income elasticities; how to calculate percentage changes; and adjusting prices for inflation. The first two of these review sections may be omitted if the student feels his knowledge of the material is adequate. The third section in addition to discussing how to adjust prices for inflation also explains the need for this and gives sources of information for the CPI. Most upper division undergraduates should already understand the introductory material in the first three sections of the unit, but many do not. The unit provides a good review and eliminates the need to cover this material extensively during valuable class time.

The procedure for forecasting hog prices begins by reproducing a portion of a page from the Hog and Pig Report. The student is shown how to use this information to forecast hog slaughter numbers in

future months. Based on NRC recommendations for feed and related weight gain, it is assumed that hogs gain at an average weight of 1.5 lbs. per day after they reach sixty pounds. Using this information, the unit explains how to determine which weight group will provide the hogs to be slaughtered in a future month. After determining the appropriate weight group, the percentage change in quantity supplied compared to the previous year is calculated. The student uses the percentage change in quantity and the own price elasticity formula to estimate the future price assuming demand remains constant. The change in quantity is graphed and it is reiterated that this is movement along the demand curve.

The next step is to determine the effect of changes in income and prices of substitutes, i.e. beef and chicken, on demand. Once these percentage changes are calculated, the students are asked to use them to find the percentage change in the quantity of hogs demanded if the price of hogs is held constant. This is graphed and students are reminded that this is a shift in demand.

The third step in the process is to put together the result of the movement along the demand curve resulting from a change in quantity supplied, ceteris paribus and the shift in demand resulting from changes in the prices of substitutes and income, ceteris paribus. This, too, is done graphically as well as verbally and mathematically. Based on the changes in supply and shift in demand, students are asked to calculate a percentage change in price and the subsequent price. This price is graphed in terms of the previous year's dollar. The

price is then inflated to the current year's level. This first example is worked using actual prices, CPI, and per capita disposable income.

A second example is worked where the students are asked to project the CPI and disposable income. In this example they are given futures market prices for beef and broilers for the month closest to but not before the date they would expect to sell their hogs. To project the CPI for the month of hog sale, it is assumed that the rate of inflation will continue to be the same as it has been from the most current month for which there is information compared to the same month in the previous year. A similar assumption is made about per capita disposable income. Per capita disposable income is published on a quarterly basis. Using the most recent quarterly data and the data from the same quarter for the previous year, a percentage change is calculated. This percentage change is then multiplied by the per capita disposable income reported for the previous year for the quarter in which the hogs will be marketed. This procedure gives an undeflated projected per capita income for the quarter in which the hog marketings will occur. Students are asked to make these projections and then forecast the price of hogs. As in the first example, the students are shown the correct answers and procedures after they have attempted each step.

After students have completed the mathematical calculations and the graphical analysis, they are asked to consider how good their forecast is compared to the actual average price for that month. They are asked to consider why the two, their forecast and the actual price, are not the same. At this point, some of the limitations of

the elasticity approach are discussed along with the many other factors that can and will affect hog prices.

Forecasting Ability of Elasticity Approach

To evaluate the accuracy of using elasticities to estimate hog prices 4 1/2 months into the future, estimates were made based on the production numbers given in the Hog and Pig Report from March, 1975 through September, 1979. Actual prices, futures prices, and USDA forecasts, along with linear estimates of CPI and per capita disposable income were used to determine the accuracy of the procedure. Actual prices for Omaha Choice steers (900-1050 lbs.) and the 7-cities barrows and gilts were obtained from Livestock and Meat Situation. The 9-city average wholesale broiler prices were obtained from Poultry and Egg Situation. CPI and per capita disposable income were obtained from Agricultural Outlook. Since futures contracts do not always mature in the month that hogs were to be marketed, the contract closest to but not before the month of the hog sale was used. The price was based on the closing price for the day following the release of the Hog and Pig Report. USDA estimates of beef and broiler prices are published on a quarterly basis in Livestock and Meat Situation and Poultry and Egg Situation. In September and June when the Hog and Pig Report is released, there are no first quarter or third quarter price estimates available from these USDA reports. It was assumed that broilers increase in price in both the first and third quarters; therefore, the high estimate from the fourth and second quarters, respectively, were used. For beef it was assumed that quarter I is a period of low beef prices and that quarter III is a period of high beef prices. Based on these assumptions, the low

price from the fourth quarter and the high price from the second quarter were used. Otherwise a simple average of the reported range was used. All prices and income were deflated to the previous year's level and then reinflated to compare them with the actual price of hogs received.

Initially, farm level demand elasticities of -.4 for hogs; .1 for the cross elasticity between hogs and beef prices; .05 for the cross elasticity between hogs and broiler prices, and .35 for income elasticity were used. These were based on a concensus of elasticity estimates obtained by Brandow, George and King, Martin and Zwartz, Myers and Havlicek, and Roy and Young. Marsh and Heironymus estimated price flexibilities which, if assumed to be the inverses of elasticity, fell within the range of previous estimates. Using these elasticities with actual prices of beef, chicken and income produced hog price forecasts that consistently over-reacted to changes in hog quantities. Since none of the elasticity estimates mentioned above except Marsh and Heironymus included data beyond 1973, and since Roy and Young's work suggests that elasticities change over time, a simple model using annual data for quantity of hogs per capita as a function of price of hogs, price of beef, price of chicken, and per capita disposable income was estimated. All price and income data were deflated by the Consumer Price Index. The estimated equation is:

$$QH = 81.92 - 2.65\ PH + 1.27\ PBR + 0.95\ PB + 0.004\ I$$

$$(4.23)(-7.12) \quad (2.20) \quad (3.43) \quad (0.82)$$

$$R^2 = 0.95 \qquad d = 1.76$$

where:

QH = liveweight consumption per person (lbs.)

PH = average 7-city market hog price,

PBR= average 9-city market wholesale broiler price

PB = average Omaha choice steers price, and

I = U.S. per capita disposable income

This equation has the expected signs on all the coefficients and they are statistically significant, with the exception of income, at the 5 percent level. Using the estimated coefficients and the mean quantity of hogs and mean prices, elasticities were estimated. The own price elasticity was found to be -.64. Cross elasticity for hogs and beef was found to be .27, for hogs and chicken .34. Income elasticity was found to be .13. All of these elasticities are within the range of elasticities found by previous researchers.

The actual hog prices and estimated prices using the above elasticities and the elasticity approach are plotted on Figure 1. These forecasts are for 4 1/2 months into the future based on the number of hogs under 60 lbs. in each quarterly Hog and Pig Report. When the estimated elasticities were used with actual income, beef and broiler prices, the mean absolute error was $4.09 cwt and 7 turning points were missed. When futures market prices were used to estimate beef and broiler prices, the average absolute error was $4.26 and 10 turning points were missed. When USDA price forecasts for beef and broiler prices were used, the average absolute error was $3.91 and 4 turning points were missed. With the exception of the April, 1978 forecasts, this procedure does remarkably well, given its simplicity. The large error in April, 1978 of $9.00 per cwt is related to the inability of the futures market and USDA to anticipate the rapid rise in beef prices which increased the demand for hogs and hence hog prices.

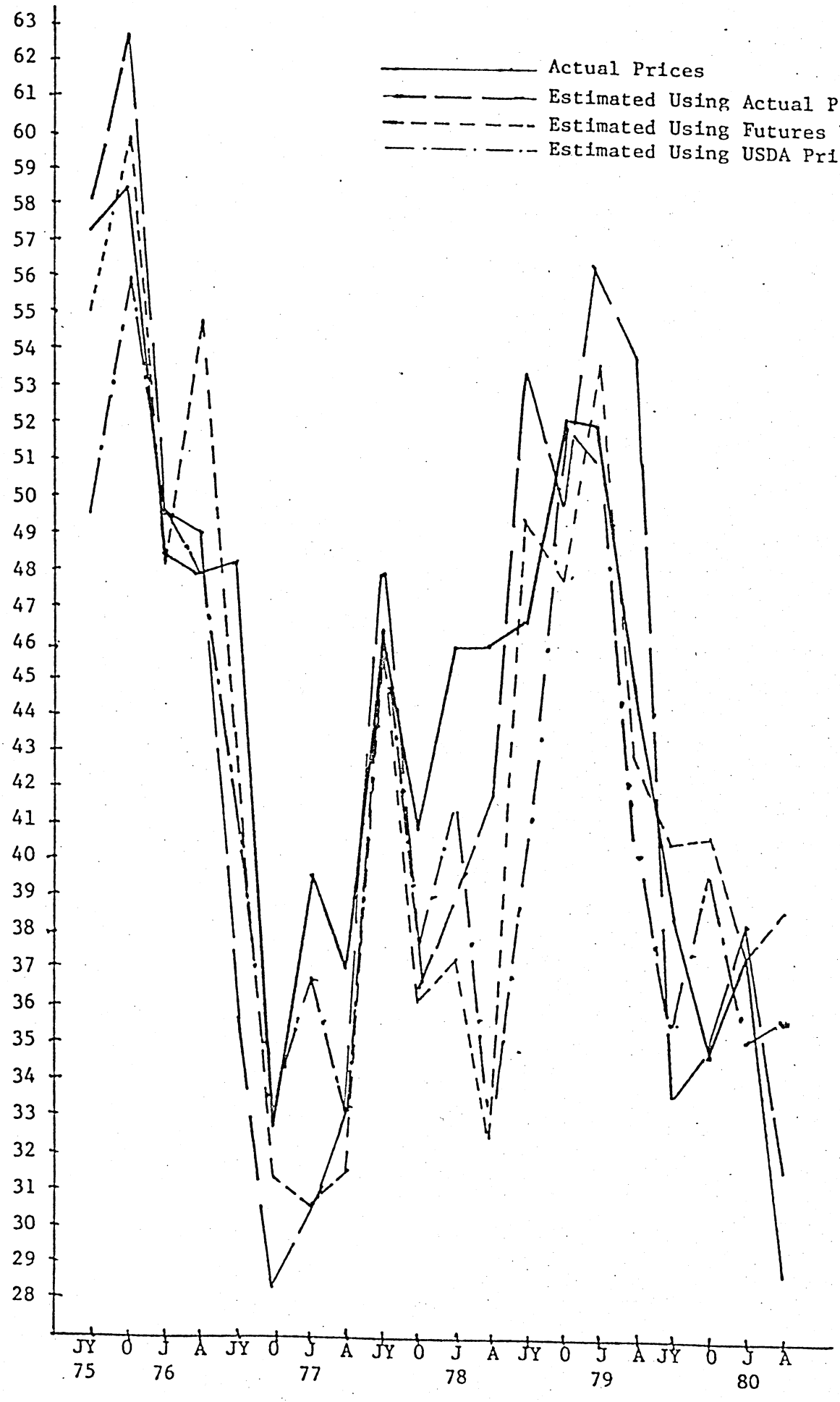


Figure 1. Actual and Estimated Hog Prices, July 1975 to April 1980.

Evaluation of Self-Learning Unit

The students were asked to evaluate the self-learning unit and comment on areas they felt were weak and needed changing. The general consensus of opinion by the students was that the unit was helpful. Some suggested that the general discussion at the beginning on movement along a demand curve versus a shift in demand, elasticities, and calculating percentage change was too elementary for them. This led to the decision to direct students who feel they are competent in these areas to start with the section on "Adjusting Prices for Income and Inflation."

The students' understanding of the concepts taught was evaluated by a problem set and questions on a mid-term and a final exam. Fifty-five percent of the students scored 95 percent or better on the problem set; five percent scored less than 70 percent. It is not possible to come to any conclusions concerning the students' performance on exams: given the length of the exams; many students did not completely finish the questions that dealt with elasticities. Even after having at least three exposures to the method and concepts: in class, in the self-learning unit, and upon return of their problem set on elasticities, some students still could not integrate the concepts of movement along demand curve and shift in demand to obtain a net change. This was the area where the greatest confusion existed. After improving the exposition and examples in this section, some students still have a difficult time properly summing up percentage changes in hog numbers and percentage shifts in demand.

From the instructor's viewpoint, the self-learning unit is beneficial in several ways. First, the review section on movement

along the demand curve, shift in demand, and the corollary direct elasticity and cross elasticity reduces in-class time spent on review. The review of computing percentage changes and deflating prices is needed by many students. The greatest benefit is that students learn that a simple procedure using elasticities with readily available free information can produce reasonably accurate price forecasts. Using actual prices and quantities, the unit clearly demonstrates to students that elasticity is a useful concept and of much practical value. A third benefit is that students are familarized with several information sources and shown their value in making marketing decisions. Fourth, the procedure of using actual prices and quantities and demonstrating these changes in supply and demand graphically help the student develop a better feel for the concept of supply, movement along a demand curve, and shift in a demand curve. Many students begin to grasp for the first time the true difference between movement along a demand curve and a shift in demand. Overall, the process of using real-life current examples, actual data, and demonstrating their usefulness in making marketing decisions greatly increases the students' appreciation for the concepts of supply, demand, and elasticity.

REFERENCES

Brandow, G.E., Interrelationships Among Demands for Farm Products and Implications for Control of Market Supply. Pennsylvania State University Agr. Exp. Sta. Bull. 680, 1961.

George, P.S. and G. A. King, Consumer Demand for Food Commodities in the United States with Projections for 1980. Giannini Foundation Memorandum, No. 26, University of Claifornia, Davis, 1971.

Hieronymous, T. A., Price Forecasting and Sales Management. Cooperative Extension Service, University of Illinois, 1979.

Kohls, Richard L. and Joseph N. Uhl. Marketing of Agricultural Products. New York: Macmillan Publishing Co., Inc., 1972.

Marsh, John M., Effects of Marketing Costs on Livestock and Meat Prices for Beef and Pork. Montana Agr. Exp. Sta., Bull. 697, May 1977.

Martin, Larry and Anthony C. Zwartz, "Spatial and Temporal Model of the North American Pork Sector for the Evaluation of Policy Alternatives," American Journal of Agricultural Economics, 75(1975): 55-66.

Myers, Lester H. and Joseph Havlicek, Jr., "Monthly Price Structure of the U.S. Beef, Pork, and Broiler Markets," in Quantative Models of Commodity Markets, edited by Walter C. Labys, Cambridge: Ballinger Publishing Co., 1975.

Purcell, Wayne D., Agricultural Marketing, Systems, Coordination, Cash and Futures Prices. Reston, Va.: Prentice-Hall, Co., 1979.

Regier, Donald W. Livestock and Derived Feed Demand in the World GOL Model. Washington D.C.: U.S. Department of Agriculture, Foreign Agr. Econ. Report No. 152, 1978.

Rhodes, James V., The Agricultural Marketing System. Columbus, Ohio: Grid Publishing, Inc., 1978.

Roy, Sujit K. and Richard D. Young, Demand for Pork: A Long-Run Analysis. Texas Tech University, Pub. No. T-1-153, July, 1977.

Shepherd, Geoffery, Gene A. Futrell, and Robert J. Strain, Marketing Farm Products: An Economic Analysis, Ames, Iowa: The Iowa State University Press, 1976.