Supply response of Grade A milk production in upper Flathead Valley
by Jack R Davidson

A THESIS Submitted to the Graduate Faculty in partial fulfillment of the requirements for the degree of Master of Science in Agricultural Economics at Montana State College
Montana State University

Abstract:
This study was devised to estimate supply response of Grade A milk in Flathead County. Examination of previous work indicates that several methods of approach have been utilized. Limitations of time and data restricted it largely to a demonstration of the manner in which the budget technique might be used for this purpose, yet some of the substantive results can be stated briefly.

A representative Grade A milk producing farm for this area was described with a synthetic model based on the use of survey data. The existing organization was related to current price for milk and other relevant farm products. For posited changes in milk price, optimal adjustments were budgeted in selected parts of the farm organization. The results in terms of milk output then serve as estimates of supply response to changes in milk price over a restricted range—but only with respect to the budgeted adjustments Elasticity of supply with respect to milk price is estimated at between .25 and .08 as a possibility of almost immediate response, based on response due to change in feeding level. Over a time period sufficient to permit changes in herd size the elasticity estimate increases. It would increase still further, if other adjustments were taken into account. On the other hand, many of the non-economic factors which influence supply response would doubtlessly reduce the actual elasticity estimates.

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Head, Major Department

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The Abstract

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PART I

INTRODUCTION

The Problem

The Concept of Supply

The concept of supply as used by economists indicates the quantities of a product or productive service that will be made available to buyers in a specified market at a specified time, at any of a series of specified prices if such prices were offered. As in the case of demand, actual production of the physical commodity is unnecessary for the existance of supply. Rather supply represents willingness and ability to make the quantity available in response to a price situation. 1/ With supply as a function of price, the quantity of a product made available is a function of price expectations.

Statement of Problem

Questions of the aggregate production functions and supply responses in agriculture are of concern to all individuals, firms and public agencies related to agriculture. 2/ Supply functions are of particular concern to those buying from or selling to operating farmers and to agencies responsible for the development of policy and administration of programs which affect farmers. The farmer's concern with supply response is indirect but important.

1/ Thomsen & Foote, Agricultural Prices, McGraw-Hill Book Company, Inc., 1952, p. 57.

2/ E. O. Heady, Economics of Agricultural Production and Resource Use, Prentice-Hall, Inc., New York, 1952, p. 672.

As an exploration in farm management research methodology the purpose of the following study will be to point to a method for the derivation of meaningful supply curves for the production of Grade A Milk. The objectives of the present investigation will be, (1) to discover the problems met in determining the factors influencing the production-response to a change in milk price, (2) to determine the various alternatives available by which Grade A dairy farms in mountain valleys of western Montana may respond, (3) to point to a method by which the response may be indicated and by which the various alternatives may be tentatively tested, and (4) to test, illustratively, some of the available alternatives to arrive at the expected response.

Review of Literature

Early Work

Studies of supply response, as concerned with agricultural production, are not new. In the past 30 years studies of farmer response to price and other factors have dealt with a wide range of farm products. The problem received considerable attention in the decade between 1930 and 1940 as an important factor in the effort to adjust agricultural production to prospective supply and demand conditions. The individual producer who would adjust his acreage and livestock numbers, with due regard to what other producers are doing, needs to judge in advance the probable total output that will compete with his production when it is ready for market. Similarly, in setting up the over-all production objectives of a national agricultural program, advance judgments must be made not only of the probable

effects of the program itself but also of farmers response to price, technological changes, and other factors. For these reasons most of the work prior to 1939 was related to the short run or immediate response. 3/

The Role of Price Expectations

One hypothesis relating to the role of price expectations in determining supply response, the "Cobweb Theorem", was presented by Mordecai Ezekiel in 1938. 4/ This was of particular value in explaining the type of response which might be expected as a result of year to year adjustments. With supply a function of price under conditions of atomistic competition, the price and production of a commodity is determined at the point where the supply and demand curves intersect. Under the static conditions assumed, a disturbance moving price and production from the intersection point sets into motion the forces to return to the original position. 5/

In considering the amount supplied as a function of the price expectations, where this is a considerable lag in the response of production to price change, and elasticity of supply = elasticity of demand, the price and production may not return to the original point but instead may circulate

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3/ R. P. Christensen and R. L. Mighell, Supply Responses in Milk Production in Dodge and Barron Counties, Wisconsin, U.S.D.A. Tech. Bul., 1941, p. 1.

4/ Mordecai Ezekiel, "The Cobweb Theorem", Quarterly Journal of Economics, LII, February, 1938.

5/ G. S. Shepherd, Agricultural Price Analysis, Iowa State College Press, 1947, p. 90.

about it. Under this concept a high price calling forth a large supply intersecting the demand at a low price would in turn call forth a relatively short supply which, in turn, would intersect the demand curve at a high point. This concept would be one of continuous fluctuation around the equilibrium point as illustrated in Part A of Figure 1 below.

When elasticity of supply is greater than the elasticity of demand a situation occurs as shown in part B of Figure 1. This would be a situation of divergent fluctuations. The magnitude of cyclical price and production changes increase over time. Under these conditions the situation might grow increasingly unstable until the elasticity of supply changed or production was abandoned. The reverse situation as shown in part C is that of convergent fluctuations in which price and production approach more and more closely to the equilibrium conditions as outlined in the static concept.

A. Continuous Cycles B. Divergent Cycles C. Convergent Cycles

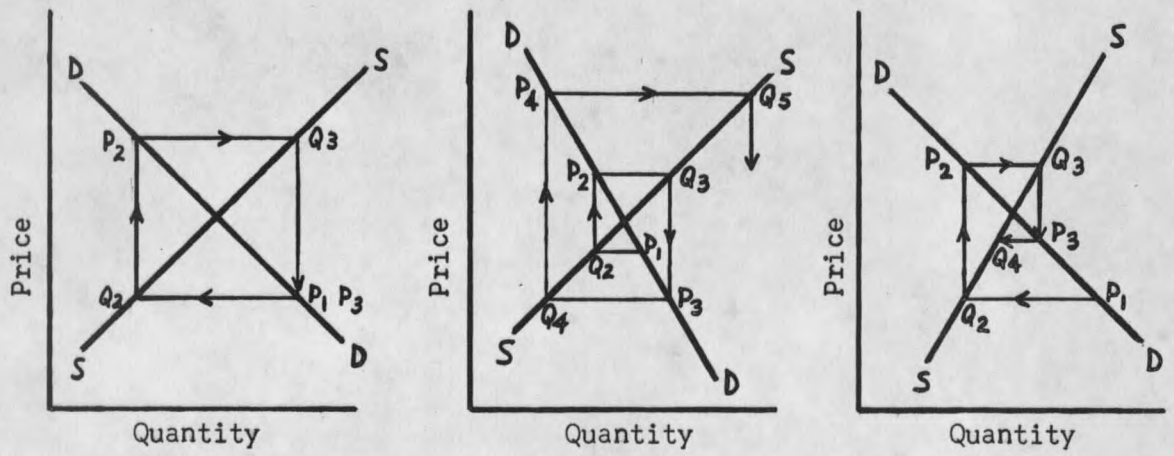

Figure 1. The mechanics of continuous, divergent and convergent cycles in prices and production.

Significance of Earlier Studies

These studies made little more than passing references to the significance of longer-term phases of supply. This situation was not peculiar to studies of production and supply, but was also found in the field of consumption and demand research in that period.

There appear to have been two principle reasons for this situation. The first is related to the rapid development and widespread use by agricultural economists of statistical procedures (including multiple correlation technique) for dealing with time-series data. As such analysis is projected further into the future, the standard error of estimate becomes larger. As the period is lengthened, the number of independent variables become larger and net influence of each is harder to estimate. Data requirements become greater and more difficult to handle. As such these statistical procedures seemed most effectively applied to short-run problems. The second and more important reason for the concern of the public research agencies with short-run problems was that these appeared to be more urgent, and most practical assistance could seemingly be rendered in this way to farmers and to the general public. Although it was recognized that farmers had important long-term decisions to make, it was generally felt that the most useful contribution could be made in developing information to aid in the year-to-year adjustments. 6/

Efforts of research workers in deriving meaningful supply curves by the historical-statistical procedure have not been too fruitful and the

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6/ Christensen and Mighell, op. cit., p. 2.

results are open to question. As indicated by G. S. Shepherd, this can be attributed to the many variables which must be taken into account in supply analysis such as weather, changes in prices of various cost items, changes in technological processes, etc. 7/ However, the value of this work as ground breaking device is very important.

Methods Developed to Determine Supply Response of Milk Production

In an attempt to analyze supply response of milk production, several alternative ways to derive supply curves have been attempted. For example, in 1940 an attempt was made to derive a supply curve for milk in a localized area of Vermont by the familiar budget procedure. 8/ In this case the supply curve represents a much longer-run period as all adjustments which could reasonable take place within ten years were permitted. Estimates were based upon the study of individual records from representative samples of farms. It consisted of working out budget estimates of production for each farm, say, ten years hence, under several different price situations--higher price for the product (say 15 percent higher), constant prices and lower price. These estimates, added up, then provide three points on the long-time curve.

This method presents difficulties of its own, and involves a good deal of estimation. The results of applying this method to a study of milk production in the Cabot-Marshfield area of Vermont are shown in Figure 2. The heavy solid line BAC shows the estimated response of production ten

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7/ Shepherd, op. cit., p. 90.

8/ R. H. Allen, Erling Hole, and R. L. Mighell, Supply Responses in Milk Production in the Cabot-Marshfield Area, Vermont, USDA Tech. Bul. 709, 1940.

years later to milk prices 15 percent higher, constant, and 15 percent lower than they were originally. A short-term (three-month) supply curve for the same area is shown by the curve SS.

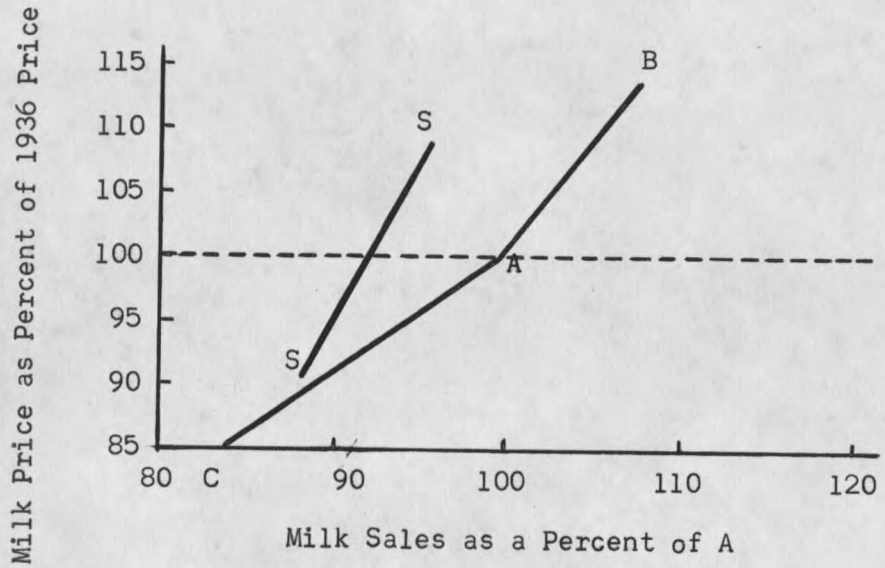

Fig. 2. Long-time and short-time responses of milk production to price changes. (As taken from Allen, Hole, and Mighell by G. S. Shepherd). 9/

Cost Analysis and Supply Curves

In developing a supply curve for an individual firm or an industry, (discussed in a later section) supply is a function of the costs that are variable. Estimations of these costs depend upon productivity estimates for variable resource services. Hence, Einar Jenson endeavored to derive a production function for feeding dairy cattle by experimental techniques.

9/ G. S. Shepherd, Agricultural Price Analysis, Iowa State College Press, 1947, p. 92-93. See also Allen, Hole, and Mighell, op. cit.

This method gives an indication of the possibilities of the experimental technique. Results from such a study can be transformed into the familiar cost curves of traditional economic theory. The portion of the marginal cost curve lying above the minimum point of the average variable cost curve represents the supply curve for the firm in terms of milk. In this case, changes in the amount supplied are assumed as due only to changes in the amount of feed input. Thus, each production function depends on the level at which the other factors are held constant. The supply curve which is derived in this fashion can be used to represent responses which are likely to occur in the short-run and are concerned with the variable feed costs. 10/ Although adaptibility of experimental data to actual situations is questionable, the importance of the method indicated and the nature of the results of such observations should not be overlooked.

Inter-Area Analysis

A third alternative has received mention but little widespread recognition. This is the possibility of developing supply curves on the basis of data collected within geographic regions throughout which production conditions are similar, but in which inter-area prices differ. If several different areas can be found with similar conditions of productions but different prices, and if these price differences have persisted long enough for the production of different areas to become adjusted to them, then the

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10/ Stanton P. Parry and William McD. Herr, "A Note on the Derivation of Short-run Supply Curves," Journal of Farm Economics, August, 1954.

prices and production per square mile in the different areas can be used as points on a long-time supply curve. 11/ It is necessary to assume that the functional relationship between feed inputs and milk output is similar between the geographic areas within the region. It also must be assumed that each area is homogeneous with respect to resources and their prices but with differing product price situations. Under these assumptions a short-run curve is meaningful only insofar as the rate of feeding is the primary response by farmers to short-run changes. 12/

Determinants of Supply

Supply Curves

At any price the respective competitive firms will attempt to operate at the output where marginal cost equals price. This will maximize returns net of variable cost and hence designate the optimum. If the total outputs of the various firms in a region or industry are added together, the total amount which will be supplied at any given price will appear. With the finding of the quantity which will be supplied at other prices the supply curve for the industry can be constructed. Given the supply and demand curve for the industry, the price at which quantity supplied equals quantity demanded is found as demonstrated in Figure 3.

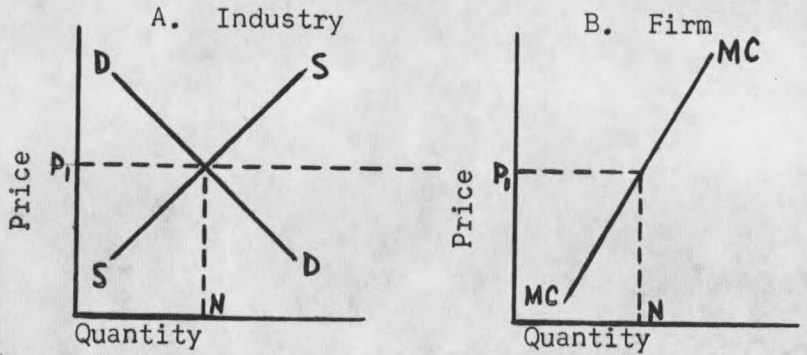

Figure 3. Price Determination of a Firm's Output

11/ Shepherd, op. cit., p. 90.

12/ For further information concerning this type of analysis see Stanton and Herr, op. cit., p. 521.

In determining the amount to be supplied only the relevant portion of the marginal cost curve or that portion lying above average variable costs is shown in Figure 3B.

The Elasticity of Supply

The elasticity of supply is the proportional relationship between prices and quantities. It can be indicated as the percentage change in quantity or output divided by the percentage change in price:

$$E_s = \frac{\Delta q}{q} \div \frac{\Delta p}{p} = \frac{\Delta q}{\Delta p} \cdot \frac{p}{q}$$

The elasticity of the supply curve will normally differ at each point on the curve. The "elasticity of the supply curve", usually relates to the arc (average) elasticity rather than point elasticity. However, the term "elasticity of supply" may refer to either. 13/

Elasticity of supply, due to the number and type of alternatives available, is usually greatly increased over longer periods of time as compared to that of shorter periods (as shown in milk supply curves, page 4). 14/ Under many different supply situations in agriculture, particularly those covering relatively short periods of time, the supply appears to be so inelastic within the normally encountered price range as to justify its designation as "fixed".

Thomsen and Foote, in attempting to analyze the difficulty of separating the effects of price from other influences on production and isolating the precise price-quantity relationships indicated by the law of supply,

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13/ Heady, op. cit., p. 674.

14/ Shepherd, loc. cit., p. 93.

indicate that the apparent exceptions reflect three conditions: (1) the difficulty or impossibility of determining what price producers or sellers expect to receive when they make their plans for production or selling; (2) the interference of weather and other environmental conditions not related to price; (3) frequent shifts in the supply schedule or curve as a whole so that it cannot be determined whether a given change in quantity resulted from a change in prices or from a change in the whole schedule of quantities associated with different prices. 15/

Sources of Supply

The sources of supply or quantity that will be furnished in response to a given price may be derived from (1) the stock of the particular commodity held in storage by the firms or (2) from production. 16/ Supply derived from production in turn must come from resources committed to the production process or resources not committed. The first type of response would necessarily depend a great deal on the storability of the product and the economic feasibility of storage as decided by the second type or length of time required for the potential producers to respond. As the length of time and certainty of price expectations are extended, the role of uncommitted resources becomes progressively more important as a factor in determining supply.

It should be pointed out that only by considering very short periods of time is there found important examples of commodities in "fixed" supply.

15/ Thomsen and Foote, op. cit., p. 70-71.

16/ Thomsen and Foote, op. cit., p. 58-9.

It should be apparent that the length of time necessary to vary the supply would depend upon the size, complexity and degree of specialization of the plants involved as well as the products produced. The reluctance of producers to commit resources in the form of fixed investment items also extends the time period necessary to induce response. When response of production becomes flexible over short periods of time, supply more nearly becomes a function of price. This function in turn is influenced as previously mentioned by prices, quantity, availability of feed stocks and uncertainty of duration of change. This analysis deals with the quantities that farmers should rationally attempt to produce in response to given price expectations to maximize net income not with the quantities actually produced insofar as these are affected by conditions outside of the firm's control. Estimates of the latter sort require the use of probability estimates unavailable for this study.

Price as a Determinant of Supply

Of the many important variables influencing production and the types of uncertainty encountered, the main criterion used in determining what production program will be followed is profitability. Any apparent lack of relationship between price and subsequent supply is largely due to the associated variables and the relative importance of non-economic considerations rather than an absence of a definite price-supply relationship. It must be remembered that despite the influence of these other factors, which tend to partially cover up the operation of the law of supply, the changes in production would have been different in the absence of the changes taking place

in the price of the commodity. As discussed previously, the response will be considered the function of price expectations. Therefore the level of price change and certainty of change necessary to cause the producer to act must be considered.

Variability in Price

The individual farmer as entrepreneur of a competitive firm, has no control over prices. Large fluctuations may occur between planting and harvesting. The coefficient of annual milk production variation in Montana for the period 1944-1954 was 28 percent. The range of milk prices in this area often varies 10 percent or more within a lactation period.

Factor prices as a rule show less variability than product prices. This has long been a point of contention to the farmer who must adjust his production to a downward shift in product price while factor prices remain inflexible.

The Hypothesis

For purposes of this study it will be assumed that profitability is the prime determinant of the amount which will be produced. Assuming the farmer is economically motivated, the hypothesis of this study is that the budget method can be adapted to a study of supply response of milk production. This should reveal, within the range of the alternatives tested, the production possible as a response to a change in price expectations.

The Method

Farm Budgeting

The farm budget consists of an operational and organizational

statement of a firm either hypothetical or actual over a given period of time. It is, under the "actual" situation, together with an estimate of income and expense related thereto, a plan of future operation. Thus it can be used as an analytical technique for comparing net returns from several alternative organizations of an individual farm firm. 17/

The budget can also be used as a descriptive device in terms of which to synthesize an average or representative situation. The flexibility of the budgeting technique has long made it a useful tool in the application of economic principles to a farm firm.

The synthetic farm model is analogous to such devices as test plots or experimental conditions used in other areas of research in agriculture. In depicting an average or representative farm to serve as a form of classification, the concept entails the construction of the model under very precisely defined conditions. In this way the method has been developed and used in a wide variety of farm management studies.

Using the Synthetic Model

The synthesizing process is used to permit freedom in combining production resources and practices so that a similar degree of managerial ability or efficiency is attained for all farms included as combined in the "average". The synthetic models, analogous to experimental technique, "fix" many of the variables found under actual conditions in order to estimate the influence of the variable factors under study.

17/ E. G. Strand and E. Hole, Supply Responses of Milk Production in Southeastern Minnesota, USDA, Tech. Bul. 789, Nov. 1941, p. 25.

Estimates of the effects of change can and often are based directly on information provided by research in such areas as agronomy, animal nutrition and agricultural engineering. Crop and livestock response information obtained from such sources may be utilized to provide the input-output data basic to the construction of farm models. 18/ Information from sample sources is utilized in determining size, type of farm and as a basis for making classifications. In general the strength of sample information used in the synthesis is in its representation of the universe in which the study is being conducted.

In practice the budgetary technique starts from a given situation. The effect of an adjustment on farm income is then calculated by estimating the additional expenses and receipts that are associated with the change. In this way the impact of alternative production practices on total farm business can be estimated. However it should be noted that this trial and error method is so time-consuming that only a few of the more important variable conditions can be tested. To facilitate this, the greater manipulative power given by linear programming may be attractive in farm management studies requiring analysis of numerous alternatives.

Short Cut Budgets

To increase the number of variables which can be tested, the method of partial budgeting will be used. Starting with the synthetic model representing the complete budget, analysis will be made by partial or "short-cut"

18/ I. E. Fellows, G. E. Frick and S. B. Weeks, Production Efficiency on New England Dairy Farms, Storrs Agr. Expr. Sta., Bull. 285, p. 9.