



Risk and uncertainty in the appraisal of sunken investments in range development
by Richard J McConnen

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

Northern Great Plains ranchers contemplating a sunken investment in range development face the problem of arriving at and properly discounting expected increments to net ranch income. Methods of determining mean expected increments to net ranch income are made in terms of long run averages rather than determining the increments as they occur over time.

The discounting process for time preference is quite well developed. However, the problem of selecting the proper discount rate is "somewhat obscure. The method of valuing such-sunken investments does not presently have adequate criteria to value the effect of risk and uncertainty.

The approach to the problem is in four phases. First, the method of extrapolating expectations was based on Hart's three principles plus a fourth principle added by the author. It was established that the time preference discount process should account for time preference only, using Keynes' three factors to determine the cost to hold money. An Uncertainty Correction factor (HG) which is a function of the Coefficient of Variation (CV) was developed from the indifference analysis of variation and effective income used by Lange and the Lutzers. The above mentioned approaches to the three main problems were then combined in an attempt to apply them in valuing a sunken investment.

The method of valuing which was developed represented a framework for valuing rather than an operational method of valuing. The importance of properly valuing the effect of risk and uncertainty on both the individual rancher and society is considered. The study reaches conclusions which are general rather than specific, inasmuch as the solutions to the three main problems mentioned are of a largely psychological origin.

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IN RANGE DEVELOPMENT

by

RICHARD J. MC CONNEN

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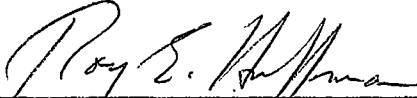
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While this work is by no means highly original, the author reserves the right to take full credit for any deficiencies and/or inconsistencies which are present.

ABSTRACT

Northern Great Plains ranchers contemplating a sunken investment in range development face the problem of arriving at and properly discounting expected increments to net ranch income. Methods of determining mean expected increments to net ranch income are made in terms of long run averages rather than determining the increments as they occur over time. The discounting process for time preference is quite well developed. However, the problem of selecting the proper discount rate is somewhat obscure. The method of valuing such sunken investments does not presently have adequate criteria to value the effect of risk and uncertainty.

The approach to the problem is in four phases. First, the method of extrapolating expectations was based on Hart's three principles plus a fourth principle added by the author. It was established that the time preference discount process should account for time preference only, using Keynes' three factors to determine the cost to hold money. An Uncertainty Correction factor (UC) which is a function of the Coefficient of Variation (CV) was developed from the indifference analysis of variation and effective income used by Lange and the Lutzes. The above mentioned approaches to the three main problems were then combined in an attempt to apply them in valuing a sunken investment.

The method of valuing which was developed represented a framework for valuing rather than an operational method of valuing. The importance of properly valuing the effect of risk and uncertainty on both the individual rancher and society is considered. The study reaches conclusions which are general rather than specific, inasmuch as the solutions to the three main problems mentioned are of a largely psychological origin.

I. The Problem, and Associated Definitions and Assumptions

The formulation of a problem consists of establishing the boundaries of the problem and identifying the contents within these boundaries. The clarification of the problem will not come about until the solution, or attempted solution, is presented.

This problem is identified as "the difficulty which arises for the planning agent in the area of decision making with regards to the valuation of a sunken investment". In this particular case, the planning agent is a livestock rancher in the Northern Great Plains. The task at hand is that of either finding or developing the method of valuation which is best suited for the geographic area and the type of enterprise in question. The problem approach will consist of three phases. First, the method of valuing which it is assumed ranchers are prone to use in practice will be developed. Secondly, a method of valuing a sunken investment will be presented which is based on pure theory. Thirdly, a model of valuing will be presented which will be an attempt to utilize the usable portions from both the first and second methods.

A "sunken investment" is an investment which when once made becomes an intrinsic part of the land. However, certain qualifications of the above definition should be made.

The mobility or immobility of an investment is a relative, not an absolute concept. Some investments may be moved or sold apart from the land with various degrees of ease (or difficulty). Immobility itself is

not the sole criterion of a sunken investment. For this paper, a sunken investment will be held to exist when the following qualifications are met.

1. The investment has to do with acquisition of new land, or the development of old land. The investment is not expected to have a scrap value. The investment is calculated to effect the slope and/or shape of the ranch's total product function.

2. The investment is made with the intent of utilizing it for more than one production cycle.

To analyze the intentions of a man is a difficult procedure. Even the man committing the act may find it impossible to know his true intent. In the case of an investment on the part of a rancher, he must answer this question himself, for he alone can know his intent. In answering, he must be realistic enough to give himself a relevant answer as to his intentions with regard to the expected life of his investment. 1/

A sunken investment is such because of both purpose and intent. The classification of investments as to sunken or not is based on a discreet decision of the rancher. Opinion may vary on border line cases, but a clarification of the intent of the investor should determine whether or not the investment is sunken.

1/ To explain: A rancher spends say, \$550 in digging a well. The well is literally, as well as physically, a sunken investment. Economically speaking, such a well may be anything but a sunken investment. If such a well were dug to enable a rancher to sell a half section of land, and the well was dug with this purpose in mind, the investment is anything but sunken to the primary investor.

The internal costs and revenues are assumed to be the causal factors which will be the basis upon which the entrepreneur will base his decision. Undoubtedly, the causal factors are of an almost infinite number. Many of the causal factors are of an intangible nature and many enjoy a complex inter-relationship with other causal factors.

This multiple hodgepodge of causal factors seem to present a Gordian knot to the investigator. For certainly, an unraveling would entitle the doer to recognition, master of a wide scope of knowledge. No such noble goal will be the purpose of this paper. In order to understand or analyze a problem of such intricacy, it is often found necessary to examine only those most relevant causal factors. Such a practice will be followed in this paper. However, it will not be presupposed that those less relevant causal factors may be ignored completely, for oft times the aggregate effect of the less relevant causal factors will exercise a governing effect on the decision in question.

Since this paper will be concerned with the problem of evaluating fixed investments on range land (range development) in the Northern Great Plains region, it is only appropriate that the nature of range land, with special reference to the area in question, be defined and examined.

The formal definitions of range may be said to number only slightly fewer than the definers. The Congress of the United States saw fit to define western range as follows: 2/

2/ The Western Range, Senate Document 199, 74th Congress, 2nd Session, 1936.

"The Western range is largely open and unfenced with control of stock by herding; when fenced, relatively large areas are enclosed. It supports with few exceptions, only native grasses and other forage crops, is never fertilized or cultivated, and can in the main be restored and maintained only through control of grazing. It consists almost exclusively of lands, which because of relatively meager precipitation or other adverse climatic conditions, or rough topography, or lack of water for irrigation, cannot successfully be used for any other agriculture."

The completeness of the above definition may be questioned, especially in light of the purpose of this paper. Yet, it is felt the definition is generally good.

The first questionable passage is the "never fertilized or cultivated." If "seldom", "practically never" or some such meaning phrase replaced the word never, the definition would be much more correct. Brush eradication, range reseeding, and other such range development programs involve varying degrees of cultivation. The mere act of cultivation need not change the basic properties of range land. Reseeded range land is used in practically the same manner as it was before the reseeding. Usually, the intensity of use increases directly with the intensity of cultivation. Fertilization is practiced to a lesser degree than cultivation, but fertilizing may still be profitable. Trace mineral fertilization of range land in Australia has proven this.

The mentioning of "adverse climatic conditions" in addition to

inadequate rainfall as a limiting factor in land use, merits some additional attention for this particular area. Prevailing winds, length of growing season, etc., may place limitations on the land use that precipitation may not entail. Such limitations are, however, usually quite unimportant when compared to the limitations caused by precipitation. Variance of annual precipitation and variance of seasonal distribution will, if the variance dips below the "critical level" for dryland farming often enough, restrict land use to that of range. It is noteworthy to mention that the "average year" seldom prevails. Saunderson mentions the "mythical" character of the average year in this area in his discussion of fluctuating grazing capacities. ^{3/} Also of particular interest is the type of distribution the average rainfall pattern makes for the Northern Great Plains. There seem to be a non-cyclical groupings of like averages. Clawson discusses this at some length and develops a means of statistical classification. ^{4/}

The uncertainty of annual precipitation may not only prescribe the intensity of use to which a land should be put, but may also determine the flexibility this intensity should enjoy. This will be discussed later.

^{3/} M. H. Saunderson, Western Stock Ranching (Univ. of Minn. Press, 1950), pp. 103-104.

^{4/} Marion Clawson, The Western Range Livestock Industry (McGraw-Hill Book Co., 1950), pp. 41-44.

II. A Description of the Method of Valuing Commonly Used by Commercial Livestock Ranchers in the Northern Great Plains.

The purpose of this section will be the presentation of a formalized expression of the method of valuing commonly used by livestock ranchers in the Northern Great Plains. It is not held that all ranchers act in the following manner, but it is felt that the principles presented are in wide acceptance.

Consciously or unconsciously, the rancher bases his valuing method on the principles of the theory of the firm. However, the valuing method for the rancher is quite apt to be in much more informal terms than those used by the economist. For the purpose of clarity, economic expressions will be used to identify the various principles of the theory of the firm.

Quenemoen, while working on an actual problem of this type, defined the theory of the firm as "a general set of principles relating factors of production into an economic unit capable of producing economic goods^{1/}." Such a definition seems acceptable for this paper.

The next task will be that of exposing the content of the theory of the firm as it is applied by the ranchers to the problem and the area in question. The examination of the content of the theory of the firm will be restrictive in the sense that any presentation will be an intrinsic part of the explanation of what ranchers are assumed to do.

^{1/} M. E. Quenemoen, Economic Aspects of Water Spreader Developments on Southeastern Montana Ranches (Mimeo Circular 69, Dec., 1952, Ag. Exp. Sta., Montana State College, Bozeman, Montana) p. 17.

Where profit maximization is held to be the goal of a rancher, as is the case for a "pure economic rancher", the point of profit maximization is determined by specific relationships of cost and revenue factors. ^{2/} While ranchers are not "purely economic", it is felt that the primary valuation of a sunken investment is made by the rancher with economic responses in mind.

A. A Consideration of Revenue Factors. The realistic assumption of a purely competitive market for the seller will greatly reduce the scope of a rancher's investigation of revenue factors. A firm with a purely competitive market for its goods is one in which every firm sells such a small percentage of any commodity that its effect on the commodity price is insignificant, and the price is the same to every seller.

The above assumption seems realistic as far as the Northern Great Plains livestock rancher is concerned. The prices paid to each rancher may in effect vary depending on the rancher's bargaining powers since livestock products are not perfectly homogeneous products. However, for theoretical purposes, these small differences may be neglected.

Under pure competition, the price received for a unit of commodity will be constant with respect to any level of production for a single firm.

^{2/} If losses are considered as negative profits, maximization of profits will also include the minimization of losses.

Both the marginal revenue and average revenue curves will coincide with the price line.

In the above discussion, it was implied that price is a single valued expectation held with certainty. Such is not the case, unless the rancher either made his analysis ex post, or he possessed perfect knowledge as to future prices at the time of analysis. If made ex post, it would have been a fact, not an expectation. An equilibrium position for a sunken investment involves one or more forward positions in time. The distance of these forward points from the present may vary from the very next moment in time to some point in the far distant future. The greater the length of this projection period, the greater the uncertainty of predicting an expected price.

Two types of outcomes are possible in future expectations. They are risk and uncertainty. "Risk refers to variability of outcomes which are measurable in an empirical or quantitative measure". ^{3/} In contrast, "Uncertainty is always present when knowledge of the future is less than perfect in the sense that the parameters of the probability distribution cannot be determined". ^{4/} The type of outcome of expectations accompanying a sunken investment will be both uncertainty and risk, with uncertainty in expectations predominating. Expectations of the future may be

^{3/} E. O. Heady, Economics of Agricultural Production and Resource Use, (Prentice-Hall, New York, 1952), p. 440.

^{4/} Ibid., p. 443.

determined, but it is not possible to assemble enough observations to predict the exact parameters of the probability distribution for expectations in the case of a commercial rancher. While the exact parameters cannot be established for many of the probability distributions of the rancher's expectations, the parameters may be known with enough certainty to treat them as known. It is on this basis that the treatment of uncertainty will be more rigorous than Heady's definition would allow. Risk and uncertainty will receive common treatment and will be jointly referred to as uncertainty.

The measurement of uncertainty may be determined by the magnitude of variation. The results are therefore subjective in nature. The degree of uncertainty is indicated by the characteristics of the probability distribution which surround the expectations in question. The unweighted consideration of the subjective probability distribution is in terms of the variation present. Variance, standard deviation, range of expected values, the degree of skewness, and the degree of kurtosis are the measurements of variation.

A skewed probability distribution is asymmetrical. Kurtosis indicates the degree of peakedness or flat topness which exists in a probability distribution. ^{5/}

^{5/} Croxton and Cowden, Applied General Statistics (Prentice-Hall, New York, 1939), pp. 234-235.

The magnitude and character of variation is not the sole indicator of uncertainty. Another indicator is that of the possibility of loss. This will be discussed later. The magnitudinal measures of variation are, however, important indicators of the possibility of loss.

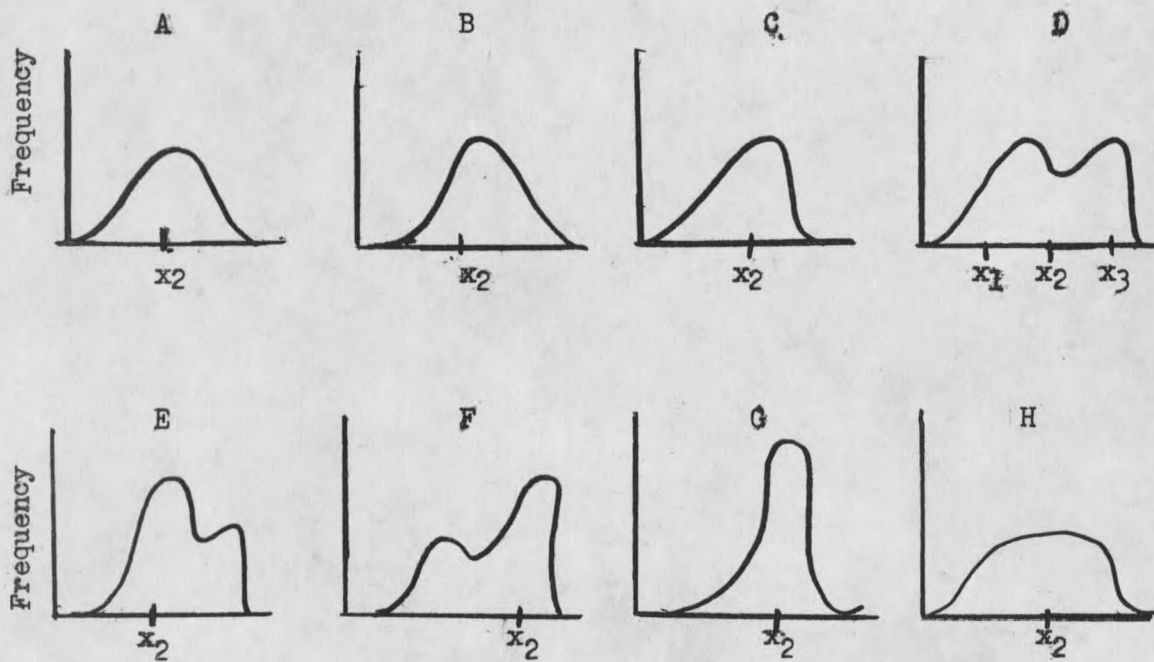


Figure 1.

Relation of Subjective Probability (frequency) Distributions and
Uncertainty.

Heady discusses some of the more prominent type of probability distributions which may represent a rancher's expectations for a certain variable; in this case, price. Figure 1 is the basis on which the discussion is made. 6/

Figure 1A represents a normal distribution of expectations. A normal curve exhibiting a greater standard deviation would entail greater uncertainty. 1B is a right-skewed probability distribution which represents a lesser chance of loss than is represented by 1A. 1C is a left-skewed probability distribution which represents a greater possibility of loss than either 1A or 1B. The U shaped probability distribution in 1D indicates that there is about equal chance of an extremely high or low price, with little chance of an intermediate price. Figure 1E is a mirrored J distribution which has connotation similar to those of 1B. The J distribution in 1F has connotations similar to those in 1C. The "chance" of a higher or lower price than the mode are about equal in 1G and 1H, but the probability attached to the mode in 1G is much greater.

The price used in reaching a static equilibrium is an expected price. The amount the expected price will vary from the present price is measured by the elasticity of expectation. 7/ But inasmuch as the

6/ Heady, op. cit., pp. 451-453.

7/ Lange, Price Flexibility and Employment, (Cowles Comm., 1944), pp. 20-21.

elasticity of expectations is never known with certainty, price expectations cannot be determined with complete certainty. An entrepreneur cannot rationally act on some definite unique value chosen indiscriminately. At best, he can only choose a range of possible values. 8/

Some particular price out of all possible prices may appear to the entrepreneur as the most probable value, and this most probable value may become the basis of his expectations. The preciseness with which the most probable price is expected to occur will depend on the range of the probability distribution of possible prices around the modal price.

An alternative basis of establishing the expected price is the use of the mean of the probability distribution for expected prices. As in the case of the modal expectation, the preciseness with which the average price is expected to occur will depend on the range of the probability distribution of possible prices around the average price.

If the distribution is truly normal, the mode, arithmetic mean, and the median will be equal. However, since many probability distributions are not likely to be normal, there are some economists who favor the use of the arithmetic mean as a basis to determine the most probable expected price. 9/

8/ Ibid, p. 29.

9/ Some of the advocates of the mean as a tool for dealing with uncertainty, are A. Pigou, The Economics of Welfare, pp. 773-774, J. R. Hicks, A Suggestion for Simplifying the Theory of Money, Economics Vol. 6, February, 35, pp. 1-19.

Either a single expected price, or a very narrow range of expected prices, must be chosen, but now the choice may be more rational than if a definite unique price had been chosen with no formal recognition of its probability of occurrence. Lange states, "The greater the range, the less definite the expected price. The range can thus be taken as a measure of the degree of uncertainty of the expectations. In most cases, the entrepreneur or consumer does not consider the whole range of possible values of the expected price, but disregards the extreme values at both tails of the probability distribution. He does so because the joint probabilities of these extreme values is too small to bother about. The range with the tail values thus cut off will be called the practical range and will serve as our measure of the degree of uncertainty of price expectations!" ^c 10/

The rancher, in making a decision with regard to a future price, will think in terms of a range of expectations. There are an almost infinite number of possible (though not probable) prices which might be expected, and these possible prices may be distributed over a great range. Certainly, the entrepreneur cannot consider the complete range of possible prices, but, as Lange suggests, will deal with a practical range of expected prices. The upper and lower limits of the practical range may be chosen common sensical or with some degree of mathematical precision at a predetermined level of probability. Seldom does the commercial entre-

10/ Ibid., pp. 29, 30.

preneur find it possible to compute mathematically the limits of the practical range for a certain level of probability, but informally, he will attempt to decide upon a practical range which has some unknown, but high, level of probability. The more definite the value of the practical range is, the better. However, such definiteness may be obtained only at a cost.

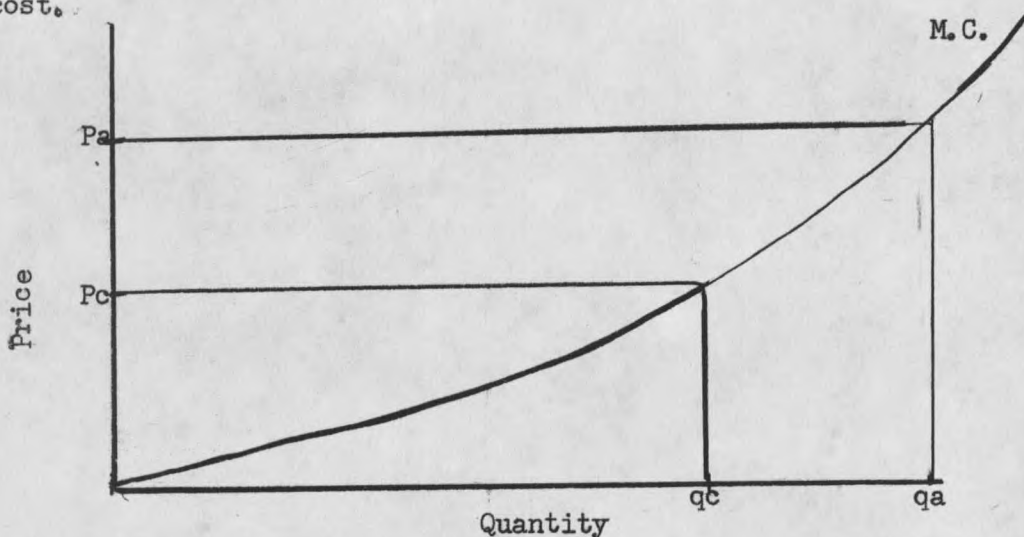


Figure 2.

Range of Production Based on Expected Prices Where the Marginal Cost Curve Is Assumed to be Known.

The rancher cannot bargain, he has but to accept a market price. He must plan his production on one price or a narrow range of prices. As a hypothetical case, an entrepreneur expects at the 95% probability level, a P_x between P_a and P_c as depicted in Figure 2. For the purpose of illustration, it is assumed his marginal cost curve is known. If the upper limit price of the practical range, P_a , occurred, he would produce q_a . If the lower limit price, P_c , occurred, he would produce q_c . Since

production is not an instantaneous process, the entrepreneur must plan to produce some quantity of X between q_a and q_c , the exact quantity being dependent on some one price in the practical range which the entrepreneur decides to act upon.

Some data have been collected by Williams at the University of Illinois with regard to farmers' willingness to assume various degrees of uncertainty. ^{11/} Williams found a pattern of preference for various levels of income and the certainty of these incomes. Jensen found a like result while engaged in a study of irrigated pastures in Montana. Jensen discussed this concept in terms of income vulnerability. ^{12/}

Examination of a hypothetical ranch investment with regard to uncertainty of income for the investment is given below. Figure 3 gives the practical range of expected prices $P_a - P_c$, the most probable P , P_b , all prices for the product of the investment, and an assumed marginal cost curve for the investment.

^{11/} Williams, "Price Expectations and Reactions to Uncertainty by Farmers in Illinois," J.F.E., February, 51, Vol. XXXII, pp. 20-39.

^{12/} C. W. Jensen, The Economics of Pasture Integration and Irrigated Farms. (Mimeo Circular 67, July, 52, Ag. Exp. Sta., Bozeman, Montana, pp. 74-78.)

