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Kentucky's 1992 Farm Capital and Labor Requirements in an Era of Uncertainty

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In 1973 the Governor of Kentucky's Council of Agriculture commissioned a Task Force at the University of Kentucky College of Agriculture to develop estimates of Kentucky's Agricultural potentials. Product potentials were estimated for 1980 and for the "long-term" -- to 1992. Similarly, capital and labor requirements were estimated for the same time periods. An assortment of estimation methods were employed. These procedures were not very specifically delineated.[1] In general, it was assumed "...farmers must make full use of their land... firms that supply agriculture must make available adequate amounts of capital...".

Such estimates are useful, as they were intended, as broad guidelines, but obviously are very heuristically conceived and potentially myopic in nature. They may not necessarily very accurately account for possible changes in technology, shifts in factor supply functions, and the changing nature of product

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[1]A summary of the general procedures and assumptions which were made is presented, along with the predictions (tables 1, 2 and 3), at the end of this paper.

markets.[2] And, they do not attempt to address the problem of accounting for the stochastic nature of production, market and institutional uncertainties that may be encountered by Kentucky's farmers over the long term (1976 to 1992).

In this paper we address certain key conceptual and analytical issues undergirding these facets of uncertainty, especially with respect to resource requirements. First, the Task Force's 1973 capital and labor estimates are briefly reviewed. Second, we introduce a model which is capable of allowing researchers to relate uncertainty levels faced by Kentucky farm producers to levels of information available on economic, social and political variables and ultimately to aggregate capital and labor requirements. Third, logic of the information-uncertainty model is coupled with a suggested procedure for revising aggregate capital and labor projections to account for varying future degrees of uncertainty. Finally, we briefly discuss the empirical research which is needed to impart more rigor and reliability into new attempts to estimate capital and labor requirements.

The Task Force Estimates

Tables 1, 2 and 3 of the Appendix reveal capital and labor requirements and 1992 predictions for Kentucky farms made in 1973 by the Agricultural College Task Force. The specific assumptions

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[2] Ideally, a rigorous long-run supply analysis would account for these ceteris paribus variables. Also, the analysis would lead to production (supply) potentials being projected for several prices of each product, i.e., a supply schedule, not just one potential level.

made in obtainting data and arriving at these estimates and projections are discussed in detail in their report (1973, pp. 11-13, 39-42). A summary of these assumptions and procedures is presented with the tables.

In general, the estimates are consistent with an aggregative production function:

$$Y = f\ (K, N), \qquad (1)$$

where

Y = total output of Kentucky's farms for a specified period (year).

K = aggregate capital level employed by farms during the same period, and

N = aggregate level of labor for the same period.

These estimates are largely deterministic; hence, they do not account for risk and uncertainty. In reality, the aggregate function should be:

$$Y = g\ (K,N,U). \qquad (2)$$

To structure this latter function, let us first examine the logic of how *the concept of "information" as a phenomenon of concern to entrepreneurs is inextricably linked to the concept of uncertainty.*

An Information-Uncertainty Model

In the real world, the entrepreneur who allocates capital and labor is normally making and implementing risky decisions while operating within an environment containing less than complete information. Figure 1 illustrates an information-risk hierarchy representing the alternative levels of information available to the entrepreneur. Associated with each level of information within the hierarchy is a corresponding risk or uncertainty condition.

This paradigm (Figure 1) transcends the traditional dichotomous definitions for risk and uncertainty. Since Knight's book appeared in 1921, (also see Doll *et al.*, pp. 182-209), it has been customary to use the term *uncertainty* to denote a situation in which the outcome or outcomes arising from decisions made by the entrepreneur are stochastic and the probabilities associated with each outcome are unknown; whereas, *risk* has been used to denote a similar condition in which the probabilities are known. We contend it is more useful to use the terms interchangeably or more precisely to think of the risk-uncertainty condition being a continum. The paradigm illustrates quite clearly the close association between the amount of risk-uncertainty and the level of information available to the entrepreneur.

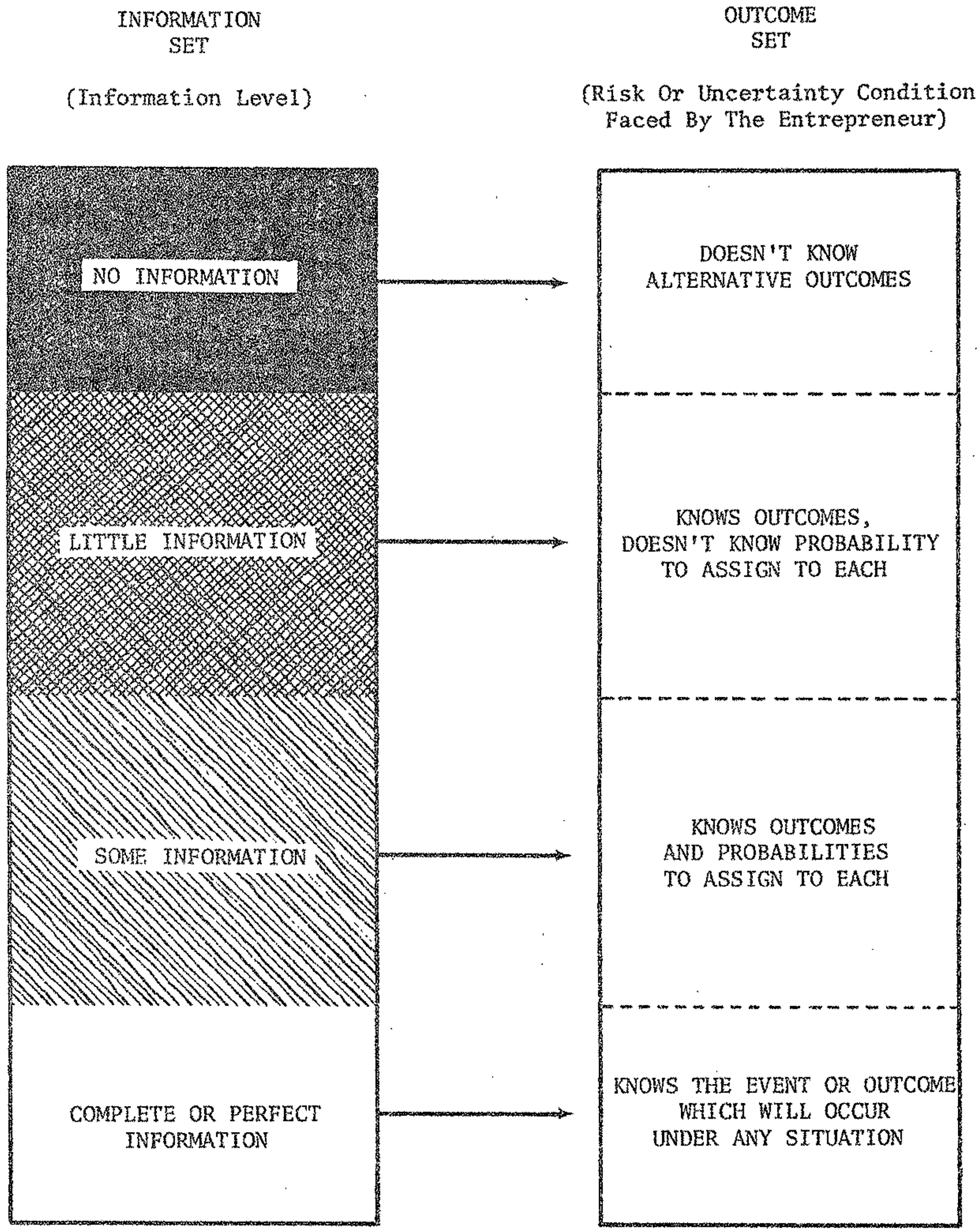

Figure 1. An Information-Risk Paradigm

The major problems faced by those conducting research ultimately to be used by decision makers are related to Figure 1, viz.,

(A) delineation of the outcome set with accompanying estimates of probabilities, and

(B) identification of the information level existing when the problem is formulated.

A general mathematical formulation of the model is shown by the function

$$U = f\ (I,\ X) \qquad (3)$$

where

U = the risk-uncertainty condition,

I = level of information ordinarily available to the entrepreneur,

X = information which is either unavailable to the entrepreneur *or* mis-information (noise).

We can postulate that

$$I = g\ (R,\ F) \qquad (4)$$

where

R = *research* information which the entrepreneur could acquire from sources external to the firm, e.g., input suppliers, land grant universities, other public or private research centers, newspapers, media, closely related firms (see Eisgruber).

F = *feedback* information from past experiences of the firm's managers. This feedback information frequently is only partially documented in the firm's records; much of it may be a rather complicated memory set, unique for each firm's entrepreneur. For example, a detailed set of farm records might be excellent feedback information.

Noise (X) is a function of political, social, economic and environmental variables, that is

$$X = h\ (S,\ E) \qquad (5)$$

where

S = combined political, social and economic variables either unavailable to the entrepreneur or available in a form not interpretable.

E = environmental forces including the weather and the availability purchased inputs.

Relations (4) and (5), for the most part, can be independently determined. Yet, the value of X cannot be completely independent of 1. Thus, efforts by the entrepreneur to acquire information (R and/or F) must be governed by the level of X. Usually we think this relationship is direct, i.e., information acquisition efforts or the cost of obtaining information must be intensified as X becomes greater.

A dynamic version of Figure 1 is a series of outcome-probability hierarchies alternated singularly with a series of information-level sets. One might liken it to the frames of a movie film. The initial set of frames are depicted in Figure 1. Subsequent frames possess only the same general appearance, being altered in exact appearance by the passing of time.

The dynamic mathematical model follows from differential calculus of expressions (3), (4) and (5) as

$$dU = \frac{\partial U}{\partial I}\, dI + \frac{\partial U}{\partial X}\, dX \qquad (6)$$

$$dI = \frac{\partial I}{\partial R}\, dR + \frac{\partial I}{\partial F}\, dF \qquad (7)$$

$$dX = \frac{\partial X}{\partial S}\, dS + \frac{\partial X}{\partial E}\, dE \qquad (8)$$

To complete this dynamic model, one must know whether: (A) explanatory variables in each expression, (3) to (5), are interrelated or independent, and (B) the postulated algebraic sign (+ or -) of each partial derivative in (6) to (8). Consider expression (6). The researcher can specify I and X to be independent, and normally can visualize that U can be reduced by increasing I and/or decreasing X. Simply put, dU is positive when the expected positive effect of $\frac{\partial U}{\partial I}\, dI$ more than offsets the expected negative effect of $\frac{\partial U}{\partial X}\, dX$.

Procedures for Adjusting Predictions for Uncertainty

Conceptually, the effects of uncertainty on capital and labor requirements may be depicted by comparing the parameters of the two production functions (1) and (2), above. Specifically, compare g (K,N,U) to f (K,N) in order to determine how much more (or less) K and/or N are needed to produce specified Y levels. But this approach is not possible, because in reality f (K,N) does not exist.

One can evaluate g (K,N,U) across time, comparing observations from cross-section data for a base period with at least one future period. This second approach can provide an estimate of the effects of changing degrees of uncertainty. It can not, however, allow one to adjust capital or labor (K or N) projected levels. The degree of uncertainty during the base period must first be established and measured *relative* to complete certainty (the bottom frame of Figure 1). And, if the adjustment procedure is to possess substantive and policy-oriented appeal, one must employ an adjustment procedure for which the cause(s) of uncertainty could be established and quantified.

The most promising procedure is one which focuses directly on an information-uncertainty model such as depicted by the paradigm (Figure 1).[3]

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[3]To our knowledge, no actual procedures have been tested.

Essentially this procedure is outlined as follows:

(A) Estimate expression (3), U = f (I,X), for several recent periods for which good data are availble. Let us assume, for the sake of argument, that in each of these periods a power function is most appropreate, i.e.,

$$f\ (I_i,\ X_i) \cong A_i\ I_i^{\alpha_i}\ X_i^{B_i}$$

for periods
$i = 1,\ 2,\ \ldots,\ t$ (9)

Thus, the percentage changes in uncertainty due to information (I) or noise (X) are the parameters α and B, respectively.

(B) Study trend(s) in the $\hat{\alpha}_i$ and $\hat{B}_i$ to gain estimates of

$$\alpha_i - \alpha_j = \frac{\Delta U_i}{\Delta I_i} \qquad (10)$$

and

$$B_i - B_j = \frac{\Delta U_i}{\Delta X_i} \qquad (11)$$

for the ith and jth periods, $i \neq j$; $i = 1, 2, \ldots, t$; $j = 1, 2, \ldots, t$.

(C) Positive values for either (10) or (11) would indicate a lessening of uncertainty; negative values would indicate more uncertainty. The magnitude of these values indicates the degree of lessening (increase). This magnitude is in percentage terms, and thus can be used to adjust the magnitudes of capital (K) and/or labor (N) necessary to yield adjusted predicted levels of production (Y) potentials.

Revised Projections

Since 1973, when the Agricultural College Task Force first prepared its' estimates of capital and labor requirements, information (I) and noise (X) variables have sharply changed. Information may have increased, at least its' availability to farmers, but so has the amount of noise. In net, there seems to be more uncertainty.

Prices of agricultural products are now much more variable and uncertain, owing to (1) depletions of grain and fiber reserve stocks, (2) sharply increased exports of most U.S. agricultural products. (3) the OPEC oil embargo and subsequent oil price hikes, and (4) a political climate in the U.S. that generally favors a "free-market" agriculture. Predictions of harsher climatic influences give rise to greater production uncertainties. Farmers are able to offset some of the increased price uncertainty due to fuller and better use of futures market hedging and forward contracting. They may be able to further alleviate both production and market uncertainties through better timing of plantings and harvestings by using larger, more sophisticated machinery (such as large tractors, planters and harvesters). But, ultimately, there must be some technical limit to our easy ability to substitute capital for labor in agriculture (see Lianos, 1971). Most observers believe that capital-intensive farming is more energy inefficient, especially in the use of fossil fuel inputs. So, what happens if political events force sharp curtailment of such inputs?

All this adds up to more uncertainty, a relatively lower value for the information (I) parameter, above, and probably a relatively higher value for the noise (X) parameter. Therefore, if these trends continue, to acheive the levels of production projected for 1992 either more capital (K), or more labor (N), or both will be required. The most probable adjustments still can come with more capital and with possible some reduction in aggregate labor requirements. The actual capital value of Kentucky farms in 1992 could substantively exceed the $18.7 billion projection shown in Table 1. Similarly, actual labor requirements could be considerably less than the 196 million man-hour figure shown in Table 2. But all this is mostly guess work. As T. W. Schultz proclaimed in 1956: "Tell me what the supply of farm products will be five or ten years from now and I shall give you meaningful answers to the more important economic problems of agriculture".

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APPENDIX

The estimates of capital and labor requirements shown in Tables 1-3 were made in 1973 by the University of Kentucky's Task Force on Agriculture (pp. 39-42). Most of these projections are based on Census data for 1959, 1964 and 1969. Capital requirements are stated in nominal units, but they do not necessarily account for sharp charges in the value of money, i.e., charges considerable different than during the 1959-1969 period. Recall, during that period the annual rate of inflation was never above 5 percent.

Procedures and assumptions employed by the Task Force in making projections are not completely spelled out in their publication. Generally, however, they either used linear or curvilinear extrapolation of 1959-'69 trends. Certain details and assumptions applicable to each individual table are noted as follows:

Table 1 -- Capital

Land values do not include acreage in forests, and livestock values do not include pleasure or race horses. The Task Force assumed that the value of farmland would increase at an annual rate of 7.5 percent from 1969 to 1980, and then increase at an annual rate of 3.7 percent. Farm machinery, livestock and poultry values were assumed to increase 5 percent annually until 1980, thereafter at 3 percent.

Table 2 -- Labor

Two methods were used to estimate labor requirements. The farm planning manual (Dept. of Agr. Econ., 1973) gives labor requirements per unit of each enterprise. Thus, the first method was to multiply these unit requirements by the Task Force estimates of the units of each enterprise which were projected, then aggregate across enterprise. The second method involved percentage (curvilinear) extrapolation of actual labor-use data for Kentucky from monthly reports issued during 1965-1972 by the Farm Labor Dept., Statistical Reporting Service (SRS) of the U.S. Dept. of Agriculture. Farm Planning Manual extrapolations reflect the Task Force's projections of increased production for most of the Commonwealth's farm enterprises. Since no allowance is made for changes in technology or for increased labor efficiency as capital substitution takes place, the SRS projections appear much more realistic and probable. Even these estimates suffer from assuming that the trend established from 1965 to 1972 will continue to 1992, but at least a curvilinear extrapolation was used.

Table 3 -- Cash Production Expenses

The Task Force report breaks down annual cash production expenses into several categories: livestock, feeds, seeds, fertilizers, other

Table 1. Capital Value of Kentucky's Farms

Capital category	1969 Value	1976 Value	1992 Projected Value
	(millions of dollars)		
Farmland and Buildings	4,041	6,376	14,358
Farm Machinery and Equipment	623	877	2,692
Livestock, Poultry	484	681	1,666
TOTAL	5,148	7,253	18,716

Table 2. Labor Requirements, Kentucky's Farms

Source of 1972 data		Millions of man hours	
	1972	1976	1992 projection
Farm Planning Manual for Kentucky Farmers (1973)	181	197	289
SRS, USDA	231	222	196

Table 3. Cash Production Expenses, Kentucky's Farms

1969 Value	1976 Value	1992 Projected Value
	(millions of dollars)	
523	896	2,668

chemicals, gasoline and fuel, hired labor, custom machine work, and other items. Data were obtained from the U.S. Agricultural Census for 1959, 1964 and 1969. As shown in Table 3, in 1969 total cash production expenditures equaled 523 million dollars. The 1976 figure ($896 million) was obtained by percentage extrapolation from the 1959-'69 trend; an 8 percent annual rate of increase was assumed. The 1992 figure assumes that this 8 percent rate continues through 1980; thereafter, the rate of increase slows to 4 percent annually.