SPECIFICATION OF BERNOULLIAN UTILITY FUNCTION IN DECISION ANALYSIS

By William W. Lin and Hui S. Chang[1]

INTRODUCTION

A few years ago, Lin, Dean, and Moore reported empirical test results of the hypothesis that farmers' operational decisions are more consistent with utility maximization than with profit maximization (*9*).[2] They concluded that Bernoullian utility maximization explained actual farmers' behavior more accurately than did profit maximization.

■ The authors propose two general functional forms, and apply them to the specification of utility functions for predicting farmers' production response. The polynomial utility functions were rejected, based on the results of a likelihood-ratio test. The appropriate degree of nonlinearity of the utility function can best be determined by using the general functional forms without *a priori* specification. Further, farmers' utility functions may exhibit a decreasing absolute risk aversion. The tendency for the Bernoullian utility maximization hypothesis to predict more risky behavior than that actually observed may have been partly due to incorrect specification of the utility function.

■ Keywords: Functional forms, Bernoullian utility function, risk aversion.

One of the procedures in the above empirical tests involves the derivation of Bernoullian utility function. Lin, Dean, and Moore employed a modified Ramsey model by asking six farm decisionmakers a series of questions in the context of decision games. A linear or polynomial function was used to specify the Bernoullian utility function for each of the six farms studied (*9*, p. 504). However, the polynomial utility function has recently been criticized because it exhibits increasing absolute risk aversion or negative marginal utility.[3] Generally, researchers agree that a utility function should imply a decreasing absolute risk aversion, not a constant or increasing one.

Several pertinent questions thus emerge: In what functional form(s) should a utility function be specified to imply a decreasing absolute risk aversion?[4] How can the chosen functional form be estimated? To what extent does the polynomial utility function bias the predictions of the Bernoullian utility maximization hypothesis on farmers' production response?

Accordingly, our objective is to suggest some answers to the above questions. First, several functional forms are reviewed for their coefficients of risk aversion. Two general forms for the Bernoullian utility function are introduced; and theoretical constraints on the parameters and the estimation procedures are discussed. Second, estimated results for a case-study farm are reported. Finally, we indicate the extent to which the polynomial utility function may have biased the prediction of Bernoullian utility maximization hypothesis on farmers' production response.

ALTERNATIVE FUNCTIONAL FORMS

Because of theoretical shortcomings of the polynomial utility function, alternative utility functions ranging from log linear, semilog, and constant elasticity of substitution (CES), to various exponential functions have been suggested lately (*3*, *4*, *8*). Table 1 summarizes these alternative utility functions and the implied restrictions on parameters, coefficients of risk aversion, and the risk aversion ranges.[5]

All these utility functions require *a priori* assumptions as to their specifications. Recent developments in the area of transformation of variables, however, suggest that the appropriate degree of nonlinearity of the utility functions can be best specified by sample observations (*1*, *12*). For example, the utility function can be specified to have the following generalized functional form:

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[2] Italicized numbers in parentheses refer to items in References at the end of this article.

[3] A utility function exhibits increasing, constant, or decreasing absolute risk aversion, depending on whether the coefficient of risk aversion increases, remains constant, or decreases as income or wealth rise. The coefficient of risk aversion, as defined by Pratt (*11*), is $r(x) = -U''(x)/U'(x)$. In this, $r(x)$ is the coefficient of risk aversion and $U'(x)$ and $U''(x)$ are the first and second derivatives of the utility function.

[4] We give no specific attention to the utility function which contains both convex and concave regions, illustrated by Hildreth (*7*).

[5] Some of the utility functions have been reviewed by Keeney and Raiffa (*8*).

Table 1—Alternative utility functions and the coefficients of risk aversion

Type of risk aversion	Functional form	Restriction	Coefficient of risk aversion	Risk average range[1]
Increasing	$U(x) = a + bx + cx^2$	$a, b > 0$; $c < 0$	$\frac{-2c}{b + 2cx}$	$\frac{b}{2c} \geqslant x \geqslant 0$
Constant[2]	$U(x) = k - \Theta e^{-\lambda x}$	—	λ	all x
Decreasing	$U(x) = a + b \log(x + d)$	—	$\frac{1}{x + d}$	$x \geqslant -d$
Decreasing	$U(x) = ax - be^{-cx}$	$a, b, c > 0$	$\frac{bc^2e^{-cx}}{a + bce^{-cx}}$	all x
Decreasing	$\log U(x) = a + b \log x$	—	$\frac{1 - b}{x}$	$b < 1$
Decreasing	$U(x) = (x + b)^c$	$0 < c < 1$	$\frac{-(c - 1)}{x + b}$	$x \geqslant -b$
Decreasing	$U(x- = (x + b)^{-c}$	$c > 0$	$\frac{c + 1}{x + b}$	$x \geqslant -b$
Decreasing	$U(x) = x + c \log (x + b)$	$c > 0$	$\frac{c}{(x + b)\ (x + c + b)}$	$x > -b$
Decreasing	$U(x) = -e^{-ax} - be^{-cx}$	$a, b, c > 0$	$\frac{a^2e^{-ax} + bc^2e^{-cx}}{ae^{-ax} + bce^{-cx}}$	all x
Decreasing	$U(x) = -e^{-ax} + bx$	$a, b > 0$	$\frac{a^2e^{-ax}}{ae^{-ax} + b}$	all x
Decreasing	$u(x) = (\beta x^{-\rho} + \alpha)^{-\frac{1}{\rho}}$	$-1 < \rho < \infty$	$(1 + \rho)\left[\frac{1}{x} + \frac{\beta}{(\beta x^{-\rho} + \alpha) \cdot x^{(1 + \rho)}}\right]$	all x

[1] Wherever the value of x goes beyond the risk aversion range, the properties of the utility function in terms of risk aversion may be changed and the utility function probably needs to be reverified. [2] See (2) for an example of this type of utility function.

$$\frac{U^\lambda - 1}{\lambda} = \alpha + \beta \frac{M^\lambda - 1}{\lambda} \qquad (1)$$

where λ is the transformation parameter, U is utility, and M is monetary income or wealth. It can be shown that the coefficient of risk aversion, r(M), has the following form:

$$r(M) = \frac{-U''}{U'} = -(\lambda - 1)\left(\frac{1}{M} - \frac{1}{U} \cdot \frac{\partial U}{\partial M}\right) \qquad (2)$$

where

$$U' = \beta \frac{M^{\lambda - 1}}{U^{\lambda - 1}}$$

and

$$U'' = \beta(\lambda - 1) \frac{M^{\lambda - 1}}{U^{\lambda - 1}} \left(\frac{1}{M} - \frac{1}{U} \cdot \frac{\partial U}{\partial M}\right) \qquad (3)$$

Decreasing risk aversion is associated with a risk coefficient which is a declining function of M; that is $r'(M) < 0$. If one is inclined to superimpose a constraint on the utility function, that the function exhibits a decreasing absolute risk aversion, all that is needed is to restrict the transformation parameter (λ) so that it is negative. Furthermore, the utility function satisfies the theoretical constraint of diminishing marginal utility if the coefficient of risk aversion ($r(M)$) is positive; implying $1/M > 1/u$. $(\partial u)/(\partial M)$ since a negative λ is generally postulated. Finally, this generalized functional form implies that risk aversion decreases as the marginal utility increases—not an unreasonable property for the utility function. Alternatively, the generalized functional form can be specified as:

$$U_i^* = \beta_0 + \beta_1 M_i^* + \beta_2 M_i^{2*} \tag{4}$$

where

$$U_i^* = \frac{(U_i^\lambda - 1)}{\lambda}$$

$$M_i^* = \frac{(M_i^\lambda - 1)}{\lambda}, \text{ and} \tag{5}$$

$$M_i^{2*} = \frac{(M_i^{2\lambda} - 1)}{\lambda}$$

and λ is a transformation parameter to be estimated.

It is obvious that if λ equals one, equations (1) and (4) are the same as the linear and polynomial utility functions. It can also be shown that equation (1) is equivalent to a log-linear form when λ approaches zero.[6] In general, different values of λ represent different degrees of curvature of the utility functions. Therefore, equations (1) and (4) are more general functional forms which provide greater flexibility in the degree and type of nonlinearity than the linear and polynomial utility functions.

Other than transforming both U and M, it is also possible to transform only U or M. If only one side of the equations is transformed, (1) and (4) are equivalent to semilog forms when λ approaches 0. In the most general case, different values of transformation parameters can be applied to different variables. In our study, however, we restrict ourselves to equations (1) and (4) and some semilog transformations.

To estimate λ along with other parameters in equations (1) and (4), we first rewrite them in stochastic forms:

$$U_i^* = \beta_0 + \beta_1 M_i^* + w_i \tag{6}$$

$$U_i^* = \beta_0 + \beta_1 M_i^* + \beta_2 M_i^{2*} + v_i \tag{7}$$

where w_i and v_i are the disturbance terms, assumed to be normally and independently distributed, each with zero mean and constant variance. Using the maximum likelihood method, Box and Cox showed that the maximum likelihood for equation (6) or (7) for a given λ, except for a given constant, is (*1*, p. 215):

$$L_{\max}(\lambda) = -(n/2)\log\hat{\sigma}^2(\lambda) + (\lambda - 1)\sum_{i=1}^{n}\log U_i \tag{8}$$

where $\hat{\sigma}^2(\lambda)$ is the error variance of equation (6) or (7). To maximize equation (8) over the entire parameter space, we only need to choose alternative values for λ over a reasonable range and regress U^* on M^* and on M^* and M^{2*}, and find the transformation parameter λ that maximizes equation (8). The maximum likelihood estimates of β's can be obtained directly from the least squares results of $\hat{\lambda}$.

Using the likelihood ratio method, an approximate $(1-\alpha)$ confidence interval for λ can be constructed since $2[L_{\max}(\hat{\lambda}) - L_{\max}(\lambda)]$ is approximately distributed as χ^2 with one degree of freedom (*1*, p. 216). Therefore, the $(1-\alpha)$ confidence interval for λ is obtained by finding that value of λ on either side of $\hat{\lambda}$ such that

$$L_{\max}(\hat{\lambda}) - L_{\max}(\lambda) = \frac{1}{2}\chi_1^2(\alpha) \tag{9}$$

REGRESSION RESULTS

Input data used in our study are those reported by Lin (*10*). Of the six cases investigated by Lin, Dean, and Moore, case-study farm 5 was chosen for the current study because the data contain no negative observations on monetary income. All the other cases contain negative observations on monetary income, for which the logarithm is undefined.

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[6] $(U^\lambda - 1)/\lambda = [\exp(\log U^\lambda) \quad 1]/\lambda = [\exp(\lambda \log U) - 1]/\lambda$. Through the Taylor expansion of $\exp(\lambda \log U)$ around $\lambda \log U = 0$,

$$(U^\lambda - 1)/\lambda = [1 + \lambda\log U + (1/2!)(\lambda\log U)^2 + (1/3!)(\lambda\log U)^3 + \ldots - 1]/\lambda = \log U + (\lambda/2!)(\log U)^2 + (\lambda^2/3!)(\log U)^3 + \ldots$$

Therefore, when $\lambda = 0$, $(U^\lambda - 1)/\lambda = \log U$. Similarly, $(M^\lambda - 1)/\lambda = \log M$ and $(M^{2\lambda} - 1)/\lambda = \log M^2$ when $\lambda = 0$. But when $\lambda = 0$, equation (4) is not estimable since $\log M^2 = 2 \log M$ and, hence, $\log M$ and $\log M^2$ are perfectly related.

Observations on the utility index of this case, however, contain four negative values. To utilize all 14 observations, every utility index was adjusted upward by 100 so that no observation would be negative. Such a linear transformation does not affect the shape of the utility function.[7]

To estimate parameters in equations (6) and (7), data on U_i, M_i, and M^2 were transformed according to equation (5) by λ's that lie between −0.10 and −1.7, at intervals of 0.1. The least-squares regressions of U^* on M^* and on M^* and M^{2*} were performed on each set of the transformed data. $L_{max}(\lambda)$ was calculated for each regression by using equation (3) with $\hat{\sigma}^2(\lambda)$ taken from the estimated variance of the disturbance term of the regression. Estimated coefficients and related statistics for selected values of λ for equations (6) and (7) appear in table 2. The estimates obtained from the linear and second-degree polynomial forms (λ=1), as well as the estimates for the log-linear form (λ=0) also appear in the table. These results show that the coefficients are all significant at the 0.01 level and that the maximum likelihood estimate of λ, $\hat{\lambda}$, is −0.70 when applied to equation (7). Based on equation (9), the null hypotheses that the utility function is a second-degree polynomial form, a linear form or a double-log form, are all rejected at the 0.05 level. Equations (6) and (7) do not exhaust other functional forms and they also do not include the third-degree polynomial form used by Lin, Dean, and Moore for this case-study farm. Thus, other functional specifications were also estimated with results shown in table 3. A comparison of the maximum likelihood values in tables 2 and 3 reveals that equation (7) with λ = −0.70 is still the maximum likelihood estimate of the Bernoullian utility function. This specification also has the highest R^2. This result conforms with the recent finding of Granger and Newbold (*5*). They state that the true model, from a set of alternative regression specifications involving different transformations of the dependent variable and under the assumption of normality, is the formulation for which R^2 is the highest. Estimated results based on positive λ values all yield lower likelihood values, supporting the theoretical constraint we employed that λ be restricted to be negative.

TESTS OF UTILITY VERSUS PROFIT MAXIMIZATION HYPOTHESES

Lin, Dean, and Moore tested three alternative behavioral hypotheses (Bernoullian utility maximization, lexicographic utility maximization, and profit maximization) by comparing the optimal plans along the "after-tax" E-V frontier. For case-study farm 5, lexicographic utility maximization predicts actual behavior better than Bernoullian utility maximization and profit maximization. The latter two perform equally poorly in this case.

It is of interest to see if the optimal plan derived from the Bernoullian utility maximization based on the "best" functional specification ($\hat{\lambda}$=−.70) predicts the actual plan differently. To do this, we first express expected utility as a function of mean and variance of "after-tax" net income. According to Taylor series expansion, the utility function U(M) can be expanded to a function in powers of (M-C) where M is a random variable (after-tax net income) and C is a fixed value (*6*):

$$U(M) = U(C) + (M-C)\frac{dU(C)}{dM} + \frac{1}{2}(M-C)^2\frac{d^2U(C)}{dM^2} + \frac{1}{3!}(M-C)^3\frac{d^3U(C)}{dM^3} + \frac{1}{4!}(M-C)^4\frac{d^4U(C)}{dM^4} + \ldots$$

By letting C equal E(M), expected net income, and by taking the expectation of this equation, we obtain the expected utility of plan *a* as:

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[7] Given the following quadratic utility function,

$$U = a + bM + cM^2 \qquad (1')$$

a linear transformation can be expressed as:

$$U^* = d + eU = d + ea + ebM^2 + ecM^2 \qquad (2')$$

or

$$U^* = a^* + b^*M + c^*M^2 \qquad (3')$$

where

$$a^* = d + ea$$

$$b^* = eb$$

$$c^* = ec$$

For equation (1′), the measure of risk aversion is, according to Pratt:

$$r(M) = -U''(M)/U'(M) = -2c/(b + 2cM).$$

For equation (3′), it is:

$$r^*(M) = -U^{*\prime\prime}(M)/U^{*\prime}(M) = -2ec/e(b + 2cM) = -2c/(b + 2cM).$$

Table 2—Bernoullian utility functions estimated from the generalized functional form;

λ	β_0	β_1	β_2	$\bar{R}^2$ [1]	$L_{max}(\lambda)$
		$U_i^* = \beta_0 + \beta_1 M_i^*$			
1.00	86.605 (6.43)	2.222 (6.86)		0.780	-49.53
0.00	3.953 (80.27)	0.366 (23.30)		0.977	-37.47
-0.10	3.283 (142.87)	0.270 (31.14)		0.987	-34.21
-0.20	2.767 (188.27)	0.190 (29.83)		0.986	-35.62
-0.50	1.760 (248.75)	0.053 (13.79)		0.936	-49.03
-1.00	0.989 (923.59)	0.004 (10.60)		0.895	-58.87
-1.70	0.588 (9643.68)	0.0001 (14.85)		0.944	-66.13
		$U_i^* = \beta_0 + \beta_1 M_i^* + \beta_2 M_i^{2*}$			
1.00	65.532 (6.31)	5.166 (6.82)	-0.038 (-4.05)	0.904	-43.75
-0.10	3.296 (115.06)	0.207 (2.48)	-0.034 (-7.60)	0.986	-34.47
-0.50	1.712 (396.73)	0.107 (23.76)	-0.017 (-12.27)	0.995	-30.82
-0.70[2]	1.331 (865.27)	0.055 (32.93)	-0.007 (-21.18)	0.998	-28.60
-1.00	0.977 (2004.35)	0.019 (31.14)	-0.001 (-24.12)	0.998	-31.57
-1.30	0.764 (4462.60)	0.007 (25.15)	-0.0003 (-21.54)	0.998	-36.51
-1.70	0.587 (16097.80)	0.001 (21.57)	-0.0002 (-19.87)	0.998	-41.49

[1] $\bar{R}^2$ is the corrected coefficient of determination. Figures in parentheses are *t*-values. [2] The maximum likelihood estimate of λ since $L_{max}(\lambda)$ is maximum at $\lambda = -0.70$.

Table 3—Bernoullian utility functions estimated from other functional forms[1]

Utility functions	$\bar{R}^2$	L_{max}
$\log U = \underset{(21.74)}{4.296} + \underset{(3.93)}{0.187}\,M$	0.53	-58.52
$U = \underset{(8.60)}{64.455} + \underset{(15.09)}{36.058}\,\log M$	0.95	-39.73
$\log U = \underset{(20.61)}{3.988} + \underset{(4.01)}{0.054}\,M - \underset{(-2.74)}{0.0005}\,M^2$	0.69	-55.49
$\log U = \underset{(20.21)}{3.786} + \underset{(4.00)}{0.113}\,M - \underset{(-2.76)}{0.002}\,M^2 + \underset{(2.27)}{0.00002}\,M^3$	0.78	-53.25
$U = \underset{(5.10)}{45.992} + \underset{(5.60)}{9.673}\,M - \underset{(-3.31)}{0.192}\,M^2 + \underset{(2.56)}{0.0012}\,M^3$ [2]	0.96	-38.28

[1] $\bar{R}^2$ is the corrected coefficient of determination, L_{max} is the logarithmic maximum likelihood value, and figures in parentheses are *t*-values. [2] This is the polynomial functional form reported in (*9*).

$$U(a) = U[E(M)] + \frac{1}{2}\sigma^2 \frac{d^2U[E(M)]}{dM^2}$$

$$+ \frac{1}{3!} g_1 \frac{d^3U[E(M)]}{dM^3}$$

$$+ \frac{1}{4!} g_2 \frac{d^4U[E(M)]}{dM^4} + \ldots$$

where

$E[M - E(M)]^2 = \sigma^2$, the variance of the distribution of M

$E[M - E(M)]^3 = g_1$, the skewness of the distribution of M

$E[M - E(M)^4 = g_2$, the kurtosis of the distribution of M

Assuming normal distribution of M, the expected utility becomes:

$$U(a) = U[E(M)] + \frac{1}{2}\sigma^2 \cdot \frac{d^2U[E(M)]}{dM^2}$$

According to (7), it can be shown that:

$$U[E(M)] = [1 - \beta_1 - \beta_2 + \beta_0\lambda + \beta_1 E(M)^{\lambda}$$

$$+ \beta_2 E(M)^{2\lambda}]^{1/\lambda} \text{ and}$$

$$\frac{d^2U[E(M)]}{dM^2} = (\lambda - 1)\frac{\partial U[E(M)]}{\partial E(M)}$$

$$\cdot \left\{ \frac{1}{E(M)} - \frac{1}{U[E(M)]} \frac{\partial U[E(M)]}{\partial E(M)} \right\}$$

where

$$\frac{\partial U[E(M)]}{\partial E(M)} = \left[\frac{U[E(M)]}{E(M)}\right]^{1-\lambda} \cdot \left[\beta_1 + 2\beta_2 E(M)^{\lambda}\right]$$

Based on the results of table 2 at λ equals -0.70, we computed the expected utility for each of the 13 alternative plans (table 4). It is clear that plan 13 (point B_5 in *9*, p. 506) no longer is the optimal plan. Instead, plans 10, 11, 12, and 13 all yield the same highest expected utility index. Thus, any plan lying within the segment between L_5 and B_5 in (*9*) is considered optimal to case-study farm 5. Thus, the Bernoullian utility maximization hypothesis could have predicted the farmer's production decision better than that reported by Lin, Dean, and Moore if a better functional specification had been adopted. At the very least, the strong preference leaning toward plan 13 as shown by the three researchers is now much reduced with the use of the "best" functional form.

Table 4—Computed expected utilities for alternative plans: $U_i^* = \beta_0 + \beta_1 M_i + \beta_2 M^{2*} + v_i, \lambda = -0.70$

Plan	Mean income[1] E(M)	Standard deviation[1] σ_M	Expected utility $U(a_i)$
4	210	168	236
5	270	187	242
6	330	205	246
7	390	245	248
8	426	283	249
9	485	315	250
10	520	353	251
11	560	410	251
12	595	465	251
13	630	517	251

[1] Mean income and standard deviation are expressed in thousands of dollars.

CONCLUSIONS

The empirical results support our hypothesis that linear and polynomial specifications of utility functions are too restrictive. The log-linear form, although it performs slightly better than linear and polynomial forms, is still not the best to use. Semilog forms perform even worse than do polynomial. The appropriate degree of nonlinearity of the utility function can best be determined by applying the maximum likelihood method to sample observations without *a priori* specification. The empirical results further suggest some limited empirical evidence that farmers' utility function may exhibit a decreasing absolute risk aversion.

The tendency for Bernoullian utility maximization hypothesis to predict more risky behavior than that actually observed (*9*) may have been due to incorrect specifications of the functional form. Our study shows that this tendency is subdued considerably with proper functional specifications. Obviously, this study presents only a very limited evidence in this inquiry. Extension of this test to a large number of sample forms is needed before our conclusions can be generalized. Nevertheless, the study does suggest that future research efforts to derive Bernoullian utility functions should pay more attention to the specification of the functional form.

REFERENCES

(1) Box, G. E. P. and D. R. Cox. "An Analysis of Transformations." *J. Royal Statis. Soc.* Series B. 26: 211-243, 1964.

(2) Buccola, Stephen E. "Procedures for Estimating Exponential Utility Functions." *Ag. Econ. Res.* 30, Jan. 1978.

(3) Christensen, L. R., and M. E. Manser. *Cost of Living Indexes and Price Indexes for U.S. Meat and Produce, 1947-1971.* Soc. Systems Res. Inst., Univ. Wisc., SSRI Rpt. 293, Madison, 1975-76.

(4) Goldberger, Arthur S. *Functional Form and Utility: A Review of Consumer Demand Theory.* Soc. Systems Res. Inst., Univ. Wis., Systems Formulation, Methodology and Policy workshop paper 6703, Madison, Oct. 1967.

(5) Granger, C. W. J. and P. Newbold. "The Use of R^2 to Determine the Appropriate Transformation of Regression Variables." *J. Econometrics* 4: 205-210, 1967.

(6) Halter, A. N. and G. W. Dean. *Decisions Under Uncertainty with Research Applications. South-Western Publ. Co., Cincinnati, 1971.*

(7) Hildreth, C. G. "What do we Know About Agricultural Producers' Behavior Under Price and Yield Uncertainty?" *Am. J. Agr. Econ.* Dec. 1977.

(8) Keeney, R. L. and H. Raiffa. *Decisions with Multiple Objectives: Preferences and Value Tradeoffs.* John Wiley and Sons, New York, 1976.

(9) Lin, William W., G. W. Dean, and C. V. Moore. "An Empirical Test of Utility vs. Profit Maximization in Agricultural Production." *Am. J. Agr. Econ.* 56: 497-508, 1974.

(10) Lin, William W. "Decisions Under Uncertainty: An Application and Test of Decision Theory in Agriculture." Unpubl. Ph.D. thesis, Univ. Calif., Davis, 1973.

(11) Pratt, J. W. "Risk Aversion in the Small and the Large." *Econometrica*, 32: 122-136, 1964.

(12) Zarembka, P. "Transformation of Variables in Econometrics." *Frontiers of Econometrics*, Academic Press, New York, 1974, pp. 81-104.

In Earlier Issues

(Carl) Alsberg's career never broke away from his past. Each stage in his life's journey made its contribution and moved him toward the next stage. His intellectual frontier moved from the natural to the social sciences; from pharmacology to biochemistry, on to the specialized chemistry of foods and then to the economic and social problems of the food supply, until he found himself accepted as an agricultural economist, his spurs having been earned by 40 years of contributory related experience. As he recognized no barriers in the flow of knowledge, his interests naturally extended into the field of international scientific cooperation. Science to him was a tool for universal application.

As a research administrator Alsberg early learned that you cannot buy research." He advised, "Never assign a man to do a research job unless he has a twinkle in his eye and wants to do it more than anything else." Moreover, he was an advocate of inductive research in both the natural and the social sciences. He expressed his position in these words, "I am convinced that in any science the accumulation of facts is of first importance . . . when the time is right, because of an adequate accumulation of facts, the general unifying principle is sure to occur at about the same time to a number of persons."

This led him to hold with respect to the social sciences that there was "too much integration, too little differentiation; too much spinning of hypothetical theories without regard to their verifiability; too little spade work in digging out facts. If in the social sciences, and especially in economics, more attention were devoted to the recording of what seem important facts and to the analysis of their significance, I am confident we should not need to worry about theory." This line of reasoning led Alsberg to suggest that there be "less writing of books and more publication of brief communications."

"Review of: *Carl Alsberg—Scientist at Large* (Joseph S. Davis, ed.)" by Joseph G. Knapp. AER, Vol. I, No. 3, July 1949, p. 102.