Cross-Substitution Between Husband and Wife as one of the Factors Determining Married Woman's Labor Supply

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Introduction

Married women's labor supply behavior has been subjected to a number of studies. Labor economists' first inquiry was focussed upon labor supply elasticity with respect to wage and income (Bancroft (1958), Lewis (1956) and Long (1958)). Subsequently, however, the number of independent variables has been increased to explain the variation in married women's labor supply. These explanatory variables include personal variables such as husband's income level or more specifically total family income less wife's earnings (Bowen and Finegan (1969), Cain (1966), Parnes (1970) and Shea *et al.* (1970)), wife's own market earning capacity either in terms of education (Bowen and Finegan (1969), Long (1958), Oppenheimer (1970) and Shea *et al.* (1970)) or imputed wage rate (Cain (1966), Kalacheck and Frederic (1970) and Kim (1971)), presence of preschool children with (Bowen and Finegan (1969), Kim (1971 and 1976)) or without consideration of age composition of the siblings (Cain (1966) and Shea *et al.* (1970)), transitory component of income relative to permanent income (Cain (1966) and Mincer (1962)), the woman's own taste or attitude toward market working (Mahoney (1961)), and the husband's attitude toward his wife's working in the labor market (Kim (1976) and Shea *et al.* (1970)), and her own health condition as a permitting factor (Parnes (1970) and Shea *et al.* (1970)). Explanatory variables of labor market include both unemployment rate (Mincer (1966)), and demand for female labor factors as developed by Bowen and Finegan (1969).

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The purpose of this paper is to add to the existing studies another explanatory variable called "cross-substitution" between husband and wife originally suggested by Cain (1966), and to test the effect of this variable upon married women's labor supply behavior by the use of a multiple regression model in which already existing independent variables are also included.

In the following pages the dependent variable is first discussed and then independent variables are operationalized particularly for the measures of cross-substitution and child care burden called "home wage". Operationalization of other independent variables are discussed only in passing so as to avoid any repetition of previous studies for which enough references are available. This is followed by a section presenting the empirical results, and the paper concludes with some discussions.

The Dependent Variable

The construct, called labor supply, can be operationalized in a number of ways either at aggregate or disaggregate levels. The one most frequently studied is a dichotomous measure of whether a person is in or out of the labor force during some reference period, usually the week immediately preceding an interview. If this figure is aggregated over a given population it yields the labor force participation rate. However, it is not an efficient measure of labor supply to the extent that it fails to indicate the individual's degree of participation (i.e., number of hours). Another frequently used measure of labor supply is number of weeks in the labor force during the corurse of a year, variation of which is not sensitive to seasonal factors, although information concerning activities during a year has to be recalled at the time of interview which may produce some error in measurement. A third measure is actual number of hours of labor supplied to the market during the reference week. Unlike the measure of number of weeks in the labor force, the problem of recall is substantially lessened in this measure. However, this measure suffers from seasonal bias at the time of survey.

In this study subjects were asked how many hours per week they usually worked. The answer to this question would be relatively free from seasonal bias and various temporary natures of the fluctuations in hours worked. Therefore, this usual number of hours worked per week was multiplied by the number of weeks in the labor force during the past year in order to obtain annual number of hours of labor supply for each woman. This measure is used as the dependent variable of the regression model in this study.

Admittedly, the use of this dependent variable violates the assumptions of homoscedasticity and normality behind regression analysis. For, the measure of weekly hours usually worked is likely

to have bimodal distribution with peaks at zero hours worked and at 40 hours worked, or perhaps trimodal with a moderate peak at about 20 hours reflecting part-timers. The shape of such bimodal or trimodal distribution may have been somewhat changed through multiplication process with the number of weeks in the labor force, but in some unknown ways. This kind of methodological limitation is a serious drawback when a model developed to test with aggregate data is applied to the disaggregate data such as this. This serves as an advanced warning for the interpretation of R^2's, and partial explanation for obtaining R^2's of 20 or even less in many disaggregate studies. For lack of any substitutable statistical technique, the writer relaxes basic assumptions of the regression analysis and proceeds to test the model with the data.[1] This national sample was representative of women 30 to 44 years of age in 1967. For the purpose of present study, only those samples who were married and lived with their husbands were selected for analysis. To permit a confident analysis of racial difference, black women were over-represented in the sample by a ratio of 3:1.[2] Because of the differences in sampling variation, separate analyses are performed for the two racial groups throughout this report.

Independent Variables

1) *Cross-substitution effect* (L): According to Cain, theoretically the coefficient of the husband's wage consists of (a) the husband's income effect which is negative and (b) a cross-substitution effect which is also negative. In his words, "The cross effect stems from the likelihood that some (although probably small) alteration in the division of market labor supplied by the household will be made between the husband and wife as the husband's market wage varies, *ceteris paribus*" [Cain (1966), p. 10].

In the present study it is hypothesized that the higher the earning capacity of the wife relative to her husband's earning capacity, the more hours of labor she will supply to the market. As the division of

1 The data were collected in 1967 as part of a longitudinal study of the labor market behavior of four age-sex cohorts of the U.S. population carried out under contract with the Manpower Administration of the U.S. Department of Labor by the Center for Human Resource Research of the Ohio State University. Tabular analysis of the initial survey was reported in Shea. *et.al.* (1970), and tabular analysis of the 1969 follow-up was reported in S. Kim, R. Roderick, and J. Shea, *Dual Careers*, Vol. II, 1972, (Columbus. Ohio: The Ohio State University, Center for Human Resource Research, 1972). Present paper is based on the initial survey data.

2 In this report "black" refers exclusively to Negroes. Actual sizes of the sample for each race are 3,606 white, 1,390 black, and 87 others. The 87 "others" (non white, non blacks) are not considered in this report.

household work between husband and wife is becoming more and more indistinct, cross-substitution of the household work between husband and wife is ever becoming easier. Were it not the culturally conditioned differential role expectations of husband and wife, it would have been rational for a household, either husband or wife, whoever happens to have the higher earning capacity, to provide the greater number of hours of labor to the market, *ceteris paribus*. However, in reality the husband in our society is expected to stay in the market and his labor supply is much more inelastic relative to labor supply curves of females in general. It is not, therefore, suggested that a husband whose earning capacity is lower than his wife's will drop out of the labor force, though in some cases he might. What is suggested here, however, is that given the level of inelasticity of male labor supply curve, a wife whose earning capacity relative to her husband's is higher than another woman whose earning capicity relative to her own husband's is likely to supply more hours of labor to the market, *ceteris paribus*. Operationally the measure of cross-substitution denoted by L is obtained by simply subtracting the wife's expected annual earning capacity (Q_2W_2') from her husband's expected annual earning capacity (Q_1M_1').

First, husband's full-time year-round expected earnings (Q_1M_1') were estimated from the coefficients of one of the four regressions of the husband's earnings. The four regressions were based on 1,472 white and 374 black husbands who worked 40 weeks or more during 1966 and for whom all the necessary data were available. For each color group husband's 1966 earnings (Q_1M_1) were regressed on population size of the place of residence (P), husband's educational attainment (E_h), and the Duncan index of husband's occupation (D_h).

Regression results of the husband's earnings for whites and blacks are shown below. (The standard error is in parenthesis and R^2s are all adjusted for degrees of freedom).

$$Q_1M_1 = 1,503 + 320.2P + 871.3E_h \quad \cdots\cdots (1)$$
$$\qquad\qquad (36.8) \quad (68.7) \qquad\qquad R^2 = .15$$

$$Q_1M_1 = 2,225 + 275.8P + 328.3E_h + 52.0D_h \quad \cdots\cdots (2)$$
$$\qquad\qquad (35.8) \quad (84.5) \quad (5.0) \qquad R^2 = .21$$

$$Q_1M_1 = 967 + 456.4P + 370E_h \quad \cdots\cdots (3)$$
$$\qquad\qquad (44.1) \quad (73.7) \qquad\qquad R^2 = .36$$

$$Q_1M_1 = 904 + 450.8P + 215.8E_h + 27.7D_h \quad \cdots\cdots (4)$$
$$\qquad\qquad (43.5) \quad (84.8) \quad (7.9) \qquad R^2 = .38$$

One of the above four estimating equations is used depending upon information available for the particular respondent's husband in order to estimate the husband's expected annual earning capacity (Q_1M_1') assuming that all husbands worked 40 weeks or more in a year. In fact, some husbands may not be able to work a full year because of some disablement. For such persons, the present expected earnings of the husband are overestimated, because in the equation husband's health condition was not used as an independent variable. However, this error is not expected to be a serious one. Coefficients of equation (1) or (3) was used for whites and blacks, respectively, to estimate expected annual earnings of the husbands for whom the Duncan index score could not be ascertained. Otherwise, equations (2) or (4) was applied respectively to whites and blacks.[3]

Secondly, the wife's expected full-time annual earnings (Q_2W_2') were obtained by multiplying actual or estimated hourly wages by 2,000 assuming that she worked full time year-round.[4] Since the husband's expected annual earnings (Q_1M_1') is estimated directly on the basis of the coefficients of annual earnings regressions of those who worked 40 weeks or more, while Q_2W_2' is estimated from the hourly wage rate assuming as if she worked 50 weeks at full time, there may be some danger to overestimate Q_2W_2'. Such overestimation may be even more pronounced for the black women because of their male counterpart's frequent underemployment in the course of a year period. This tends to suppress the variation in the amount of differences between Q_1M_1' and Q_2W_2'.

2) *Wage effect (W)*: According to the theory an increase in wage rate makes leisure more expensive and therefore leads one to purchase less of it and supply more hours to labor market, a substitution effect. At the same time, however, increase in wage rate increases one's level of income which tends to decrease the amount of labor supplied to the market, an income effect. Net results of these opposite effects cannot be predicted, *a priori*. However, in empirical studies whether one uses number of years of education obtained or estimated hourly wage rate as one's earning capacity a consistently positive effect has been observed. While Mincer theorizes that married women make

3 Unlike the wife's case, husband's education is a categorical variable; 0–4 years, 5–7 years, 8 years, 9–11 years, 12 years, 13–15 years, and 16 years or more.

4 One may wonder why the husband's annual expected earning capacity could not be converted into hourly wage rate terms so as to be comparable with the wife's. The present tape contains information about the number of weeks worked by husband only in a categorical form, because of which conversion of annual earnings into hourly wage rate would involve a larger error.

choices among three alternatives-leisure, housework and market work, Parnes has written as follows:

> Since work in the home is far more important in the case of women than in the case of men, there would be no theoretical inconsistency in finding that the income effect predominates in the case of men while the substitution effect predominates in the case of married women. (Parnes (1970), p. 9).

Like Cain and Kalacheck the wage rate has been estimated for those whose wage information is lacking either because of nonparticipation in market work or other reasons. The methods of operationalizing the woman's wage variable are reported in the Appendix A.

3) *Home wage or child care burden (C)*: Among the various homemaking tasks which restrict woman's supply of labor to the market, the presence of children especially under age six is the most powerful deterrent. Hence, most previous studies have tested the effect of this variable by the use of a dummy variable, 1 if there is a child under six years of age, and O if not. By recognizing the fact that children of different ages exert somewhat different types and amounts of burden on a mother, Bowen and Finegan devised eight mutually exclusive categories of child-age combinations, and examined the differential influence of the child-age categories upon the mother's labor force behavior (Bowen and Finegan (1969) and Kim (1976)). The eight child-age combinations and mothers' labor force participation rates corresponding to each of these categories are shown in Appendix B. Bowen and Finegan found that the presence of younger children had the strongest deterrent effect upon a married woman's participation. Futhermore, the presence of children age 14 to 17, in conjunction with children under six years of age, had a rather permissive effect upon the mother's participation compared with the situation where there are children under age 6 but no children 14 to 17 years of age, presumably because the older children could provide some assistance in caring for the younger children.

The eight categories used by Bowen and Finegan could be used as a scale with which the inhibiting effect of the different child-age combinations upon mother's labor supply can be measured. Thus, a "home wage" scale was constructed by assigning ordinal scale values to the eight mutually exclusive child-age classifications. In constructing this scale a couple of crude assumptions are made. First, the presence of children tends to increase a mother's housework especially when they are not enrolled in school. Second, an increase in number of children does not monotonically increase the child-care burden. It is well known fact that child-care cost per child decreases at a rapid rate as the number of children increases (economy of scale). (Seth and Spindler (1968), p. 106).

These assumptions are operationalized by taking the square root of the number of children under 15 years of age and not enrolled in school, and multiplying it by the weight given to the child-age category to obtain the final value of the home wage scale. For example, if a household has one child under 6 years of age not enrolled, the square root of 1 multiplied by the weight of 8 becomes 8 points; if there are two children in that same category, the square root of 2 is multiplied by 8 which becomes 11.31. If there are three children of ages 5, 7, and 14, the weight assigned to this category being 5, square root of 3 (number of children) is multiplied by 5. which becomes 8.66, and so on. Admittedly this is a crude way of estimating the amount of housework. In particular, the exclusion of school-age children from consideration as a burden to their mothers may have some serious drawbacks.[5] Nevertheless, the advantage of the scale is its combination of the two factors, age and number of children, into a single quantitative variable called "home wage", denoted by C.

4) *Other independent variables:* The effects of each total family income less respondent's earnings, denoted by Y, and unemployment rate (U) of the local labor market where each subject resided are expected to be negative. Following after Bowen and Finegan the femininity index (F) was achieved for not only SMSA's but also each local labor market outside of SMSA's where our subjects resided based on the 1960 census data with expected sign of the coefficient positive.

Empirical Results

Stepwise regression analysis performed separately for each color indicates that the order in which each independent variable entered the equation is not exactly the same for white and black. However, the variable first entered in the equation in both colors is the measure of home wage scale, C, constructed to incorporate the combined effect of number and ages of children. This variable performs exceedingly well.

The coefficient of total family income less respondent's earnings, Y, is negative and statistically significant at .01 level for both colors. Again for both colors, the coefficient of the respondents' wage in terms of hourly wage rate, W, is positive and statistically significant at .01 level indicating that the substitution effect is greater than the own-income effect of the wife's wage rate. According to the coefficients, a $1.00 increase in the woman's market hourly wage rate is associated

5 Although not reported here, the home wage scale was tried by including number of children enrolled in school. But this performed poorly, as expected, because of the fact that children enrolled in school exert much less of a burden to mothers than do those who are not enrolled.

Table 1

Stepwise Regression Coefficients for the Determinants of
Usual Annual Number of Hours of Labor Supplied By White Married Women
(standard errors are in parenthesis)

N = 2309

Step	Constant	C	L	W	Y	F	U	R^2 adj	F
1.	806	−66.18 (4.66)**						.08	201.74
2.	1068	−61.08 (4.64)**	−.09 (.01)**					.11	136.40
3.	663	−62.49 (4.57)**	−.10 (.01)**	223.60 (25.49)**				.13	119.59
4.	732	−64.88 (4.56)**	−.08 (.01)**	252.40 (25.86)**	−.021 (.004)**			.14	98.46
5.	353	−65.02 (4.54)**	−.08 (.01)**	250.80 (25.78)**	−.021 (.004)**	12.76 (3.18)**		.15	82.50
6.	363	−65.05 (4.55)**	−.08 (.01)**	250.70 (25.78)**	−.021 (.004)**	12.81 (3.19)	−.27 (.93)	.15	68.73
Unit of Measurement		Home Wage Scale	$/year difference	$/hour	$/year	Index Score	1/10%		
Mean value		3.01	2976	1.93	8087	30.7	42		

*p<.05

**p<.01

Table II

Stepwise Regression Coefficients for the Determinants of
Usual Annual Number of Hours of Labor Supplied by Black Married Women.
(standard errors in parenthesis)

Step	Constant	C	W	F	Y	U	L	R^2 adj	F	N=607
1.	1225	−59.86 (9.01)**						.07	44.18	
2.	909	−56.22 (8.91)**	198.80 (45.42)**					.09	32.33	
3.	81	−55.84 (8.85)**	209.60 (45.19)**	25.41 (7.90)**				.11	25.34	
4.	228	−58.68 (8.86)**	257.80 (48 38)**	24.19 (7.87)**	−.035 (.013)**			.12	21.03	
5.	508	−58.33 (8.86)**	251.10 (48.52)**	21.34 (8.07)**	−.038 (.013)**	−3.39 (2.17)		.12	17.35	
6.	580	−57.75 (8.87)**	236.20 (50.57)**	21.25 (8.07)**	−.033 (.014)**	−3.87 (2.22)*	−.03 (.03)	.12	14.64	
Unit of Measurement		Home wage scale	$/hour	Index Score	$/year	1/10%	$/year difference			
Mean Value		3.41	1.52	31.9	4924	48	1450			

*p<.05
**p<.01

with about two hundred fifty additional hours of labor supply per year for the whites and slightly less hours (two hundred thirty-six) for the blacks.

The effect of cross-substitution between the husband and wife, L, upon the wife's hours of labor supply is highly significant for the whites. The coefficient of this variable for the blacks, however, is not significant at .05 level although its sign is as expected. With the proper sign of the coefficients maintained, in case of the white couple, the husband's earning capacity of $1,000 over and above the wife's earning capacity per annum is associated with a reduction in the wife's labor supply of about 80 hours per year.

Concerning the two labor market variables used in the disaggregate model, the coefficient of the female demand index shows a highly significant result for both color groups. It is interesting to note that an increase of one point in the femininity index of the labor market where the subject resided is associated with an increase in labor supply per year of a little more than 21 hours among black married women and close to 13 hours per year among white women. Black women's such higher sensitivity to market conditions is also observable in their response to the discouraging effect of unemployment rates in the market. The coefficient of unemployment variable is significant only for the black women at .05 level, but not for the white.

Discussion

As mentioned before there is some methodological limitation in using the regression model for the kind of dependent variable such as labor supply measure. Hence, one should be extremely cautious in interpreting R^2 in the equation. However, it should be noted that the home wage scale explains more variance than all the rest of the independent variables combined together regardless of color. From this one is tempted to suggest that providing adequate child care facilities would enhance the amount of labor supplied by married women with younger children. However, it should be quickly added that the degree of adequacy with respect to the quality of child care differs by individuals. Unless public or private child-care facilities meet some standard of quality that satisfies the mothers, there would not be any observable effect upon their labor supply. There is a need for additional study to determine the desired types and qualities of child care.

Potentially there is some problem of multi-colinearity among the variables, Y, W, and L where L is in essence $Q_1 M_1' - Q_2 W_2'$. A careful examination of each step where inter-related variables are entered does indicate that the coefficient of L is slightly affected when W and Y entered the equation. However, its magnitude of change is not so

great to concern for the validity of the measure.

One potentially useful interpretation of the results is the combined effects of the cross-substitution and the wife's market wages upon woman's labor supply. Holding the husband's earning capacity constant, an increase in the wife's market earning capacity will not only have a positive wage effect but also will reduce the earning capacity difference between the husband and wife, and, in turn, bring about an even larger supply of the wife's labor to the market. For example, if a woman's market wage is increased by 50¢ an hour holding her husband's income constant, its positive wage effect would result in an increase of her market labor supply per year of 125 hours for the whites and 118 hours for the blacks. To this, among the whites, the cross-substitution effect will result in an additional labor supply per year of 80 hours because 50¢ per hour increase would mean an increase of $1,000 in expected earning capacity under the same kind of assumption made before (full-time, full year work). Thus, in case of the whites the combined effects of W and L both of which as a result of 50¢ increase in hourly wage would bring about an increase of 205 hours of additional labor supply as opposed to black women's possible increase in labor supply of 118 hours. Potentially this explanation can be extended to the time series analysis of differential rate of increase in labor force participation rate between white and black over years if cross section model can be applicable to time series data at all. (See Long's comment upon Mincer's article (1962), pp. 98-105).

However, at this time, one wonders why the effect of L is not statistically significant among the blacks in the model?

Since black women's commitment to market work has been traditionally much stronger than that of the whites, they may simply be less sensitive to the variations in earning capacity relative to their husbands, thus yielding no statistical significance for the coefficient of L among the blacks. To put this phenomenon into another explanatory framework[6] there may be some level of family income to meet basic necessities and if the head of a family does not earn that minimum level, the remaining family members would have to enter the market. Irrespective of her relative earning capacity or taste, the wife will have to work if a family's main income source from the husband is not adequate to maintain a subsistence level, say four or five thousand dollars a year. Only if the family can enjoy income above the satisfaction of lower level needs, would she be able to decide to enter or not to enter the market based on a number of different considerations

6 The author is indebted to an anonymous reader of the early draft of a similar paper from whom a number of criticisms have been received and incorporated in the present paper.

such as her earning capacity relative to her husband's, and her taste. If that were the case, the black family's average total family income less respondent's earnings being only $4,924 in our sample as opposed to the white counterpart's $8,087, there is greater need for the black woman to work in order to help attain such minimum level of income than is true in the white family. Accordingly, one would expect no statistical significance for the coefficient of L.

Another alternative explanation for failing to observe a statistical significance of the black woman's cross-substitution effect variable is this. For black families, in order to attain the same adequate income level, it takes a greater number of family members to work than is true for white families. This means that the per capita contribution to the family's income by the husband is less among the black families. Under such circumstances, the housewife's decision to supply her hours of labor to the market cannot adequately be based on a rational comparison only between her earning capacity and that of her husband but in conjunction with all other family members' income. Then one would hardly obtain any statistical significance for the variable, L.

At any rate, over all performance of the regression model computed separately for each color group seems to indicate that white women's labor supply is much more influenced by her expected earning capacity relative to her husband's while the black women's labor supply behavior is much more sensitive to the labor market variables. It is "opportunity" to work rather than the wife's earning capacity relative to her husband's that induces supply of labor among the black women.

Appendix A

It is necessary to devise a model in order to estimate the expected earning capacity of women whose market wage information is not available. A number of predictor variables have been tested: (1) Educational attainment; (2) Degree of urbanization in terms of the size of population where respondent resided; (3) Self-health rating; (4) The Duncan Socio-economic index of occupation held between leaving school and the first marriage; (5) Extent of training outside school; and (6) Total number of years during which the subject worked at least six months since leaving school.

To summarize the result in brief, multiple regressions of all possible combinations of the independent variables were tested for each color separately. Since the purpose of the model was to make a prediction of the dependent variable, expected market wage, the largest size of R^2 obtainable with minimum number of independent variables dictated the selections of the equation with different combination of inde-

pendent variables for each color (370 whites and 249 black married sample women served for the base upon which the regressions were tested).

The four final regression equations thus selected are as follows: The first two equations are for the whites and the last two are for the blacks. Standard error is provided in parenthesis and R^2's are all adjusted for the degrees of freedom.

$$W_{h1} = -12.83 + 16.67E + 7.14P \quad (1)$$
$$(1.91) \quad (1.48) \qquad R^2 = .10$$

$$W_{h2} = -46.26 + 17.3E + 6.44P + 2.75N \quad (2)$$
$$(1.89) \quad (1.48) \quad (.61) \qquad R^2 = .12$$

$$W_{b1} = -92 + 19.87E + 9.07P \quad (3)$$
$$(1.51) \quad (1.65) \qquad R^2 = .50$$

$$W_{b2} = -40.65 + 11.72E + 8.82P + 1.64D \quad (4)$$
$$(1.89) \quad (1.53) \quad (.26) \qquad R^2 = .57$$

Where E stands for number of years of formal education, P stands for the degree of urbanization, N for the number of years in which the respondent worked at least six months since leaving school, proxy for seniority, and D for Duncan index of occupation held between leaving school and marriage.

The coefficients of equation (1) were used to estimate market wage rate for the whites for whom information about the number of years worked since leaving school could not be ascertained. Therefore equation (2) was used for whites who did have information on the number of years worked. Equaiton (3) was used to estimate black's market wage whose occupation was not ascertained, and equation (4) was for the blacks whose occupation was ascertained. The Duncan index was chosen for blacks because this variable had higher predictive power for the black women.

Appendix B

Eight Mutually Exclusive Categories of Child-Age Combinations and Adjusted Labor Force Participation Rates of Married Women 14 to 54 Years of Age, Total Color Groups Living in Urban Areas in the 1960 Census Week, and Assigned Weights.

Presence of child-age category	Adjusted[a] labor force participation rate	Weight
With children under 6 only	13.2	8
With children under 6 and children 6-13 but no child 14-17	15.0	7
With children under 6 and children 14-17, but no child 6-13	23.6	6
With children under 6 and children 6-13 and children 14-17	20.7	5
With children 6-13 only	36.2	4
With children 6-13 and children 14-17	36.5	3
With children 14-17 only	53.3	2
With no children under 18	56.1	1

a: adjusted for the effects of color, age, schooling, other family income, and employment status of husband.

Source: Except for the column, weight, adapted from Table 5-2, Bowen and Finegan (2), p. 97.

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