Determinants of Infant Feeding: A Household Production Approach*

John S. Akin
University of North Carolina at Chapel Hill

Charles C. Griffin
Yale University

David K. Guilkey and Barry M. Popkin
University of North Carolina at Chapel Hill

I. Introduction

The patterns, determinants, and consequences of breast-feeding have been subjects of considerable controversy and policy debate over the past decade. The controversy has revolved around three issues.

First, it was originally believed that the incidence and duration of breast-feeding were declining in low-income countries. The World Fertility Surveys (WFS), with nationally representative, randomly collected samples from many low-income countries, suggest, however, that there has not been a general decline in the proportion of children ever breast-fed. On the basis of other data sets, as well as the WFS, it seems reasonable to conclude that there has been a fairly general decline in duration, especially for infants 9 months of age or older. This decline seems to have been limited to urban areas in the Caribbean, Latin America, and selected countries of Asia and Africa. Breast-feeding continues to be almost universal during the first year of life in most of Asia and Africa and during the first 6–9 months in rural South America.[1]

The second aspect of the controversy concerns the allegation that formula and food company promotion has been responsible for the assumed changes in breast-feeding behavior. Although a large body of empirical work has analyzed some of the factors thought to influence breast-feeding, only a few studies have explicitly examined the role of the formula and food industries. Researchers have documented certain industry practices, and some have attempted to correlate these prac-

0013-0079/86/3401-0002$01.00

tices with individual feeding decisions,[2] but no one has used cross-sectional data to establish causal links between industry practices and household behavior in the presence of controls for other variables.

The third issue has been the assumption that the increased use of formula and other breast milk substitutes has resulted in greater infant morbidity and mortality. Although infants are probably the most vulnerable age group and breast milk provides immunological protection to them, it is not clear which patterns of infant diet have negative effects on health, nor is the nature of these effects fully understood. Moreover, a causal link between infant-feeding methods and infant health has not been carefully established. For example, in Malaysia, Butz, DaVanzo, and Habicht found that 78% of the correlation between infant mortality and formula feeding was in fact accounted for by infants' dying before they had the chance to breast-feed.[3]

In this article we organize these different aspects of the infant-feeding controversy into a consistent model of household behavior. We then examine one issue—the choice of infant-feeding technique—in a manner consistent with this conceptual framework. The following section presents our conceptual model and briefly compares it with other work in this area. In section 3, we discuss the appropriate estimation method. We briefly describe, in section 4, the survey used to estimate our econometric model. Section 5 contains an explanation of how we constructed the dependent variable, and in section 6 we describe the explanatory variables used as well as the rationale for their inclusion. We analyze the results in section 7 and conclude by comparing the results of this approach to those of the standard one.

II. Conceptual Model

There tend to be two alternatives for modeling infant-feeding decisions. The first, which has served as the foundation for most previous data collection and estimation efforts but has never been made explicit by analysts, relies on conventional consumption analysis. It assumes that mothers, for whatever reason, gain satisfaction from the practice of breast-feeding. The focus of this approach is wholly on the mother's desire to breast-feed and, in that context, on the economic, biological, social, and marketing factors that affect her preferences for the practice. Empirical work based on this model concentrates on the ever/never choice and on duration of breast-feeding.[4]

The second type of model characterizes households by their desire to produce nutrition for the baby.[5] Households have two related choices: first, the amount of nutrition they prefer to produce for the infant; and second, how they produce the desired level of nutrition.

Viewing the infant-feeding decision as simply one of using or not using breast milk has a major drawback in that it fails to account for the simultaneous use of other foods. However, this simultaneous use is exactly the focus of the household production model, whose structural equations emphasize that the household's central interest is the nutrition of the baby, not breast-feeding per se, and that as a practical matter there are a number of foods that can serve as either substitutes for or complements to breast milk.

We propose a conceptual framework based on the household production approach in which the range of infant-feeding choices facing households is modeled explicitly. We develop this model more completely elsewhere.[6] In essence, the household is assumed to maximize a utility index that is a function of the quality of the infant (represented by its nutritional status) and of the consumption of other commodities. Child nutritional status is produced by combining breast milk (B), breast milk substitutes (M), and solid foods (S) with time inputs of the mother and mother substitutes. Household technology is defined by the mother's human capital (including her age and health status), the infant's age and health status, the availability of mother substitutes, and the physical capital used to produce infant nutrition. Production of infant nutrition and other commodities is subject to standard time and income constraints.

As noted in the brief review of other work in this area, the interest has historically been in whether a woman breast-feeds at all and, if so, for how long. Up to now, we have treated this consumption model as an alternative to the household production model. The foregoing discussion suggests, however, that because the consumption model narrows the focus of the researcher, it may lead to a system of demand equations that improperly excludes goods that are close substitutes for breast milk. The major hypothesis of our household production model is that observing a single-method approach to infant feeding would be rare. Because households have several methods at their disposal and because these methods are not mutually exclusive, the probability of using one feeding technique, such as breast-feeding, to the exclusion of all others is low. Even in regions where commercially produced breast milk substitutes are not available, mothers may react to household constraints by early introduction of supplemental foods and other liquids. We therefore expect to find practices characterized most often by "breast and bottle" rather than "breast versus bottle."

III. Method of Estimation

In estimating the choice of feeding (or production) process, we do not have data adequate to estimate actual production isoquants or to solve for optimal combinations of inputs. However, we do know the set of feeding techniques available to the household as well as the feeding choices actually made. Moreover, although we do not know the form of the production function, we generally have observations on determinants of its form, such as human capital, beliefs, and availability of mother substitutes. We similarly have information on the determinants of the allocation of resources among nutrition and other types of household production, such as prices, wages, income, family size, and assets. We therefore estimate the choice of feeding method (or production process) on the basis of explanatory variables that include price, income, and the technical determinants of this choice, as well as control variables for other household characteristics. These variables are discussed in more detail below. In this section we explain the estimation method, which has several novel features.

Our model describes a situation in which there is a set of feeding methods by which mothers can attempt to achieve nutritional objectives. The feeding methods are clearly not mutually exclusive because, for example, a child can be fed both breast milk substitutes and supplemental foods at the same time. The estimation method must take into account lack of mutual exclusivity, along with the fact that the decisions are jointly dependent or correlated with each other. By jointly dependent or correlated we mean that, for example, if a mother chooses to breast-feed her child, this decision will be related to the decision to feed the child breast milk substitutes and the decision to feed the child solid foods. Children are only fed enough food to meet the mother's nutritional objectives, so there obviously will be some correlations among choices concerning each specific food type.

It is important to emphasize that we do not model these feeding choices within the framework of the classical structural simultaneous equations model, in which a system of structural equations is specified and some endogenous variables are allowed to be functions of other endogenous variables. Our approach leads us instead to a system of demand equations in which each endogenous variable is only a function of a set of exogenous variables. The endogenous variables are then allowed to be correlated with each other so that the probability of a mother choosing one type of feeding method becomes conditional on choices she makes about using other feeding methods.

If our set of endogenous variables were continuous, an example of an appropriate method of estimation would be seemingly unrelated regression equations where jointly determined dependent variables are correlated with each other through the error terms. Our dependent variables are dichotomous, so a method that allows for qualitative variables, the multivariate logit model, is used.[7] This model was developed independently by Schmidt and Strauss, who used it to examine a person's occupational choice and the industry that he or she chose to be employed in as joint decisions, and by Nerlove and Press, who used it to examine the decision of Filipino farmers to adopt one or more of several modern agricultural practices. The method is discussed in detail in Maddala, where he points out that some researchers have tried to interpret the model as a simultaneous equations method but that in fact it is not.[8]

The set of equations that are estimated can be written as follows:

$$\log\left[\frac{P(B = 1 \mid M,S)}{P(B = 0 \mid M,S)}\right]_t = X_t\beta + \delta M_t + \gamma S_t$$

$$\log\left[\frac{P(M = 1 \mid B,S)}{P(M = 0 \mid B,S)}\right]_t = X_t\alpha + \delta B_t + \omega S_t \qquad (1)$$

$$\log\left[\frac{P(S = 1 \mid B,M)}{P(S = 0 \mid B,M)}\right]_t = X_t\psi + \gamma B_t + \omega M_t.$$

The dependent variables are represented, as before, by B (breast-feeding), M (feeding of breast milk substitutes), and S (feeding of supplemental foods). For each observation any of these choices can take a value of zero or one. For example, a mother who breast-feeds and bottle-feeds but has not yet introduced supplemental foods is represented by $B = 1$, $M = 1$, and $S = 0$. A mother who breast-feeds exclusively has $B = 1, M = 0$, and $S = 0$. The variable X_t represents a $1 \times t$ vector of exogenous variables, and β, α, and γ are $t \times 1$ vectors of unknown parameters. Although there is no theoretical reason for the same set of exogenous variables to be in each equation, we impose this restriction principally to accommodate the data available to us.

Note that each equation in (1) includes the other two feeding choices as right-hand-side variables. This way of writing the equations has led to widespread confusion and caused some researchers to interpret the above system as a structural simultaneous equations model. It is clearly not simultaneous because all the probabilities are *conditional* probabilities. Furthermore, note that the coefficients on the endogenous variables are symmetric (the effects of B on S and of S on B are equal). These terms are correlations, although they are not standardized to lie between -1 and $+1$. Finally, there are no identification conditions for this model, as there are for the structural simultaneous equations model.

Equation (1) presents the probability of choosing to use each particular feeding method *conditional* on the other two choices. Equation (2) demonstrates the form of the *unconditional* joint probabilities for one possible combination of feeding methods:

$$P(B_t = 1, M_t = 0, S_t = 0) = \frac{e^{X_t\beta}}{D_t}, \qquad (2)$$

where

$$D_t = e^{X_t\beta} + e^{X_\epsilon\alpha} + e^{X_\epsilon\psi} + e^{X_t\beta+\delta} + e^{X_t\beta+\gamma} + e^{X_t\beta+\gamma+\delta} + e^{X_t\alpha+\delta} + e^{X_t\alpha+\omega} + e^{X_t\alpha+\delta+\omega} + e^{X_t\psi+\gamma} + e^{X_t\psi+\omega} + e^{X_t\psi+\gamma+\omega}. \qquad (3)$$

Formulas similar to (2) and (3) can be written for the eight other possible mixes of feeding methods. It is easy to see that the three choices are jointly dependent, with no endogenous variable appearing on the right-hand side of an unconditional probability equation. This form of the relationship is also useful for simulating the effects of changes in exogenous variables on the joint probabilities of the feeding choices.

IV. The Setting and Data

Estimation of the model is accomplished using data from a 1978 household survey and a 1981 community survey conducted in 100 randomly selected communities in the Bicol region of the Philippines. The Bicol region lies about 300 kilometers southeast of Manila and consists of four provinces located on Luzon Island (Camarines Sur, Albay, Sorsogon, and Camarines Norte) plus two island provinces (Catanduanes and Masbate). The 1980 population was approximately 3.47 million, with 83% living in rural areas. The prominent Bicol economic activities are farming and fishing, which tend to be done on a small scale as family-owned businesses. The World Bank classified 55.4% of the families as poor in 1975, which made it the third poorest among the 12 Philippine regions. Literacy levels are quite high, however, with about 90% of the population capable of reading, although few people attend school beyond the sixth grade.

There is an effort underway by the Philippine government and international development agencies to complete the Bicol River Basin Development Program, a large, integrated development project. Its objectives are to improve agricultural productivity through double rice cropping, irrigation, and better drainage; to build and maintain an improved road system; to promote more business activity and investment; and to improve household water supplies, sanitation, and health.

To document and evaluate the effects of this project, a baseline Bicol Multipurpose Survey (BMS78) of 1,903 households in 100 communities (*barangays*) in the three mainland provinces of the region was completed in 1978.[9] The survey is a compilation of socioeconomic, agricultural, and demographic data on these households; their 12,000 residents; and their communities.

In 1981, under the sponsorship of the Carolina Population Center, interviewers from the Ateneo de Naga Research and Service Center (which conducted the 1978 survey) visited all health facilities and a sample of stores serving the 100 survey communities. The final sample consisted of 518 government, private, and traditional medical facilities or practitioners and 73 stores. Questions asked at the medical facilities measured the availability, coverage, and cost of medical services and gathered information on contacts with infant formula and food companies. Over 1,400 traditional and modern health professionals at these facilities completed a questionnaire measuring their knowledge of and attitudes toward breast-feeding. At the stores, a field investigator recorded the price, size of container, and content measure for each brand of milk, formula, and infant food available.

V. Description of Dependent Variables

Of the BMS78 households, 632 contained at least one child under 24 months of age at the time of the survey. Our sample consists of these 632 open-interval (youngest) children. Of these, 93% had been breast-fed, but 62% had also been fed formula, evaporated milk, or some other type of breast milk substitute (see table 1) by the end of their first

TABLE 1

SAMPLE STATISTICS

Dependent Variables	*N*	%
Initial breast-feeding decision	618	92.6
Status at 3 months:		
Breast-feed*	509	92.3
Breast milk substitutes	551	32.3
Supplemental foods	551	12.7
Breast-feed (entire sample)	551	88.0
Status at 6 months:		
Breast-feed*	415	95.7
Breast milk substitutes	472	42.8
Supplemental foods	472	57.6
Breast-feed (entire sample)	472	84.1
Status at 9 months:		
Breast-feed*	329	93.9
Breast milk substitutes	398	53.7
Supplemental foods	387	89.1
Breast-feed (entire sample)	387	79.8
Status at 12 months:		
Breast-feed*	249	92.8
Breast milk substitutes	312	61.9
Supplemental foods	312	97.1
Breast-feed (entire sample)	312	74.0
Independent Variables	**Mean**	**SD**
Price of infant formula (centavos/g)	4.02	3.05
Whether infant formula available (1 = yes; 0 = no)	.91	.28
Distance to store (km)	8.45	8.13
Price of rice (pesos/kg)	2.06	.09
Child over 15 trained in child care	.33	.47
Mother stays/works at home (1 = yes; 0 = no)	.85	.36
Mother has hired help (1 = yes; 0 = no)	.07	.25
Number of girls aged 6–15	.91	1.05
Birth order of child studied	5.20	2.97
Mother uses contraceptive pill (1 = yes; 0 = no)	.05	.22
Mother uses any other contraceptive (1 = yes; 0 = no)	.31	.46
Value of assets (pesos)	3,431.97	11,800.61
Urban residence (1 = urban; 0 = rural)	.21	.41
Infant is male (1 = male; 0 = female)	.52	.50
Mother's education (years)	7.29	3.10
Mother's age (years)	31.76	6.80
Mother received free sample (1 = yes; 0 = no)	.08	.27
Health professional BF knowledge (raw score range 0–40)	19.55	3.05
Health professional BF attitude (raw score range 0–40)	6.45	1.37
Health professional or facility distributes formula samples (1 = yes; 0 = no)	.21	.41

TABLE 1 (*Continued*)

Other Variables	Mean	SD
Condensed milk variable (1 = yes; 0 = no)	.98	.14
Powdered milk variable (1 = yes; 0 = no)	.97	.17
Child's age (months)	11.8	7.07
Child's age breast-feeding stopped (months)†	9.57	5.18
Child's age substitutes started (months)‡	4.28	4.30
Child's age any supplemental foods started (months)§	6.01	2.65

SOURCES.—*Bicol Multipurpose Survey* (1978); and *Bicol Multipurpose Supplemental Survey* (1981).

NOTE.—BF = breast-feeding.

* The proportion of infants breast-fed in the previous time period that were still being breast-fed; based on an original sample of 618 observations. N = 632 (before observations with missing values were dropped).

† For 181 who had stopped.

‡ For 389 who were fed breast milk substitutes.

§ For 486 who had started supplementing diet.

year. The average age for these children was 11.8 months at the time of the 1978 survey; the average age at which breast-feeding stopped completely was 9.6 months; the average age at which breast milk substitutes were started was 4.3 months; and the average age at which supplemental foods were introduced was 6 months. This information is based on mothers' recall responses. The averages refer to different sample sizes, of course, because many children were too young at the time of the survey to have been weaned, and many had not yet been fed breast milk substitutes or supplemental foods.

These feeding variables are the basis for calculating the feeding method used at each stage of the infant's life. We begin with the feeding decision at birth and reanalyze it at the end of each 3-month interval up to 1 year. The initial feeding decision is a choice between bottle and breast; each of the subsequent decisions includes the third possibility, introducing supplemental foods. The following discussion explains our procedures more thoroughly.

Beginning at the top of table 1, for the initial breast-feeding decision the sample size is 618, which is the original sample of 632 pared down by missing values for one or more variables. The next set of dependent variables indicates the feeding status for the children at the end of 3 months. Any child less than 3 months old is dropped from the sample at this stage, which leaves 551 infants. The sample sizes for the three choices are unequal because the breast-feeding alternative at 3 months excludes those who were not breast-fed at birth. These infants are dropped from the breast-feeding equation on the assumption that lactation was not restarted by mothers once it had ended. In table 1, we continue to report the fraction of the entire sample breast-feeding at each interval, but the breast-feeding variable with the smaller sample size is the one used in the analysis for each set of equations. Moreover, we assume that once mothers introduced breast milk substitutes or supplemental foods, they continued using those feeding methods for the rest of the first year. This procedure is necessary because the Bicol survey contains information on the introduction of breast milk substitutes and supplementary foods but reports no ending points for these choices. The values of the dependent variable are determined for each interval by the feeding methods used at the end of the interval.

The statistics show that of those eligible to breast-feed in each interval, there is a fairly constant and slow rate of attrition from breast-feeding of about 7% every 3 months. This behavior reduces the breast-feeding proportion from 93% at birth to a still large 74% at 12 months. Breast milk substitutes are used by only 7% of the sample at birth, but at the end of 3 months, 32% of the sample use them. Use of breast milk substitutes climbs steadily after the third month to include 62% of the sample by 12 months; even so, simultaneous breast-feeding continues for nearly three-fourths of the 1-year-old children. By the third month, 12% of the infants are fed supplemental foods, and by the end of the first year, nearly all are getting solid foods.

VI. Description of Independent Variables

The explanatory variables are classified into four categories: economic, biomedical, demographic controls, and health facility/practitioner characteristics. Each category is discussed below.

Economic Variables

The utility function in the full model contains two arguments: infant nutrition and other goods. Assuming separability, the initial allocation of resources between the two branches depends on the shadow price of each commodity, the income and time endowment of the household, and the utility derived from consumption of each category of goods. We can capture the preallocation of resources to nutrition, therefore, by measuring household preferences for diverting resources to the baby and the total income available. These taste and income factors affect the choice of feeding method indirectly through the relative mix of time and money devoted to producing infant nutrition.

Each production process is characterized by its requirement for time and money as inputs. These requirements depend on technical characteristics of production, the prices of the inputs, and the shadow price of time, all of which vary by household. The physical technology of production, which affects the efficiency of alternatives to breast-feeding, is characterized by the amount of capital goods used in preparing food (refrigerator, stove) and the human capital of the mother and her substitutes. We will explain how we measure each of these economic variables.

Because of data problems with income calculations for the Bicol data that were available at the time of this analysis, we approximate household income with the value of household assets, such as the house, lot, vehicles, and appliances. Using this general asset variable forces us to delete several important capital items from the analysis. So few households in the Bicol region have a refrigerator or stove, for example, that possessing such items is very highly correlated with the asset measure and causes convergence problems for the estimation procedure. This measure is a good proxy for permanent income, however, which may on some grounds be more important than current income as a determinant of behavior. On the other hand, the use of this permanent income proxy may cause a bias in the coefficient relative to that which would be obtained by using current income because young people, for example, may have relatively high incomes but few accumulated assets.

Input prices are assumed to have both a time price and a cash price that are exogenous to the household. The relevant variables include formula prices, rice prices, availability of formula, and distance to the local store.[10]

The formula prices used in the analysis are the prices of the least expensive formula present in each store visited during the 1981 community survey. This pricing system could cause two minor problems. First, matching 1981 prices to 1978 household behavior requires the assumption that the cost of formula relative to breast milk and weaning foods was constant over the 3-year period. This is probably not an unreasonable assumption for a small subset of such easily substitutable goods over a short period of time, but perhaps more important, it cannot be avoided. The second problem is that in 1981, powdered formula was available in communities where 91% of the sample was located, leaving 9% without apparent access to formula. Economically, the opportunity cost or shadow price of formula for this 9% of the sample approaches infinity. Therefore, we triple the highest price of formula available to the sample and arbitrarily substitute this "infinite" formula price for the otherwise missing price facing these households. This procedure is superior, in our judgment, to the alternatives, which include deleting households without access to formula, giving them a price of zero for formula, or substituting a price for an alternative type of milk. In the first case, we would discard essential information; in the second case, undervalue opportunity cost; and in the third, incorrectly measure the variable. We include a qualitative variable that measures the availability of formula so that availability is measured by a shift in the constant term instead of by the formula price coefficient.

The price of rice appears as a regressor because the Bicolano weaning food, *lugaw,* is a porridge usually made of rice. Rice prices come from the 1978 household survey, reported as the price paid by the household per kilogram of rice in the week previous to the survey.

The shadow price of breast milk should be included as an independent variable, but it is conceptually more difficult to measure and is not exogenous to the household. Although there is an opportunity cost of breast-feeding in terms of time and additional food for the mother, these are probably not measurable. Time costs are partially captured for this sample by other variables, but the cash cost of the nutrients required to produce breast milk are not included.

The time cost of using commercial breast milk substitutes and weaning foods are approximated by the distance from the household to the most commonly used local store. This procedure relies on the assumption that marketing time is the most important time element distinguishing these feeding methods from breast-feeding.

Because of the previously mentioned problems with the income variables in the Bicol data, time costs are not weighted by the opportunity cost of mothers' time. To partially compensate for this measurement problem, mothers' time constraints are also represented by a series of qualitative variables. These include whether any child in the household over age 15 is trained in child care, whether the mother is at home (she either works at home or does not have a job), whether the mother has household help, and the number of girls in the household between the ages of 6 and 15. In addition, the birth order of the child is included, in part to capture the number of children in the household (hence the competing claims on a mother who stays at home) and in part to capture preferences (or lack thereof) for breast-feeding the *n*th child.

In a manner consistent with the household production literature, we include education as a measure of the human capital the mother brings into the production process. We distinguish, however, between the general level of the mother's education and her knowledge or beliefs specific to the choice of feeding technique. Higher levels of education are believed to make home production more efficient in general. Education may also affect the relative productivity of different inputs by increasing, for example, the efficiency of using purchased foods but not increasing the speed or effectiveness of breast-feeding.

Beliefs, on the other hand, are usually discussed in terms of a preference for breast over bottle, a willingness to breast-feed with or without supplementation, or a predisposition to introduce supplemental foods at an early age. Beliefs therefore affect the number of combinations of feeding processes that the mother considers to be valid parts of the production function and directly affect the choice of feeding method. We therefore include a separate set of variables that are associated with belief formation. These are discussed below.

Biomedical Factors

Biological and genetic conditions define the foundations on which the behavioral aspects of infant nutrition are based. Mother's age, parity, diet, body size, body composition, nutritional status, health, contraceptive decisions, and even her anxiety level may affect her ability to lactate and thus her choice of feeding technique. The infant's health status also affects breast milk production because the supply of breast milk appears to depend on the frequency, intensity, and duration of suckling.

These factors would be measured best by the child's physical well-being (health status and age), its interest in suckling (an inverse function of the amount of supplementation), the mother's physical health (health status, nutritional status, and age), and the mother's ability to lactate (whether she breast-feeds in the previous period and whether she uses oral contraceptives). In fact, we come quite close to this paradigm with the Bicol data. We do not have information on the child's health status, but reestimating the model for each age interval is equivalent to interacting all variables with the age of the child. We thereby control explicitly for the effects of the child's growth and changing physical needs on feeding methods. We also do not have data on the mother's health status, but we do have her age and contraceptive practices. In addition, censoring the breast-feeding sample for those who quit and conditioning our estimated probabilities regarding use of other feeding methods restricts the breast-feeding sample to those who are able to breast-feed and controls for the indirect effects of using other feeding methods on the ability to breast-feed.

Demographic Controls

We must control in some manner for preference factors and technological constraints that we are not able to model or measure explicitly. Urban residence is included to control for systematic shifts in available technology, efficiency of markets, and community preferences that may be associated with living in a town. The child's sex is used to control for possible sex biases in allocating household resources.

Health Professional/Promotion Variables

We include a number of industry and health professional variables thought to contribute to the mother's choice of feeding method. Economically, these are technical factors that help determine the shape of isoquants. The 1978 survey reported the location of birth and the type of attending practitioner. About 90% of the deliveries took place at home, about two-thirds of them attended by traditional midwives (*hilots*). Most of the other home deliveries were attended by trained midwives. From the 1981 community survey we can calculate the closest modern public facility, modern private facility, and *hilot* serving each *barangay*. Because we do not know the actual identity of the delivery practitioner, we assume that women delivering at home with a *hilot* use the closest one, that those delivering at home with a trained midwife use the one from the closest government clinic, and that those delivering in a clinic or hospital use the closest facility. For all facilities and individual practitioners we know whether they distributed free formula samples in 1981,[11] and we can construct measures of both their attitudes towards breast-feeding and their knowledge of the practice.[12]

Because we do not know the identity of the practitioners serving the women in 1978, those using an attendant operating out of a clinic or hospital are assumed to have been exposed to the average knowledge and attitude scores of people working in that facility and to the practice of that clinic regarding sample distribution. Women whose closest practitioner was in individual practice are assumed to have been exposed to that individual's knowledge, attitudes, and formula sample distribution policy.

We also know from the 1978 household survey whether the mother actually received a free formula sample. We use both this variable and clinic distribution practices to measure formal and informal promotional contacts between the mother and agents of the infant-feeding industry.

VII. Analysis

The following analysis refers to the coefficient estimates in table 2, part A, and to the changes in probability recorded in table 3, part A. Table 2 estimates come from individual equations for each feeding decision (using breast milk, breast milk substitutes, or supplemental foods) for the age intervals shown. The top row of estimates in table 3 comes from substituting the mean values for each independent variable into the equations and estimating the probability of using each type of feeding method, at each age interval, for a statistically average baby. Each independent variable is then changed from its mean value to the mean plus 10% (or for a dummy variable, from a value of zero to a value of one) to calculate the remaining entries in the table, which represent the resulting changes in probability while holding all other independent variables constant. For example, the second entry in the first column indicates that increasing the price of formula by 10% reduces the probability of breast-feeding at birth by .008 for the average baby in the sample. Only the starred numbers in table 3 should be given much credence; all other changes depend on coefficients that are not significantly different from zero. This procedure simulates the same procedure used to calculate elasticities when the dependent variables are continuous.

Economic Variables

Of all the possible effects of the formula price variable, the one we would be most confident in predicting is a depressing effect of higher formula prices on formula use. In fact, however, the coefficient on the

TABLE 2

Logit Estimations of Infant-Feeding Model

	Initial Breast-Feeding Decision	Age 0–3 Months			Age 4–6 Months			Age 7–9 Months			Age 10–12 Months		
	B	*B*	*M*	*S*	*B*	*M*	*S*	*B*	*M*	*S*	*B*	*M*	*S*
A. Independent Variables													
Constant	15.63	20.65	−3.2	−9.86	−6.93	1.67	−9.17	8.74	5	−5.34	−3.81	−3.33	−8.46
	1.88*	1.29	−.6	−1.53	−.36	.28	−1.82*	.64	.8	−.63	−.24	−.48	0
Price of infant formula	−.43	−1.07	.23	.65	1.08	.16	.32	−.35	.2	.03	1.28	.69	3.19
	−.79	−1.08	.69	1.62	.79	.41	.99	−.39	.5	.06	1.09	1.59	1.59
Availability of infant formula	−4.69	−11.79	2.8	6.69	12.49	2.57	2.67	−3.6	2.36	−.92	13.27	7.47	−.2
	−.81	−1.11	.78	1.56	.85	.62	.77	−.36	.56	−.16	1.05	1.61	0
Distance to store	.06	.28	−.01	0	−.06	−.04	0	.09	−.01	.01	.01	.01	−.01
	1.95*	2.82***	−.88	−.06	−2.32**	−2.16**	−.04	1.77*	−.88	.26	.46	.36	−.29
Price of rice	−1.81	1.5	−.46	.69	−.25	−1.26	2.48	−3.79	−2.73	2.68	−3.99	−1.92	−.17
	−.91	.34	−.36	.46	−.06	−.92	2.11**	−1.2	−1.84*	1.24	−1.69*	−1.17	−.03
Value of household assets	.01	−.02	−.01	.02	−.01	.02	.03	0	.03	.07	.03	.05	.03
	.55	−1.02	−.64	1.6	−.45	.7	1.14	.11	.77	1.07	.43	1.17	.2
Child over age 15 trained in child care	1.00	−.33	.24	.56	.85	.48	.22	.36	.55	.8	.1	.86	1.23
	2.39**	−.53	.96	1.62	1.15	1.68*	.89	.51	1.82*	1.74*	.14	2.4**	1.18
Mother stays/works at home	−.54	.57	−.27	−.26	−.76	−1.27	.47	.9	−1	.19	−.7	−1.49	.6
	−1.08	.89	−.87	−.68	−.93	−3.7***	1.56	1.43	−2.68***	.37	−.8	−3.16***	.44
Presence of hired household help	−.9	−.1	.22	1.15	−.11	.96	.74	−1.08	7.91	.11	10.08	8.28	6.13
	−1.47	−.08	.43	2.23**	−.1	1.27	1.23	−1.07	.31	.09	.06	.22	.11
N of girls aged 6–15	−.13	−.38	−.17	−.24	−.41	−.12	−.08	.11	−.12	−.03	−.25	−.33	.53
	−.73	−1.01	−1.27	−1.31	−1.14	−.79	−.69	.24	−.74	−.15	−.66	−1.83*	1.08

Birth order of infant	−.07	.1	.05	−.05	−.26	−.01	−.05	.01	−.01	0	.1	−.08	−.13
	−.78	.63	.82	−.59	−1.22	−.16	−.82	.07	−.11	.01	.59	−.87	−.54
Mother uses contraceptive pills	−.36	−1.95	−.13	.01	9.35	−.07	−.7	−.45	−.63	1.36	−.16	−.99	8.84
	−.56	−1.79*	−.24	.02	.14	−.12	−1.46	−.41	−1.06	1.23	−.12	−1.48	.07
Mother uses any contraceptive	−.76	.27	.08	.42	−.71	−.22	.59	.8	.25	−.38	−.31	.41	−.24
	−2.12**	.37	.33	1.35	−1.04	−.75	2.32**	1.04	.82	−.93	−.5	1.15	−.23
Urban residence	−.2	.33	.06	−.01	.04	.34	.15	.31	.55	.29	10.3	.7	−1.11
	−.54	.43	.24	−.03	.06	1.15	.61	.45	1.68*	.63	.14	1.73*	−1.22
Male infant	.54	.03	.04	−.16	.76	.08	−.09	.56	.14	−.03	.53	.48	−.78
	1.58	.06	.17	−.58	1.2	.34	−.43	.99	.54	−.07	.95	1.65*	−.93
Mother's education	−.04	−.21	.06	−.03	−.24	.07	−.05	−.15	.06	−.04	0	.12	−.05
	−.67	−1.81*	1.48	−.56	−2.14**	1.38	−1.27	−1.27	1.17	−.61	−.01	1.71*	−.28
Mother's age	−.06	−.17	.02	−.04	.04	0	.01	.03	−.02	0	−.04	−.01	−.01
	−1.57	−2.57**	.94	−1.17	.4	−.12	.42	.35	−.71	.07	−.73	−.32	−.14
Mother given free samples	.83	2.03	.64	−.27	0	1.13	−.1	.19	.82	8.05	.59	.56	5.43
	1.18	1.79*	1.8*	−.56	0	2.74***	−.26	.22	1.82*	.29	.51	.98	.17
Health professional knowledge	.04	.21	.08	−.08	−.04	.02	−.02	.15	−.03	.04	−.09	−.12	−.02
	.64	1.78*	1.7*	−1.36	−.36	.35	−.46	1.27	−.51	.57	−.74	−1.81*	−.09
Health professional BF attitude	−.18	−.05	0	.09	.28	.08	−.05	.42	.12	.09	−.28	.06	.2
	−1.17	−.22	.04	.76	1.09	.85	−.66	1.67*	1.27	.66	−1.17	.58	.73
Facility distributes formula samples	−1.03	−1.23	−.06	.61	−.29	.49	.22	−1.04	.94	−.81	2.04	1.65	−1.07
	−2.29**	−1.62	−.18	1.51	−.33	1.36	.68	−1.31	2.21**	−1.45	1.44	2.77***	−.84
Correlation:	...	...	−3.98	−.41	...	−3.9	.45	...	−2.87	1.13	...	−2.23	2.67
Breast-feeding	...	...	−7.09***	−.06	...	−6.63***	1.68*	...	−5.65***	1.56	...	−5.43***	2.08**
Correlation:	...	−3.98	...	.72	−3.9	...	1.44	−2.87	...	1.04	−2.23	...	3.01
Formula feeding	...	−3.7***	...	2.21**	−3.34***	...	5.44***	−2.9***	...	2.31**	−2.35**	...	2.52**
Correlation:	...	−.41	.72	...	.45	1.44	...	1.13	1.04	...	2.67	3.01	...
Supplemental foods	...	−1.01	2.31**	...	.47	5.66***	...	1.95*	2.45**	...	1.84*	2.66***	...

SOURCES.—Based on data from Bicol Multipurpose Survey (1978); and Bicol Multipurpose Supplemental Survey (1981).
NOTE.—Second line denotes asymptotic t-statistics. BF = breast-feeding.
* Significant at .10 level.
** Significant at .05 level.
*** Significant at .01 level.

TABLE 3

PREDICTED PROBABILITIES AND CHANGES IN PREDICTIONS BASED ON LOGIT ESTIMATES OF INFANT-FEEDING MODEL

	Initial Breast-Feeding Decision	Age 0–3 Months			Age 4–6 Months			Age 7–9 Months			Age 10–12 Months		
	B	*B*	*M*	*S*	*B*	*M*	*S*	*B*	*M*	*S*	*B*	*M*	*S*
A. Independent Variables													
P at mean values of independent variables	.958	.999	.210	.102	.996	.456	.578	.974	.758	.969	.990	.892	1.00
Price of formula (+10%)	−.008	0	.015	.026	.001	.015	.030	−.004	.014	0	.004	.023	0
Availability of formula (= 1)	−.062	−.001	.051	.163	.996	.434	.524	−.032	.528	−.019	.996	.926	0
Distance to store (+10%)	.002*	0*	−.002	0	0*	−.008*	0	.002*	−.002	0	0	0	0
Price of rice (+10%)	−.018	0	−.015	.014	0	−.063	.117*	−.029	−.117*	.013	−.012*	−.045	0
Teen trained in child care (= 1)	.036*	0	.041	.055	.003	.120*	.053	.009	.096*	.022*	.001	.077*	0
Mother stays home (= 1)	−.019	0	−.047	−.025	−.002	−.303*	.115	.031	−.151*	.006	−.006	−.099*	0
Hired help (= 1)	−.052	0	.038	.154*	0	.233	.166	−.045	.328	.003	.013	.164	0
Girls ages 6–15 (+10%)	−.006	0	−.003	−.002	0	−.003	−.002	0	−.002	0	0	−.003*	0
Infant's birth order (+10%)	−.001	0	.005	−.002	−.001	−.002	−.006	0	−.001	0	.001	−.004	0
Contraceptive pill use (= 1)	−.017	−.003*	−.020	.001	.006	−.018	−.173	−.014	−.131	.024	−.002	−.132	0
Any contraceptive (= 1)	−.037*	0	.014	.042	−.003	−.055	.140*	.017	.045	−.012	−.003	.037	0
Assets (+10%)	0	0	0	.001	0	.002	.002	0	.002	.001	0	.002	0
Urban residence (= 1)	−.009	0	.010	−.001	0	.085	.036	.007	.092*	.008	.066	.058*	0
Infant sex (= male)	.022	0	.006	−.015	.003	.020	−.021	.014	.025	−.001	.005	.047*	0
Mother's education (+10%)	−.001	0*	.008	−.002	−.001*	.013	−.010	−.003	.008	−.001	0	.008*	0
Mother's age (+10%)	−.008	0*	.013	−.011	.001	−.003	.008	.002	−.012	0	−.001	−.003	0
Received free samples (= 1)	.025	.001*	.121*	−.023	0	.270*	−.024	.004	.125*	.066	.005	.046	0
Health professional BF knowledge (+10%)	.003	0*	.025*	−.013	0	.008	−.009	.006	−.009	.002	−.002	−.024*	0
Health professional BF attitude (+10%)	−.005	0	0	.005	.001	.013	−.008	.006*	.014	.002	−.002	.004	0
Facility distributes samples (= 1)	−.056*	−.001	−.010	.004	−.001	.122	.052	−.038	.146*	−.031	.011	.108*	0
B. Correlation Terms													
Breast-feed (= 1)	...	...	−.750*	−.074	...	−.648*	.333*	...	−.335*	.034	...	−.158*	.001*
Formula feed (= 1)	...	−.009*	...	−.004*	−.044*	...	.116*	−.105*	...	.049*	−.026*	...	.001*
Supplement foods (= 1)	...	0	.138*	...	.002	.339*	...	.046*	.228*	...	.121*	.622*	...

SOURCES.—Based on data from Bicol Multipurpose Survey (1978); and Bicol Multipurpose Supplemental Survey (1981).
NOTE.—BF = breast-feeding.
* Coefficient corresponding from table 2 is significant at or above the .10 level.

formula price variable is never statistically significant, and it has the opposite of the expected sign in almost every case.

The dummy variable measuring the availability of formula also does not produce statistically significant results. Similarly, the price of rice is generally not significant. However, the signs of both sets of coefficients are usually consistent with expectations based on microeconomic theory.

The one economic variable that has a logical and significant effect is distance to the store that sells the formula. For the breast-feeding decision, the farther away the store, the more likely the woman is to breast-feed initially and continue through the third month. There is an inexplicable switch of the sign in the sixth month; however, the positive effect of store distance on breast-feeding continues thereafter through the ninth month. For the decision to feed breast milk substitutes, the distance effect is negative in all but the twelfth month, although only one coefficient is statistically significant. This is fairly good evidence that the more difficult it is to get to a store, the more likely the woman is to breast-feed and the less likely she is to feed substitutes. At the same time, distance to a store does not appear to affect the introduction of solid foods, which may indicate that these foods are produced primarily in the home from household food supplies.

If distance effects are considered in combination with the weak results for formula price and availability, it appears that the major cost factor determining feeding technique is accessibility of stores, not the cost of formula. It is useful to reiterate that the distance variable measures distance to the nearest store, whether or not it sells formula, and not distance to the nearest store selling formula. A logical hypothesis flowing from this discovery is that it may matter less whether formula is on store shelves than how far away the store is from the woman's residence. These distance results are consistent with those from work in other low-income countries.[13]

The asset variable, our proxy for income, has very little, if any, effect on the choice of feeding method. In only one case does the coefficient on income approach statistical significance (at the 90% level), and in that instance, the effect is to increase the probability of introducing supplemental foods in the 0–3-month interval. Reference to table 3, however, shows that this effect is so small that a 10% increase in the value of assets causes only a .001 increase in the probability of using supplemental foods. In fact, as presented in table 3, the whole set of predicted probability changes for the asset variable is close to zero. This result is consistent with the hypothesis that income does not affect the choice of feeding method but instead affects the total amount of nutrition supplied to the infant.

The value-of-time variables measure three things: whether the mother is at home; if so, how many children are pressing for her services; and whether she has helpers. Whether the mother stays home appears to be irrelevant to the feeding decision during the first 3 months, but thereafter it has a highly significant, negative effect on whether the mother introduces breast milk substitutes. Staying home does not have a statistically significant effect on either the speed with which supplementary foods are introduced or the probability of breast-feeding; it simply reduces the probability of using breast milk substitutes.

The "value of mothers' time" literature suggests that a mother who stays home but has a large number of children has higher opportunity costs, or more demands placed on her time, than a mother staying home but having fewer children. If breast-feeding is more time-intensive for the mother than the alternatives, then we would expect to find a positive effect on the probability of breast-feeding for mothers staying home coupled with a negative effect for the birth order of the child. However, the variable controlling for the number of children (birth order of infant) is never significant. The important variable, therefore, may simply be the work-related one (whether the mother works or stays at home), and it affects breast-feeding only indirectly through its retardant effect on introducing breast milk substitutes.

The three variables measuring the presence of helpers (girls aged 6–15, teens trained in child care, and hired helpers) have differing effects. The number of girls aged 6–15 is statistically significant only in reducing the probability of using breast milk substitutes at the 10–12-month period—not an important result. Whether teenagers help with child care, however, has a significant, positive effect on how soon breast milk substitutes or solid foods are introduced, starting at the third month. Initially, mothers with older children are more likely to breast-feed; by the third month the presence of trained teens begins to increase the probability that supplemental foods will be introduced (statistically significant at the 89% level); and after the sixth month their presence has a smaller but still positive effect on the likelihood of introducing both solid foods and breast milk substitutes. The presence of hired help has similar effects, especially in the third month. These effects, however, are generally less significant statistically.

To summarize, a mother staying home or working at home is not necessarily more likely to breast-feed than a mother who works outside the house, but she is less likely to introduce breast milk substitutes after the third month. Working outside the home does not make the mother more likely to stop breast-feeding, only to initiate mixed feeding by adding breast milk substitutes after the third month. The presence of other helpers in the household generally increases the probability that supplemental foods are added earlier; it also increases the probability that breast milk substitutes are added after the sixth month.

Internal household time allocation effects and the effects of mothers working outside the home on breast-feeding must therefore be felt indirectly through the correlations of the alternative feeding methods.

Biomedical Factors
If the mother uses contraceptive pills, she is significantly more likely to stop breast-feeding by the third month than a similar mother who does not use the pill, but there is no other significant effect for this variable. If the mother uses any modern contraceptive, it reduces the likelihood that she will breast-feed at all and increases the probability that she will add supplemental foods by the sixth month.

To the extent that age is a proxy for the declining ability of a woman to breast-feed, older women are expected to be less likely to start breast-feeding and more likely to stop earlier than younger women. Our results are consistent with this statement. Age is a significant but weak predictor of failure to breast-feed from the start and of cessation of the practice, if started, in the 0–3-month interval.

Demographic Controls
These control variables are present in the equations to isolate the effects of the economic variables on which the analysis focuses. This procedure has the side effect of supplying estimates of the demographic variables' effects as well, although it is less clear what these variables measure and what their coefficient signs should be. For example, whether the infant is male seems to have little effect on feeding behavior, although for the initial feeding decision the positive effect on the probability of breast-feeding is just below our significance threshold. What this finding means is more difficult to discover.

Urban residence does not appear to affect feeding behavior systematically until after 6 months, at which point it begins to increase the probability that breast milk substitutes will be introduced. Education (our measure of human capital) of the mother has a statistically significant negative effect on breast-feeding in both the 0–3-month interval and the 4–6-month interval. Its only other significant effect is a positive one on feeding breast milk substitutes in the 10–12-month interval. For both the urban and education variables the magnitudes of the predicted effects in table 3 are not large and could easily be overwhelmed by other factors.

These results demonstrate the importance of directly measuring factors that are often proxied by urban- and education-type variables, such as work-related phenomena, availability of markets, differences in health care services, and a more "modern" orientation. Other studies that link declines in breast-feeding to increased education and urban residence on the basis of simple frequency tabulations, averages, or correlations may be misleading because of this measurement problem.

Health Professional/Food Industry Variables
Our two formula promotion variables require careful interpretation. The first, which is also the more reliable, is whether the mother received a free formula sample. This variable has a counterintuitive positive effect on the probability of breast-feeding up to age 3 months. It also has a large, significant, and positive effect on the probability of introducing breast milk substitutes for the 0–3-, 4–6-, and 7–9-month intervals. Thus, receiving formula samples increases the probability of introducing breast milk substitutes over most of the first year, but it also seems to have a positive effect on the probability of breast-feeding in the first interval.

To reiterate, our second measure of promotion measures whether the facility or practitioner that assisted the mother at delivery gave away formula samples in 1981. Although this variable is less than perfect because we are not certain which practitioner was seen, it is certainly of interest as a first approximation in measuring a very important phenomenon. A possible problem with interpretation is related to causality assumptions. The type of information that we have could explain feeding behavior if promotional practices determine choice of feeding method, or it could simply be demonstrating a correlation that exists if women who want to feed breast milk substitutes are the ones who choose to go to health clinics that distribute free samples.

With these qualifications in mind, we note that the facility-level sample distribution variable has three statistically significant effects. A woman exposed to a facility distributing formula samples is found to be less likely to breast-feed initially and more likely to introduce breast milk substitutes in both the 7–9- and 10–12-month intervals. The important effect is probably the initial one, reducing the probability of ever breast-feeding. The changes in probability shown in table 3 indicate that if the average infant is taken from an area where free samples are not distributed (in the type of delivery facility used) to an area where formula samples are distributed (in that same type of facility), the infant will experience a .06 drop in the probability of being breastfed at birth, other things held constant. Because the mother's actual receipt of samples at her infant's birth is controlled for in this analysis, this reduction in probability seems to be due either to characteristics of the mothers who choose facilities that give out samples or to a community-level effect, such as a demonstration effect.

Health professionals' knowledge of lactation and attitude toward breast-feeding appear to have some effect on the infant feeding behavior of the women in this sample. The results are not intuitive, however, and follow no obviously logical pattern. The knowledge variable has a positive effect on the probability of breast-feeding in the 0–3-month interval but also a positive effect on the probability of introducing substitutes in the same time period and a negative effect on introducing substitutes in the 10–12-month period.

Correlation Terms

The correlation terms (presented in part B of tables 2 and 3) are almost always large and statistically significant. Breast-feeding and feeding breast milk substitutes are negatively correlated in all age intervals; supplementation and feeding breast milk substitutes are positively correlated in all age intervals; and breast-feeding and supplementation become positively correlated after the sixth month.

That the correlation terms are statistically significant is powerful evidence that failure to include them is equivalent to misspecifying the model by omitting important variables. This omission effectively imposes invalid restrictions on the coefficients (that the correlation coefficients equal zero). Consequently, failure to include the correlations leads to the use of the wrong variance-covariance matrix, the reporting of incorrect standard errors, and the calculation of incorrect asymptotic *t*-statistics. For qualitative dependent variable techniques such as the one used here, we do not know the direction of these errors, which makes the inclusion of the correlation terms to prevent the errors even more important.

To demonstrate more clearly the value of our model and our estimation approach, we have included table 4, which displays the coefficients for the breast-feeding equation alone (run for the 0–3-,4–6-, 7–9-, and 10–12-month intervals without the correlation terms). Before our model and estimation procedures were developed, this single equation approach by age interval would arguably have been the most advanced estimation method available.

In comparing the coefficients in table 4 with those in table 2, we see that there are nine sign changes (all for statistically insignificant coefficients) and six changes in the coefficients meeting our test of statistical significance (α = .10). Several of the changes in asymptotic *t*-statistics are quite large (e.g., from 1.2 to 1.7). On the assumption that the full model is the correct one, the problems with the variance-covariance matrix implied by these swings in *t*-statistics suggest that analysts should be cautious in using single-equation models.

For these reasons—the belief, based on our model, that this is the correct way to study infant feeding, the high significance levels on our correlation coefficients, and the shifts in *t*-statistics caused by eliminating the extra equations and correlation terms—we believe that failure to use the approach described here introduces serious statistical problems in the analysis of infant-feeding behavior. The problem extends to data collection as well—an issue referred to above. All surveys of which we are aware have collected only breast-feeding data and therefore cannot be used to estimate a properly specified model.

For interpreting results, the problem is more subtle. An analyst with access to only the table 4 results would conclude that women farther away from stores are more likely to breast-feed for the first 9 months, that mothers who start breast-feeding but use contraceptive

TABLE 4

LOGIT ESTIMATES OF BREAST-FEEDING EQUATIONS WITHOUT CORRELATIONS

INDEPENDENT VARIABLES	BREAST-FEEDING			
	0–3 Months	4–6 Months	7–9 Months	10–12 Months
Constant	17.55	−8.81	6.89	−2.43
	1.34	−.52	.56	−.15
Price of infant formula	−1.02	.81	−.74	1.17
	−1.25	.71	−.92	.99
Availability of infant formula	−11.43	8.94	−7.66	11.93
	−1.31	.72	−.89	.93
Distance to store	.21	−.04	.11	0
	2.88***	−1.88*	2.22**	.12
Price of rice	1.24	1.79	−1.17	−3.62
	.36	.5	−.44	−1.71*
Value of household assets	−.01	−.02	0	.02
	−.76	−.67	.17	.27
Child over age 15 trained in child care	−.21	.46	.18	−.08
	−.39	.69	.26	−.11
Mother stays/works at home	.78	−.54	1.12	−.1
	1.35	−.67	1.82*	−.12
Presence of hired household help	−.58	−.48	−1.37	10.82
	−.67	−.48	−1.37	.04
N of girls ages 6–15	−.08	−.25	.14	.01
	−.3	−.84	.34	.03
Birth order of infant	.05	−.3	.02	.1
	.34	−1.66*	.11	.62
Mother uses contraceptive pills	−1.68	18.04	−.29	.34
	−1.93*	0	−.28	.28
Mother uses any contraceptive	−.11	−.26	.65	−.38
	−.19	−.44	.88	−.62
Urban residence	.09	.01	.12	10.18
	.16	.01	.19	.13
Infant is male	−.07	.72	.6	.37
	−.14	1.27	1.13	.71
Mother's education	−.14	−.31	−.17	−.03
	−1.6	−2.72***	−1.45	−.24
Mother's age	−.14	.06	.05	−.03
	−2.5**	.68	.66	−.57
Mother given free samples	1.48	−.07	.37	.38
	1.55	−.08	.44	.33
Health professional BF knowledge	.05	−.03	.22	−.06
	.49	−.22	1.9*	−.5
Health professional BF attitude	.19	.11	.28	−.28
	.96	.53	1.25	−1.23
Facility distributes formula samples	−1.02	−.6	−1.33	1.23
	−1.55	−.72	−1.73*	.99

SOURCES.—Based on data from Bicol Multipurpose Survey (1978); and Bicol Multipurpose Supplemental Survey (1981).

NOTE.—BF = breast-feeding.

* Significant at .10 level.

** Significant at .05 level.

*** Significant at .01 level.

pills are less likely to continue to breast-feed through the third month, that older women are more likely to discontinue breast-feeding by the third month, and that highly educated mothers are more likely to stop breast-feeding by the sixth month. This is exactly the information supplied by the breast-feeding equations in our larger model.

Consequently, interpretation of breast-feeding determinants alone would not be strongly affected. The loss of information, however, is enormous. All of the coincidental effects for the Bicol sample culled from the equations regarding supplemental food and breast milk substitutes are not seen. The two most glaring losses are, first, the positive effects of the working and household help variables on the early introduction of supplements and breast milk substitutes and, second, the positive effect of receiving free samples on early introduction of breast milk substitutes. The analyst looking at table 4 alone would be forced to conclude, for example, that receiving free samples or using a clinic where free samples are commonly given away has no effect on breast-feeding behavior. Table 2 shows that this conclusion is not true—these practices may have no direct effect on breast-feeding, but they do indirectly affect it by increasing the probability of earlier use of breast milk substitutes, a practice that in turn has a negative correlation with breast-feeding.

VIII. Conclusion

We believe the most important contributions of this article to be the conceptual framework and the demonstration of an appropriate limited dependent variable estimation technique. The presentation of the infant-feeding decision as a joint selection of breast milk, breast milk substitutes, and supplemental foods is an entirely new approach in this area. It represents one of the first efforts to model the structure of household production decisions. Our approach provides a plausible statistical "reenactment" of how one small but important household decision is made—how to feed a baby. By modeling the decision process explicitly, we recover information lost by analysts who focus only on reduced-form breast-feeding demand equations. Statistically, our work suggests that the omission of correlations among feeding methods may lead to incorrect inferences.

Perhaps the most startling analytical conclusion is reached by examining table 3. Apart from the column for the initial feeding decision, each column headed by a *B* is filled with zeros or very small values, whereas the breast milk substitutes and supplementation columns tend to show large effects for some independent variables. This situation implies that the independent variables do not have very much explanatory power, even when statistically significant, as far as breast-feeding is concerned. This is consistent with the table 1 statistics that show the prevalence of breast-feeding across all time intervals, even at 12 months. Changes in breast-feeding behavior—for this sample at least—are the indirect consequence of the gradual supplementation of the child's diet with breast milk substitutes after the first few months. In other words, the independent variables appear not to affect breast-feeding behavior strongly per se but to affect the feeding of breast milk substitutes and the timing of supplementation with solid food, which in turn work in a somewhat diluted fashion on breast-feeding. All of this information is absent from table 4, in which the typical approach of looking at breast-feeding alone is followed.

Few other studies exist to inform us as to whether the feeding patterns we find are typical or atypical.[14] A recent review by the U.S. government has shown that knowledge of supplemental food and breast milk substitute feeding patterns for infants is very limited.[15] If our conceptual model is correct and women face comparable time and economic constraints wherever they live, we would expect to find that these Filipino results are not unique. The most important difference may be in the nature of the breast milk substitutes and supplemental foods rather than in the feeding patterns per se.

Notes

* The Bicol River Basin Development Project and USAID, particularly Don Wadley and David Heesen, are thanked for providing access to the BMS78 data set. Ross Laboratories, USAID, and the Nestle Coordinating Center for Nutrition, Inc., assisted in the funding of the BMSS81 survey. We also thank the Ateneo de Naga Research and Service Center and its predecessor for an excellent job in collecting the 1978 and 1981 Bicol data. The Carolina Population Center and Ross Laboratories—particularly Tom McCollough, Judith Gussler, and Gilbert Martinez—are thanked for funding the final analysis. Larry Taylor, Lynn Igoe, and Margaret Mauney are thanked for their assistance in computer work, editing, and typing, respectively.

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