Estimating the Health Impact of Industry Infant Food Marketing Practices in The Philippines

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MEASURE Evaluation

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ABSTRACT

The observed decline in the prevalence and duration of breast-feeding in less developed countries and the accompanying increase in bottle feeding and early supplementation is a source of concern for professionals in the health and development fields and for policy makers. A focal point for this concern is the aggressive marketing of infant formula and other commercial feeding products to third world mothers that began in the 1970's. The primary concern is for the health and welfare of the infants. Though a considerable literature exists on the relationship between infant feeding practices and infant health and some work analyzing the effect of infant food marketing activities on mothers' feeding choices has been done, very little has been done tracing the links from marketing to ultimate health outcomes. Using a panel data set covering some nearly 2900 infants born between May 1, 1983 and April 30, 1984 in the Cebu region of the Philippines, mothers' feeding decisions and infantile diarrheal morbidity rates are modeled and jointly estimated using semi-parametric estimation methods. The data clearly supports the hypothesis that infant feeding practices are important determinants of diarrheal morbidity and that breast-feeding, both exclusively and in combination with supplementation, reduces the incidence of diarrhea. Our results also show that marketing activities have affected infant feeding choices and simulations are used to trace the effects of marketing on child health. Even though the observed marketing behavior does cause some shifting from lower risk feeding behavior to higher risk feeding behavior, the marketing induced changes in feeding behavior are not sufficiently large to produce major aggregate changes in diarrheal morbidity rates. This finding may be partially a result of the timing of our study in that marketing activities were not as pervasive as they probably had been earlier because of some voluntary compliance with the WHO Code. It is also partially the result of the fact that some of the marketing induced change in feeding patterns is between various mixed feeding patterns that involve roughly equal risk of diarrheal morbidity. Also the presence of effects of poor water supplies and other inadequate sanitation facilities and practices (which were a major underlying source of infantile diarrhea in the Cebu sample) tended to discourage the choice of high risk feeding patterns.

I. Introduction

The benefits of breast-feeding are well known. Breast-feeding provides proper nutrition and, except in extreme cases of mothers' malnutrition or ill health, breast milk is available in nutritionally adequate amounts at low direct cost. In addition, breast-feeding provides certain immunological benefits to the child and also intangible benefits such as mother and child bonding. For these reasons, the apparent decline in prevalence and duration of breast-feeding and the accompanying increase in bottle feeding and early supplementation observed in less developed countries during the 1970's was a source of considerable worry in the health and development communities.[1] The aggressive marketing by multinational companies of infant formula and other commercial feeding products to mothers in third world countries became a focal point of this concern in the 1970's. The debate, at one level, was straightforward. Opponents of the infant formula industry argued that low income, uneducated mothers who might otherwise breast-feed were persuaded by various marketing practices to bottle feed and that often these mothers did not have the knowledge or the resources necessary to use bottle feeding methods in a nutritionally sufficient or safe and hygienic fashion. Critics conclude that many infants in less developed countries suffered malnutrition and death as a result of formula and related food products companies' efforts promoting their products.[2] The manufacturers argue that marketing was directed toward the higher income more educated portion of the population who have the knowledge and the resources to use the products properly, and toward working mothers, who may not find exclusive breast-feeding a viable alternative; and, they argue that it is the misuse of their products, not the products themselves, which is the source of the problems.

Though the intensity of the “Nestle” debate has subsided, the importance of policy toward breast-feeding as a nutrition and health intervention for the reduction of morbidity and mortality among young children in developing countries and as a method for family planning has continued.[3]

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1. See Popkin, Bilsborrow and Akin (1982).

2. See Dobbing (1988) and Miller (1983), for an overview of the infant feeding controversy.

3. USAID’s current initiative in the area is the Linkages Program which crosses the boundaries of health/nutrition and family planning.

Though a considerable literature exists on the relationship between infant feeding practices and infant health[4] and a fair amount of work has been done analyzing the effect of infant food marketing activities on mothers' feeding choices,[5] very little has been done attempting to trace through the links from marketing to ultimate health outcomes. Two health issues have received attention in the literature. First, formula feeding can be expensive relative to typical incomes in less developed countries causing bottle feeding mothers to over dilute the mixture or substitute less nutritious foods (e.g., powdered, evaporated or condensed milks) for formula leading to malnutrition of the infant.[6] Second, the general lack of safe sources of drinking water and the poor hygiene practices of poorer, less educated mothers places bottle fed babies at a higher risk of contracting gastroenteritis and diarrhea. Diarrheal disease is a major factor in infant morbidity and mortality in less developed countries and is generally believed to be more prevalent among bottle fed babies.[7] In this paper we use a detailed longitudinal data set for the Cebu region of the Philippines to examine the effect that infant food marketing activities have on infant health by tracing through the effects marketing has on feeding choices and the effects that feeding choices have on the likelihood of infantile diarrhea.

II. Conceptual Model of Feeding Choices and Health Outcomes

Estimating the effect that marketing activities have on infant health outcomes is difficult because of the complexity of the feeding decision itself. Health outcomes such as diarrheal morbidity are the result of both "proximate" and "underlying" determinants. Proximate determinants are those factors that directly enter into the pathology of the disease process. The probability that an infant will have diarrhea at any point in time depends on 1) the environmental exposure factors faced by the child such as water

4. For example see the Cebu Study Team (1991, 1992).

5. For example see Greiner and Latham (1982), Griffin, Popkin and Spicer (1984), Stewart et al. (1991), and Guilkey and Stewart (1995).

6. See Sim, F.G. (1980)

7. See T. H. Greiner (1975), F. D. Miller (1983), D. B. Jelliffe and E.F.P. Jelliffe (1977), J. VanDerslice and J. Briscoe (1992), and P. W. Yoon, et al. (1996).

quality, exposure to unsanitary conditions, and so forth; 2) the type, quality, and quantity of nutrition the child receives; 3) the "knowledge" and time the mother brings to the process of converting inputs into child health; and 4) and the inherent underlying healthiness of the child. Some of these factors are exogenous and measurable. For example if the family has access to clean piped water in their community, the likelihood of diarrheal morbidity is less. However, some of these factors are endogenous, that is a matter of choice and behavior. In the present case, the mother's choice of feeding practices is a decision that she makes that will affect the child's health and presumably she will take those effects into account when she makes her decision. The feeding decision, however, may depend on factors (such as the prices of food commodities) that have no direct effect on the disease process, in other words they are underlying determinants. This jointness of decision and outcome makes estimation of the relationships complex. The analysis of feeding decisions is further complicated by the fact that the mother's feeding decision is not a single choice but rather a sequence of choices made over time with each choice being dependent on the outcomes of previous choices. The most obvious interrelationship being that once breast-feeding has ceased, it is difficult and ultimately impossible to re-initiate.

The standard approach in economics is to use the household production framework to model this joint decision making process.[8] In this approach, the child's health is determined by the mother's choice of purchased inputs (e.g., infant food, health care, etc.), the use of household supplied inputs (e.g., her own time in breast-feeding) and various exogenous household, community, and individual characteristics measuring exposure and susceptibility factors. The mother's primary interest is the health and well being of her family and her infant. The mother must make her choices subject to the constraints on her time and income and her perception of how feeding choices will affect the health of her child. Further, feeding choice is not a single decision but a sequence of decisions that must be made at different times in the child's life and how a given feeding choice will affect the child's health will depend on the age of the child, the past health status of the child and the presence or absence of environmental factors (e.g., water quality, sanitation, etc.). Finally, in making her feeding decisions, the mother cannot be certain as to the health consequences of those decisions for the child. She must rely on her knowledge and experience and her perception of the benefits and safety of particular

[8] See, for example Akin et al. (1985) and Rosenzweig and Schultz (1983).

feeding choices and she may have been influenced by information she has received through the marketing efforts of infant food companies. A schematic of this process is presented in **Figure 1**.

For the empirical version of the model, feeding decisions are proximate determinants of diarrheal morbidity. Other proximate determinants of diarrheal morbidity are environmental exposure factors, community factors, and the child's past health outcomes. The proximate determinants of feeding decisions include economic factors such as prices and incomes, characteristics of the mother, child and family and the marketing influences to which the mother has been exposed. There are also underlying determinants of the feeding choice. Because the mother is making her feeding decisions with the health of the child in mind, her decision will include all those exogenous factors that affect health outcomes such as water quality.

In estimating the model described above, we consider three endogenous variables.[9] The first two are health outcomes. Of primary interest is diarrheal morbidity. This is measured by a dichotomous variable indicating whether at each point in time, the child has had diarrhea in the past week. Because the probability of a child having diarrhea at a point in time, depends in part on the child's current health state, diarrhea in the previous period is included in the diarrhea equation as is the child’s growth over the previous period (measured by weight velocity which is defined as percentage change in weight over the period). Feeding choices for this paper are measured by dichotomous variables that describe a "pattern" of feeding the mother is using at each observed point in time. The four feeding patterns we use are described in terms of the primary methods and foods given to the child and include 1) exclusive breast-feeding, 2) exclusive feeding of commercial milk and formula products, 3) breast-feeding supplemented commercial milk and formula products, and 4) breast-feeding supplemented with other foods.

III. Econometric Model

The estimation of the process by which feeding patterns affect whether the infant is observed to have diarrhea as described above is complicated by the fact that both feeding pattern and the child's past health status are also outcome variables over which

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[9]. The definition of all variables and the way in which they are measured is described in more detail in the data section.

the mother of the child has some influence. In addition, we assume that past episodes of diarrhea may affect whether the child currently is reported to have diarrhea. To understand the statistical problems that arise, we need to lay out the statistical specification of the models that we estimate. First, consider an equation that explains the child's weight velocity:

$$V_{tij} = X_{tij}\beta_V + \mu_{Vij} + \eta_{Vj} + \varepsilon_{tij} \quad \textbf{(1)}$$

This equation states that the weight velocity of child i (i=1,2,...,N_j) from community j (j=1,2,...J) at time t (t=1,2,3) is a function of a set of exogenous individual, household, and community factors that we denote by X_{tij} and an unknown set of coefficients β_V to be estimated. Also included in equation (1) is a set of unknown factors, μ_{Vij}, that are fixed through time such as family genetic factors, and other household and individual fixed unobservables that affect the child's growth. The η_{Vj} represent community level unobservable variables. Finally, individual level unobserved factors that could represent shocks to health are denoted by the ϵ_{ti}'s which are assumed to be identically and independently normally distributed random variables with mean zero and standard deviation σ_ϵ. This equation is a reduced form equation in the sense that we are not interested in the proximate determinants of weight velocity and so we only consider the basic, underlying exogenous factors that influence weight velocity. Included in the set of explanatory variables are the marketing variables that are the primary interest in this paper.

We also utilize a reduced form specification for choice of feeding pattern:

$$\ln[\frac{P(F_{tij}=k)}{P(F_{tij}=1)}] = X_{tij}\beta_F + \mu_{Fij} + \eta_{Fj} \quad \textbf{(2)}$$

where the dependent variable is the log odds that child i from community j is fed from feeding pattern k (k=2,3,4) relative to pattern 1 at time t. The choice of pattern 1 in the denominator is arbitrary-- see Guilkey and Stewart (1995) for more details. As in equation (1), we assume that individual and community level time invariant unobservables, μ and η, affect the choice of feeding pattern.

The final dependent variable explains whether or not child i from community j had diarrhea at time t:

$$\ln[\frac{P(D_{tij}=1)}{P(D_{tij}=0)}] = Z_{tij}\beta_D + F_{t-1,ij}\alpha_D + \phi_D V_{t-1,ij} + \lambda_D D_{t-1,ij} + \mu_{Dij} + \eta_{Dj} \qquad \textbf{(3)}$$

where the Z_{tij}'s represent exogenous variables such as rainfall and community density that may have direct effects on whether the child has diarrhea and β_D is the corresponding set of coefficients to be estimated. We assume that the child's past health status ($V_{t-1,ij}$) and past feeding decisions by the mother ($F_{t-1,ij}$) affect whether the infant currently has diarrhea. In addition, whether the child had diarrhea two months earlier ($D_{t-1,ij}$) is also allowed to affect current diarrhea. Finally, fixed unobservable variables at both the individual and community level affect whether the child has diarrhea.

The structure of the model makes clear the statistical problem with simply estimating equation (3) without taking into account the fact there could be overlap in the set of unobservable variables which would cause the μ's and η's across the three equations to be correlated. For example, the μ's could contain unobserved information about the mother's past experience with other children. The mother may know that her children are predisposed to getting diarrhea and because of this she may exclusively breast-feed the current child. An estimation procedure that does not recognize the positive correlation in the error terms of the two equations would tend to underestimate the beneficial effects of breast-feeding in reducing diarrhea.

Estimation of the system of equations is also necessary if we are to measure the effects of marketing practices on whether or not the child has diarrhea since marketing is hypothesized to have only indirect effects through its effect on choice of infant feeding pattern and past health status. To quantify these indirect effects, we simulate at the individual level how changes in marketing practices affect weight velocity and feeding practice and then the effect of changes in these variables on diarrhea. More details on our simulation methodology are provided below.

The estimation procedure that we use is a type of full information maximum likelihood method that explicitly takes these types of correlations into account by estimating jointly all three equations in the system. We use an extension of Heckman and Singer's (1984) semiparametric method that does not impose any specific distributional assumptions on the unobserved heterogeneity but instead assumes that it can be approximated by a discrete probability distribution where both the mass points and the probabilities are estimated. This approach has been used successfully by Mroz and Weir (1990) to estimate discrete time hazard models for child spacing and Blau (1994) to estimate the hazard of retirement jointly with a set of reduced form equations so that the endogeneity of some of the right-hand-side variables in the hazard equation could be controlled. A comparison of the assumption of normal errors with that of non-parametric error term distributions in structural equations models was done by Mroz and Guilkey (1992).[10] They found that when the true distribution of the errors was approximately normal the parametric and non-parametric estimators gave very similar results. When the true distribution was far from normal, the non-parametric estimator generated much more accurate parameter estimates.

To build the likelihood function, we start with the diarrhea equation and note that conditional upon μ_{ij} and η_j, the contribution to the likelihood function from equation (3) for child i from community j where for simplicity we assume that all children are observed for all 3 periods is:

$$L_{Dij}(\mu_{Dij}, \eta_{Dj}) = \prod_{t=1}^{3} P(D_{tij} = 0 \mid \mu_{Dij}, \eta_{Dj})^{(1-D_{tij})} P(D_{tij} = 1 \mid \mu_{Dij}, \eta_{Dj})^{D_{tij}} \quad \textbf{(4)}$$

where the probabilities on the right-hand-side of equation (4) are easily obtained from equation (3). We assume that the time zero value for diarrhea is zero and that there is no need to control for initial conditions.

The contribution to the likelihood function for weight velocity again conditional on the two sets of unobservables is:

$$L_{Vij}(\mu_{Vij}, \eta_{Vj}) = \prod_{t=1}^{3} \frac{1}{\sigma_\varepsilon} \phi\left(\frac{V_{tij} - X_{tij}\beta_V - \mu_{Vij} - \eta_{Vj}}{\sigma_\varepsilon}\right) \quad \textbf{(5)}$$

where ϕ is the standard normal density function and σ_ϵ is the standard deviation of ϵ_{tij} all other terms are as defined previously. Finally, define the indicator variable I_{tijk} to be equal to one if child i from community j is fed from pattern k at time t. The contribution to the likelihood function for the feeding pattern dependent variable can then be written as:

[10] For a study that applies a parametric distribution for the unobserved heterogeneity in a systems of equations context see e.g. Lillard and Willis (1994)

$$L_{Fij}(\mu_{Fij},\eta_{Fj}) = \prod_{t=1}^{3}\prod_{k=1}^{4} P(I_{tijk}=1 \mid \mu_{Fij},\eta_{Fj})^{I_{tijk}} \quad \textbf{(6)}$$

Using equations (4), (5), and (6), the contribution to the likelihood function for child i from community j conditional on μ and η is:

$$L_{Dij}\ (\mu_{Dij},\eta_{Dj})\ L_{Vij}\ (\mu_{Vij},\eta_{Vj})\ L_{Fij}(\mu_{Fij},\eta_{Fj}). \quad \textbf{(7)}$$

The contribution to the likelihood function unconditional on μ is obtained by integrating over the range of μ. Suppose we approximate the distribution of μ with Q discrete points each with probability P_q (q=1,2,...,Q), then:

$$L_{ij}(\eta_{Dj},\eta_{Vj},\eta_{Fj}) = \sum_{q=1}^{Q} P_q\ [L_{ij}(\mu_{Dq},\ \eta_{Dj})L_{ij}(\mu_{Vq},\eta_{Vj})L_{ij}(\mu_{Fq},\eta_{Fj})]. \quad \textbf{(8)}$$

The estimation procedure that we use does not restrict the mass points for the discrete distributions to be the same across the three equations. Instead, using a generalization due to Mroz (1997), each mass point is estimated separately for each equation. Note that in the standard discrete factor model (see, for example, Heckman and Singer, 1984 or Mroz and Guilkey, 1996) restrictions of the following form are imposed: $\mu_{Vq} = \rho_V\mu_q$ and $\mu_{Dq} = \rho_D\mu_q$. Thus we see that the standard specification requires that the mass points be the same across equations and the heterogeneity in each equation is linearly related to the heterogeneity in other equations. The more general specification allows more flexibility in the pattern of correlations across the error terms. For more details, see Mroz (1997) who refers to the more general specification as nonlinear heterogeneity.

The product of (8) over the N_j children in community j yields the contribution to the likelihood function for community j conditional on η_j:

$$L_j(\eta_{Dj},\eta_{Vj},\eta_{Fj}) = \prod_{i=1}^{N_j} L_{ij}(\eta_{Dj},\eta_{Vj},\eta_{Fj}) \quad \textbf{(9)}$$

The contribution to the likelihood function for community j unconditional on η is obtained by integrating over the range of η. Suppose we approximate the distribution of μ with R discrete points each with probability P_r (r=1,2,...,R), then:

$$L_j = \sum_{r=1}^{R} P_r L_j(\eta_{Dr}, \eta_{Vr}, \eta_{Fr}) \qquad \textbf{(10)}$$

where we again allow the mass points to differ across equations. The likelihood function is simply the product of (10) over the J communities.

The discrete factor FIML method is identified without exclusion restrictions. However, we do not need to rely on nonlinearities to obtain identification. The exclusion restrictions used to identify the model and tests of these restrictions are discussed in the empirical results section of the paper.

III. The Data

This paper uses data from a longitudinal survey conducted in Metropolitan Cebu from February 1983 to April 1986. Metropolitan Cebu had 243 barangays with 171,702 households and a population of slightly more than a million. All pregnant women in 33 randomly selected barangays who gave birth between May 1, 1983 and April 30, 1984 are included in our sample. Each mother was interviewed every two months through the first two years of her child's life. In this paper, we use the longitudinal data for 2,890 women gathered at the infants' age of 2, 4 and 6 months.[11] Descriptions of the variables used in the study and sample statistics are reported in Table 1.

Feeding Patterns

Quantifying the feeding choices is inherently difficult in that it involves several dimensions including the quantity of food given and the types of food fed. In this paper the feeding choices are analyzed in terms of the patterns of foods the mother feeds her child at each point in time. The mother's feeding practices are assigned to one of four

[11]. Interviews were also conducted during the last trimester of the pregnancy (baseline interview) and shortly after the birth of their child (birth interview). Community-level data on such things as commodity prices and characteristics of health care facilities were gathered periodically throughout the survey period and matched with the longitudinal data from mothers to reflect community conditions at the time of each longitudinal interview.

patterns based on the primary types of the foods used by the mother to feed her child.[12] Mothers were placed in either one of two exclusive feeding patterns (exclusive feeding of breast milk or commercial breast-milk substitutes,[13] or in one of two mixed feeding patterns (breast-feeding supplemented with commercial breast-milk substitutes or other foods[14]).[15] **Figure 2** provides an overview of the distribution of feeding patterns that were observed over the three longitudes. In the first longitude 84% breast-fed either exclusively (49%) or with some supplementation (35%). By the third longitude, total breast-feeding had declined to 77% with exclusive breast-feeding down to 8% of the sample.

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12. Feeding patterns are based on the mother's recall of all foods given to the child over the 24 hours immediately prior to the interview. It is important to note that because the mother is placed in a pattern based on feeding behavior during the past 24 hours, this categorization does not necessarily hold over the longer term. That is, what we observe at one point in time is not necessarily indicative of what the mother "in general" does, though on average it will be. Because a mother may have breast-fed two days before the interview, not breast-fed the day before the interview, and then breast-fed the day after the interview, we do not model the decision not to breast-feed in one twenty-four hour period as being irreversible. The surveys contain data on the quantities of particular foods given, but these appear to be subject to a fair degree of measurement error. In past work we have found categorical descriptions of feeding behavior to perform better in estimation Guilkey and Stewart (1995). Also see Bisgrove, Popkin, and Barba, (1989, 1991) for more complete information on the collection of feeding pattern data.

13. Commercial breast-milk substitutes include infant formula and evaporated, condensed and powdered milks. In earlier work on choice of feeding patterns, Guilkey and Stewart (1995), commercial infant formula and other commercial milks were treated as separate feeding categories for both exclusive and mixed feeding resulting in a total of six feeding patterns. Very little in explanatory power was gained by separating formula from other commercial milks so the number of patterns was collapsed to four to reduce the computational complexity of the estimation.

14. The "other foods" category includes a variety of foods exclusive of infant formula and commercial milks. These consisted largely of indigenous infant feeding supplements including grits, gruels, fruit juices, and the like.

15. All other logical patterns, those that involve the feeding of formula or breast-milk substitutes supplemented by other foods, or patterns that contained no milks but only other supplemental foods did not occur in the sample in sufficient frequency to be included in the analysis. These other patterns represented fewer that 1% of the sample and were dropped from the analysis.

Health Outcomes

Measures of diarrheal morbidity are based on the mother's responses as to whether the child had diarrhea in the week prior to the interview. Diarrhea was reported for 6.3% of the infants at age two months and 11.7% and 19.4% at ages four and six months, respectively. Weight velocity (percentage change in weight) was used as a general proxy of the child's growth and health and is used as an explanatory variable for diarrhea.

Marketing

In the context of our model of infant feeding and health outcomes, marketing activities can be thought of as information that may influence the mother's choice of feeding pattern that in turn influences morbidity. In the estimated model we consider the effects of four primary indicators of marketing activity. These include the mother's recall of advertising during the study period, the mother's baseline recall of formula brand names, whether the mother received a sample of infant formula at the time of her delivery, and the availability of the product in retail outlets.

The choice of which marketing practices to consider follows from the public policy controversy that has surrounded the infant feeding debate in less developed countries. In the mid-1970's many observers began to raise a protest over the marketing practices of infant food companies in less developed nations. The allegations included charges that infant food companies used high pressure sales tactics including extensive media advertising, direct sales contact, extensive distribution of samples, and various tactics to influence the practices and advice of the medical community relating to infant feeding. These allegations were supported by a substantial case study literature and anecdotal documentation.[16] In May of 1981 the World Health Assembly passed the International Code of Marketing for Breast Milk Substitutes. The code required formula labels to contain clear information on the superiority of breast-feeding and the hazards of formula feeding, prohibited labels from containing photographs of infants, restricted the distribution of free samples and the use of medical facilities to promote the use of infant formula, and restricted the advertising of infant formula; however the code was voluntary and had no enforcement mechanisms. Though most infant formula companies pledged

16. See, for example, Bader (1976), Greiner (1975), Sim (1980), and Miller (1983).

compliance with the code, allegations of noncompliance continued.[17] The Philippines began to draft their own code for the marketing of breast-milk substitutes in May of 1981. The Philippine code was stronger than the WHO code in several respects. It covered not only infant formula but also all other products that could be used as breast-milk substitutes, and its enforcement mechanism included criminal sanctions for violators. Although not signed into law until December 22, 1986, the Philippine code was the subject of extensive debate during most of the period of our study and may have had an impact on the extent to which marketing activity was observed during the time of our study.[18]

By far the most controversial marketing practices employed by infant food firms are media advertising of products and the distribution of free samples of the products.[19] Infant feeding products were advertised in a variety of media including radio, television, newspapers, magazines, and billboards. At the baseline interview and at each longitude, the mothers were asked if they had heard or seen any advertisement or read any print media that recommended how their baby should be fed. The responses were coded based on three types of recommendations the mother might recall: feed commercial products (formula or other commercial milks), breast-feed, feed other foods (exclusive of formula, milks, and breast milk). Recall of advertising promoting commercial feeding products was rare. The low incidence of advertising messages may be partly a result of

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17. See Community Nutrition Institute (1988).

18. In 1983, at the same time the baseline and birth studies were being conducted, the National Coalition for the Promotion of Breast-feeding and Childcare, a watchdog group for voluntary compliance with the WHO code, reported continued violations of the code in the Philippines. After earlier opposition to the Philippines code, Filipro, the Nestle affiliate and largest infant milk dealer in the Philippines, announced In March of 1983 its support of the Philippine code and major changes in marketing practices to fully comply with the codes provisions including complete ban on consumer advertising and promotion of its infant formula, a complete ban on mothercraft nurses, and limitation of the distribution of samples for "professional evaluation." See Lopez, Montemayor and Lacson (1984).

19. An equally controversial practice of infant food companies was the use of "milk nurses" who directly contact individuals to discuss infant feeding practices or provide free samples of feeding products. This practice seems to have largely disappeared in the Philippines. The baseline survey conducted in February 1983 - March 1984, found only four of the 3327 mothers interviewed reporting contact with a food company representative.

some voluntary compliance to the WHO Code. Across all three longitudes an average of 3.7% of the mothers recall hearing, reading, or seeing a media advertisement recommending feeding infants formula or commercial milks and 15% recall advertisements recommending the feeding of other foods to their infant. The Philippine Government also engaged in active efforts at promoting breast-feeding as evidenced by the relatively high proportion of mothers (10%) who recall a pro-breast-feeding media message. The distribution of free samples was more wide spread with roughly one in five mothers receiving a free sample of infant formula.

While the advertising and sample distribution variables allow us to quantify the marketing influences the mother is currently subject to, it is likely past marketing activities (which well may have been more extensive) will also affect the mother's choices. At the baseline interview (taken in the last trimester of the mother's pregnancy) each mother was asked what types of foods might be fed to an infant. In response to this question, over 90% of the sample named a *brand* of infant formula. To reflect this past exposure to marketing activity a dichotomous brand recall variable was constructed that took on a value of one if the mother knew one or more brand names of infant formula at baseline and zero otherwise. This variable provides some control for differences in information the mother brings to the initial feeding decision.

Another marketing influence to consider is the commercial distribution network: whether the products are physically available in a location accessible to the mother. Related to accessibility are the activities of promotional pricing and "on-site" promotion of the product including the way in which the product is labeled.[20] In this paper and in past research we have explored a variety of product availability measures based on the food price survey data and mother's recall of availability but have found only the distance from the mother's residence to a major road, a general measure of the isolation of the mother's residence, shows a consistent significant effect on feeding decisions.

A final type of marketing mechanism requires some discussion. These are the marketing influences that work indirectly through the medical care delivery system. Health professionals involved with prenatal care and the delivery of infants are often

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20. Data on promotional pricing and on site promotion is not available at a sufficiently dis-aggregated level to be used. A survey of small local retail food stores (*sari sari* stores) done by The Nutrition Center of the Philippines (1986) found that formulas and milk products were prominently displayed in many of the *sari sari* stores surveyed.

contacted by food manufacturers and provided with educational and advertising materials and free samples of the product for distribution to patients.[21] Health professionals in turn provide infant-feeding information and advice to their patients, and the content and strength of their recommendations may be affected by their contacts with infant food manufacturers. Popkin and Fernandez (1988) report extensive industry activities directed toward health professionals in our study area. We are unable to make a direct linkage between industry contact with health professionals and the health professional's contact with the mothers. We do know, however, whether the mother delivered her baby at a health facility away from her home and used this information as a proxy for information provided by health care professionals and the institutional practices of health care facilities. Thirty-eight percent of our sample delivered their baby away from home. In previous work we included a variable to describe the feeding recommendation made to the mother by medical professionals. Feeding recommendations by health professionals were surprisingly rare; but when they occur, the recommendation was almost universally to breast-feed the baby. The variable showed no effect in preliminary estimations of the feeding equations and was excluded from the final estimation.

Economic Variables

Because the feeding choice is at least partially an economic choice, household income and the set of prices faced by the household are the direct economic determinants of feeding choice. The time-varying prices for infant formula[22] and the staple good corn were included in the estimation. In past research, a variety of continuous income and asset measures were constructed, the final model uses dichotomous variables to place each observation in a wealthy, middle, or poor income category.[23]

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21. See Popkin, Yamamoto, and Griffin, (1985) and Popkin and Fernandez, (1988).

22. In theory the prices of all relevant goods should be included. There was substantial collinearity among the prices of milks that might be used for infant feeding, so only the price of formula along with the price of corn were used in the final estimation.

23. Both continuous income and assets measures were obtained for each family at baseline. In a substantial number of cases, households that had large amounts of assets reported low, and, sometimes, negative income. After experimentation with a number of alternative income measures, we finally chose dichotomous measures based on the cross tabulations of the

The value of the mother's time is another important theoretical price variable. This is the shadow price of the time she spends in providing feeding and child care. A measure of this price could not be directly included in the estimation.[24] Mother's education and age, however, serve as proxy variable for the mother's opportunity cost of time. Finally a barangay level wage variable was included that measures the wage rate for unskilled labor in the community.

Health state and health inputs

At any point in time, the mother's feeding choice likely depends on the current and past health state of the child. The current health of the child depends not only on the feeding pattern but also on the past health of the child and the current environmental conditions and other health related inputs that are available to the child. Because we use a reduced form specification for the feeding equations, we preclude the use of endogenous variables measuring the child's health status but we include exogenous variables that are determinants of that health status. These variables include the availability of inputs to the child care activity. Variables that describe inputs available to the mother include measures of household composition, and measures of related services (whether a gas or kerosene stove or refrigerator is available in the home and a measure of whether good quality drinking water was available in the mother's home). Population density of her community and the distance from her home to a major road may proxy for the availability of health related inputs A time varying measure of the cumulative rainfall in the mother's community is also included because of the impact weather conditions have on the health of the child. Measures of whether the area around the house had poor drainage and whether animals were kept in the home provide proxies for exposure to pathogens.

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continuous income and asset measures. The wealthy group was defined as those families that were in *either* the top 25% of the assets or income measures; the poor group was defined as those that were in the bottom 50% of *both* income and assets.

[24]. We tried to create a measure by constructing an hourly wage rate for all women in the sample, using Heckman's (1974) method that involves using selectivity corrected estimates of a wage equation for working women. Because only a small proportion of mothers in the sample worked for wage and most of the wage prediction would required estimation for out of sample values of exogenous variable for non-working mothers, no value of time variable is included in the analysis.

Other Exogenous Variables

Tastes and preferences certainly will differ across mothers in the sample. Though some part of the difference is sure to be unobserved heterogeneity, some differences in preferences may be systematically related to observable variables such as socioeconomic status. Socioeconomic status of the household was proxied in a variety of ways. The level of education of the mother and father clearly proxy for status, although mother's education is related to other factors as well--value of time in particular. An urban/rural dummy variable was also included in the final model to reflect possible difference in access and cultural difference between the urban and rural populations.

The fact that many of the included variables proxy for many different phenomena makes it impossible to interpret their empirical impact directly to specific structural pathways in the model. For example mother’s education may well increase child health because more educated mothers may be able to more efficiently use the resources available to produce infant health. However, more educated mothers also have a higher opportunity cost of time and may therefore devote less time to child care and nutrition resulting in adverse health outcomes. While it is possible to estimate the overall effect of mother's education, in the current structure we cannot break down the effect into the two pathways described above. However by including as much information in the empirical models as possible, it is hoped that our estimates of the effect of marketing activities on feeding choices and feeding choices on the probability of diarrhea are sharpened.

Finally dichotomous variables for each longitude were included to reflect the changes in the feeding patterns and the probability of diarrhea that will result as the child matures and becomes able to eat a wider variety of food types and is subject to different exposure factors as the child becomes more mobile.

IV. Estimation and Results

The feeding equation, weight velocity equation, and diarrhea equation were jointly estimated as a system using the full information maximum likelihood method described above. The estimated parameters of the heterogeneity distribution are reported in Table 2 while the estimated structural coefficients, standard errors, and t statistics are reported in Table 3. We discuss the estimated heterogeneity parameters first.

Following Mroz and Guilkey (1992), we kept adding points of support to both the community and individual heterogeneity distributions until the improvement in the likelihood function was less than the additional number of parameters estimated. The final model had 4 points of support for the community heterogeneity and 7 points for the individual heterogeneity. As additional points were added, some of the estimated mass points tended to become quite large indicating, for a subset of the sample, certain values of the dependent variables were very unlikely (see Mroz, 1997 and Mroz and Weir, 1990). When this happened, we simply restricted the mass point to the large estimated value as additional mass points were added and estimated the probability weight associated with the fixed mass point. In the final model, only 7 out of a possible 51 estimated mass points had to be restricted in this manner and 5 of these were in the exclusive commercial versus exclusive breast-feeding comparison for the feeding pattern choice equation.

The likelihood ratio test of the joint significance of the estimated parameters of the heterogeneity distribution yielded a test statistic of 2,830 indicating major improvement over the null model that assumes independence in the errors across the three sets of equations. The first column of Table 2 presents the estimated probability weights and the remaining columns present the estimated mass points. Since all equations include constants, the first mass point in each equation must be restricted to zero for identification purposes.

To test the robustness of our results, two other specifications for the heterogeneity distribution were also tried. First, we also estimated the linear form of the heterogeneity distribution. This method yielded results that were substantively similar to the nonlinear form for diarrhea structural equation. However, it affords less flexibility in dealing with outliers and so we preferred the nonlinear specification. Second, we also introduced time varying individual level heterogeneity that was correlated across equations. This generalization did not add explanatory power and had high cost in terms of the number of additional parameters that needed to be estimated. We therefore do not include this generalization in our final model.

Since the estimated heterogeneity parameters are difficult to interpret, we calculated the correlation matrix for both the community and individual level estimated discrete distributions. The correlations between the diarrhea equation and each of the other equations are as follows:

Equation	Individual	Community

Exclusive Commercial vs Exclusive Breast-Feeding	-.316	.707
Commercial Mixed vs Exclusive Breast-Feeding	.145	.363
Other Mixed vs Exclusive Breast-Feeding	.003	.296
Weight Velocity	.351	.787

These correlations along with the likelihood ratio test presented above provide substantial evidence of the need to use estimation methods that correct for heterogeneity bias in the estimation of the diarrhea equation.

The diarrhea equation estimates the effects the various factors have on the likelihood the child will have diarrhea during the week before the interview. Exclusive breast-feeding is the omitted feeding pattern so the coefficients on the included feeding patterns are interpreted as the change in the likelihood of diarrhea associated with each alternative feeding pattern relative to the likelihood of diarrhea had the child been exclusively breast-feed. The exclusive feeding of formula or other commercial milk products result in a statistically significant increase in the likelihood of diarrheal morbidity. The coefficient for the mixed breast and commercial milk feeding pattern is negative and significant suggesting a lower diarrheal morbidity for children fed a combination of breast and commercial milk. We will discuss this result further below. The coefficient for the mixed breast-feeding and other foods pattern is positive but not statistically significant suggesting that this pattern produces no greater risk of morbidity than exclusive breast-feeding.

Other variables have the expected relationship with diarrheal morbidity. Environmental factors such as the availability of good water and the absence of exposure factors such as animals in the house, poor drainage, and high level of rainfall all reduce diarrheal morbidity and are generally statistically significant. The probability of the infant having diarrhea is significantly higher in poor households than in wealthy ones and the children of older, and thus presumably more experienced mothers, are less likely to have diarrhea. Finally previous incidents of diarrhea are a strong predictor of current episodes with children who had diarrhea in the past period being significantly more likely to have it in the current period, and healthier children (as indicated by higher weight velocities) are less likely to have diarrhea.

We did two sets of simulations based on our estimated model. In the first set, we simply simulate the effects associated with changes in feeding patterns on the probability that a child will get diarrhea. In the second set, we examine the effects of exogenous variables on the probability of diarrhea by simulating through all three equations in the model. A discussion of this second set of simulations is presented below after the discussion of the estimation results for the weight velocity and feeding pattern equations. For the first set of simulations, we proceeded as follows. The actual values of all variables associated with each child were used to predict the probability of diarrheal morbidity for the child at each point in time. We then averaged over all children in the sample. Note that lagged diarrhea is an explanatory variable. We assume that no child has diarrhea at birth but in successive periods, we substitute predicted diarrhea from the previous time period.

To simulate the effects of the four feeding patterns, the model was recalculated inserting different values for feeding patterns but leaving all other variables at their observed level in the sample. Intuitively, the experiment is to observe what would happen to diarrheal morbidity in this sample of children if we change nothing but the pattern of feeding they received. We calculated the simulated diarrheal morbidity for: (1) all infants exclusively breast-fed; (2) all infants exclusively fed commercial milks; (3) all infants mixed, fed breast milk and commercial milks; and (4) all infants mixed, fed breast milk and other food. The results of these simulations and the actual morbidity rates are shown graphically for all three longitudes in **Figure 3**. lf all children were exclusively breast-fed, there would be reduced diarrheal morbidity but the reduction is relatively small. At the other extreme had all mothers exclusively fed their infants commercial milks, the morbidity rate would have been 9.1% and at age two months and 24.9% by age six months. It is interesting to note that the pattern associated with the lowest level of diarrheal morbidity at each point in time is breast-feeding mixed with commercial milks. This result is probably due to the fact that “exclusively breast-fed” children in the Philippines are often given water. The water could, of course, be contaminated and this fact could lead to the slightly elevated levels simulated diarrheal morbidity associated with exclusive breast-feeding. See Cebu Study Team (1992) for details on the relative prevalence of diarrhea for children that are truly exclusively breast-fed versus children who are breast-fed and also give non-nutritive liquids. Since the focus in this paper is on marketing effects and we would not expect differential behavior for these two groups, they are combined into the one exclusive breast-feeding category.

Before turning to a discussion of the other two equations in the system, it is interesting to compare the results of our heterogeneity corrected parameter estimates to estimates that would be obtained from simple estimation of the diarrhea equation with no controls for the presence of right-hand-side endogenous variables. In spite of the large error correlations and highly significant heterogeneity parameters, the results for the two estimations were remarkably similar. Even simulations done with the simple model produced results that were substantively similar to the results presented above. Clearly, the results of this paper are quite robust to alternative estimation methods.

In a previous paper (Guilkey and Stewart, 1995) we have discussed the analysis of the feeding choice equations in detail and will not repeat that entire discussion here. In general, economic factors play an important role. Families with higher incomes and education are more likely to choose patterns involving commercial feeding products as are urban mothers. In general, higher formula prices discourage the use of commercial feeding products though the price effects are statistically insignificant. Marketing activities are also found to have some significant effects on feeding choices. The distribution of free samples of formula increases the likelihood of exclusive and mixed feeding of commercial milks. The advertising of commercial feeding products tends to increase their use both exclusively and as supplements to breast-feeding. Finally the effect of past marketing activities, as proxied by the mother's voluntary recall of an infant formula brand name, significantly increases the choice of all patterns relative to exclusive breast-feeding except mixed breast-feeding with other food. Interaction with the medical system as proxied by whether the mother delivered her baby away from home also had significant effect on feeding choices in the direction of reducing exclusive breast-feeding with the largest and most significant related to an increasing use of exclusive feeding of commercial milks.

The results for the estimation of the weight velocity equation are also presented in Table 3. The reason for estimating this reduced from equation was to control for the endogeneity of weight velocity in the diarrhea equation. These reduced form results are somewhat difficult to interpret but we get the expected result that the children of more highly educated mothers have higher weight velocity as do the children of younger women. We see that, at this age, males have higher weight velocity than females. We also see strong effects for many of the variables that provide identification for the three equation system. A joint test of significant on the excluded exogenous variables in both the weight velocity equation and the feeding pattern equations strongly reject the null hypothesis that the coefficients are jointly zero.

Quantifying the effects of underlying variables such as marketing on diarrheal morbidity requires simulation through the entire system of equations. To simulate the effect of underlying exogenous factors the model was simulated with all exogenous variables set at their actual values. This allows a calculation of simulated feeding patterns and simulated weight velocity . These are used to calculate the simulated morbidity rates.[25] The size of the effect of any particular factor can be gauged by setting it to particular values and then simulating through the system to obtain estimates of morbidity rates.

Our primary interest in this paper is to examine the effect that marketing activities had on the diarrheal morbidity rate. In the same way as described above, we simulated the effects of the advertising of commercial products, the distribution of free samples of formula, and the effect of pro-breast-feeding marketing activities as represented by mother's recall of advertisements suggesting that she breast-feed her baby. For advertising, the model was simulated for the case in which no individual had heard, seen, or read an advertisement promoting the feeding of formula or commercial milk products and the case in which every mother had been exposed to such an advertisement in each period. Similarly, simulations were also done for cases in which all mothers received a free sample of infant formula compared to the scenario where none received a free sample and where all mothers recalled a pro-breast-feeding marketing message and the case where no mother recalled such a message. These simulations are reported in **Figure 4**.

As is clear from Figure 4, market activities had virtually no apparent effect on diarrheal morbidity rates. These results should not be too surprising. Feeding decisions and diarrheal morbidity varied with many factors; the mother's exposure to marketing activity was only one of these. The feeding equation identified significant but relatively small reductions in morbidity rates associated with both exclusive and mixed breast-feeding and significant but again not extremely large increases in the morbidity rate

[25]. It should be noted that these simulated morbidity rates, because they are estimates based only on the values of the exogenous variables, differ slightly from the actual sample morbidity rates. The sample rates are 6.3%, 11.7% and 19.4% for ages 2, 4, and 6 months respectively. The corresponding simulated morbidity rates based on the actual values of the exogenous variables are 6.0%, 11.2% and 18.7%.

associated with the exclusive feeding of formula or commercial milks. While it is true that the various marketing practices do appear to have statistically significant effects on feeding choices and that these effects result in a reduction of total breast-feeding (both exclusive and mixed feeding patterns) these reductions are relatively small.[26] The effect of marketing for the Cebu sample was, to a large extent, to cause a switch between the patterns of breast-feeding supplemented with indigenous "other" food to patterns of breast-feeding supplemented with commercial feeding products. Given the estimates obtained from the diarrhea equation, these marketing induced changes in feeding behavior will have small effects on morbidity rates. Only switches to patterns that include no breast-feeding will increase diarrheal morbidity. Thus a factor that causes relatively small changes in behavior where it matters (choosing no breast-feeding at all) will not produce large changes in the observed aggregate morbidity rate. By way of contrast, the last two bars in Figure 4 show the simulated diarrheal morbidity rates for scenarios in which all mothers had access to piped water compared to the case where none had access. These simulations can be compared to simulated morbidity rates for our sample where 7% of the families had access to piped water. Had all mothers in our sample had access to piped water in their homes, diarrheal morbidity would have dropped from a simulated 6% to 4.3% at age 2 months, 11.8% to 8.1% at four months, and 18.7 to 13.8 at age six months.

V. Conclusions

The Cebu data provides an incredibly rich source of data for studying issues relating to infant nutrition and health. Using that data we have modeled infantile diarrheal morbidity rates and estimated them jointly with feeding decisions and past health outcomes for a panel covering some nearly 2900 infants and their mothers at three points in time during the first six months of life. Within this framework the effect of the marketing activities of infant food companies as an underlying factor affecting infantile

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26. In our detailed analysis of feeding pattern choice (Guilkey and Stewart, 1995) we simulated that total breast-feeding rates would drop by less than 1% at age six months and by less than 4% at age six months if one simulated a world in which no mother received a free sample of formula compared to a world where every mother received a sample of formula. Simulated changes in breast-feeding rates associated with other marketing variable were of similar magnitudes.

diarrhea was examined. The data clearly supports the hypothesis that infant feeding practices are an important proximate determinant of diarrheal morbidity and that breast-feeding, both exclusively and in combination with supplementation, reduces the incidence of diarrhea to a large extent, especially when the child is around six months old. Though marketing activities are found to alter feeding choice, for our sample at least, these changes do not result in extremely large changes in total morbidity rates.

These results need to be interpreted with considerable caution because of limitations in both the data and the empirical techniques used. The first issue is one of the timing of the survey. An ideal experiment would be to use data from two identical populations, one exposed to no marketing activity and the other exposed to intensive marketing. This is not the case for the Cebu sample. Because of some apparent voluntary compliance with the WHO code, some of the most criticized marketing practices were observed for only small fractions of the sample (advertising) while others were not observed at all (direct sales contacts by "milk nurses"). The problem is further complicated by the fact that behavior is likely affected by <u>past</u> marketing activity as well as current activity. Our only indication of marketing activity prior to the survey is the mother's response to the open-ended question "What foods are you aware of that you might feed your infant?". In response to this question 90% of our sample responded with a *brand name* of formula. This, almost universal, awareness of formula brand names could only have been generated with extensive past marketing activity. Empirically, we must rely on the behavior of the 10% of the sample that did not respond with a brand name to identify the effect of past marketing activity. Statistically, this is possible if these mothers' negative response to this question reflect the fact that they are truly unaffected by past marketing and if we can adequately account for other differences between these mothers and those responding with recall of a formula brand name. Not surprisingly, mothers not recalling a formula brand name come disproportionately from the poorer, less educated, more rural segments of the sample.

It must also be recognized that our categorization of mothers into feeding patterns may cause some problems. Mothers are placed in a feeding pattern based on twenty-four hour recall of feeding. Thus an exclusive breast-feeder is a mother who *in the last twenty four hours* exclusively breast-fed her child. It might be the case that a mother who exclusively breast-fed yesterday may supplement with formula tomorrow. The twenty-four hour recall question was used because the correspondence between what the mother said she did and what she actually did is likely better for shorter rather than longer recall periods. It is the case that the most likely observation for the feeding pattern reporting for yesterday is the feeding pattern that is generally used around the time of the survey, however the correspondence need not be exact. To the extent that we do have mothers classified as exclusive breast-feeders who in reality supplement on some regular basis, and mothers classified as exclusive formula feeders who to some extent are still breast-feeding, the morbidity effects of feeding patterns will be blurred.

Finally it should be noted that the high underlying morbidity rate in which the effects of poor water supplies and other inadequate sanitation facilities and practices have substantial effects that may swamp the marketing effects.

Even given these limitations, this study provides strong evidence that the choice to breast-feed results in a significantly reduced risk of diarrheal morbidity. Marketing activity has significant effects on the mother's choice of feeding practices and these effects, though not extremely large, move mothers away from feeding patterns that include breast-feeding. Though combining the two effects does not result in large estimated increases in morbidity attributable to marketing activities.

Figures

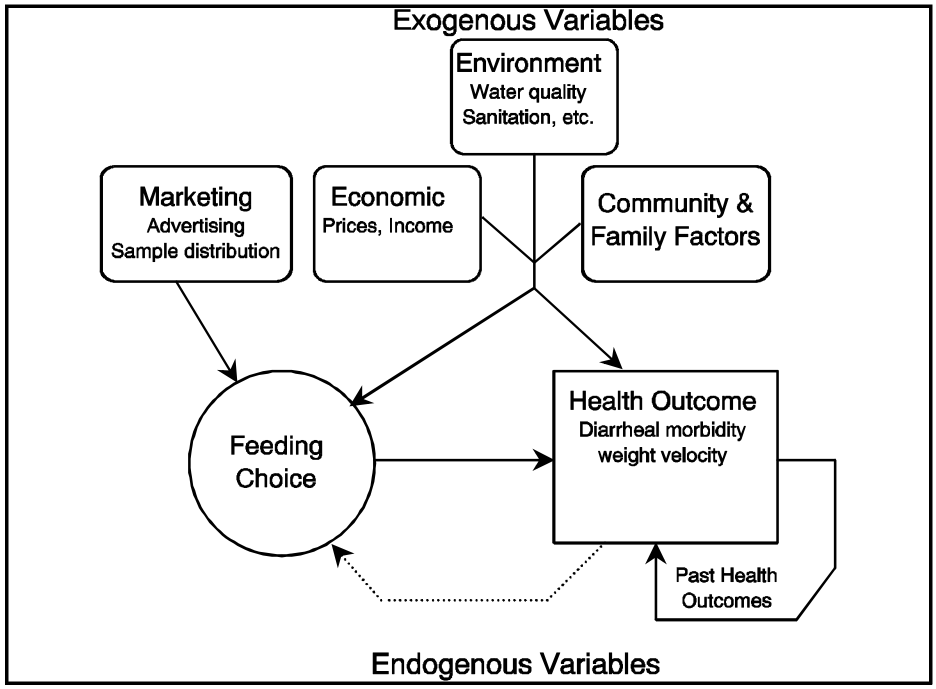

Figure 1

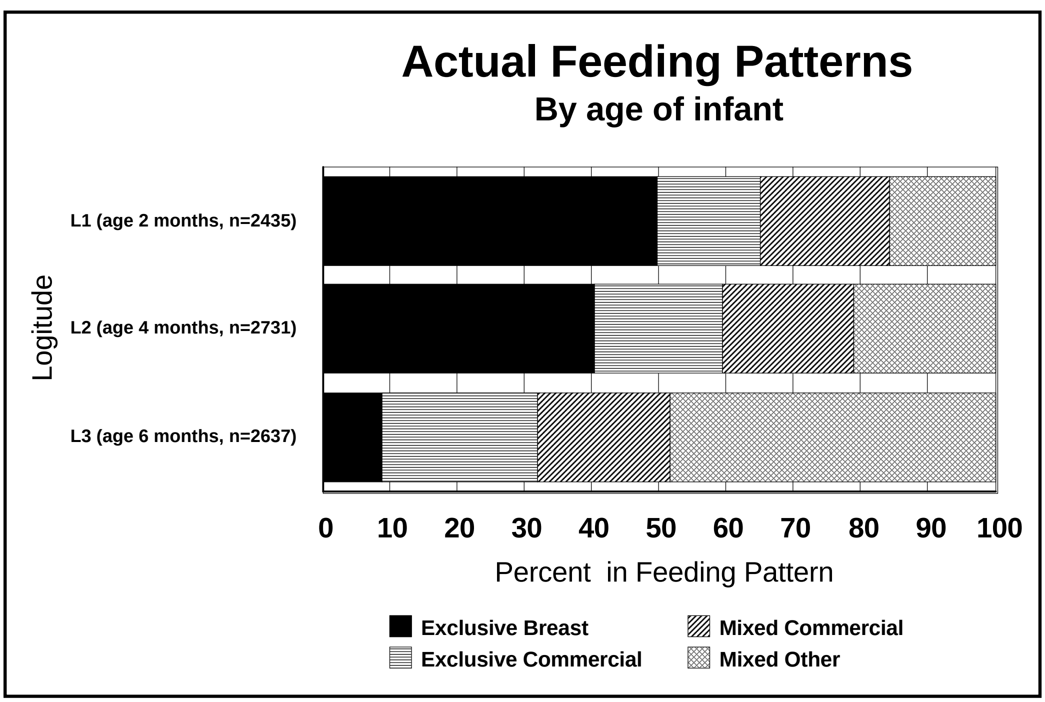

Figure 2

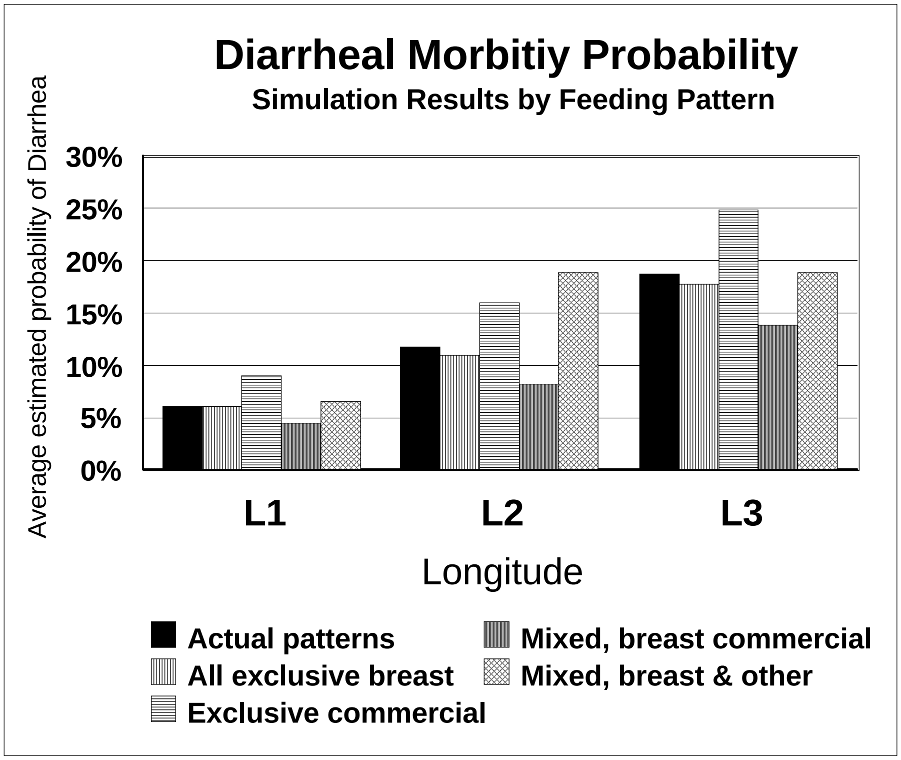

Figure 3

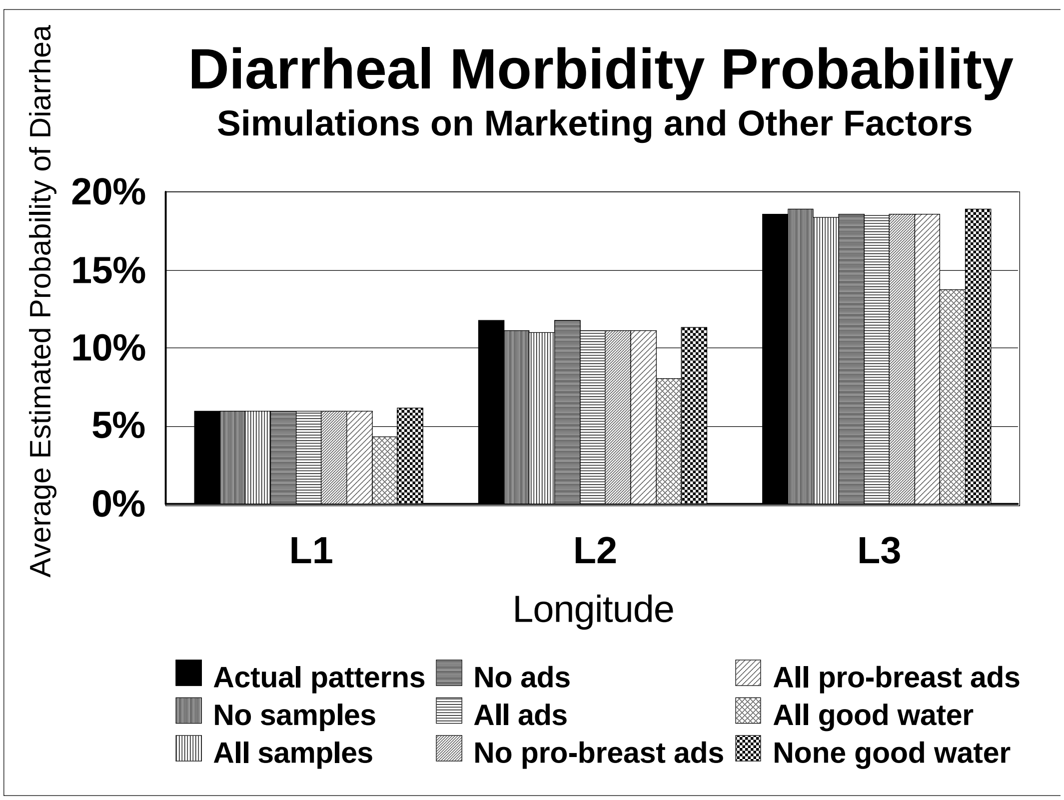

Figure 4

Table 1: Variable Definitions and Descriptive Statistics (n = 7803)

Variable Name	Variable Description	Mean	Std. Dev.
	Endogenous Variables		
	Feeding Pattern		
bf_ex[1]	Exclusive breast-feeding (excluded category)	0.316	0.465
com_ex[1]	Exclusive commercial milk feeding	0..197	0..398
com_mix[1]	Mixed feeding: breast and commercial milk	0.190	0..392
othr_mix[1]	Mixed feeding: breast and other	0.297	0..457
	Health Outcomes		
diarwk[1,2]	Child had diarrhea previous week	0.126	0.332
ldiarwk[1,2]	Diarrhea lagged one period	0.063	0.243
weightvl[1]	Weight velocity	20.493	10.460
	Exogenous Variables		
	Economic Factors		
poory[2]	Family in poorest group	0.310	0.463
wealthy[2]	Family in wealthiest group	0.378	0.485
min_f[1]	Barangay formula price	490.689	117.900
corn[1]	Barangay corn price	314.736	85.860
wage[1]	Barangay wage rate	13.418	5.967
	Family Demographics and Assets		
mothage	Mother's age	26.150	6.008
motgrd[3]	Mother's level of education	7.074	3.305
fathage	Father's age	27.794	8.151
fatgrd	Father's level of education	8.448	5.821
sexchild[2]	Sex of the child (male = 1)	0.530	0.499
ownteve[2]	Family owns a TV	0.187	0.389
refriger[2]	Family owns a refrigerator	0.068	0.252
stove[2]	Family owns a modern stove	0.272	0.445
	Environmental and exposure		
pipedwat[2]	Family has access to piped water supply	0.070	0.255
animalin[2]	Animal kept in home	0.393	0.488
nodrain[2]	Drainage around home is poor	0.284	0.451
densty	Population density of Barangay	1.460	1.885
distroad	Distance from household to major road	287.360	903.900
urban[2]	Household is in urban barangay	0.759	0.427
l2[2]	observation is from 2nd longitude	0.350	0.477
l3[2]	observation is from 2nd longitude	0.338	0.473
rcum14f[1]	Cumulative rainfall last 14 days	73.696	46.300

Table 1: Variable Definitions and Descriptive Statistics (n = 7803)

Variable Name	Variable Description	Mean	Std. Dev.
	Marketing exposure		
recallf[2]	Mother recalls formula brand name at baseline	0.906	0.292
samlform[2,]	Mother received free sample of formula	0.217	0.412
feedcom[1,2]	Mother recalls media ad recommending	0.037	0.189
feedo[1,2]	Mother recalls media ad recommending feeding	0.152	0.359
feedb[1,2]	Mother recalls media ad recommending breast	0.105	0.306
delaway[2]	Mother delivered child away from home	0.390	0.488

Notes: [1]denotes time varying variable.
[2]denotes dichotomous variable (value is 1 if statement is true, 0 otherwise)

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Table 2:
Estimated Heterogeneity Parameters (Standard Errors in Parentheses)

	Diarrhea	com_ex vs bf_ex	com_mix vs bf_ex	othr_mix vs bf_ex	Weight Velocity
Probability Weight	**Mass point**				
Community Level					
0.228	0	0	0	0	0
0.144	-0.299 (0.122)	2.297 (0.645)	0.566 (0.263)	0.938 (0.145)	0.005 (0.027)
0.311	-0.478 (0.122)	-1.537 (0.685)	-0.907 (0.313)	-0.564 (0.157)	-0.017 (0.030)
0.317	0.182 (0.107)	2.011 (0.622)	-0.339 (0.288)	0.007 (0.132)	-0.015 (0.026)
Individual Level					
0.171	0	0	0	0	0
0.151	-0.206 (0.404)	19.751 (fixed)	4.721 (0.423)	-0.186 (0.356)	-0.071 (0.049)
0.045	0.788 (0.416)	-19.198 (fixed)	7.264 (0.829)	0.272 (0.72)	-0.005 (0.064)
0.046	-0.003 (0.494)	65.47 (fixed)	5.22 (fixed)	-1.406 (fixed)	-0.313 (0.086)
0.308	0.436 (0.398)	9.967 (fixed)	2.25 (0.414)	-0.800 (0.285)	0.047 (0.044)
0.084	0.164 (0.439)	28.598 (fixed)	7.277 (0.578)	-0.042 (0.516)	-0.160 (0.060)
0.195	0.079 (0.408)	-0.807 (0.933)	-1.971 (0.626)	-2.552 (0.204)	0.082 (0.041)

Table 3: Estimation Results:
System Including Diarrhea, Feeding Choice, and Weight Velocity

Diarrhea Equation:
DEPENDENT VARIABLE = diarwk

Variable	Coefficient	Standard Error	t-Statistic
com_ex	0.448	0.232	1.935
othr_mix	0.079	0.131	0.601
com_mix	-0.328	0.167	-1.957
urban	0.009	0.103	0.085
densty	-0.018	0.026	-0.682
pipedwat	-0.364	0.167	-2.186
rcum14f	0.011	0.008	1.393
nodrain	0.354	0.109	3.262
animalin	0.159	0.074	2.153
motgrd	-0.01	0.014	-0.739
mothage	-0.135	0.062	-2.152
poory	0.16	0.092	1.74
wealthy	-0.007	0.093	-0.071
sexchild	0.179	0.073	2.454
l2	0.382	113	3.368
l3	0.707	0.139	5.503
weightvl	-0.278	0.05	-5.572
ldiarwk	0.485	0.119	4.064
constant	-1.988	0.456	-4.364

Table 3: Estimation Results, continued:
System Including Diarrhea, Feeding Choice, and Weight Velocity

Feeding Pattern Equations:
DEPENDENT VARIABLE = pat4c
Patterns: 1 = exclusive breast-feeding 2 = exclusive commercial milk
3 = breast & commercial milk 4 = breast & other

2 vs. 1: Exclusive commercial milk vs. exclusive breast-feeding

Variable	Coefficient	Std Error	t-stat
l2	3.746	0.295	12.707
l3	8.15	0.387	21.042
urban	1.706	0.624	2.733
motgrd	0.944	0.062	15.292
mothage	1.901	0.379	5.02
fatgrd	0.777	0.316	2.456
fathage	0.282	0.037	7.537
sexchild	1.315	0.343	3.826
stove	5.093	0.423	12.041
refriger	2.33	0.634	3.662
ownteve	-0.638	0.474	-1.346
wage	-0.003	0.004	0
distroad	-0.249	0.0441	-5.646
densty	-0.308	0.116	-2.648
pipedwat	-0.443	0.603	-0.734
nodrain	2.34	0.501	4.672
animalin	-0.157	0.286	-0.549
rcum14f	-0.048	0.026	-1.835
poory	0.593	0.484	1.226
wealthy	2.321	0.472	4.914
corn	0.16	0.205	0.784
min_f	-0.197	0.151	-1.309
recallf	2.623	0.689	3.807
delaway	3.759	0.449	8.374
samlform	1.799	0.435	4.138
feedcom	1.114	0.56	1.99
feedo	-0.877	0.358	-2.453
feedb	-0.51	0.412	-1.238
constant	-47.18	1.406	-33.57

Table 3: Estimation Results, continued:
System Including Diarrhea, Feeding Choice, and Weight Velocity

Feeding Pattern Equations:
DEPENDENT VARIABLE = pat4c
Patterns: 1 = exclusive breast-feeding 2 = exclusive commercial milk
3 = breast & commercial milk 4 = breast & other

3 vs. 1: Breast & Commercial milk vs. Exclusive Breast-Feeding

Variable	Coefficient	Std Error	t- stat
l2	1.056	0.125	8.453
l3	3.659	0.183	20.044
urban	0.885	0.26	3.41
motgrd	0.285	0.029	9.705
mothage	1.098	0.182	6.023
fatgrd	0.097	0.016	6.14
fathage	0.336	0.149	2.26
sexchild	0.499	0.157	3.18
stove	1.314	0.192	6.851
refriger	0.6	0.326	1.718
ownteve	0.236	0.227	1.038
wage	0.02	0.017	1.167
distroad	-0.082	0.016	-5.015
densty	-0.007	0.058	-0.131
pipedwat	-0.278	0.315	-0.882
nodrain	0.291	0.206	1.415
animalin	-0.12	0.127	-0.947
rcum14f	-0.008	0.011	-0.712
poory	-0.373	0.198	-1.882
wealthy	0.434	0.198	2.195
corn	-0.028	0.096	-0.289
min_f	-0.004	0.06	-0.06
recallf	1.116	0.304	3.676
delaway	0.889	0.192	4.616
samlform	0.92	0.201	4.566
feedcom	0.39	0.295	1.323
feedo	0.007	0.159	0.047
feedb	0.019	0.184	0.105
constant	-13.302	0.851	-15.64

Table 3: Estimation Results, continued:
System Including Diarrhea, Feeding Choice, and Weight Velocity

Feeding Pattern Equations:
DEPENDENT VARIABLE = pat4c
Patterns: 1 = exclusive breast-feeding 2 = exclusive commercial milk
3 = breast & commercial milk 4 = breast & other

4 vs. 1: Breast & Other vs. Exclusive Breast-Feeding

Variable	Coefficient	Std Error	t- Statistic
l2	0.616	0.091	6.802
l3	3.54	0.138	25.591
urban	0.251	0.121	2.084
motgrd	0.027	0.018	1.471
mothage	0.513	0.106	4.858
fatgrd	0.003	0.01	0.355
fathage	-0.097	0.089	-1.095
sexchild	0.338	0.086	3.911
stove	0.309	0.134	2.296
refriger	0.198	0.29	0.683
ownteve	-0.386	0.172	-2.252
wage	0.032	0.008	3.871
distroad	0.003	0.004	0.785
densty	0.036	0.036	0.98
pipedwat	-0.124	0.251	-0.494
nodrain	-0.007	0.139	-0.049
animalin	-0.012	0.085	-0.145
rcum14f	0.007	0.008	0.901
poory	-0.097	0.103	-0.935
wealthy	0.114	0.114	0.997
corn	0.178	0.059	3.006
min_f	0.029	0.039	0.75
recallf	0.001	0.135	0.009
delaway	0.407	0.121	3.37
samlform	0.042	0.142	0.299
feedcom	0.122	0.24	0.51
feedo	-0.007	0.121	-0.058
feedb	0.204	0.135	1.497
constant	-3.356	0.479	-7.005

Table 3: Estimation Results, continued:
System Including Diarrhea, Feeding Choice, and Weight Velocity

Weight Velocity Equation: DEPENDENT VARIABLE = weightvl			
Variable	**Coefficient**	**Std Error**	**t Statistic**
l2	-0.916	0.021	-43.033
l3	-1.753	0.023	-76.836
urban	-0.023	0.024	-0.972
motgrd	0.008	0.003	2.462
mothage	-0.087	0.02	-4.36
fatgrd	0.001	0.002	0.506
fathage	-0.013	0.017	-0.763
sexchild	0.234	0.017	13.638
stove	-0.013	0.024	-0.548
refriger	-0.001	0.042	-0.033
ownteve	0.054	0.029	1.886
wage	0.002	0.002	1.486
distroad	0.003	0.001	3.015
densty	-0.006	0.007	-0.965
pipedwat	0.037	0.038	0.985
nodrain	-0.05	0.025	-1.954
animalin	-0.003	0.018	-0.178
rcum14f	-0.003	0.002	-1.786
poory	0.007	0.022	0.335
wealthy	0.031	0.022	1.382
corn	-0.046	0.012	-3.772
min_f	0.02	0.009	2.207
recallf	0.077	0.031	2.481
delaway	0.119	0.023	5.256
samlform	0.036	0.024	1.463
feedcom	0.044	0.045	0.965
feedo	-0.016	0.024	-0.679
feedb	0.003	0.028	0.096
constant	2.975	0.085	34.829
σ_{ϵ}	0.738	0.019	38.951

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