The "Glass of Milk" Subsidy Program and Malnutrition in Peru

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This study of the Vaso de Leche ("Glass of Milk") feeding program in Peru looks for evidence that this in-kind transfer program aimed at young children furthers nutritional objectives. The study links public expenditure data with household survey data to substantiate the targeting and to model the determinants of nutritional outcomes. It confirms that the social transfer program targets poor households and households with low nutritional status. Nevertheless, the study fails to find econometric evidence that the nutritional objectives are being achieved.

In designing transfer programs, governments are motivated by equity or efficiency objectives or both. Das, Do, and Özler (2005) discuss these objectives for conditional cash transfer programs, but their analysis also applies to in-kind transfers and commodity price subsidies. While such subsidies or transfers may be politically pragmatic or administratively more feasible where markets or banks are rudimentary, the choice of in-kind or conditional transfers over direct unconditional cash transfers is generally based on the assumed presence of a market failure. For example, a food price subsidy or commodity transfer may be designed to improve the nutritional status of vulnerable groups—as well as to augment the real incomes of constituents—based on the possibility that intrahousehold allocations do not reflect the rates of return to investments in children. Food subsides may also be motivated by the view that past underinvestments in education led to current inefficiencies in the allocation of inputs into the production of health.

No direct measure of behavior is necessary for assessing equity-driven transfers to households. The equity-improving objective can be assessed in terms of its effect on the distribution of household incomes or on poverty reduction. In contrast, as Das, Do, and Özler (2005) point out, the evaluation of transfers differs if the main motivation is increasing efficiency rather than addressing equity. If a conditional

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transfer is designed to increase consumption of a commodity or use of a service, one approach is to look at the net increase (after any substitution) of consumption of that good. An alternative or additional approach is to look at the outcome that the conditionality is designed to affect. Nutritional objectives of in-kind transfers are often expressed as incremental consumption of one or more goods or one or more nutrients. However, since the transferred or subsidized good can be substituted for other items in the diet, it is preferable to focus the evaluation on the impact on child growth, as, for example, in evaluations of the impact of conditional transfers on nutrition in Mexico (Behrman and Hoddinott 2005; Rivera, Sotres-Alvarez, and others 2003). These individual-specific measures are behavior-induced outcomes that are distinct from the standard welfarist measure of total consumption.

When it comes to meeting nutritional objectives through in-kind transfers, milk is often believed to be a particularly effective commodity.[1] While exclusive breast-feeding is widely advocated for children under six months old, the value of supplementation with other milk at a later age is less clear. There is some clinical evidence that milk supplementation contributes to child growth but mainly in communities where the diet is based almost entirely on root crops or when milk supplements are combined with specific interventions to shift behavior (Rivera, Hotz, and others 2003). Thus, nutritionists generally do not advocate milk as a candidate for subsidies because of its high nutrient costs and low energy density (Kennedy and Alderman 1987).

Milk subsidy programs are nonetheless prevalent, and so it is important to assess their ability to achieve their nutritional objectives. It is surprising therefore that while there are several published studies on the distributional incidence of milk or milk product subsidies, evaluations of the nutritional impact of subsidy programs are hard to find.

The literature generally takes three forms. First, there are studies of milk programs that do not include evidence on nutritional impacts. These include Tuck and Lindert's (1996) study of milk consumption in Tunisia's subsidy program (accounting for 10 percent of overall subsidies at their peak), Esanu and Lindert's (1996) analysis of Romania's milk program, and the World Bank's (2003) report on the distribution of fluid milk in the Brazilian state of Rio Grande do Sul. Similarly, while Alderman and del Ninno (1999) estimate that exempting milk from South Africa's value added tax—similar to a consumer subsidy costing more than $150 million a year—leads to a 0.18 percent increase in protein consumption (0.03 percent for the poorest 40 percent of the population), they do not provide evidence for its effect on malnutrition rates.

Second, there are analyses of programs that include milk as one of many subsidized foods for which nutritional impacts are documented but for which the effect cannot be singled out. For example, Rush and others (1988) and Carlson and Senauer

1. For example, as reported in the December 13, 2003, issue of *The Economist,* China recently instituted a school milk program after noting the comparatively small stature of its citizens.

(2003) find that the Women, Infants, and Children Feeding Program in the United States is clearly beneficial. That program is not confined to either milk or milk substitutes, however, and these studies do not single out the role of milk subsidies. Nor is milk generally distinguished in the literature on school feeding, even though it is often included in such programs. Powell and others (1998) report the impact of one such successful program that included milk. However, the nutritional experience of such programs is generally mixed, in part because of irregular implementation (Levinger 1986).

Third, there are a handful of studies of milk programs that do present nutritional evidence—for example, studies of Mexico's Liconsa fluid milk distribution program by Gundersen and others (2000), Kennedy and Alderman (1987), and Grosh (1994). Although Grosh (1994) finds the subsidies to be distributed progressively, none of these studies shows an impact on child growth.

Simply stated, it is not known whether policies to subsidize milk are effective at achieving nutritional objectives, and without knowing this it is hard to fully understand the motivation for the in-kind transfer. This article addresses this question by studying Peru's Vaso de Leche ("Glass of Milk") program, which provides primarily milk and milk substitutes to low-income households and is motivated by nutritional objectives. The program is well suited for this analysis because its benefits are distributed progressively (Stifel and Alderman 2005), thus eliminating one common reason for a commodity distribution program to have a limited nutritional impact. This permits focusing on the nutritional outcomes that might have motivated the subsidy program. Addressing the question of nutritional impact is not straightforward, however, since randomized evaluations of full-scale interventions are often hard to implement in politically popular transfer programs. Therefore, the approach applied here links public expenditure data with household survey information to assess the program's impact on nutritional outcomes.

I. Description of the Vaso de Leche Program

At a cost of $97 million in 2001, Vaso de Leche is the largest social transfer in Peru and the second largest component of transfers from the central government to municipalities (Instituto Apoyo and World Bank 2002). Introduced as a pilot in Lima in 1984, the program expanded nationally during the economic crises in the late 1980s and early part of the 1990s. By 1998 the program had expanded to reach 44 percent of households with children aged from 3 to 11 through earmarked monthly transfers to municipalities (Younger 2002). By law, these municipalities are required to have an administrative committee composed of elected representatives of beneficiaries, the mayor, another local official, and a representative from the ministry of health. In addition to this administrative committee, each community has an elected Vaso de Leche mothers committee. This committee, which has a fair degree of discretionary decision-making (Instituto Apoyo and World Bank 2002), identifies the beneficiaries, the timing of deliveries, and, within limits, the commodities to be distributed.

Despite its name, the Vaso de Leche program distributes more than milk and milk substitutes. In some cases, cereals or a combination of commodities are distributed instead of or in addition to milk products. For example, 46 percent of recipient households receive one product (67 percent of them receive milk or milk substitutes), while 51 percent receive two products (88 percent of them receive milk or milk substitutes).[2] Nonetheless, according to calculations of this study using data from the Vaso de Leche Public Expenditure Tracking Survey, milk and milk substitutes (such as powdered milk and soymilk) account for an average of 77.5 percent of the value of total transfers. Furthermore, for households in the two poorest quintiles, milk accounts for 93.3 percent of the value of the transfers and milk substitutes for 80.4 percent.

Priority is given to households with children six years old or younger or with pregnant or lactating women. Once these first-tier beneficiaries are attended to, households with children aged from 7 to 13 and people with tuberculosis may participate. Within both categories, priority is based on need.[3]

There have been many excellent recent studies on the distribution of social expenditures in Peru and of Vaso de Leche in particular. For example, Younger (2002) finds a pattern of progressive distribution of Vaso de Leche benefits, with improved targeting between 1994 and 1997 as coverage increased. Using a different methodology and one of the data sources employed in the current analysis (a 1997 household survey), Ruggeri Laderchi (2001) also examines the overall distribution of food transfers and their impact on food consumption and nutrition. She finds that the transfers are slightly progressive, although the poorest 40 percent of households received only 46 percent of total transfers. She also finds that while the total share of income from food-related transfers had no impact on the height of children, the income share from participation in the Vaso de Leche program had a significant impact on standardized child height (Ruggeri Laderchi 2001, p. 36). Her specification, which treats participation as exogenous, yields a positive effect only when income is instrumented and when district fixed effects are included at the same time. The impact appears negative and, in some specifications, statistically significant in the absence of these recommended econometric procedures.

A recent Public Expenditure Tracking Survey followed the budget trail from the central government to the Vaso de Leche beneficiaries (Instituto Apoyo and World Bank 2002; World Bank and Inter-American Development Bank 2002). The study finds an appreciable variation between communities in the timing of delivery, the commodities chosen, and the administrative fees charged. Virtually all the funds released by the center were transferred to municipal Vaso de Leche

2. Powdered milk is considered a milk substitute in this context. Although the law states that the distributed products should be in prepared form, this occurs in only 39 percent of the committees outside of Lima, and only 7 percent of the recipients report consuming the products at the point of pickup (Instituto Apoyo and World Bank 2002).

3. While the laws on the Vaso de Leche indicate that malnourished individuals are to receive priority, nutritional measures (such as anthropometric indicators) are not used for targeting purposes. See, for example, Law 27470 in El Peruano (2001).

administrative budgets and further down to the mothers committees, with only some documented small-scale leakage in the allocations. The study finds more substantial discrepancies between the commodity allocations reported by the committees and by the household, however. The study could not account for a quarter of the product transferred. Most of the unexplained gap was in urban districts (particularly provincial capitals).[4]

II. Research Strategy

This section describes the approach to modeling the determinants of nutritional status[5] and discusses the estimation strategy in the presence of endogenous program placement.

Modeling the Determinants of Nutritional Status

To determine the impact of the Vaso de Leche program on nutrition, the determinants of child nutritional status are estimated using program expenditures as an explanatory variable. The approach is to estimate the intention to treat rather than the effect of the treatment on the treated. The intention to treat can be conceptualized as the effect of the Vaso de Leche transfers being offered regardless of actual participation or dropout. In this analysis, the counterfactual of interest is the state of the world if the program had not existed, which is compared with the state of the world in the presence of the program (Heckman, Lalonde, and Smith 1999). This is distinct from the counterfactual for the effect of the treatment on the treated, which is the state of the treated if the program had not existed compared with the state of the treated in the presence of the program.

Evaluation of the intention to treat looks at the difference between outcomes among the eligible population where the treatment is available compared with the same population where it has not been made available, preferably controlling for site selection. Evaluation of the treatment on the treated looks at differences in the expected outcomes, conditional on participation. It is generally not possible to go directly from one form of evaluation to the other without additional assumptions since it is not usually possible to ascertain the participation of members of the control group had they had the same opportunities as the treatment group.

Both types of comparisons convey useful information. But, as Heckman, Lalonde, and Smith (1999) observe in their review of methodologies for

4. The study also found leakage or dilution in the sense that children did not always receive the milk that was obtained by the household. However, this is not only a difficult topic to quantify, but the welfare interpretations of this so-called leakage also differ from those of leakages in the public expenditure allocation chain. As argued in Alderman and others (1995), expecting a transferred good to be consumed entirely by one targeted individual within a household unit is not easily reconciled with any standard household model. Nor is the intrahousehold allocation as likely to be influenced by program administration as are errors of inclusion and exclusion in targeting on poverty.

5. The model is fairly standard in the literature (Strauss and Thomas 1995). This exposition draws on Sahn and Stifel (2002).

evaluation, it is often evaluation of the intention to treat that is of policy relevance (see also Rouse 1998). So, while this analysis does not measure the marginal contribution of milk consumption itself to nutritional status, the impact that is measured allows one to assess whether government expenditures on milk subsidies improve nutrition. This focus, then, differs from that of other studies on feeding programs and in-kind transfers, such as Ruggeri Laderchi (2001), which attempt to measure the effect of the treatment on the treated.

The theoretical framework for the estimation is derived from a household model in the tradition of Becker (1981). Assume that the household maximizes a quasi-concave utility function that takes as its arguments consumption of milk, x_m, all other commodities and services, x_o, leisure, l, and the health status, θ (of which a child's anthropometric measurement, h, is one dimension) of each household member. The household solves the following problem

$$\max_{x_m, x_o, l, \theta} u(x_m, x_o, l, \theta; A, Z) \tag{1}$$

where A and Z, respectively, represent household and community characteristics, some of which are not observed. Allocation choices are made conditional on the budget constraint:

$$p_m x_m + p_o x_o = w(\mathrm{T} - l) + y \tag{2}$$

where p_m is the price of milk, p_o a vector of prices, w a vector of household members' wages, T a vector of the household members' maximum number of work hours, and y the household nonwage income.

The nutritional status of children, h, is determined by a biological health production technology:

$$h_i = H(\mathrm{I}, A, Z, \mu_i) \tag{3}$$

where I is a vector of health inputs and μ_i represents the unobservable individual, family, and community characteristics that affect the child's nutritional outcomes. Household characteristics (such as demographics and educational levels), A, can have an impact on health by affecting household allocation decisions. Community characteristics (such as access to clean water), Z, can also have direct impacts on nutritional outcomes. Note that the input vector I includes consumption goods (such as milk) that contribute positively to household welfare both directly through x_m and x_o and indirectly through h. This represents the simultaneous choice of consumption goods and health inputs.

Given this simultaneity, the household's optimization problem can be solved to get a set of demand equations for goods and services (x), leisure (l), and health (θ). A subset of the health demand equations is the reduced-form demand equation for child nutrition, represented as follows:

$$h_i = \tilde{h}(A, Z, \varepsilon_i) \tag{4}$$

where ε_i is the child-specific random disturbance term, which is assumed to be uncorrelated with the other elements of the demand function.

The dependent variable is the standardized anthropometric height-for-age *z*-score (*HAZ*) for children under five years of age. *HAZ* is defined as $(h - h_r)/\sigma_r$, where h is the observed height of a child of a specified sex and age group, h_r the median height in the reference population of children of that sex and age group, and σ_r the standard deviation of height measurement for the reference population of that sex and age group. The standard reference population recommended by the World Health Organization is that of the United States National Center for Health Statistics. As several studies have indicated that less than 10 percent of the worldwide variance in height can be ascribed to genetic or racial differences (Martorell and Habicht 1986), this reference population is appropriate. Children with a *HAZ* score of less than –2 are usually classified as stunted.

The set of predictors consists of characteristics of the child (such as age, sex, and birth order), household demographic variables (such as household size and age and sex composition), characteristics of the parents (such as educational attainment and mother's age and height), access to public services (such as piped drinking water), and a dummy variable for living in an urban area. Given the propoor targeting of the Vaso de Leche program, predicted log per capita household expenditure was also included in the estimated model to control for household wealth.

Endogenous Program Placement and Explanatory Variables

The primary purpose of this exercise was not to model the overall determinants of nutrition but to see whether the Vaso de Leche program has an impact on nutrition. In terms of the model described in the previous section, this effect can be transmitted in two ways: by increasing household income by the value of the milk transfer (if this is the entire effect, the transfer is said to be inframarginal) and by directly increasing the level of milk consumption above what would have been consumed had the transfer been made in the form of cash by influencing the marginal price. Thus, the reduced-form health demand function is adapted to include the Vaso de Leche transfers as an explanatory variable to pick up the direct effect of the program on child health independent of its role as an income transfer:

$$h_i = h(VL, A, Z, \varepsilon_i). \tag{5}$$

As noted, the program is evaluated based on the intention to treat—in this case, conditional on the funding for the Vaso de Leche at the local level—and not on the household choice to take up this opportunity. Modeling the impact on self-selecting participants would require making a set of additional assumptions to determine the impact on the random eligible participant. While conditioning on the Vaso de Leche allocation to the community in lieu of participation means not having to solve the issue of endogenous household choice, the problem of potential bias from endogenous program placement remains (Rosenzweig and Wolpin 1986). Not even the sign of any potential bias can be established since an estimated impact may be overestimated if programs are placed where the anticipated return is higher than average or be underestimated (or even negative) if programs go to favored but more developed communities.

This issue is addressed by using observations of Vaso de Leche expenditures from two different rounds of Demographic and Household Surveys (1996 and 2000). Thus, fixed effect estimations can control for the initial conditions in the communities. The general form of the models to be estimated is as follows:

$$h_{i,d,t} = \alpha + \phi x_{i,d,t} + \beta A_{i,d,t} + \lambda Z_{i,d,t} + \gamma VL_{d,t} + \sum_{d} \delta D_d + \varepsilon_{i,d,t} \tag{6}$$

where i is the index for individual children, d the indicator for the district in which the child resides, and t the year (1996 or 2000). VL is the district level per capita Vaso de Leche expenditure. The fixed effect version also includes, D, the set of district dummy variables. The inclusion of these dummy variables removes the influence of any time-invariant district effects, including any that might correlate with the allocation of Vaso de Leche funds.

This approach compares the differences in the changes in health status when Vaso de Leche transfers change, controlling for other community characteristics. In effect, γ is the difference in differences estimator (Moffitt 1991) of the effect of Vaso de Leche transfers on child health. Per capita expenditure on the program increased between survey years from 29.4 soles in 1996 to 37 soles in 2000, or more than 25 percent. The coefficient of variation for the change in expenditures is 0.47, indicating substantial variation in the rates by which coverage increased to identify a first difference at the community level.[6]) The expenditure data are based on total expenditures in each district and not a sample and are thus analogous to a census of expenditures.

As an additional precaution for site selection bias, instrumental variable methods were also employed with the fixed effects models to account for the possibility of any remaining unobserved factors affecting malnutrition that vary over time and are also correlated with the change in Vaso de Leche expenditures. This was approached in two ways.

First, standard two-stage least squares models were used in which the identifying instrument is the district-level Peruvian Social Fund Fondo Nacional de Compensación y Desarollo (FONCODES) index of unmet basic needs, a composite of various measures—including access to schooling, electricity, water, sanitation, adequate housing, and measures of illiteracy—based on the 1993 census (Schady 1998). As shown in the results, the FONCODES index is correlated with district-level Vaso de

6. There were 315 districts in the study. While the relatively small number of observations per district implies that the district dummy variable will not be measured with precision, the estimates are unbiased. If the aim were to make a statement about the level of malnutrition in any given district, then the sample size in that district would be critical. However, for making a statement about the nutritional status of children at a given level of per capita program expenditures, it is the overall sample, adjusted for cluster sampling, as well as the variance of the regressor, the district means and the covariance between them, that determines this precision.

Leche expenditures, satisfying one condition for valid instruments. The other condition, which is uncorrelated with the error term, is plausible given that the index was formulated based on the 1993 census, three years before the 1996 Demographic and Health Survey (DHS). The FONCODES index may be correlated with the *levels* of the unobserved factors, but since the analysis also includes fixed effects estimates that are, in effect, based on the *change* in Vaso de Leche expenditures, the properties of the instrument in these estimates are based on the assumption that the index is uncorrelated with *changes* in unobserved factors. If the parameter of interest—the impact of Vaso de Leche expenditures—points to the same conclusion over the set of estimates, there can be reasonable confidence that the conclusion is robust. Although the surveys are pooled, implicitly restricting the parameters of individual and household characteristics to be constant over time, the instrumenting equations are allowed to vary between periods. This is done in two ways: by including a time dummy variable as a shifter and by allowing all of the parameters to vary over time (in which case province-level fixed effects models are estimated).

Moreover, because the basis for the FONCODES index will remain problematic, a second instrumental variable-type method is also employed using a different means of identification. In this method, proposed by Lewbel (2004) (see also Rigobon 2003), the identification of γ comes from exploiting the heteroskedasticity of the first-stage equation (Vaso de Leche expenditures). To illustrate, begin by defining the first-stage equation as

$$VL = \alpha_2 + \zeta X + v \tag{7}$$

where X can include all or a subset of the explanatory variables in the main equation and can include instruments such as the FONCODES index. If $\text{cov}(X,v^2)$ is nonzero (i.e., if the data are heteroskedastic), then γ and the other parameters in the main equation can be estimated consistently without external instruments by an ordinary linear two-stage least squares regression in which all the exogenous right-side variables and $(X - \bar{X})\hat{v}^2$ are used as instruments for Vaso de Leche expenditures. The requirement that $\text{cov}(X,v^2) \neq 0$ is tested by applying a Breusch and Pagan (1979) test for heteroskedasticity to the first-stage equation.

The district-level Vaso de Leche expenditure data are merged with the DHS data for 1996 and 2000 to create a data set with 19,053 observations on child heights, which is used to estimate the model. The per capita Vaso de Leche district expenditure variable is the district average amount spent in the two years before and including the 1996 and 2000 surveys.

Thus, five variations of the model are estimated using individual child nutritional status as the dependent variable. First, ordinary least squares (OLS) model is used to estimate the basic nonfixed effects model. Second, a series of fixed effects models are estimated, starting with an OLS model. Third, this is followed by a time-varying instrumental variable model that is run with province-level (not district-level) dummy variables, since time-varying district dummies in the instrumenting equation would perfectly predict the district-level Vaso de Leche expenditure values. The fourth is a fixed effects model using instrumental variable methods in which a time dummy variable is included in the instrumenting equation. Lastly, Lewbel's (2004) method of taking advantage of the heteroskedastic nature of the data for identification is used to verify that the results are robust. The particular advantage of this fifth model is that it does not use the FONCODES index classifications at all and thus is free of any possible problems associated with that instrument. In summary, the following models are estimated: (a) basic OLS; (b) district fixed effects, OLS; (c) province fixed effects, time-varying instrumental variable; (d) district fixed effects, time dummy variable in instrumental variable equation; and (e) district fixed effects, heteroskedasticity identification.

In all of the estimates, Huber–White standard errors are estimated to correct for homogeneity among observations in the 1,364 primary sampling units (clusters).[7]

Finally, while selective migration into high Vaso de Leche districts is theoretically a possibility, it is unlikely that the small transfer (1.8 percent of the income of the poor on average in 1997) is a major determinant of migration. To get an indication of whether this is a major concern, survey data were used to examine the probability that an individual migrated to the district of current residence from another district. While the Vaso de Leche allocation in the district of origin is not known, the marginal effect of current Vaso de Leche expenditures on the probability of migrating in the past ten years is known to be –0.0004 (z = –0.73). Thus, the results are unlikely to be biased if current residence is taken as exogenously determined.

III. Description of Data Sources

This analysis of the Vaso de Leche program benefits from a wealth of data sources available in Peru. The data come from four main sources: information on the geographic allocation of Vaso de Leche program expenditures, national household living standard surveys, national DHS, and the Public Expenditure Tracking Survey. While having multiple data sources is preferred, for evaluating nutritional impacts as illustrated here analysts need only program expenditure and household survey data with child anthropometrics.

Vaso de Leche Expenditures

The Vaso de Leche program has maintained monthly records of expenditures allocated to each administrative (department, province, and district) region in Peru since 1994. This information, along with district population sizes from the 1993 census and the 2000 pre-census, is used to determine real

7. There is slight change in standard errors if the Huber-White standard errors correction is based on districts rather than the less aggregated sample units.

annual total and per capita program expenditures in each of the recipient districts for 1994–2000. Allocations to the district program committees do not translate fully into benefits to recipients, but considering the small scale of the leakages found at the committee level by the Public Expenditure Tracking Survey, they likely represent a reasonably accurate proxy for the value of benefits available to district residents.

Living Standard Surveys

Two sources of household living standard surveys were available for this study. The first is the National Household Survey (Encuesta Nacional de Hogares, ENAHO), collected by the National Institute of Statistics and Information (INEI) in 1998, 1999, and 2000. These nationally representative surveys of more than 6,500 households (2,000 for the 2000 survey) were carried out quarterly, with each quarter's survey focusing on a different theme. This analysis concentrates on data from the second quarter module, which focuses on social services and includes information on participation in the Vaso de Leche program. Household income information is also available for each module.

The second source is the 1994 and 1997 National Living Standards Survey (Encuesta Nacional de Hogares sobre Medicion de Niveles de Vida, ENNIV), collected by Instituto Cuanto. These nationally representative surveys of more than 3,500 households collect multiple indicators of household and individual well-being (e.g., education, housing, health, economic activity, consumption, and assets). The 1994 ENNIV includes information on Vaso de Leche participation by household, and the 1997 data also include estimates of the values of the transfers made to the household. Anthropometric measurements of heights and weights of young children were also recorded.

Demographic and Health Surveys

DHS were carried out in Peru in 1996 and 2000. These nationally representative surveys of more than 28,000 households each are part of a program funded by the United States Agency for International Development and implemented by Macro International Inc., which has included more than 70 nationally representative household surveys in more than 50 countries. The surveys are conducted in single rounds with two main instruments: an individual questionnaire for women of reproductive age (15–49 years old) and a household schedule. Child anthropometric measurements are recorded in the individual module. The household schedule collects information on household members, assets, and access to public services. Since income or expenditure data are not collected, the asset data in the survey were used to predict household per capita expenditures. This was done by estimating a model of log household per capita expenditures in the 1997 ENNIV data, including the value of in-kind transfers. The explanatory variables in this model are assets in the 1997 ENNIV data that are also available in the DHS data. This model was then used to predict the values of household expenditures in the DHS data.[8]

Public Expenditure Tracking Survey

The Public Expenditure Tracking Survey for the Vaso de Leche program was conducted by Instituto Apoyo at the end of 2001 and early in 2002, to quantify leakages and delays in public expenditure disbursements and to assess the effects of deficiencies in the system on the quality of the services provided. Thus, interviews were conducted at three levels: the municipality, the mothers committee, and the household. One hundred municipalities were sampled, and four mothers committees were randomly selected from each. Lastly, four beneficiary households were selected randomly from each mothers committee in the sample. Because there are fewer than four committees in some municipalities, only 393 committees and 1,587 beneficiary households were interviewed. The household survey includes information on household demographics, assets, and participation in the Vaso de Leche program, including the values of transfers, products received, and additional purchases made.

As with the DHS, neither income nor expenditure data were collected. Nonetheless, the share of the total program received, by wealth quintiles, was established by constructing a wealth index from the households' asset information using a factor-analysis methodology that is regularly applied to the DHS data sets (Filmer and Pritchett 2001; Sahn and Stifel 2003). Because information on households that do not participate in the Vaso de Leche program is not included in the Public Expenditure Tracking Survey data, asset weights are derived from the nationally representative 2000 DHS and applied to the tracking survey data. This permits determining how households sampled in the tracking survey rank relative to the overall national population.

The purposes for which the various data sets are used are summarized in appendix Table A.1. Vaso de Leche targeting is evaluated using the DHS, ENNIV, and ENAHO data. The Public Expenditure Tracking Survey data are used to examine the degree to which Vaso de Leche transfers are inframarginal, and the DHS[9] and the district-level Vaso de Leche expenditure data are used in the child nutrition models.

8. The results of the first-stage regressions estimated with the ENNIV 1997 data are available on request from the authors.

9. Only the DHS data are employed for the nutrition models for two main reasons. First, two comparable data sets with anthropometric measurements are needed, so that district dummy variables as well as Vaso de Leche subsidies can be included in the models (see World Bank 1999 for a discussion of some of the comparability issues related to the ENNIV surveys). Second, although both the 1994 and 1997 ENNIV data sets have anthropometric data, the earliest year for which Vaso de Leche expenditure data are available is 1994. As explained in the text, the models use the average subsidies for the two years prior to and including the survey as explanatory variables, which would not be available for the 1994 ENNIV.

IV. Results

Before examining the impact of Vaso de Leche expenditures on nutritional outcomes, this section clarifies earlier statements regarding the distribution of Vaso de Leche transfers and targeting.

Distribution

The results confirm that the Vaso de Leche program is reasonably well targeted in terms of both household incomes and child nutritional status, though there have been some leakages. For incomes, this is done by comparing the coverage rates of households by their per capita income levels[10] for five household surveys (Table 1). The percentage of households with children aged six and under (tier I target group) who receive Vaso de Leche transfers declines sharply with the level of income. For example, in 1994, coverage rates declined from 38 percent ([39.3 + 37.0]/2) of the households in the two poorest quintiles to less than 8 percent in the richest. As the coverage for all households with children increased from 28 percent in 1994 to 48 percent in 2000, coverage in the two poorest quintiles rose from 38 to 68 percent ([68.2 + 66.9]/2). While there was a concurrent increase for the more well-off people in the population, the poorest 40 percent of eligible households received more than three times as much as the richest 20 percent on average. These coverage rates compare favorably to the experiences in other Latin American countries (Grosh 1994) and other developing countries (Coady, Grosh, and Hoddinott 2004).

The Public Expenditure Tracking Survey data show that the mean transfer to households in the poorest national asset index quintile is 23 percent larger than to households in the richest quintile. Notably, the bulk of this comes in the form of milk products. The mean value of milk products transferred to the poorest quintile is 135 soles and 18 soles for milk substitutes and other products. Conversely, the mean values of other products received in the other quintiles are between 52 and 100 percent of the mean value of the milk products they receive (see Stifel and Alderman 2005 for more details). Therefore, milk product transfers are generally progressive in the values received by beneficiaries, while transfers of nonmilk products are not.

In nutrition-based targeting, the Vaso de Leche program also is concentrated on households with children of low nutritional status, as illustrated by coverage rates of all children under five years of age by quintile of *HAZ* for the three household surveys with information on both Vaso de Leche participation and anthropometric status of children (Table 2). To give a sense of program leakage to nonmalnourished children, the percentage of the children in each of the quintiles who are stunted is also shown (*HAZ* below –2). In 1997, for example, 64 percent of children in the least well-nourished quintile (those who are all stunted) lived in households that received Vaso de Leche food transfers, while just over 30 percent

10. Household per capita consumption is used for the 1994 and 1997 ENNIV data.

TABLE 1. Vaso de Leche Coverage Rates by Quintiles of Per Capita Income (Percent)

Quintile	ENNIV[a] 1994	ENNIV[a] 1997	ENAHO 1998	ENAHO 1999	ENAHO 2000	Annual transfers per capita (1997 soles) ENNIV 1997
1 (poorest)	39.3	60.5	65.5	59.4	68.2	26
2	37.0	52.4	61.5	50.0	66.9	30
3	34.3	44.6	48.2	39.4	49.4	19
4	20.1	30.7	36.0	29.3	37.3	22
5 (richest)	7.8	15.8	20.2	15.8	15.2	7
Total	27.7	40.8	46.3	38.8	47.5	21

[a]Expenditure per capita rather than income quintiles.

Note: Domain is the set of households with at least one child aged six or younger. Encuesta Nacional de Hogares sobre Medicion de Niveles de Vida (ENNIV) is a National Living Standards Survey; Encuesta Nacional de Hogares (ENAHO) is a National Household Survey.

Source: Authors' analysis based on data described in the text; see also appendix table A.1.

TABLE 2. Vaso de Leche Coverage Rates and Child Malnutrition by Quintiles of Height for Age *z*-scores (*HAZ*) (Percent)

Quintile	ENNIV 1994	DHS 1996	ENNIV 1997
Share of children in program			
1	42.8	41.6	64.0
2	33.8	33.2	49.2
3	28.4	26.4	41.8
4	25.4	21.7	34.8
5	20.0	20.8	30.5
Total	30.1	28.7	44.1
Share of children who are stunted			
1	100.0	100.0	100.0
2	39.1	29.5	19.0
3	0.0	0.0	0.0
4	0.0	0.0	0.0
5	0.0	0.0	0.0

Note: Domain is the set of children with *HAZ*. ENNIV (Encuesta Nacional de Hogares sobre Medicion de Niveles de Vida) is National Living Standards Survey; DHS, Demographic and Household Survey.

Source: Authors' analysis based on data described in the text; see also appendix table A.1.

in the most nourished quintile lived in households that received transfers. Nonetheless, despite the fact that the primary stated objective of the Vaso de Leche program is to reduce the levels of malnutrition in Peru, over a third of the intended beneficiaries in the most malnourished quintile were missed.

It is possible that targeting of children based on ex ante nutritional needs would have resulted in improved ex post outcomes. This could explain the low

TABLE 3. Inframarginality of Vaso de Leche Transfers by Quintile of Per Capita Expenditure (Percent of Beneficiary Households)

	Total	1 (Poorest)	2	3	4	5 (Richest)
Share that receive						
Fluid milk/dairy products	29.4	18.4	20.1	23.0	32.9	41.3
Milk substitutes[a]	53.3	74.8	48.8	43.2	51.5	48.7
Milk and milk substitutes[a]	79.5	89.6	67.3	63.9	81.7	85.4
Other products	58.3	22.3	58.7	62.6	62.9	74.9
Share that purchase additional[b]						
Fluid milk/dairy products	42.5	20.7	14.6	30.4	52.1	52.6
Milk substitutes[a]	2.6	2.2	3.0	4.1	1.5	3.0
Milk and milk substitutes[a]	48.6	36.1	38.9	36.4	57.2	58.7
Other products	26.5	9.7	19.7	15.0	26.6	37.1

[a]Includes powdered milk.

[b]Share of beneficiary households that receive the product.

Source: Authors' analysis based on data described in the text; see also appendix table A.1.

levels of coverage of malnourished children. However, if targeting based on ex ante needs is persistently effective, then as the nutritional status of participants improves over time, deterioration in the degree of targeting on malnutrition should be observed. This appears not to be the case; coverage rates for malnourished children rose from 42.5 percent in 1994 to 63.5 percent in 1997.

The Public Expenditure Tracking Survey data offer further indication of whether the quantities of milk provided to households by the program are extramarginal.[11] If so, they are expected to have a larger impact on milk consumption than an inframarginal program might have. While inframarginal transfers and extramarginal transfers have the same income effect, extramarginal transfers have a price effect as well.

Nearly half of recipients consume additional amounts of the products distributed to them through the Vaso de Leche program (Table 3). For example, for the 80 percent of recipients who receive milk and milk substitutes from the program, 49 percent purchase additional milk and milk substitutes. For 29 percent of households that receive milk and dairy products, the program is inframarginal for 43 percent of them with respect to these products. While only 3 percent of households that receive milk substitutes (53 percent of recipient households) purchase additional milk substitutes, most of these households also purchase milk and dairy products. For half of these households, the Vaso de Leche program

11. The transfer is extramarginal if ex post consumption (what is observed) is exactly equal to the transfer - the recipient would consume less of the product if the transfer were in the form of cash (the recipient is consuming at the kink in the budget constraint). Alternatively, if the recipient purchases additional amounts of the product, the transfer is inframarginal.

is inframarginal over the more broadly defined category of milk and milk substitutes (hence the 49 percent figure above) but not for milk substitutes alone.

Thus, although the Vaso de Leche program is found to be reasonably well targeted to the expected beneficiary groups, it is unclear ex ante what effect the program has had on reducing child malnutrition. The econometric analysis, discussed below, sheds some light on this issue.

Impact of Vaso de Leche Transfers on Nutritional Outcomes

This section assesses the impact of the Vaso de Leche food transfer program on nutrition by examining how the transfers affect child nutritional outcomes. This is done by estimating reduced-form models with standardized *HAZ* of children less than five years of age as the dependent variable. The summary statistics of the variables used in the model are shown in Table 4.

The stunting rate dropped only marginally from 26.0 percent in 1996 to 25.8 percent in 2000. This difference is not statistically significant. Because of the many confounding influences, however, the lack of progress in reducing child malnutrition is not sufficient in itself to assess the impact of the Vaso de Leche program. So models are also used.

These reduced-form models are conditioned on predicted log per capita household expenditures as a proxy for the potentially endogenous actual household expenditures.[12] In all of the models, the parameter estimates on expenditures are statistically significant at the 99 percent level of confidence (Table 5), confirming that household wealth has a positive impact on child nutritional status, a finding consistent with results on the impact of instrumented expenditure for Peru (Haddad and others 2003). For the basic models (without fixed effects), the parameter estimate is approximately 0.43; in the fixed effects models, these parameter estimates drop to between 0.16 and 0.19. Using the income response in the fixed effects models and an average income growth of 3.5 percent per capita, neutrally distributed, a counterfactual can be constructed using the 1996 DHS data. They indicate that the 26 percent malnutrition rate in that year would have declined to 25.2 percent in 2000, which is somewhat below the observed level. Moreover, the small transfer embodied in the Vaso de Leche would by itself have a negligible impact of roughly 0.003 on average *z*-scores.

However, as discussed in Das, Do, and Özler (2005), in-kind or conditional transfers are expected to have a greater impact on behavior than indicated by an income transfer alone. If so, an additional direct impact from the Vaso de Leche expenditures would be expected above any impact on the level of expenditures. But the direct effect of program expenditures is negative in all of the models (Table 5), although it is not statistically significant in any. Moreover, the parameter estimates are substantively small. Thus, overall there is no evidence that expenditures on the Vaso de Leche program have a direct positive impact on the

12. These models were also estimated using an asset index constructed using factor analysis (Sahn and Stifel 2002) as a control for wealth. The results, which are qualitatively the same, are available on request from the authors.

TABLE 4. Means of Variables Used in *HAZ* Models, DHS 1996 and 2000

Variable	Pooled sample		1996		2000	
	Mean	Standard deviation	Mean	Standard deviation	Mean	Standard deviation
Percent stunted	25.9		26.0		25.8	
HAZ[a]	–1.11	1.34	–1.07	1.34	–1.18	1.32
Per capita Vaso de Leche district expenditures	31.90	7.63	29.43	5.90	37.00	8.23
Log per capita household expenditures (predicted)	8.22	0.39	8.23	0.40	8.21	0.38
Male dummy variable	0.50	0.50	0.50	0.50	0.50	0.50
Multiple birth dummy variable	0.01	0.11	0.01	0.12	0.01	0.11
Birth order, second child	0.22	0.42	0.22	0.42	0.23	0.42
Birth order, third child	0.16	0.37	0.16	0.37	0.17	0.37
Birth order, fourth child	0.10	0.30	0.11	0.31	0.10	0.29
Birth order, fifth child	0.07	0.25	0.07	0.25	0.07	0.25
Birth order, sixth child and above	0.14	0.35	0.15	0.35	0.14	0.34
Age 0–6 months	0.10	0.30	0.10	0.31	0.09	0.29
Age 7–12 months	0.10	0.31	0.11	0.31	0.10	0.29
Age 13–18 months	0.10	0.30	0.10	0.30	0.10	0.30
Age 25–35 months	0.19	0.39	0.19	0.39	0.18	0.39
Age 36–59 months	0.41	0.49	0.41	0.49	0.42	0.49
Share household members age 0–5 (%)	0.30	0.13	0.30	0.13	0.29	0.12
Share household girls age 6–15 (%)	0.10	0.12	0.10	0.12	0.10	0.12
Share household boys age 6–15 (%)	0.10	0.12	0.10	0.12	0.10	0.12

(Continued)

TABLE 4. Continued

	Pooled sample		1996		2000	
Variable	Mean	Standard deviation	Mean	Standard deviation	Mean	Standard deviation
Share household women 16–25 (%)	0.10	0.12	0.10	0.12	0.10	0.12
Share household women 26–65 (%)	0.16	0.11	0.16	0.11	0.16	0.11
Share household men 16–25 (%)	0.07	0.11	0.07	0.11	0.06	0.11
Share household men 26–65 (%)	0.17	0.10	0.16	0.10	0.17	0.09
Number of household members	6.38	2.56	6.42	2.60	6.29	2.49
Head is male	0.88	0.32	0.88	0.32	0.88	0.33
Head is indigenous	0.12	0.33	0.12	0.32	0.14	0.34
Mother's age	29.24	6.77	29.21	6.75	29.29	6.82
Mother's height (centimeters)	150.33	5.67	150.33	5.80	150.33	5.40
Mother's education, primary	0.36	0.48	0.36	0.48	0.38	0.48
Mother's education, secondary	0.39	0.49	0.40	0.49	0.38	0.48
Mother's education, postsecondary	0.16	0.37	0.15	0.36	0.17	0.38
Father's education, primary	0.30	0.46	0.30	0.46	0.30	0.46
Father's education, secondary	0.44	0.50	0.45	0.50	0.42	0.49

(Continued)

TABLE 4. Continued

Variable	Pooled sample Mean	Pooled sample Standard deviation	1996 Mean	1996 Standard deviation	2000 Mean	2000 Standard deviation
Father's education, postsecondary	0.20	0.40	0.20	0.40	0.20	0.40
House floor dirt dummy variable	0.51	0.50	0.51	0.50	0.51	0.50
Piped drinking water dummy variable	0.55	0.50	0.54	0.50	0.58	0.49
Flush toilet dummy variable	0.40	0.49	0.41	0.49	0.39	0.49
Urban dummy variable	0.68	0.47	0.71	0.45	0.61	0.49
Number of observations	19,053		12,045		7,008	

[a]Standardized anthropometric height for age *z*-score (*HAZ*).

Source: Authors' analysis based on data described in the text; see also appendix table A.1.

Table 5. Reduced-Form Models of Height for Age *z*-score *(HAZ)* (Ages 0–59), Peru Demographic and Household Surveys 1996 and 2000

	OLS (1)		District fixed effects: OLS (2)		District fixed effects: Time varying IV (3)[a]		District fixed effects: Time dummy IV (4)		District fixed effects: Heteroskedasticity Identification (5)	
	Coefficient	*t*-statistic	Coefficient	*t*-statistic	Coefficient	*t*-statistic	Coefficient	*t*-statistic	Coefficient	*t*-statistic
Per capita Vaso de Leche district expenditures	−0.0015	−0.90	−0.0022	−0.90	−0.0019	−0.79	−0.0018	−0.75	−0.0025	−0.89
Log per capita household expenditures (predicted)	0.422	7.61***	0.164	2.90***	0.192	3.36***	0.164	2.90***	0.164	2.90***
Male dummy variable	−0.083	−4.27***	−0.075	−3.96***	−0.080	−4.23***	−0.075	−3.96***	−0.075	−3.96***
Multiple birth dummy variable	−0.415	−4.03***	−0.459	−4.80***	−0.461	−4.86***	−0.459	−4.80***	−0.459	−4.81***
Birth order, second child	−0.069	−2.06***	−0.062	−1.86*	−0.067	−2.01**	−0.062	−1.86*	−0.062	−1.86*
Birth order, third child	−0.160	−3.99***	−0.140	−3.53***	−0.151	−3.82***	−0.140	−3.52***	−0.140	−3.53***
Birth order,fourth child	−0.274	−5.53***	−0.256	−5.29***	−0.267	−5.57***	−0.256	−5.29***	−0.256	−5.29***
Birth order,fifth child	−0.382	−5.97***	−0.333	−5.42***	−0.351	−5.68***	−0.333	−5.41***	−0.333	−5.42***
Birth order, sixthchild and above	−0.434	−6.69***	−0.364	−5.82***	−0.378	−6.02***	−0.364	−5.81***	−0.364	−5.82***
Age 0–6 months	1.163	25.12***	1.138	24.47***	1.143	24.79***	1.138	24.47***	1.138	24.47***
Age 7–12 months	0.662	14.02***	0.638	13.76***	0.644	13.96***	0.638	13.76***	0.638	13.75***
Age 13–18 months	0.148	3.24***	0.139	3.13***	0.146	3.25***	0.140	3.13***	0.139	3.13***
Age 25–35 months	0.283	6.90***	0.265	6.72***	0.270	6.89***	0.265	6.72***	0.265	6.72***
Age 36–59 months	0.054	1.51	0.044	1.29	0.046	1.34	0.044	1.29	0.044	1.29
Share householdmembers age 0–5 (%)	−0.670	−3.04***	−0.599	−2.74***	−0.600	−2.78***	−0.598	−2.73***	−0.600	−2.74***
Share householdgirls age 6–15 (%)	−0.3067	−1.38	−0.211	−0.95	−0.198	−0.90	−0.210	−0.94	−0.212	−0.95
Share householdboys age 6–15 (%)	−0.373	−1.62	−0.300	−1.33	−0.297	−1.33	−0.299	−1.33	−0.301	−1.33
Share householdwomen 16–25 (%)	−0.029	−0.12	0.019	0.08	0.022	0.09	0.020	0.08	0.019	0.08
Share householdwomen 26–65 (%)	0.107	0.43	0.225	0.94	0.231	0.97	0.226	0.95	0.224	0.94
Share householdmen 16–25 (%)	0.214	0.91	0.290	1.25	0.278	1.21	0.291	1.25	0.290	1.24

(Continued)

TABLE 5. Continued

	OLS (1)		District fixed effects: OLS (2)		District fixed effects: Time varying IV (3)[a]		District fixed effects: Time dummy IV (4)		District fixed effects: Heteroskedasticity Identification (5)	
	Coefficient	*t*-statistic	Coefficient	*t*-statistic	Coefficient	*t*-statistic	Coefficient	*t*-statistic	Coefficient	*t*-statistic
Share householdmen 26–65 (%)	0.348	1.46	0.424	1.79*	0.428	1.83*	0.424	1.79*	0.424	1.78*
Number of householdmembers	−0.026	−5.24***	−0.023	−4.64***	−0.023	−4.74***	−0.023	−4.63***	−0.023	−4.64***
Head is male	−0.133	−3.41***	−0.095	−2.46**	−0.097	−2.53**	−0.095	−2.45**	−0.096	−2.46**
Head is indigenous	−0.226	−4.68***	−0.272	−4.91***	−0.254	−4.77***	−0.272	−4.91***	−0.272	−4.91***
Mother's age	0.063	3.75*	0.057	3.43***	0.058	3.51***	0.057	3.43***	0.057	3.43***
Mother's agesquared	−0.001	−2.67***	−0.001	−2.52**	−0.001	−2.54**	−0.001	−2.52**	−0.001	−2.52**
Mother'sheight (centimeters)	0.054	23.07***	0.051	22.65***	0.052	23.10***	0.051	22.65***	0.051	22.65***
Mother's education, primary	0.013	0.25	−0.021	−0.44	−0.017	−0.36	−0.022	−0.45	−0.021	−0.44
Mother's education, secondary	0.072	1.19	0.020	0.35	0.028	0.49	0.020	0.34	0.020	0.35
Mother's education, postsecondary	0.116	1.70*	0.113	1.75*	0.120	1.89*	0.112	1.74*	0.113	1.75*
Father's education, primary	−0.002	−0.04	0.013	0.26	0.017	0.36	0.013	0.27	0.012	0.26
Father's education, secondary	0.108	2.38**	0.113	2.52**	0.113	2.53**	0.113	2.53**	0.113	2.52**
Father's education, postsecondary	0.012	0.24	0.104	2.00**	0.099	1.90*	0.104	2.00**	0.104	1.99**
House floor dirtdummy variable	−0.052	−1.85*	−0.088	−2.99***	−0.080	−2.82***	−0.089	−2.99***	−0.088	−2.99***
Piped drinking waterdummy variable	−0.029	−0.97	0.028	0.95	0.031	1.05	0.028	0.95	0.028	0.96
Flush toilet dummy variable	0.107	2.93***	0.111	3.08***	0.096	2.7***	0.111	3.08***	0.110	3.07***
Urban dummyvariable	0.211	5.30***	District fixed effect		Fixed effect		Fixed effect		Fixed effect	

(Continued)

Table 5. Continued

	OLS (1)		District fixed effects							
			OLS (2)		Time varying IV (3)[a]		Time dummy IV (4)		Heteroskedasticity Identification (5)	
	Coefficient	t-statistic	Coefficient	t-statistic	Coefficient	t-statistic	Coefficient	t-statistic	Coefficient	t-statistic
Constant	−13.75	−22.12***	dummies omitted		dummies omitted		dummies omitted		dummies omitted	
FONCODES index (t = 0) in IV equation					0.222	49.21***				
FONCODES index (t = 1)in IV equation					0.311	53.63***				
FONCODES index inIV equation							0.150	2.43**		
F-statistic (H_0:instruments jointly 0)					153.6**		4329.0**			
χ^2 (H_0: OLS and IVestimates same)					5.56*		6.27*			
χ^2 (Breusch–Pagan test)										699.90**
Number of observations	19,053		19,053		19,053		19,053			19,053
R^2	0.300		0.356		0.341		0.355			0.355

OLS, ordinary least squares.

*Significant at the 90 percent level of confidence.

**Significant at the 95 percent level of confidence.

***Significant at the 99 percent level of confidence.

[a]Province-level fixed effects.

Note: Instrument in IV models is district-level FONCODES index.

Source: Authors' analysis based on data described in the text; see also appendix table A.1.

nutritional outcomes of young children—the group to whom the program is directed—using either the preferred approach (controlling for the initial conditions in communities with district fixed effects) or other models.

In both of the standard instrumental variable models, the identifying instrument (FONCODES index of unmet needs) is significantly correlated with per capita district expenditures, and the instruments overall (including the time dummy variable) are jointly significant at the 1 percent level.[13] The first-stage parameter estimates for the FONCODES index for both 1996 and 2000 in the time-varying instrumental variable model (model 3) are positive and strongly significant, with a larger effect in 2000. While this confirms that the instrument is valid in terms of its correlation with Vaso de Leche expenditures, it also implies that marginal program targeting is propoor (Lanjouw and Ravallion 1999). The positive parameter estimates for the instruments suggest that the incidence of inframarginal Vaso de Leche spending benefits districts with higher FONCODES indices—the poor benefit more from marginal increases in program spending that may not be distributed homogeneously across all districts.

In model 5, the chi-squared statistic for the Breusch–Pagan test of heteroskedasticity is 699.9, implying that the data in the first-stage equation are heteroskedastic. Thus, following Lewbel (2004), the condition is met for consistent estimation of the impact of Vaso de Leche expenditures on child health. Although the methodology differs from that of models 3 and 4, the parameter estimate is similar.

A few additional specifications were also tried (these are not shown here but are available from the authors). For example, while no average impact is observed in these regressions, it is possible that the impact is greater among the poor, where malnutrition rates are higher. Thus, the regressions were rerun for only the poorest 40 percent. The point estimates for the coefficient of per capita Vaso de Leche expenditures remained negative and were greater in absolute value for all of the models than the results reported in Table 5.[14] Thus, there is no indication that the impact on the poor was masked by aggregation. Similarly, the results are unchanged when children under six months of age are excluded, to rule out the possibility that children who were being breast-feed would respond less to an in-kind subsidy[15]and when the

13. Durbin-Wu-Hausman chi-square tests that the OLS and instrumental variable estimates are the same are all rejected at the 5 percent level (table 5).

14. While probit analysis does not use all of the information available in the data since the variation in the continuous dependent variable is ignored when it is converted to a binary variable, the model was also tested with a probit analysis as the threshold to keep the focus on the malnourished. The coefficient of Vaso de Leche expenditures remained nonsignificant.

15. In addition, the models were reestimated using other measures of nutritional status. The results were similar to the estimates presented here. More specifically, two measures were used: weight-for-height z-scores *(WHZ)*, a measure of short-term nutritional status, and weight-for-age z-scores *(WAZ)*, a composite of weight for height and height for age. A further test of robustness involved splittig the sample into urban and rural samples and estimating separate models. Since program leakage is higher in urban areas than in rural areas, a program effect might have been expected in rural areas, but the separate estimates did not differ substantially from those presented in this article. Therefore, an aggregation bias from pooling the urban and rural samples appears not to be driving the results.

parameters are allowed to differ across urban and rural areas in the fixed effects models.

Nonsignificant coefficients in a population survey may mask a response if beneficiaries are a small share of the population. However, the program covers nearly half the population and two-thirds of the poor. Thus, more than 8,000 individuals in the sample are beneficiaries of the program. Nonsignificant coefficients may also reflect imprecision in measurement. In this case, the confidence intervals—while narrow—do cross over into positive values. Still, at the largest positive value for the 95 percent confidence interval for the impact of 37 soles ($11.50) of program expenditures per capita in, say, model 2, the program would increase *z*-scores by 0.09.

V. Conclusion

This article looked for evidence that the politically popular focus on the provision of milk to young children can further nutritional objectives. It studied expenditures on the Vaso de Leche feeding program in Peru, a program that is reasonably progressive in its distributional impact relative to international experience (Grosh 1994; Coady, Grosh, and Hoddinott 2004). The article was motivated by the paucity of evidence on the nutritional impact of similar programs worldwide despite the millions of dollars spent on them each year. It illustrates a methodology for linking public expenditure data with household survey data first to substantiate the targeting and then to model the determinants of nutritional outcomes of children to see whether Vaso de Leche program interventions have an impact on nutrition.

In the models of standardized child heights, the magnitude of program expenditures provided to the community rather than household participation is used as an explanatory variable, solving the issue of endogenous household choice. Even when accounting for endogenous program placement with fixed effects models, and further with alternative approaches to instrumental variables, Vaso de Leche program expenditures are found to have no impact on the nutritional outcomes of young children—the group to whom the program is targeted.

The results do confirm that the Vaso de Leche program is reasonably well targeted to poor households and to households with low nutritional status: some 50 percent of the poor received program benefits, while less than 20 percent of the nonpoor did. In value terms, more than 60 percent (possibly up to 75 percent) of the allocated Vaso de Leche budget goes to the poor. Therefore, the absence of a measurable impact on child growth is not likely explained by mistargeting. Indeed, given that the program expenditure has no observed impact on nutritional status other than that through any increase in household expenditures, further improvements in targeting are not by themselves likely to affect nutritional outcomes. To gauge this, the effect of redistributing all of the Vaso de Leche benefits received by the nonpoor evenly among the poor was simulated using the household expenditure coefficient from the district fixed effects models. Malnutrition rates decreased only 0.28 percentage points.

One possible reason why the impact of food subsidies beyond their value as income transfers is limited may be the degree to which the commodity transfers are inframarginal. The 2002 Public Expenditure Tracking Survey data show that transfers of milk and milk substitutes from the Vaso de Leche program are inframarginal for approximately half the households that receive them. This can be only a partial explanation, however, since the results do not change when the estimates are confined to the poorest 40 percent, a group for which milk is less likely to be inframarginal.

There are, however, other means by which a subsidy to milk might achieve an improvement in child nutrition. For example, milk fortification may be a promising way to address anemia; programs in Argentina, Chile, and Mexico currently fortify milk with iron to achieve this objective. Randomization of fortification in two dozen communities in Mexico verified the efficacy of this approach (J. Rivera, pers. comm.). However, this was not an objective of the Vaso de Leche program in Peru during the period being studied.

Another possible approach to milk subsidies is to include them as part of a broader program for improving nutrition, as with the Women, Infants, and Children program in the United States. The review by Rivera, Hotz, and others (2003) and an earlier article by Garcia and Pinstrup-Andersen (1987) indicate the efficacy of supplementation programs that include nutrition education. Again, the Vaso de Leche program is not directly embedded in other interventions aimed at improving nutrition, so the current study cannot assess this possibility. Still, as this study (and the few similar studies in the literature) fails to find an impact on child growth from a subsidy on commercial milk products, the results reinforce the view that without additional measures dairy subsidies do not address the efficiency objectives of a transfer program in addressing malnutrition. Despite being reasonably well targeted to the poor and malnourished, the Vaso de Leche program fails to improve the nutritional status of young children. The implication for Peru and for other countries is that where costly in-kind transfers are also largely inframarginal and not fortified with micronutrients, they offer little if any efficiency gains as measured by improved child nutritional outcomes. Under such circumstances, cash transfers could be less costly and potentially an equally effective means of achieving nutritional and other distributional objectives.

Appendix Table A.1. Data Sources and Their Use in the Analysis

Data source	Type	Year	Anthropo metrics	Welfarist metric	Information on Vaso de Leche participation	Use in analysis
National Household Survey (Encuesta Nacional de Hogares, ENAHO)	Household survey	1998	No	Income	Indicators	Income targeting
		1999	No	Income	Indicators	Income targeting
		2000	No	Income	Indicators	Income targeting
National Living Standards Survey (Encuesta Nacional de Hogares sobre Medicion de Niveles de Vida, ENNIV)	Household survey	1994	Yes	Consumption	Indicators	Income and nutrition targeting
		1997[a]	Yes	Consumption	Values	Income and nutrition targeting
Demographic and Household Survey	Household survey	1996	Yes	Asset index	Indicators	Nutrition targeting and child nutrition models
		2000	Yes	Asset index	No	Child nutrition models
Public Expenditure Tracking Survey	Expenditure tracking/household survey	2001/02	No	Asset index	All households surveyed are participants	Inframarginality analysis
Vaso de Leche program expenditure data	District-level records	1994–2000				Nutrition impact regressions

[a] Data set used by Ruggeri Laderchi (2001).

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