Women's Asset Ownership and Children's Nutritional Status:

Evidence from Papua New Guinea

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Keywords: Papua New Guinea, children, health, nutrition, assets, gender

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I. Introduction

Improving women's control over assets can augment women's economic security and bargaining power, which in turn may have powerful consequences for the health and well-being of their children. Women's control over financial resources can affect the health of their children through multiple channels, including their ability to purchase goods and services that improve children's health and nutritional status. In addition to improving women's income-generating capacities, asset ownership can also strengthen their control over resources within the household. There is an established literature on bargaining in the context of households where even if the budget of the household remains constant, women's asset ownership may strengthen their negotiating power in household decision-making by improving their fall-back position, which in turn can change intra-household spending patterns (Agarwal, 1994; Pitt, Khandker, & Cartwright, 2006; Deere & Twyman, 2012). Although improvements in household assets can benefit all members, resources concentrated in the hands of women can contribute to higher spending on children's health and nutrition compared to resources concentrated in the hands of men (Lundberg & Pollak, 1993).

Strengthening women's formal ownership of assets can increase the availability of collateral to obtain loans, which in turn can provide women the financial means to invest in entrepreneurial activities and increase household expenditures. In the case of land, formal, registered land rights can affect women's agricultural productivity and earnings power through increased security of land tenure. Women's land ownership, alone or jointly, and access to productive agricultural assets can also increase their bargaining power within the home, as evidenced by findings for India (Garikipati, 2009), Nepal (Mishra & Sam, 2016), Peru (Wiig, 2013), and Ethiopia (Muchomba, 2017). The benefits can also occur outside of the household,

such as when land ownership empowers women to reduce their reliance on survival sex as a source of income (Muchomba, Wang, & Agosta, 2014).

Several influential studies have shown that additional income controlled by mothers leads to greater household expenditures on inputs into child well-being including food, education, and health services (McElroy, 1990; Thomas, 1997; Quisumbing & Maluccio, 2003; Doss, 2006; Kumar & Quisumbing, 2012). However, there are very few studies that trace the direct effects of women's asset ownership on children's health, mostly because there is so little sex-disaggregated data on asset ownership. Two exceptions are Allendorf (2007), which finds that women in Nepal who own land are less likely to have underweight children, and Menon, Rodgers, & Nguyen (2014), which finds that land registration in women's names in Vietnam is associated with several health and educational benefits for children, including a lower incidence of illness, increased health insurance coverage, higher school enrollment, and a reallocation of household expenditures toward food and away from alcohol and tobacco.

Our study helps to fill this knowledge gap by examining the link between women's asset ownership and children's nutritional status in Papua New Guinea, a country with some of the highest rates of child stunting and wasting in the world (World Health Organization, 2017). At the national level, 48 percent of young children are stunted, 11 percent are wasted, and 27 percent are underweight, with higher rates in rural areas as compared to urban areas. These high rates have persisted for decades, and the lack of improvement is at odds with global trends (Saweri, 2003; Hou, 2016). Moreover, Papua New Guinea is one of the world's most rural countries, with one of the most isolated populations. The majority (86 percent) of Papua New Guinea's households still live in the rural sector, and four out of five people live in rugged or coastal terrain without access to roads and public transportation (World Bank, 2013).

Malnutrition is thought to be the leading cause of death amongst children and has been perhaps overlooked in the fight to control other causes of death (Aipit, Aipit, & Laman, 2014). While several earlier studies have shown that measures of women's empowerment have beneficial effects for children's nutritional status in Papua New Guinea (e.g. Gibson 1999; Gibson & Rozelle 2004; and Imai & Eklund 2008), none have examined women's asset ownership.

Our analysis utilizes data from Papua New Guinea's 2009-2010 Household Income and Expenditure Survey (HIES), a rich household-level dataset with detailed information on human capital indicators, socioeconomic status, and children's anthropometric measures. The HIES also contains gender-disaggregated information on asset ownership, which is unusual among household surveys for developing countries. The availability of this data, combined with the high incidence of children's malnutrition, makes Papua New Guinea a highly relevant and important case study for examining how women's asset ownership is associated with child health. The data are used to examine the determinants of children's nutritional status, as measured by height-for-age (HAZ scores), weight-for-height (WHZ scores) and weight-for-age Z-scores (WAZ scores). At the lower tail of the distribution, each of these measures are indicators of nutritional deprivation: children whose height-for-age is more than two standard deviations below the median of the international reference population for children of the same gender are considered stunted; children whose weight-for-height is more than two standard deviations below the median of the reference population are wasted; and children whose weight-for-age is more than two standard deviations below the median of the reference population are underweight. The analysis is based on both ordinary least squares regressions and detailed quantile regressions that control for a complete set of proximate determinants of child health.

We also perform a battery of specification tests to determine more precisely the mechanism through which women's asset ownership is linked to children's nutritional status.

II. Data and Methodology

The empirical analysis uses Papua New Guinea's 2009-2010 Household Income and Expenditure Survey (HIES). The cleaned HIES consists of 4,081 households and 22,718 individuals. Our sample consists of children under 72 months of age (the maximum age for which the HIES has anthropometric information for children), for a total of 3,381 children. Because we are interested in how women's asset ownership influences their bargaining power within the household, we restricted the sample to children of mothers who are currently married. Similarly, because four of the six assets covered by the survey questionnaire are mostly relevant for farming and fishing communities, we further restrict the sample to children living in rural areas, leaving an analytic sample of 1,651 children. Sensitivity tests are performed that compare the main results to those using the full sample of 3,381 children. We use data in the HIES on children's gender, age, height, and weight to specify children's nutritional status as height-for-age, weight-for-height, and weight-for-age Z-scores. These measures compare a child to a reference population. For population-based assessment, the Z-score is routinely considered to be the best system for analysis of anthropometric data and the best indicator of malnutrition. The Z-score specifies the relevant anthropometric value as a number of standard deviations above or below the reference median of the World Health Organization Reference Population for children of the same gender (World Health Organization, 2006).

Sample means are presented in Table 1 for both the sample of all children as well as the analytic sample of children with married mothers in rural areas, each weighted to the national level using HIES sample weights. For the full sample, Table 1 indicates that on average, slightly

more than half of children in the sample are boys (52 percent). The children are spread out evenly across the age groups, with slightly more children ages 24-35 months and slightly fewer in the older age groups. Relatively few mothers have tertiary education (6 percent) while 42 percent of mothers have not completed their primary schooling. Although fathers on average have higher educational attainment than mothers, two thirds of the fathers have just a primary school education or below. There is an even larger gender differential in smoking: 20 percent of mothers versus 55 percent of fathers. The average household has three children under the age of 15. Moreover, fewer than a quarter of young children live in households that have access to tap water; just 10 percent of children live in households that have an improved toilet facility (that is, a flush toilet or a ventilated improved pit latrine); and only 12 percent of children live in urban areas in the full sample.

These means are broadly comparable for the analytic sample of children with married mothers in rural areas. As expected, the average HAZ, WHZ, and WAZ scores are slightly lower for rural children relative to the national average. Other indicators of socioeconomic status are also slightly lower for these rural-sector children relative to the national average, including their mothers' educational attainment as well as the percent of households with access to tap water and improved toilets. Also in the analytic sample, relatively more households are concentrated in the lower expenditure quintiles (which were constructed using expenditure data for all households in the HIES).

Table 1 also shows asset ownership by mothers. Our definition of asset ownership is consistent with legislation and customs around property ownership in Papua New Guinea. By law, women and men are guaranteed the same rights to own and manage all non-land assets (Organization for Economic Cooperation and Development, 2014). Closely related, sons and

daughters are guaranteed equal inheritance rights to property, as are male and female widowers. Regardless of their marital status, women and men have equal rights in engaging in commercial transactions related to real estate and non-land assets, and home ownership can be in the name of the man and/or the woman (World Bank 2012). Women also have the legal right to administer non-land assets without male intervention, regardless of how they acquired the asset. However, women still face considerable discrimination in ownership and control over non-land assets due to social norms, traditional practices, and religious customs.

Closely related, at the time the survey was conducted women could not use their non-land assets as collateral for loans, so women who had no title to customary land lacked access to the formal credit market. Over 90 percent of land in Papua New Guinea is subject to customary tenure as opposed to statutory tenure, and customary land usually consists of a territory controlled by associated kin groups (World Bank, 2012). Inheritance of customary-held land is based on patrilineal lines, so the national legislation on equal inheritance does not apply to land. Even in communities where land inheritance is based on matrilineal lines, men generally have the rights of control of the land. Although women are restricted from owning and controlling land and claiming any share of land royalties or lease payments, they do often have land-usage rights. In fact, women produce about 80 percent of the country's food output (Organization for Economic Cooperation and Development, 2014).

These discriminatory social institutions in Papua New Guinea make it difficult for women to have sole ownership of assets. Among all 160 countries tracked in the OECD (2014) database on social institutions and gender, Papua New Guinea has the fifth-highest level of discrimination in women's access to assets and resources. The four countries in which women

fare worse are in Sub-Saharan Africa, a region known for women's lack of legal rights to own and control land and other assets.

Quite unusual among nationally-representative household surveys (including the Demographic and Health Survey), Papua New Guinea's HIES has individual-specific data on asset ownership. The HIES has questions about six types of assets: livestock, poultry, agricultural equipment, fishing equipment, house/apartment, and furniture/household goods. The survey does not include land in the list of six assets. For each of these assets, the survey asks if someone in the household has ownership of the asset, and if so, who in the household owns the asset (with separate spaces for up to five household members). Options for joint-ownership by the household or ownership by the entire "clan" are also included. Because women's sole ownership of assets is still relatively uncommon in Papua New Guinea even among female-headed households, we operationalized mother's asset ownership as the mother's identification code appearing in any one of the five spaces for a particular asset. For example, if the survey indicates that three people in a household own livestock, it could be that the mother owns a sheep, the father owns a cow, and the grandfather owns a pig. Here the mother is coded as owning livestock. Similarly, if the mother owns a sickle and the father owns a plow, the survey lists two owners for agricultural equipment, and we code the mother as owning agricultural equipment. Co-ownership of a house by the husband and wife is treated in the same way. As shown in Table 1 for the sample of all young children, the most common asset owned by mothers is agriculture equipment (36 percent). Other food-production items are less common: livestock (23 percent), poultry (13 percent), and fishing equipment (15 percent). About one quarter of mothers claim ownership of their homes and the furniture, and married mothers in the rural sector have relatively higher ownership rates of all the asset types except for furniture.

To consolidate the ownership information on the six different assets, we construct three aggregate indices for inclusion in our regression models. The first index is a variable generated using principle components analysis (PCA). PCA collapses the six asset variables by creating an index using a linear combination of the variables. We use only the first PCA component since it assigns the most weight to assets that have the most variation across households and thus shows the maximum possible differences between households. As discussed in Filmer & Pritchett (2001) and McKenzie (2005), the higher-order components have relatively smaller benefits and lower interpretability. This index is hereafter referred to as the PCA asset index. Note that a potential problem in using a PCA-based asset index based on just six assets is that households could be clumped into a small number of distinct clusters, which would make it difficult to differentiate among households in their ownership of assets. However, this issue is unlikely to be a problem due to low levels of asset ownership in rural areas (Vyas & Kumaranayake, 2006). The second index of asset ownership – henceforth called the standardized asset index – is the sum of the standardized values of the dummy variables for each individual asset. The third index – henceforth called the basic asset index – simply adds the dummy variables for individual asset ownership together, which results in an index that ranges from 0 (when a woman owns none of the asset types) to 6 (when a woman owns all six of the asset types).

Our sample includes two other indices that we constructed to better understand the mechanism through which women's asset ownership impacts child health: 1) an index for women's decision-making power, and 2) an index for justifiable wife-beating as an indicator of attitudes within the household toward women and children. The decision-making index uses PCA to combine eleven options for the question "Who in the household usually makes the decision about ___?" Respondents are asked to note up to five people who make various

decisions about purchasing food, clothing, medicine, education, debt, and marriage partner for the children. As with the construction of the PCA index for maternal asset ownership, we use only the first PCA component. The index for justifiable wife-beating is also constructed using PCA applied to five options in the following survey question: "Is a husband justified in hitting or beating his wife in the following situations?" The situations include burning the food, neglecting the children, going out without telling the husband, refusing sex, and arguing with the husband. Women who contribute more to decision making in the home are expected to have a greater say in the health and health care of their children, thus contributing positively to children's nutritional status. Conversely, if the wife and/or husband believe that wife-beating is justifiable, the mother is likely to have less say in the health the children which would contribute negatively to children's nutritional status.

The empirical analysis starts with an OLS regression analysis of the determinants of children's nutritional status. The estimation equation is specified as follows:

$$Y_i = \alpha_0 + \alpha_1 A_i + \alpha_2 X_i + \varepsilon_i \quad (1)$$

The notation Y_i denotes the nutritional status of child i, alternatively measured as weight-for-age, weight-for-height, and height-for-age Z-scores. The variable A is an indicator for the mother's ownership of a particular asset or group of assets, and the matrix X represents individual and household-level controls including: a dummy variable for whether the child is a boy; the birth order of the child; dummy variables for the child's age group at the time of the survey; dummy variables for mother's level of educational attainment and for father's educational attainment; dummy variables for whether the mother and father currently smoke; index for women's decision-making power; index for justifiable wife-beating; dummy variables for household expenditure quintiles; continuous variables for household composition including the number of

working-age adults (ages 15-65), number of children (age<14), and number of elderly (age>65) in a household; dummy variables for whether the household has access to tap water and whether the household has an improved toilet; and dummy variables for geographic regions (Southern, Highlands, Momase, and Islands). The main regression results are reported for the analytic sample of children with married mothers who live in rural areas, with robustness checks run for the full sample (which include dummy variables for married mother and urban residence). All statistical analyses are weighted to the national population using the sampling weights provided in the HIES. Because the survey records multiple children per household as separate observations, we correct the standard errors for clustering at the level of the household.

Quantile regression permits an analysis of the impact of independent variables on different sections of the dependent variable distribution, compared to the OLS comparison at the mean, which can offer a more complete picture of the effects of female asset ownership. The quantile regression parameter explains the marginal effect of an independent variable on a specified quantile of the dependent variable. The estimated coefficients from various quantiles are comparable. Given the structure of the anthropometrics, children at the left tail (poor health) of the distribution may have a disparate marginal response to a given independent variable than healthier children at the median or right tail of the distribution. These differences are not apparent with the OLS estimated coefficients. Several studies have used this method to detect crucial asymmetrical effects of various treatments on child health in developing countries (Bassolé, 2007; Kizhakethalackal, Mukherjee, & Alvi, 2013; Aturupane, Deolalikar, & Gunewardena, 2011). The quantile regression equation is specified as follows:

$$Quant_{\tau}(Y_i) = \alpha(\tau)_0 + \alpha(\tau)_1 A_i + \alpha(\tau)_2 X_i + \varepsilon(\tau)_i \quad (2)$$

where τ indicates the specified quantile. We estimate the model at $\tau = 0.10, 0.25, 0.50, 0.75$, and 0.90.

III. Regression Results

Table 2 reports OLS estimates from the full models for height-for-age, weight-for-height, and weight-for-age Z-scores, including all controls and one representative measure of women's asset ownership (the PCA asset index). In terms of our key indicator of interest, mother's asset ownership, the table shows that mother's asset ownership is positively and significantly associated with children's HAZ, WHZ, and WAZ scores: as the asset index rises by one point, the average HAZ score increases by 0.10 points and children's WHZ and WAZ scores rise by 0.14 points. Hence, even after controlling for a full set of proximate determinants of child health (socioeconomic status, household composition, and environmental factors), maternal asset ownership has a statistically significant effect on children's nutritional status. Note that height-for-age is an indicator of long-term nutritional status, capturing the effects of chronic nutritional deprivation or chronic or recurrent illness, while WHZ and WAZ scores capture short-term nutritional status, including recent, short-term inadequate nutritional intake, or recent illnesses such as diarrhea that cause weight loss. Once could conclude from the relatively smaller coefficient for the HAZ score that maternal asset ownership matters more for children's nutritional status in the short-term for managing shocks to children's health and nutritional intake than it does in the long-term for dealing with chronic nutritional deprivation.

Among the other control variables, the main determinants of children's nutritional status are the child's age, the index for justifiable wife-beating, father's education, and geographic region. Very young children are more likely to have higher HAZ and WAZ scores than the oldest children, while the opposite is true for WHZ scores. Children who live in households in

which wife-beating is justified have lower WHZ and WAZ scores, while children whose fathers have at least a primary school education fare better in terms of their WHZ and their WAZ scores. Finally, living in the Highlands region contributes positively to children's WHZ and WAZ scores but not to HAZ scores. A possible reason is that WHZ and WAZ scores are both affected by short-term shocks to a child's health such as a severe illness that causes weight loss, and the Highlands is an area known to have less malaria than other parts of the country because of its high altitude. None of the other control variables are statistically significant for more than one of the nutritional status indicators. Unlike men's education, women's education is not associated with children's nutritional status, a result that is in direct contrast with findings for other developing countries and lends doubt to the argument that in Papua New Guinea women's education improves their bargaining power within the home. However, so few women have higher levels of education in the sample, the marginal effects on child health are challenging to estimate.

One potential issue in our model is that some of the control variables may be picking up "post-treatment" effects that are related to women's asset ownership, or are endogenous. For example, households in which women own assets may be more likely to have access to tap water and improved toilets. Thus, women's asset ownership could have a direct positive effect on children's nutritional status, and it could also benefit children through the mediating effect of their living in homes with tap water and improved toilets. One way to gauge the extent to which maternal asset ownership operates directly and indirectly to affect children's nutritional status is to estimate a baseline model that includes only control variables that have virtually no likelihood of picking up such "post-treatment" effects. This method, however, runs the risk additional omitted variable bias if at least one excluded variable in the baseline model is associated with at

least one included variable and is correlated with child health. This bias can be positive or negative. As a robustness check we estimated a baseline model, and in comparison to the full model the coefficient on the asset index in the baseline model is virtually the same for children's HAZ scores, but for WHZ and WAZ scores the coefficients are smaller in magnitude and not statistically significant. This set of results suggests two potential issues: 1) that other household characteristics mediate the effect of maternal asset ownership on children's WHZ and WAZ scores, so the total effect of maternal asset ownership is captured in the full model but not in the baseline model and/or 2) the coefficients in the baseline WHZ and WAZ regressions were biased downwards due to omitted variable bias. The strong correlation between both child health and excluded regressors and included and excluded regressors suggests the latter is true. However, for children's HAZ scores, the direct effect and the total effect of women's asset ownership are virtually the same.

Table 3 shows the coefficient estimates for all three asset indices as well as the individual assets in the OLS regressions for HAZ, WHZ, and WAZ scores. Each entry in the table is estimated in a separate regression with the full set of control variables. The table indicates that the standardized asset index and the basic additive index also have positive and statistically significant coefficients across the three indicators of nutritional status, with slightly larger effects for WHZ and WAZ scores compared to HAZ scores. Among the individual assets, there is just one asset – fishing equipment – that is statistically significant and positive across all three indicators of nutritional status. Children of mothers who own fishing equipment have nutritional status indicators that are 0.31 to 0.47 points higher than children of mothers who do not own fishing equipment. Fishing in Papua New Guinea is considered a high-value activity not only for meeting a household's subsistence needs but also for generating cash earnings, and more women

have become interested in fishery as a field of study in school and as an occupation (World Bank 2012). The second asset related to food production – agricultural equipment – is also positively and significantly linked to children's nutritional status, in this case to two of the three indicators (HAZ and WAZ scores). Women's ownership of livestock, which depending on the breed can be used to generate income and/or as a source of protein, is positively associated with children's WAZ scores. The two asset indicators related to a household's dwelling (the home and the furniture) are each positively associated with one nutritional status indicator. These assets do not contribute directly to food production but can help to strengthen women's bargaining power within the home. The only asset that has no meaningful or statistically significant relationship with children's nutritional status is poultry even though poultry farming can be used to generate income and meet a household's protein needs.

Specific portions of the child nutrition Z-score distributions are analyzed using quantile regression analysis. Table 4 presents quantile-regression estimated coefficients for the three consolidated asset measures. As with the previous table, each entry was estimated in a separate regression with the full set of control variables. The first panel shows that HAZ scores are greater for children of mothers with asset ownership, but only at the median and the 75th percentile. Depending upon the asset index used, a one point increase in the index improves the HAZ score between 0.04 and 0.12 points. These results are similar to the OLS estimates, although the estimates at the median are slightly larger at the top end of the range.

The second panel of Table 4 shows that women's asset ownership when measured by the PCA index significantly improves WHZ scores throughout the distribution. When measured by the other two indices, women's asset ownership improves children's WHZ scores at the median and above. Moreover, the coefficients across asset measurement tend to increase in size into the

right tail of the distribution. Focusing on the PCA asset index, at the median, a one unit increase in this asset index increases the WHZ score by 0.17 points compared to 0.20 and 0.22 points at the 75^{th} and 90^{th} quantiles, respectively. Finally, the third panel of the table shows that WAZ scores are significantly positive throughout the distribution, although their values are convex in nature. Hence the effect of women's asset ownership on WAZ scores tends to decline when moving from the left tail to the median and then increases when moving to the right tail. Thus, the behavior of the distribution of the WAZ coefficients is like that of the WHZ coefficients to the right of the median although the effect is smaller in magnitude for the WAZ scores. Since low HAZ is an indication of long-term nutritional inadequacy and, unlike WHZ and WAZ, the quantile regression indicates that women's asset ownership only matters for the children in the right-hand side of the distribution, it appears that women's asset ownership impacts the short-term health of all children, but only the long-term health of those who are already relatively healthy.

Results from more detailed quantile regressions for the individual assets suggest that these conclusions for the aggregate asset indices are largely driven by ownership of fishing equipment and agricultural equipment across most parts of the distribution, especially for WAZ scores (results available upon request). In contrast, the coefficients for ownership of poultry are often negative and statistically insignificant. Animal husbandry, including poultry, is a common source of food consumption and income generation in Papua New Guinea. However, the government has implemented very little in the way of biosecurity measures. Therefore, the country still faces issues associated with pathogens that spread from animals to humans and infect residents frequently, particularly those with vulnerable immune systems (e.g. elderly, sick, and young.) Several diseases that infect poultry can spread to humans and cause symptoms

including diarrhea. Zambrana *et al.* (2014) conducted a meta-analysis of the existing literature and found that domestic exposure to poultry is strongly associated with incidence of human campylobacteriosis and diarrhea. Thus, the biohazards associated with poultry may overwhelm the positive association between female ownership of chickens and children's nutritional status, especially in the short term.

The conclusion from the quantile regressions that mother's asset ownership at the lower tail of the distribution matters mostly for weight-for-age Z-scores is confirmed with additional tests in which our three measures of children's nutritional status are converted from continuous variables into binary variables for stunted, wasted, and underweight. Logistic regression is used to relate the odds of a child being stunted (or wasted or underweight) to a measure of women's asset ownership as well as the full set of control variables. Odds ratio estimates for just the maternal asset ownership variables are found in Table 5. Consistent with the quantile regression results for the lower tail of the WAZ distribution, children have lower odds of being underweight when their mothers own more assets. This result is mostly driven by agricultural equipment, fishing equipment, and furniture. For example, a child whose mother owns fishing equipment has about half the odds of being underweight compared to a child whose mother does not own fishing equipment. Interestingly, a child is more likely to be wasted if his or her mother owns poultry. The result is suggestive that living in close quarters with this breed of livestock may be introducing negative health effects that counteract any benefits from the protein intake that may be afforded by raising chickens.

We performed several tests to check for the robustness of the main results. To conserve space the results are not reported in this paper but they are available upon request. First, we performed the same OLS regressions for the full sample of children, including children of

unmarried mothers and children who live in urban areas. Our main results are similar, although all the coefficient estimates for maternal asset ownership are slightly smaller in magnitude and estimated with somewhat less precision. This outcome is consistent with the expectation that when women own assets that can be used to generate income – especially fishing equipment and agricultural equipment – they can contribute economically toward the health of their children, and these assets would matter more in the rural sector than the urban sector.

Next, we operationalized maternal ownership of assets as the mother being the only person in the household listed as owning a particular asset. In this case, using the restricted sample of children of married mothers in the rural sector, our estimates on the various asset indicators for children's HAZ scores are weaker and precision on the PCA asset index falls, but otherwise the results are comparable and we are still left with the conclusion that women's asset ownership (especially fishing equipment and agricultural equipment) contributes positively and significantly to children's nutritional status. We attribute the loss of precision in many of the estimates to the fact that women's sole ownership of an asset is less common among the survey respondents than women being one of up to five people in a household who own assets in a particular category.

We estimate a similar set of regressions in which mother's asset ownership is replaced with father's asset ownership (operationalized as the father being one of up to five people listed as owning an asset). The results in these specification tests are quite similar to those in the main results in Table 2 in that the coefficient on the PCA asset index is positive and statistically significant for the three measures of child health, and the magnitudes are almost the same. This result supports the argument that the main mechanism through which women's asset ownership improves children's nutritional status is through improvements in their income-generating

capacities rather than stronger bargaining power within the household. Hence children fare better in households in which at least one parent owns assets, and the beneficial effects are very similar for mothers' and fathers' asset ownership. Finally, we estimate a set of regressions in which the mother has shared ownership over each asset with the aggregate household or clan, but not in her own name. In this case, none of the coefficient estimates for the asset indices or individual assets are statistically significant influences on child health. These results imply that it is important for women's income-generating capacity that they can claim direct ownership of an asset rather than own an asset collectively.

V. Conclusion

In principle, improving women's control over assets can augment women's economic security and bargaining power within the home, which in turn may have powerful consequences for the health and well-being of their children. However, apart from two previous studies for Nepal and Vietnam (Allendorf 2007; and Menon, Rodgers, & Nguyen 2014), very little empirical evidence has supported this assertion, mostly because so few developing countries have large-scale datasets with gender-disaggregated information on asset ownership. Our study helps to fill this gap with new evidence on mother's asset ownership and children's health in Papua New Guinea, a country with uniquely-available data on women's asset ownership and unusually high rates of child malnutrition. Results from ordinary least squares regressions point to beneficial effects of maternal ownership of assets for children's height-for-age, weight-for-height, and weight-for-age Z-scores, even after controlling for a large set of control variables for socioeconomic status, household composition, and environmental characteristics. Among the three indicators, maternal asset ownership has bigger impacts on WHZ and WAZ scores, both of which are shorter-term indicators of children's nutritional status. Ownership of fishing

equipment is particularly important for all three indicators, and ownership of agriculture equipment matters for two of the three indicators. Both assets strengthen the ability of mothers to meet their children's subsistence needs and to generate income in the marketplace. In contrast, due to the biohazards and illnesses associated with domestic poultry, the positive effects of poultry ownership may be overwhelmed in the short-term by symptoms such as diarrhea that can contribute to nutritional deprivation. Additional results from detailed quantile regressions confirm that the positive effects of mother's asset ownership and children's nutritional status occur at different parts of the distribution, especially for children's WAZ scores. A series of specification tests suggests that the main mechanism through which women's asset ownership affects children's nutritional status is by strengthening their income-generating capacity. Because the results are similar for fathers' asset ownership, we conclude that children in poor families have better nutritional status if at least one of their parents owns assets that enhance the household's economic security.

Evaluating the economic benefits of women's asset ownership is particularly important given that gender-aware spending programs are starting to gain prominence in policymaking efforts. Examples include the conditional cash transfer (CCT) programs such as *Oportunidades* in Mexico (subsequently renamed *Prospera*) and *Bolsa Familia* in Brazil, which were first devised based on scholarship showing the benefits of concentrating resources in the hands of women. CCT's are typically structured as cash disbursements made to women conditional on the undertaking of certain actions, usually related to children's school enrollment and visits to healthcare providers for checkups and vaccinations. These programs are now prevalent across developing regions and are used as a poverty reduction tool, showing that small budgets can go a long way if they are targeted. However, despite the appeal of programs providing women with

greater access to cash, not all studies have been able to identify impacts on measures of women's empowerment and child health, thus pointing to the need for additional strategies that target productive income-generating opportunities for women (Buvinić & Furst-Nichols, 2016). Our analysis suggests that women's ownership and control of assets largely improves child health by empowering women to support their households, although policymakers should address the biohazards and deleterious effects of domestic poultry through education regarding safe animal husbandry.

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Table 1. Sample Means: Children under 72 Months of Age (In percent unless otherwise indicated; standard deviations in parentheses)

	All Children		Children of Married Mothers in Rural Areas	
	Mean	SD	Mean	SD
Dependent variables				
Height-for-age z-score	-1.719	(1.667)	-1.796	(1.655)
Weight-for-height z-score	-0.130	(1.864)	-0.140	(1.891)
Weight-for-age z score	-0.998	(1.642)	-1.057	(1.656)
Stunted	0.481	(0.500)	0.503	(0.500)
Wasted	0.111	(0.314)	0.111	(0.314)
Underweight	0.270	(0.444)	0.284	(0.451)
Mother has ownership of asset				
Livestock	0.225	(0.418)	0.257	(0.437)
Poultry	0.130	(0.336)	0.144	(0.351)
Agricultural equipment	0.358	(0.479)	0.376	(0.485)
Fishing equipment	0.151	(0.359)	0.169	(0.375)
House	0.249	(0.433)	0.255	(0.436)
Furniture	0.270	(0.444)	0.250	(0.433)
Child characteristics				
Boy	0.523	(0.500)	0.525	(0.500)
Birth order	2.864	(1.478)	2.863	(1.462)
Age < 12 months	0.176	(0.381)	0.178	(0.382)
Age 12-23 months	0.170	(0.375)	0.170	(0.375)
Age 24-35 months	0.198	(0.399)	0.193	(0.395)
Age 36-47 months	0.167	(0.373)	0.164	(0.370)
Age 48-59 months	0.159	(0.365)	0.159	(0.366)
Age 60-71 months	0.131	(0.338)	0.137	(0.344)
Mother's characteristics				
Mother is married	0.908	(0.289)	1.000	(0.000)
Mother's education				
Less than primary school	0.422	(0.494)	0.436	(0.496)
Primary school	0.365	(0.481)	0.389	(0.488)
Secondary school	0.153	(0.360)	0.142	(0.349)
Tertiary school	0.060	(0.238)	0.033	(0.179)
Mother smokes	0.197	(0.398)	0.207	(0.405)
Index for decision-making power	0.048	(0.923)	0.007	(0.999)
Index for justifiable wife-beating	0.065	(0.985)	0.037	(0.992)
Father's characteristics				
Father's education				
Less than primary school	0.334	(0.472)	0.312	(0.464)
Primary school	0.329	(0.470)	0.376	(0.485)

Secondary school	0.194	(0.396)	0.194	(0.396)
Tertiary school	0.143	(0.350)	0.117	(0.322)
Father smokes	0.554	(0.497)	0.609	(0.488)
Household characteristics				
Bottom expenditure quintile	0.206	(0.404)	0.226	(0.418)
2nd expenditure quintile	0.210	(0.407)	0.232	(0.422)
3rd expenditure quintile	0.188	(0.391)	0.200	(0.400)
4th expenditure quintile	0.194	(0.395)	0.196	(0.397)
Top expenditure quintile	0.203	(0.402)	0.145	(0.353)
Number of working-age adults	3.158	(1.725)	3.021	(1.532)
Number of children (age<15)	3.346	(1.599)	3.348	(1.562)
Number of elderly (age>65)	0.092	(0.323)	0.091	(0.326)
Access to tap water	0.226	(0.419)	0.160	(0.367)
Improved toilet	0.099	(0.298)	0.037	(0.190)
Live in urban area	0.121	(0.327)	0.000	(0.000)
Geographic region				
Southern	0.204	(0.403)	0.170	(0.376)
Highlands	0.334	(0.472)	0.362	(0.481)
Momase	0.319	(0.466)	0.317	(0.466)
Islands	0.143	(0.350)	0.150	(0.358)
Sample size	3,381		1,651	

Note: Weighted to national level with HIES sample weights. Mother's asset ownership is when the mother is one of up to five owners within a household of a particular asset category.

Table 2. Determinants of HAZ, WHZ, and WAZ Scores: Full Model OLS Regressions

Full Model	**HAZ Scores**	**WHZ Scores**	**WAZ Scores**
Mother's asset ownership			
PCA asset index	0.101**	0.142**	0.143***
	(0.051)	(0.056)	(0.050)
Child characteristics			
Boy	-0.178**	0.094	-0.103
	(0.084)	(0.101)	(0.083)
Birth order	-0.105	-0.116	-0.168**
	(0.079)	(0.088)	(0.074)
Child's age (ref: 60-71 months)			
Age < 12 months	0.985***	-0.485**	1.027***
	(0.189)	(0.235)	(0.177)
Age 12-23 months	0.362**	-0.291	0.449***
	(0.162)	(0.189)	(0.154)
Age 24-35 months	0.231*	0.204	0.570***
	(0.136)	(0.169)	(0.145)
Age 36-47 months	0.126	-0.104	0.232
	(0.143)	(0.167)	(0.147)
Age 48-59 months	0.127	0.125	0.175
	(0.139)	(0.173)	(0.141)
Mother's characteristics			
Mother's education (ref: less than primary)			
Primary school	-0.068	-0.019	0.000
	(0.116)	(0.137)	(0.116)
Secondary school	-0.100	-0.180	0.068
	(0.153)	(0.189)	(0.161)
Tertiary school	0.142	0.050	0.398
	(0.289)	(0.316)	(0.265)
Mother smokes	0.183	0.176	0.170
	(0.130)	(0.151)	(0.132)
Index for decision-making power	-0.035	0.069	0.073
	(0.056)	(0.065)	(0.054)
Index for justifiable wife-beating	-0.019	-0.153**	-0.140***
	(0.050)	(0.060)	(0.051)
Father's characteristics			
Father's education (ref: less than primary)			
Primary school	0.039	0.347**	0.212*
	(0.123)	(0.144)	(0.125)
Secondary school	0.084	0.562***	0.247*
	(0.146)	(0.180)	(0.141)
Tertiary school	0.186	0.350	0.176

	(0.166)	(0.218)	(0.173)
Father smokes	-0.155	-0.115	-0.043
	(0.103)	(0.123)	(0.102)
Household characteristics			
Expenditure quintiles (ref: top quintile)			
Bottom expenditure quintile	-0.111	-0.251	-0.076
	(0.195)	(0.216)	(0.187)
2nd expenditure quintile	-0.103	-0.378*	-0.221
	(0.173)	(0.208)	(0.175)
3rd expenditure quintile	-0.077	-0.290	0.082
	(0.173)	(0.207)	(0.187)
4th expenditure quintile	0.111	-0.378*	-0.002
	(0.171)	(0.209)	(0.172)
Number of working-age adults	-0.100***	0.008	-0.009
	(0.032)	(0.043)	(0.035)
Number of children (age<15)	0.115	0.086	0.130*
	(0.075)	(0.087)	(0.074)
Number of elderly (age>65)	0.255	0.299	0.149
	(0.166)	(0.201)	(0.158)
Access to tap water	0.119	-0.246	-0.097
	(0.141)	(0.191)	(0.130)
Improved toilet	-0.041	0.560**	0.365
	(0.204)	(0.268)	(0.235)
Geographic region (ref: Southern)			
Highlands	-0.349**	1.114***	0.768***
	(0.140)	(0.171)	(0.144)
Momase	-0.238*	0.091	-0.059
	(0.131)	(0.156)	(0.129)
Islands	0.017	-0.198	-0.210
	(0.151)	(0.163)	(0.139)

Note: Standard errors, in parentheses, are clustered at the household level. The notation *** is p <0.01, ** is p <0.05, * is p <0.10. Sample is children of married mothers in rural sector (n=1,651).

Table 3. OLS Regression Results for Alternative Measures of Mother's Asset Ownership

	HAZ Scores	**WHZ Scores**	**WAZ Scores**
Aggregate indices			
PCA asset index	0.101**	0.142**	0.143***
	(0.051)	(0.056)	(0.050)
Standardized asset index	0.028**	0.030*	0.033**
	(0.013)	(0.016)	(0.013)
Basic asset index	0.065**	0.072*	0.079**
	(0.032)	(0.038)	(0.031)
Individual assets			
Livestock	0.151	0.082	0.232*
	(0.111)	(0.139)	(0.118)
Poultry	0.021	-0.079	-0.189
	(0.127)	(0.172)	(0.139)
Agricultural equipment	0.223**	0.181	0.212**
	(0.102)	(0.119)	(0.103)
Fishing equipment	0.380***	0.314**	0.473***
	(0.133)	(0.146)	(0.127)
House	-0.055	0.239*	0.074
	(0.110)	(0.128)	(0.104)
Furniture	0.150	0.184	0.214*
	(0.119)	(0.133)	(0.118)

Note: Standard errors, in parentheses, are clustered at the household level. The notation *** is p <0.01, ** is p <0.05, * is p <0.10. Sample is children of married mothers in the rural sector (n=1,651). Each entry comes from a separate regression using the full set of control variables.

Table 4. Summary of Quantile Regression Estimates for Mother's Asset Ownership Indices

	Quantile				
	0.10	0.25	0.50	0.75	0.90
Asset index coefficients for HAZ scores					
PCA asset index	-0.027	0.003	0.116**	0.122*	0.053
	(0.040)	(0.037)	(0.047)	(0.071)	(0.140)
Standardized asset index	-0.005	0.000	0.035***	0.035*	0.009
	(0.011)	(0.010)	(0.013)	(0.020)	(0.039)
Basic asset index	-0.012	0.001	0.082***	0.080*	0.024
	(0.025)	(0.023)	(0.031)	(0.046)	(0.090)
Asset index coefficients for WHZ scores					
PCA asset index	0.171*	0.121*	0.173***	0.201***	0.218*
	(0.092)	(0.072)	(0.061)	(0.061)	(0.113)
Standardized asset index	0.009	0.011	0.035**	0.048***	0.046
	(0.027)	(0.019)	(0.017)	(0.016)	(0.029)
Basic asset index	0.025	0.03	0.087**	0.119***	0.107
	(0.063)	(0.044)	(0.038)	(0.038)	(0.067)
Asset index coefficients for WAZ scores					
PCA asset index	0.173***	0.162***	0.108**	0.208***	0.195**
	(0.051)	(0.052)	(0.048)	(0.061)	(0.090)
Standardized asset index	0.035**	0.030**	0.027**	0.042***	0.045**
	(0.015)	(0.015)	(0.013)	(0.016)	(0.023)
Basic asset index	0.088**	0.070**	0.064**	0.097***	0.107**
	(0.036)	(0.034)	(0.030)	(0.037)	(0.053)

Note: Standard errors, in parentheses, are clustered at the household level. The notation *** is p <0.01, ** is p <0.05, * is p <0.10. Coefficients are taken from separate quantile regressions that include the full set of control variables. Sample is children of married mothers in the rural sector (n=1,651).

Table 5. Logistic Regression Results: Odds Ratios for Mother's Asset Ownership

	Stunted	**Wasted**	**Underweight**
Aggregate indices			
PCA asset index	0.941	0.950	0.825***
	(0.055)	(0.079)	(0.054)
Standardized asset index	0.983	1.016	0.963**
	(0.016)	(0.023)	(0.017)
Basic asset index	0.961	1.035	0.911**
	(0.036)	(0.055)	(0.037)
Individual assets			
Livestock	0.885	1.320	0.826
	(0.118)	(0.266)	(0.127)
Poultry	1.024	1.496*	1.261
	(0.160)	(0.325)	(0.225)
Agricultural equipment	0.882	0.978	0.734**
	(0.104)	(0.176)	(0.097)
Fishing equipment	0.831	0.745	0.554***
	(0.126)	(0.165)	(0.097)
House	1.130	0.927	0.908
	(0.147)	(0.177)	(0.131)
Furniture	0.795*	1.203	0.761*
	(0.109)	(0.238)	(0.112)

Note: Standard errors, in parentheses, are clustered at the household level. The notation *** is $p < 0.01$, ** is $p < 0.05$, * is $p < 0.10$. Sample is children of married mothers in the rural sector (n=1,651). Each entry comes from a separate regression using the full set of control variables.