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***Abstract*:** This paper examines gender differentiated asset dynamics over a 20 year period (1988-2008) in Northern Nigeria. The paper first examines the state of the literature on poverty dynamics, especially with respect to gender differences and agriculture. We then present new evidence to investigate whether there has been a catch-up effect for women in agricultural households who had initially low assets in 1988 and whether asset inequality within households is predicted by initial assets. The household survey conducted in Kaduna State, Nigeria tracked individuals from 200 households originally surveyed in 1988 to their households in 2008, a total of 576 additional households owing to splits. Household-level assets such as livestock holdings and household capital capture different dimensions of the household's portfolio of wealth, including gender differentiated shares of assets such as livestock and household capital. The analysis finds that women's assets grow more slowly than men's assets over a long time horizon. The mechanism through which differential asset stocks grew over the twenty year period is related to the relative prices of the assets in the gender differentiated portfolio. Men, who primarily held livestock, benefited from large price increases in livestock. Women's assets, which were primarily held as goods, both durables and jewellery, had much smaller price increases. The increased price of livestock may have been driven by the expansion of cultivated land in the villages, which increased demand for bullocks to plough. We find some suggestive evidence that these price fluctuations reinforced gender asset inequality within households for both types of assets considered.

***Key words*:** gender, women, agriculture, asset accumulation, asset dynamics, livestock, Nigeria, household behaviour, panel data

JEL codes: Q12, O13, J16, D90

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Introduction

Poverty dynamics reveal critical information regarding the transition paths that households experience moving out of or slipping into poverty over a given time horizon. Much recent attention in the poverty dynamics literature has focused on asset dynamics (see for example Addison *et al.*, 2009; Carter and Barrett, 2006, and; Baulch and Hoddinott, 2000). Carter and Barrett (2006) provide a recent overview of the evolution of the poverty dynamics literature, categorizing poverty measures in four generations: i) static income or expenditure poverty, ii) dynamic income or expenditure poverty, iii) static asset poverty, and iv) dynamic asset poverty. Assets are a particularly important indicator of household welfare as asset stocks fluctuate less widely than consumption or income measures.[2] In a recent review of the poverty dynamics literature, Addison *et al*. (2009) identify several gaps in the literature including longer time horizon analysis to investigate inter-generational poverty dynamics, especially from a gender disaggregated perspective. However, few studies present results of gender differentiated asset dynamics, with the notable exceptions of Antanopoulos and Floro (2005), Deere and Doss (2006), and Quisumbing (2009a and 2009b), owing to the paucity of longitudinal gender disaggregated asset data. This paper contributes to the literature by investigating asset dynamics by gender over a 20 year period and applying new econometric techniques that improve the quality of regression estimates by minimizing cluster correlated regression errors, which can be problematic when dealing with a small number of clusters.

Comprehending poverty dynamics is a critical component of understanding the relationship between gender and agriculture. Gender differences in asset holdings potentially affect women's welfare, especially women in agricultural households, for two important reasons. First, participation in agriculture is a defining feature of many poor households throughout the world (Banerjee and Duflo, 2007). Understanding poverty dynamics in this sector is therefore critical for improving welfare levels of all people in the sector including women. Second, we know that women are particularly disadvantaged in agriculture because they have less access to land (Meinzen-Dick *et al*., 1997 and Gregorio *et al*., 2008) and have less access to inputs on their plots than men. This creates lower productivity on their plots relative to men because

[2] In addition, it should be noted that including assets into welfare measurement incorporates the vital dimension of production because income and consumption flows are typically generated by asset stocks (Addison *et al*., 2009).

of this inefficient input allocation within their households (Udry, 1996 and Duflo and Udry, 2004).

In this paper, we take a multi-dimensional approach to illustrate how asset stocks of agricultural households have changed over time and been divided inter-generationally over a 20 year period in four villages in Northern Nigeria. Our two primary questions examine: a) 'What role do initial household endowments have on men's and women's future asset stocks in terms of both levels of assets held and differences in the growth rate of assets?', and; b) 'What role do initial household endowments have on men's and women's future intrahousehold inequality?'.

A collection of studies investigating initial asset endowments in Sub-Saharan Africa demonstrates how initial endowment levels are essential to generating higher returns and improved welfare over time (see Peters, 2006; Barrett *et al*., 2001; Adato *et al.*, 2006; Barrett *et al*., 2006a; Barrett *et al*., 2006b; Whitehead, 2006, and; Little *et al.*, 2006). In addition, existing evidence illustrates the presence of intrahousehold inequalities and their problematic nature in rural, agricultural contexts (see Thomas, 1997; Hoddinott and Haddad, 1995; Quisumbing and de la Brière, 2000; Dey Abbas, 1981 and 1997'; Udry, 1996, and; Akresh, 2005, amongst others). However, studies that address the long-run role of initial endowments on asset stocks for men and women separately, instead of the aggregate household, are scarce.

We find that women's assets grow more slowly compared with men's assets over a long time horizon. The mechanism through which asset stocks grew over the twenty year period is related to the relative prices of the assets in gender differentiated portfolios. Men who primarily held livestock saw large price increases in the value of their assets, and also held assets that biologically multiply (such as livestock). Women's assets on the other hand were primarily held as goods, both durables and jewellery, whose value increased marginally. The price of livestock may have been driven by expansion of arable land in the villages and the intensification of agriculture, which in turn increased demand for bullocks to plough. This reinforces gender asset inequality within households for both types of assets considered, as recent studies, such as Quisumbing and Baulch (2009) among others, show. Our findings differ from Quisumbing and Baulch (2009) with respect to the mechanism through which gender-differentiated asset inequality is perpetuated. The authors identify access to well-functioning labour and capital markets as critical mechanisms for explaining long run asset accumulation, particularly for non-land asset growth. In contrast, our hypothesis is that

changes in the relative returns to asset prices, especially livestock prices, may lead to differential returns to men's and women's assets.[3]

In addition to our findings on gender differentiated asset dynamics, the paper carefully considers the problem of within group correlation which may bias the standard errors of our estimates, especially with small numbers of clusters. The issue of small numbers of clusters in panel surveys is not uncommon. In our review of panel data sets that followed households over at least a 10 year period, we find that sample sizes range from 51 and 55 households in Moser and Felton (2009) and Lybbert *et al*. (2004), respectively, to 1 477 households in the Ethiopian Rural Household Survey.[4] Following Cameron *et al*. (2008), we correct for potential biases in standard errors by employing the wild bootstrap, which has been shown to perform well with small numbers of clusters, to test whether our key parameter estimates are significantly different than zero.

In the second section of this paper, we review the studies that use panel data to understand the stylized facts about asset dynamics drawing on the review pieces by both Addison *et al*. (2009), Carter and Barrett (2006) and Baulch and Hoddinott (2000). We then briefly review the few studies that investigate poverty dynamics with emphasis on gender differences over longer time horizons. In the third section, we outline the econometric strategy that we employ to answer the two central questions of this study. The fourth section describes the data collected by the authors to create a 20 year panel survey from households in Northern Nigeria. We discuss the tracking process whereby we traced individuals from households surveyed in 1988 to their current households in 2008 within the original survey villages. The fifth section describes the descriptive statistics and key variables used in the analysis. The sixth section presents our empirical results and the last section concludes.

3 Quisumbing and Baulch (2009) also suggest that the exclusion of women in labour markets and other market activities creates gender specific livelihood pathways, which can reinforce gender non-land household asset imbalances.

[4] In ascending order, we find a heterogeneous distribution of panel sample sizes of at least 10 years from around the globe. Examples of smaller sample sizes include 51 households collected over a 26 year period (Moser and Felton, 2009), 55 households over 17 years (Lybbert *et al*., 2004), 89 households over 13 years (Barrett *et al*., 2006), and 155 households over 18 years (Scott, 2000). This is followed by a sample size of 257 households collected over an 18 year period (Quisumbing and McNiven, 2007), 360 households over 17 years (Hoddinott, 2006), and 400 households over 15 years (Gunning *et al*., 2000). The sample size of the panel data used for this study, 576 households collected over a 20 year period, is next, followed by 713 households over 13 years (Beegle *et al*., 2006), and 957 households over 20 years (Quisumbing, 2009). Lastly, the largest panel data set identified in our review consists of 1,477 households collected over a 10 year period (Dercon *et al*., 2009).

Poverty Dynamics: literature review

Several papers have recently reviewed the poverty dynamics literature including Addison *et al.* (2009), Carter and Barrett (2006) and Baulch and Hoddinott (2000). This review outlines papers in this literature that are of particular importance to understanding linkages between poverty dynamics, gender and agriculture. Baulch and Hoddinott (2000), in their review of 14 poverty assessments using panel data, provide a valuable study of poverty measures that incorporate the dimension of time. The authors demonstrate that transitory poverty is often the largest share of poor households at a given time period. In particular, they disaggregate poverty status into three categories – "always", "sometimes" and "never" – to show that using conventional poverty indicators with only one observed cross-section provides a false sense of reality in terms of poverty, especially with respect to poverty persistence and mobility. This is confirmed by Foster (2009) and Calvo and Dercon (2009) who introduce the element of time into conventional measures (using panel data) and find considerably different estimates of poverty in Argentina and Ethiopia, respectively. As such, it is worth reiterating "…that if policy continues as it has to date, treating the chronic poor as being like the transient poor but a little bit 'further behind', that hundreds of millions of people are likely to stay poor and many of those yet to be born will spend their lives in poverty" (p. 401, Hulme, 2003).

Perhaps one of the most important facets of incorporating time into poverty assessments is that it enables the analysis of inter-generational transmission of poverty. For instance, using panel data, Günther and Klasen (2009) demonstrate that although income poverty has fallen considerably in Vietnam, young people in households with low education among older members often end up having low education themselves. Similarly, using panel data, Quisumbing (2009) illustrates that inter-generational asset transfers, particularly human and physical capital, can create or stifle pathways out of poverty in the Philippines.

Inter-generational poverty transmission is influenced both by the overall trajectory of a household's welfare, which is related to its endowment accumulation; the returns to it and the incidence of major internal (household) or external (shock) events. A number of studies showed that key internal events, such as illness, malnutrition or high funeral expenses, at critical times in the life cycle, especially during early life, can have irreversible effects on individual capabilities and long term effects on poverty and wages (see Loury, 1981; Strauss and Thomas, 1998; Alderman *et al*., 2006, and; Hoddinott *et al*., 2008). The use of panel data,

as shown by Krishna (2009), provides a more nuanced evaluation of poverty because it accounts for the impacts of predictable lifecycle events and the sustained effects of major external events, such as droughts. Moreover, being able to identify the determinants of inter-generational poverty transmission provides policy makers with crucial information for designing effective poverty reduction interventions.

Returns to household endowments are also powerful determinants of welfare. Barrett *et al*. (2006a) point out that households who can take advantage of opportunities, generally those who are better off and well positioned, experience higher returns. In Malawi, Peters (2006) demonstrates that the liberalization of tobacco production primarily benefited farmers who were better positioned in the beginning in terms of land, labour and credit. Increased endowments helped this subset of the population join growers' clubs and access preferable world prices. In Cote d'Ivoire, Barrett *et al*. (2001) show that the ability of households to take advantage of non-farm and emerging opportunities, especially those facilitated by macroeconomic policy adjustments, is predicated by ex-ante conditions. In particular, the authors show that households with greater initial skills and land endowments benefit disproportionately compared with their poorer counterparts. In South Africa Adato *et al*., (2006) find that privileged households were best able to capitalize on the economic opportunities resulting from the end of apartheid. They also show that wealthier households are more effective in using social capital to take advantage of improved production technologies and higher return livelihoods; for poorer households, social capital is insufficient to overcome a lack of productive asset holdings.

Moreover, Barrett *et al*. (2006b) illustrate that wealthier households in Madagascar were better able to adopt enhanced production technology, considerably boosting crop yields. Disadvantaged households, on the other hand, were effectively prevented from taking up such technology owing to their relative lack of credit, insurance and labour. In addition, Whitehead (2006), in a study on Ghanaian agriculture, demonstrates that farmers with greater initial stocks of land, livestock and male labour are able to take advantage of new high-value crops and improved ploughing technology. Those with lower endowments produced lower yields and accessed inferior terms of trade, compared with their wealthier counterparts, leading to less wealth accumulation. Further, Little *et al*. (2006) find that pre-drought livestock ownership in Ethiopia leads to more rapid post-shock recovery and improved wealth. This is consistent with the results for Kenya presented by Barrett *et al*., (2006b). As such, it becomes

clear that initial endowment levels are strong predictors of improved welfare over time across a wide variety of circumstances.

In addition to increasing the likelihood of adopting agricultural technology and increasing welfare after shocks occur, a number of studies suggest that returns to endowments may play an integral role in defining asset accumulation (Baulch and Hoddinnott, 2000; Gunning *et al*., 2000; Maluccio *et al*., 2000; Glewwe and Hall, 1998, and; Lanjouw and Stern, 1993). Gunning *et al.*, (2000) and Maluccio *et al*., (2000) specifically show how large exogenous events, such as resettlement of households in Zimbabwe or the abolition of apartheid in South Africa, can have more significant effects on returns than small, continuous improvements in asset stocks. More importantly, it is clear that poverty measures derived from panel data, which allow for the consideration of initial endowments, asset accumulation and varying returns to endowments, provide an enhanced, more nuanced understanding of poverty.

Given the benefits of relying on assets to measure welfare and changes in poverty, a number of studies have emerged that focus on long-run asset dynamics. Carter and Barrett (2006) suggest locally increasing returns at the microeconomic level, due to returns to scale, sunk costs to productivity and risk rationing, indicating a positive relationship between asset levels and marginal returns to assets. Considering this, and using panel data to incorporate the dimension of time, Quisumbing (2009) shows that inter-generationally transferred assets increase current consumption and asset levels (though they do not always prevent against chronic poverty). The positive inter-generational relationship is consistent with findings from Behrman and Taubman (1985 and 1990) showing that in the United States parents' income is positively associated with children's future earnings.

Yet despite the fact that women generally have lower asset endowments, it has been illustrated that increasing women's resources has uniquely beneficial effects on household outcomes (Deere and Doss, 2006). Thomas (1997), using data from Brazil, shows that women spend considerably more on education, health and household services, which leads to higher per capita calorie intake and income, compared with their male counterparts. Interestingly, this large dichotomy in gender income effects is reduced when only considering households in which both mother and father participate in the labour market. These findings correspond closely with those from Hoddinott and Haddad (1995) in Côte d'Ivoire and Quisumbing and de la Brière (2000) in Bangladesh.

With respect to agriculture, differences in bargaining power within households affect productive resource allocation, especially levels of input use and productivity on male and female plots. Dey Abbas (1997) highlights the role that gender asymmetries play in diminishing female productivity, particularly in limiting their ability to adopt productivity-enhancing technologies (also see Guyer, 1981 and 1986; Sen, 1985; Roberts, 1988 and 1991, and; Whitehead, 1990, amongst others). Dey Abbas draws attention to a program in The Gambia focused on boosting agricultural productivity via the introduction of advanced technology. In the process of trying to boost agricultural productivity, the project also motivated men to take advantage of women's relatively weaker land rights in order to shift control of unexpectedly promising land and crops to their own control.

By ignoring gender asymmetries in the intrahousehold resource allocation process, particularly those related to agricultural production, the intervention actually weakened the bargaining position (and welfare) of women in the household. This unintended, negative consequence on women's rights and welfare, which was exacerbated by the pre-existing bargaining parameters as well as a combination of agricultural productivity and gender asymmetries, has also been observed elsewhere. For instance, studies in Cameroon (Jones, 1986), Kenya (Hanger and Morris, 1973; Bevan *et al*., 1989), The Gambia (Dey Abbas, 1981), and Burkina Faso (McMillan, 1987) demonstrate how asymmetrical intrahousehold resource allocation mechanisms, coupled with agricultural productivity and gender imbalances, have led to tepid adoption of productivity enhancing technologies or higher value crops and, subsequently, lower agricultural output for women.

Although there is a lack of recent empirical evidence analyzing gender differences in the use of production inputs, tools, and equipment, a recent review of the literature by Peterman *et al*., (2010a) indicates that 19 of 24 relevant studies do identify that men have higher mean access to specific agricultural resources than women, although the impact of this disparity on output and productivity varies. For instance, in Malawi, Gilbert, Sakala, and Benson (2002) show that asymmetric fertilizer use by gender does exist and explain that this is because women have less access to it. In the case of Uganda, Nkedi-Kizza *et al*., (2002) demonstrate that there is no difference in soil fertility across male and female owned plots, but do find that lower yields for female-owned plots are likely due to a lack of fertilizer, extension, and so forth. Moreover, in Zimbabwe, Horrel and Krishnan (2007) show that the difference in agricultural productivity can be significantly explained by the differences in farm machinery use by gender.

In Benin, Kinkingninhoun-Mêdagbé *et al*., (2008) also find significant gender differences in pesticide use in a small study of rice farmers and largely attribute these to gender discrimination. Furthermore, in Malawi, Uttaro (2002) show that one of the reasons why women have less access to agricultural resources, like fertilizer and seeds, is due to the unfavourable prices that are available to them. In the case of Zimbabwe, Horrell and Krishnan (2007) indicate that women receive lower prices and have less access to desirable selling consortiums. For example, in Nigeria Sanginga *et al*., (2007) find that females farmers are less likely to plant improved soybean seeds partially because male farmers have superior access to market opportunities and therefore have more money to spend on hiring labor.

In Botswana, Oladele and Monkhei (2008) suggest that this dichotomy is also an issue with livestock when they find that men are significantly more likely to own cattle, donkeys, and horses, as opposed to women who are significantly more likely to own goats that are less valuable for powering plows and producing manure fertilizer. Similarly, in Ethiopia, Pender and Gebremedhin (2006) show a negative association between the use of oxen and female household heads and that when factors like labor and oxen use are held constant crop yields for female headed households are 42 percent lower than for male headed households. Lastly, Peterman *et al*., (2010b) note that gender differences in quantity and quality of agricultural inputs, cultural norms, as well as prices of inputs and credit, are defining factors for agricultural production differences between men and women.

In summary, the literature makes it apparent that analysis of long term asset dynamics is essential for understanding household welfare. Moreover, it is evident that at the household level, as is typical in poverty analysis, is insufficient for appropriate programme design given intrahousehold inequalities. Furthermore, these studies suggest that an important gap exists in the literature in terms of understanding long-run gender disaggregated asset dynamics, especially in agricultural households. In order to bridge this gap, we estimate the effects of household endowments on future asset holdings by gender over a time horizon of 20 years. The next section delineates our econometric strategy to achieve this objective.

Econometric Strategy

The econometric strategy to identify the effects of initial household endowments on future gender differentiated asset levels draws on the poverty dynamics literature in which lagged

assets, households and village characteristics determine future asset stocks, subject to stochastic shocks over time. In our analysis, we consider two types of assets: the value of household capital and livestock holdings. We use household assets in 1988 as our measure of initial endowments and estimate the impact of these initial endowments on future gender disaggregated asset stocks in 2008; controlling for household characteristics including household composition, age of the household head, education level of head of household, initial landholdings and village indicators to capture variation in village characteristics. Equation 1 specifies the econometric relationship to be estimated in levels of assets, while Equation 2 specifies the relationship in natural logs.

(1) $$Assets_{h,g,2008} = \alpha Assets_{h,1988} + \beta \ln X_{h,1988} + \varepsilon_{v,h,t}$$

(2) $$\ln Assets_{h,g,2008} = \alpha \ln Assets_{h,1988} + \beta \ln X_{h,1988} + \varepsilon_{v,h,t}$$

The asset variables are specified for each household *h*, by gender *g* in the specified year. For both these equations, we are primarily concerned with the sign of α. If $\alpha > 1$ in equation 1, then this implies positive asset accumulation over time, whereas in equation 2 if $\alpha > 0$, then gender differentiated asset growth out of initial assets is positive. We also control in these regressions for a set of household level covariates, *X*, which include the household head's age and education; household composition including the number of men, women and dependents; and land holdings. The error term is composed of unobservable variation in villages (*v*) and households (*h*) over time (*t*). To control for village level unobservables, we include village indicators in the regression.

In equations 1 and 2, we first estimate each of these equations by gender. Then we restrict the data to a subsample of "original" households to estimate whether these longer-established households have different asset dynamics than the pooled set of both original and split households. We define an *original household* as a household who was originally interviewed in 1988 and that resides in the same location with at least one of the following members who was previously interviewed: the household head, the household head's spouse or the oldest adult male of the household head. We define *split households* as households that split from the originally interviewed household and that consist of at least one person who was previously included in an original household, but who no longer resides in the original household; having formed a new household. We discuss attrition and the distribution of original and split households in the next section.

The second set of equations that we estimate investigates intrahousehold inequality of assets. Using the share of women's assets relative to men's, we again estimate the effect of household assets in 1988 on gender differentiated asset shares in 2008, controlling for initial household characteristics. Equation 3 specifies the relationship in natural logs.

$$(3) \qquad Assetshare_{h,g,2008} = \alpha \ln Assets_{h,1988} + \beta \ln X_{h,1988} + \varepsilon_{v,h,t}$$

The interpretation of α is similar to that of equation 1 and 2 with the significant difference that α now represents the elasticity of female asset shares in 2008 with respect to initial assets in 1988. We control for the same set of covariates X as in equations 1 and 2, as well as include village indicators to control for village level unobservables.

A key econometric issue that we address in all regression specifications is the correction of the standard errors for within-group dependence. Heteroskedastic-robust standard errors are commonly calculated following White (1980). However, a large literature illustrates that cluster robust standard errors might be downward biased, if the number of clusters in the sample is small (Moulton, 1986 and 1990; Angrist and Lavy, 2002; Bertrand *et al*. 2004, and; Donald and Lang, 2007). This is because inference is based on the asymptotic assumption that the number of clusters tends to infinity. Cameron *et al*. (2008) illustrate that wild bootstrap methods perform particularly well in estimating standard estimates with small numbers of clusters[5]. Following their approach, we first estimate in the original sample the standard errors, coefficient estimates and residuals imposing the null hypothesis. We then resample with replacement from the original sample residual vectors, $\hat{u}_v^* = \hat{u}_v$ with probability 0.5 and $\hat{u}_v^* = -\hat{u}_v$ with probability 0.5, to construct a pseudo-sample of $\{(\hat{y}_1^*, X_1),...,(\hat{y}_v^*, X_v)\}$ where the subscript *V* is the number of village clusters and $\hat{y}_v^* = X_v'\hat{\beta} + \hat{u}_v^*$. Wald statistics are then estimated for the unrestricted, original sample and the pseudo-sample with the null hypothesis imposed. In our analysis, we calculate the wild bootstrap standard errors and present the p value of the hypothesis test that the coefficient is statistically different from zero using the wild bootstrapped standard errors. This test provides additional econometric evidence that the results are econometrically meaningful despite the small number of clusters in the sample.

[5] The wild bootstrap was developed by Wu (1986), Liu (1988) and Mammen (1993).

Data Description

In 1988, a small scale household survey was undertaken with 200 households in four rural villages near the town of Zaria, Kaduna State[6]. The data produced a rich set of information over the survey period on informal transactions, household welfare, and production activities, among other topics. In May 2008, a tracking survey was undertaken by the authors to determine whether it would be possible 20 years later to follow-up with some of the individuals that were originally surveyed. In combination with the many qualitative interviews that we held with village leaders and residents during the tracking survey, detailed information on the individuals from households previously surveyed in 1988-89 was collected to identify previously surveyed households and households that had divided to establish new households over the 20 year period. Roster data from the 1988 survey were used to confirm members of the household, ages and relationships between household members. Many of the survey respondents in 1988 remained in the village after marriage and formed new households. This is especially true for brothers who divided family assets after they were married. For the purposes of the tracking, one brother, usually the eldest, was classified as remaining resident in the household, while younger siblings formed their own households, if they remained in the village. Of the original households that could potentially be tracked, at least one member was resident in 169 households, or 84.5 percent over the 20 years. Village leaders and residents were willing participants in the tracking exercise. Many former respondents had kept certificates of appreciation or photographs from the previous survey team.

After the tracking exercise was completed, the survey design was undertaken and field work was scheduled to commence in November 2008, which corresponded closely to Round 7 of the original field work in 1988[7]. In addition to following closely the ordering, sequencing and phrasing of questions from the original survey, the field work was organized to replicate as closely as possible the careful interviewing strategy described in Udry (1990) whereby male enumerators interviewed the male head and female enumerators interviewed the female head in the household. An intensive field testing and enumerator training was conducted to assure uniform implementation of the questionnaire in the field. Households were re-interviewed if there was at least one individual from the original survey in a household. In total, 169

[6] This work was led by Christopher Udry who was hosted by Amadou Bello University in Zaria.

[7] The 1988 data is drawn from a nine round survey conducted over a one year period.

households of the 200 original households were tracked from the data set in 1988, and 407 household that split from these original households were tracked within the survey villages. Therefore, there are 576 households in the 2008 re-survey.

Table 1 presents evidence regarding the factors of attrition in the data set. Of the original households, 84.5 percent were found and re-surveyed in the follow-up 2008 survey. The attrition rate in the sample is within the bounds of attrition found in other panel surveys reviewed by Alderman et al., (2001). In analysing the factors that could predict attrition from the household's 1988 characteristics, we find few significant variables that predict attrition. Common sources of selection bias in other studies include wealth or household demographics[8], which may downwardly bias estimates. We include in the attrition regression explanatory variables including the age of the household head, the household head's occupation, household composition, land size among types of land (gona and fadama land[9]), number of livestock, value of livestock, and household assets. Among these variables, there is a negative correlation with the number of men in the household and attrition, while there is a positive correlation with the amount of fadama land owned in 1988 and attrition. While the positive correlation between fadama land and attrition may mean that wealthier households were more likely to attrite, none of the other asset variables (livestock, assets, gona land) confirm this hypothesis.

[8] Education levels are very low in this sample, so concerns about higher attrition rates among educated households are not relevant for this sample. We do include a variable that measures whether any household member has special skills that may be rewarded differentially in the labour market. In the estimates in Table 1, we find no effect of special skills on attrition.

[9] Gona land is highland and is generally considered less valuable than fadama land, which is defined as a lowland area that retains water throughout a longer period of the planting and growing season.

Table 1. Determinants of household attrition

Age of household head	-0.001
	(0.002)
Head has special skill	0.004
	(0.041)
Number of men	-0.060***
	(0.017)
Number of women	-0.033
	(0.039)
Number of household dependents	0.004
	(0.009)
Land size Gona (hectares)	-0.006
	(0.006)
Land size Fadama (hectares)	0.037*
	(0.019)
Number of livestock	0.0004
	(0.008)
Value of livestock (in 1,000 NGN)	0.001
	(0.012)
Value of household assets (in 1,000 NGN)	-0.001
	(0.007)
Observations	196

The number of observations is the 196 households from the 1988 data with complete information. Village fixed effects included. Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1

The tracking study provided not only useful information on attrition in the sample, but also the opportunity to undertake qualitative work in the villages and develop the household questionnaires. From these field visits, a detailed set of survey instruments was designed to replicate the interview structure used in 1988, in which a male and female respondent were asked to report on gender specific agriculture, assets, labour and credit activities among other topics. The primary difference between the 1988 and 2008 questionnaire design was the inclusion of retrospective questions about shocks and the collection of gender-disaggregated information on a similar set of assets used in 1988 (household capital, livestock and agricultural equipment). Differences in household assets do not vary due to the inclusion of additional categories in the 2008 questionnaire; as the list used in the 1988 questionnaire was relied on to ensure comparability. The field research included a set of qualitative interviews both during the tracking exercise, pre-testing and beginning of fieldwork, which informed the design of the household questionnaire. In addition to the qualitative interviews on village and household characteristics, a community questionnaire was administered to a group of village leaders to provide information on village infrastructure.

Udry (1990) provides his detailed observations on the survey villages compared with other anthropological work that had been conducted in the area by David Norman and co-authors (1972 and 1976). The predominant crops (maize, guinea corn and rice) cultivated by these rural, agricultural households remained similar to those cultivated in 1988, with the exception of tobacco, sorghum and cotton which are rarely grown in the villages. The timing of planting and harvest seasons in the villages has also remained invariant over time. Dry season farming is still prevalent in the survey villages and irrigation on household plots greatly expanded. Electricity is now found in three of the four villages through the use of motorized generators and electric lines, but well water is still the primary source of drinking water in three of the villages with the fourth having access to a hand pump. Households reported, as in 1988, that savings in the form of livestock, agricultural equipment and grains were their primary means of storing wealth, although village leaders also reported a higher prevalence of mutual savings or *adashi* groups in three of the four survey villages, as well as increased use of savings accounts in commercial banks.

Descriptive Statistics

Following much of the literature on poverty dynamics, we take a multidimensional approach to measuring asset dynamics as assets may differ with respect to liquidity and productive use. We define livestock and household capital in a count index for household capital and in Tropical Livestock Units (TLU) for livestock, as well as the value of these holdings. The items listed in the livestock TLU index are identical to the 1988 survey data. The household list of durables only differs by a few items that did not exist as a household durable in 1988 households such as DVD and videos, but that are a distinguishing feature of increased household wealth in 2008 that should be captured. In Table 2, we present descriptive statistics on household asset holdings and demographic characteristics between the 1988 and 2008 samples. Both livestock and household capital values are presented in real terms in Table 2.[10] Livestock value increased by NGN 39,406 in the 20 year period, which is a statistically significant difference at the 1 percent level. Land holdings among households did not vary significantly between the two survey rounds. Fadama land holdings did show a modest increase by 0.82 hectares, but this difference was not significant. Household capital, defined from a list of household durables and housewares, increased between the two survey rounds,

[10] Nominal 2008 values are deflated to generate real 2008 values based on the changes in the exchange rates (USD 1 = NGN 4 in 1988 to NGN 118 in 2008).

increasing by 1,975 real NGN which was also statistically significant. Household demographic characteristics, including the age of the household head and the number of wives in the household, did not differ among the two survey rounds, assuaging concerns that the sample may be biased by the aging of the full sample. However, the number of men included in the household decreased between 1988 and 2008 by 0.58 persons, while the number of dependents increased in the sample households by 1.87 dependents.

Table 2. Differences in household assets and demographics in 1988 and 2008

Variable	1988 Mean	2008 Mean	Difference in means
Livestock value	1,960	41,365	39,406***
Household capital value	1,113	3,088	1,975***
Gona land size	3.17	3.18	0.01
Fadama land size	0.44	1.26	0.82
Household head age	39.83	40.55	0.72
Household head primary school attendance	0.14	0.44	0.31***
Number of household wives	1.49	1.54	0.06
Number of household men	2.48	1.90	-0.58***
Number of household dependents	3.60	5.47	1.87***
Observations	200	576	

Statistitical significance between means is indicated by the following: *** p<0.01, ** p<0.05, * p<0.1. Nominal 2008 values are deflated to generate real 2008 values based on the changes in exchange rates (USD 1 = NGN 4 in 1988 to NGN 118 in 2008).

From both our qualitative work and the survey data, there appears to be an expansion of land (on the aggregate level) in these four villages, which may be related to the population pressures experienced resulting from growth over time. Although the change in average household land size varies across the four villages, the increase in total land cultivated is consistent across villages in 2008 on a scale of two to four times values from 1988 among those who own land. It should also be pointed out that while essentially 100 percent of households reported land ownership in 1988, this percentage is closer to 60 percent in 2008. The increase in reported landlessness in 2008, which is distributed across all four villages, likely reflects not only land constraints related to population growth, but also a shift from agricultural to non-farm activities for some households. It also represents a shift to more

intensive cultivation techniques as the amount of irrigated land in the villages has increased. Statistically significant differences are not observed in key household characteristics, such as head age, size, number of wives, education and so forth, when comparing the landless with landed groups in 2008.

There has been considerable change in both livestock and household capital over time, but more so for livestock. In Table 3, we present livestock holdings and value over time, disaggregated by gender in 2008. From 1988, the index of livestock holdings in TLU has grown noticeably for both men and women, indicating a sizeable increase across the two groups. In terms of livestock values, substantial growth is, once again, present for both men and women over the two decades. That being said, the value of men's livestock holdings is estimated to be roughly over 200 percent than that of women in 2008. The increase in both the number of livestock and especially the value of livestock appear to have disproportionately favoured the asset accumulation of men. This is because women who own livestock tend to own smaller animals such as poultry whereas men own larger draft animals.

Table 3. Livestock holdings and value in 1988 and 2008

	1988 Household Assets		**Male Assets in 2008 Households**		**Female Assets in 2008 Households**	
	Mean	*Std. Dev*	*Mean*	*Std Dev*	*Mean*	*Std Dev.*
Livestock Index (in TLU)	2.7	5.08	7.79	18.96	6.07	9.82
Livestock Value (in NGN)	1,960	4,005	27,889	56,849	13,476	30,130
Observations	169		576		576	

Nominal 2008 values are deflated to generate real 2008 values based on the changes in exchange rates (USD 1 = NGN 4 in 1988 to NGN 118 in 2008).

Further analysis of livestock changes are shown in Table 4, which illustrates the change in median values over time of the five most common types of livestock. Distinctions between nominal and real values in 2008 suggest that for some types of livestock, such as fowl, goats, sheep and donkeys, the real change has not been nearly as large when compared with cows and bulls. Given that cows and bulls are predominantly owned by males for use in field

ploughing (or as a means of saving), these descriptive statistics suggest that the overall increase in median livestock values over the 20 year period has been inequitably in favour of men. The extraordinary increase in cow and bull prices is not surprising, given the mounting population pressure and resulting demand for land that likely drove up the demand for bullocks to plough.

Table 4. Median value of livestock in NGN

	Median Nominal Value in 1988	Median Nominal Value in 2008	Median Real Value in 2008	Nominal Percentage Change	Real Percentage Change
Fowl	9	367	12	358	4
Goats	65	4,83	142	4,118	77
Sheep	100	6,000	203	5,900	103
Cows & Bulls	100	50,000	1,695	49,900	1,595
Donkeys	300	10,000	339	9,700	39

Nominal 2008 values are deflated to generate real 2008 values based on the changes in exchange rates (USD 1 = NGN 4 in 1988 to NGN 118 in 2008).

Because the resampling strategy included the tracking of all individuals who could be found in the 1988 survey villages from the original survey in their new households, we disaggregate differences in assets and household characteristics by original households from the 1988 survey and those that split off from the original households in Table 5. Asset stocks of livestock and household capital are uniformly smaller in households that split from original households. These differences are large for the value of livestock holdings (a difference of NGN 2,795), but smaller with respect to household capital (a difference of NGN 181). This seems to be primarily caused by lifecycle effects between the subsamples of original and split households as original households have older heads of household by 19 years. As households get older, assets may be drawn down or distributed as household members split from the household and take assets with them.

Descriptive statistics for gender differentiated asset holdings in 2008, including both livestock and household capital, are presented in Table 6. In addition to differences in mean asset levels by gender, the mean gender differentiated asset shares are also reported. Men have higher levels of livestock holdings by 14,413 naira which is statistically different between genders at the 5 percent level of significance. Women hold more household capital then men, but

differences in household capital holdings are lower than differences in livestock holdings. The difference between men's and women's household capital holdings is NGN 281.

Table 5. Differences in assets between split and original households in 2008

	Split		Original		Difference in means
Variable	*Mean*	*Std. Dev.*	*Mean*	*Std. Dev.*	
Total asset value	43,925	64,882	47,070	66,422	-3,145
Livestock Value	40,545	64,333	43,341	65,674	-2,795
Household capital value	3,035	3,537	3,216	4,428	-181
Land size Gona	2.46	11.03	4.93	21.38	-2.47*
Land size Fadama	1.37	15.03	0.99	3.13	0.37
Household head Age	35.04	10.57	53.80	16.25	-18.76***
Household head primary school attendance	0.54	0.50	0.21	0.41	0.33***
Number of household wives	1.44	1.00	1.78	1.09	-0.33***
Number of household men	1.58	1.10	2.68	1.65	-1.10***
Number of household dependents	5.02	3.86	6.53	4.13	-1.51***
Observations	407		169		

Nominal 2008 values are deflated to generate real 2008 values based on the changes in exchange rates (USD 1 = NGN 4 in 1988 to NGN 118 in 2008).

Table 6. Gender differentiated assets in 2008

Variable	**Male**	**Female**	**Difference in Means**
Livestock value	27,889	13,476	14,413**
	(56,849)	(30,130)	
Livestock asset share	0.522	0.478	0.045
Household capital value	1,685	1,403	281**
	(3,305)	(1,449)	

Household capital asset share	0.478	0.522	-0.045
Observations	576	576	

The large disparity in livestock and smaller gap in household capital holdings between men and women is important considering that livestock make up a greater share of asset holdings for men than women. Livestock makes up roughly 52 percent of male asset shares, while household capital only represents approximately 48 percent. On the other hand, livestock represent nearly 48 percent of female asset shares and household capital makes up approximately 52 percent. From our descriptive work, gender specific asset portfolios vary considerably and such differences likely play influential roles in determining asset dynamics over time. We examine the magnitude and significance of these differences in the next section.

Empirical Results

To address the question whether initial asset endowments affect gender differentiated asset accumulation inter-generationally, we estimate equations 1 and 2. Equation 1 describes the transformation of initial levels of household assets in 1988 into gender differentiated holdings in 2008, while equation 2 illustrates the growth of these assets in the natural log specification. The estimates are presented in Table 7 and 8. In the results using levels of assets, initial capital levels have statistically significant effects on men's and women's future household capital levels. However, the elasticity of initial household capital on future male holdings of capital is much larger than that for women (0.24 compared to 0.01). The estimated p values using the wild bootstrap standard errors indicate that the null hypothesis that the respective coefficients are statistically equal to zero can not be rejected. Neither the initial livestock holding point estimate is statistically significant when estimated with the clustered standard errors, but both livestock coefficients for men and women are greater than unity. In the male livestock regression, the coefficient of lagged household livestock holdings is statistically different than zero when the wild bootstrapped p values are estimated. When the subsample is restricted to original households to estimate equation 1, initial household capital has a statistically significant effect on men's household capital holdings in 2008 at the 10 percent level of significance. The magnitude of this coefficient is more than twice as large than in the full sample. The effects of initial livestock holdings in the original household subsample are

similar, but slightly greater, to those found in the full sample of households. In both the male and female livestock regressions, the lagged household livestock coefficient is statistically different from zero at the 5 percent level of significance.

Table 7. Regression results: lagged endowment – levels

Sample restriction	**Full sample**				**Original Households only**			
Variables	*Household capital 2008*		*Livestock 2008*		*Household capital 2008*		*Livestock 2008*	
	Male	Female	Male	Female	Male	Female	Male	Female
Household Capital Value 1988	0.235	0.011			0.588	-0.019		
	(7.405) ***	(0.291)			(2.428)*	(1.671)		
	[0.123]	[0.829]			[0.367]	[0.695]		
Livestock Value 1988			3.395	1.667			4.844	1.689
			(1.865)	(2.262)			(1.443)	(2.112)
			[0.981]**	[0.827]			[0.981] **	[0.961]**
Observations	558	558	558	558	162	162	162	162
R-squared	0.114	0.051	0.116	0.097	0.468	0.151	0.219	0.128

Village fixed effects included. Household characteristics included are household head age, a household head schooling dummy, land holdings and household composition variables including the number of wives of the head, the number of men, women and dependents. Robust standard errors in parentheses. P values of the wild bootstrapped hypothesis test that the coefficient is statistically different than zero in brackets. *** p<0.01, ** p<0.05, * p<0.1.

In Table 8, the results of equation 2 are reported using natural logs of asset values. These coefficients are interpreted as the elasticity of the gendered asset stock with respect to the initial asset stock. Men's and women's household capital elasticities are similar and negative, suggesting convergence towards a steady state asset level. Livestock elasticities are much larger for men than for women; implying that initial assets spur faster capital accumulation for men, but not for women. In the restricted subsample of original households from 1988, the asset elasticities have a distinctly different pattern. Men's elasticities are positive for both household capital and livestock whereas women's elasticities are negative for household capital and slightly positive and statistically different than zero. This suggests that as households age, women's assets deteriorate at increasing rates relative to men's in both their level and share of capital, and increase at a much smaller rate in comparison to men's with respect to their livestock holdings. The clustered standard error estimates do not indicate statistical significance of these results from the log specification except for the male livestock regression in the original subsample of households. The p values of the wild bootstrapped hypothesis tests indicate that all the livestock coefficients estimated are statistically different than zero.

Gender differentiated asset dynamics translate into greater asset inequality in addition to gendered differences in asset levels and growth rates. This is confirmed in Table 9 (equation 3) where the effect of initial asset endowments on the female share of assets is uniformly negative for the full sample and the subsample of originally surveyed households. The point estimates for household capital are similar in both subsamples, but the effects of initial livestock holdings on female livestock inequality are large and negative in the subsample of originally surveyed households. This suggests that as households age within this sample, greater household inequality of livestock holdings results. Though these coefficients are consistently negative across the set of regressions in Table 9, none are statistically significant, so these results should be interpreted as indicative, but not conclusive proof of these trends.

Table 8. Regression results: lagged endowments – logs

Sample restriction	**Full sample**				**Original households only**			
Variables	*Household capital 2008*		*Livestock 2008*		*Household capital 2008*		*Livestock 2008*	
	Male	Female	Male	Female	Male	Female	Male	Female
Household capital value 1988	-0.009	-0.023			0.029	-0.019		
	(0.564)	(1.191)			(0.526)	(0.388)		
	[0.872]	[0.841]			[0.957]*	[0.847]		
Livestock value 1988			0.149	0.037			0.477	0.042
			(2.255)	(0.472)			(2.659)*	(0.226)
			[0.925]*	[0.951]*			[0.901]*	[0.949]*
Observations	558	558	558	558	162	162	162	162
R-squared	0.045	0.035	0.141	0.060	0.105	0.099	0.246	0.064

Village fixed effects included. Household characteristics included are the log of household head age, a household head schooling dummy, land holdings, and household composition variables including the number of wives of the head, the number of men, women and dependents. Robust standard errors in parentheses. P values of the wild bootstrapped hypothesis test that the coefficient is statistically different than zero in brackets. *** p<0.01, ** p<0.05, * p<0.1.

Table 9. Regression results: women's asset shares – logs

Sample restriction	**Full sample**		**Original households only**	
Variables (x 100):	*Female capital share in 2008*	*Female livestock share in 2008*	*Female capital share in 2008*	*Female livestock share in 2008*
Household Capital Value 1988	-0.34		-0.31	
	(2.242)		(0.521)	
	[0.428]		[0.831]	
Livestock Value 1988		-0.47		-1.26
		(0.843)		(1.488)
		[0.899]		[0.705]
Observations	558	558	162	162
R-squared	0.0615	0.0443	0.144	0.0804

Village fixed effects included. Household characteristics included are household head age, a household head schooling dummy, land holdings, and household composition variables including the number of wives of the head, the number of men, women and dependents. Robust standard errors in parentheses. P values of the wild bootstrapped hypothesis test that the coefficient is statistically different than zero in brackets*** p<0.01, ** p<0.05, * p<0.1

Conclusion

After reviewing the literature on poverty dynamics, we provide new evidence about gender differentiated asset dynamics in Northern Nigeria. Over a twenty year period, we show (Table 8) that the impact of initial livestock holdings is a much larger determinant of future accumulation for men than for women. These initial asset stocks favour an increasing men's share of capital and livestock holdings within the household. It is not only that women's livestock levels are lower than men's, but this inequality also tends to be reinforced over long time horizons. While women's household capital is larger than men's in our sample, household capital also deteriorates more quickly for women in older households (Table 8).

Deteriorations in women's livestock holdings may be driven by several factors including differential access to livestock markets, agricultural knowledge and extension, or the liquidation of larger shares of assets when households respond to shocks. These results suggest that targeting of social protection and agricultural

extension programs, especially for elderly women in agricultural households, is important to increase and protect the assets of women. These types of interventions in rural agricultural households can have a large impact on moving households out of poverty and achieving international targets for poverty reduction.

The results from the levels, logs and asset shares specifications suggest gender differentiated asset dynamics over generations. The mechanisms through which gender asset inequality is reinforced over generations may differ depending on the economic environment. Combining both our qualitative and quantitative analysis, increased growth of population among the survey villages has increased the value of land and intensified cultivation within the villages. This increased demand for land caused some households to move out of agriculture, as evidenced by the larger share of households reporting no land holdings in the 2008 survey, but also increased demand for draft animals as an input into the agricultural production process. As the survey villages remain primarily rural agricultural villages, even after 20 years, changes in the labour markets have been moderate, especially as men continue to work in some secondary agricultural wage labour jobs during planting or harvest season, but these jobs are restricted for women. Therefore, the mechanism through which gender asset inequality was reinforced intra-generationally has been through changes in the relative prices of men's and women's assets. From a policy perspective, increasing access for women to a diversified asset portfolio is a critical component of rural poverty alleviation, so that women as well as men may share in the returns to assets. If women are able to capture the gains of asset price increases over time, their ability to liquidate assets in response to shocks could greatly improve rural welfare.

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