Geography of Gender Gaps: Regional patterns of income and farm nonfarm interaction among male- and female-headed households in eight African countries

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ABSTRACT

Many studies stress the existence of gender based income gaps across African production systems. Contextualizing such gaps in relation to regional characteristics, production systems and nonfarm linkages challenges this. Household level data from 21 regions across eight African countries, collected in 2002 and 2008, is used to analyse production dynamics, market participation and nonfarm linkages. Gender gaps are absent in seventeen of the regions regardless of the overall regional income level. The results suggest that neither poverty nor growth in general discriminate against female headed households, but that causes of gender discrimination need to be found in specific regional contexts.

Keywords: Sub-Saharan Africa, gender gaps, nonfarm linkages, regional perspectives

1. INTRODUCTION

Since the signing of the Maputo Declaration in 2003, small-scale agriculture has increasingly been viewed as the key to broad-based development and poverty reduction in sub-Saharan Africa. Recent productivity increases, although unevenly distributed have also in some respects redirected the African research agenda towards drawing lessons from dynamic processes (Andersson Djurfeldt & Djurfeldt, forthcoming 2013; Binswanger-Mkhize, McCalla, & Patel, 2010; Haggblade & Hazell, 2010). Although political ambitions as well as empirical tendencies point to the potential smallholder basis of agrarian growth the gendered aspects of agriculture-based development often remain poorly understood, whether in dynamic or less dynamic contexts. Yet some gendered assumptions have emerged as received wisdom in relation to the process of smallholder based growth (Jackson, 2007; O'Laughlin, 2007). One generalization is the stubborn persistence of gender based resource and income gaps that cut across African production systems and favor male headed households over their female headed counterparts. Such gaps translate into lower productivity and income levels on female headed farm units and also serve as explanations for relatively slow productivity increases and persistent income poverty in the African smallholder sector as a whole (FAO, 2011; IFAD, 2011; Quisumbing & Pandolfelli, 2010; World Bank, FAO, & IFAD, 2009). Both growth and poverty dynamics discriminate against female headed households who in their role as "the poorest of the poor" often serve as a proxy for the most vulnerable households (see Chant, 2007 for a discussion). Accumulation among wealthier households is perceived to occur at the expense of weaker ones (see Bernstein, 2004; Bryceson, 1999; Havnevik et al., 2007) through polarization processes where female headed households are considered among the most vulnerable groups.

Equity as well as efficiency based considerations suggest that resource inequalities between men and women farmers need to be addressed as a key component of pro-poor agricultural

growth. Nonetheless, the indiscriminate existence of a gender gap that favors men over women has been questioned earlier (Appleton, 1996; Quisumbing et al., 2001). This paper adds to this literature through contextualizing and problematizing inter-household income differences in relation to *regional characteristics* as well as linkages to the nonfarm sector. Placing gendered income gaps in regional perspective may provide a more nuanced analysis of gender based income differences in rural Africa, both within and outside agriculture.

Methodologically the article uses a social science based geographical approach in analysing quantitative data from 3412 smallholder households (cross-sectional sample in 2008) in 21 regions across eight African countries – Ethiopia, Ghana, Kenya, Malawi, Mozambique, Nigeria, Tanzania and Zambia. The existence and evolution of gendered production dynamics, market linkages and nonfarm linkages are analyzed on the basis of panel data collected in 2002 and 2008, to consider three key questions: Firstly, can differences in income among male and female headed households be said to exist – i. e. are there gender gaps in income, whether at national or regional level? Secondly, can these gaps be traced to household level or regional characteristics commonly associated with differences in income and productivity found in the literature? And thirdly, conversely, how can the possible lack of gender based differences in income be understood, again in the context of these characteristics.

2. THEORETICAL PERSPECTIVES

The aggregate existence of a gender gap is well documented: only 15 per cent of landholdings in sub-Saharan Africa are held by households headed by women, and their average sizes are smaller than those held by men (FAO, 2011).

(a) The received wisdom – agriculture based gender gaps

A wealth of literature establishes the differences between female and male headed smallholder households with respect to access to key productive assets such as land, labor, technology, credit and extension services (Doss & Morris, 2001; Doss, 2001; Meinzen-Dick et al., 2010; Quisumbing & Pandolfelli, 2010).

The use of land is moreover constrained by lack of labor either in absolute terms or seasonally (Takane, 2008). Lower levels of input use – whether as fertilizers, improved cultivars, labor or draught power - among women have been shown to affect yields negatively in a number of African countries (Alene et al., 2008; Doss & Morris, 2001; Horrell & Krishnan, 2009; Kumase et al., 2008; Tiruneh et al., 2001; Udry, Hoddinott, Alderman, & Haddad, 1995). The lower productivity of female headed households is connected to the use of lower levels of inputs, rather than poorer farming skills (FAO, 2011). Extension systems that cater primarily to men farmers or to women farmers in male headed households fail to redress these productivity gaps.

The consequences of such differences are aggravated by demographic, social and environmental factors. For instance, higher dependency ratios among female headed households may result in losses in productivity. Also, their constant use of land in the face of insecure tenure rights and lacking protective social networks undermines soil fertility, lowering yields further (Goldstein & Udry, 2008). Market access may be constrained by cultural and economic factors inhibiting women from using public transport or leaving their homesteads to reach markets. Reproductive responsibilities may also restrict the time available for marketing (Quisumbing & Pandolfelli, 2010).

Historical as well as more recent studies have shown how commercialization of previously subsistence oriented production leads to increased male control of female labor within male headed households as well as gender based segmentation of markets more generally (Moore & Vaughan, 1994; Udry, 1996; World Bank et al., 2009). While these findings document general gender based inequality in relation to productive assets, institutions and commercial opportunities, a consideration of regional production contexts and nonfarm linkages may frame the understanding of such inequality further.

(b) Placing gender productivity differentials in regional production contexts

Placing differential access to resources and markets in relation to gendered production systems and regional dynamics is necessary to contextualize the existence as well as the nature of gender gaps. In this regard, inspiration can be drawn from Wiggins' (2000) review of village studies of African farming systems which shows how pockets of intensified production are obscured by macro level averages that hide regional variation in production systems. Detailed anthropological and historical studies also document regional variation in gender based stratification of production systems both between female and male headed households as well as within households (see Moore & Vaughan, 1994). Gendered patterns of cultivation and marketing provide pointers to the nature and cause of gender gaps in productivity, while studies of a particular crop may neglect gendered production and commercialization dynamics in smallholder systems based on multiple crops or mixed farming.

(c) Placing gendered productivity differentials in relation to nonfarm linkages

Although rural livelihoods in Africa are still predominantly based on agriculture, the realization that nonfarm sources of income (such as petty trading, sale of crafts or provision of various services) provide important complements to agrarian income is increasingly

placing agriculture in wider livelihood contexts (IFAD, 2011). The study of regional production systems therefore needs to be complemented also with perspectives that consider the interaction between the farm and nonfarm sectors. Here the distributional consequences of such linkages at the regional level are tied to differences in the initial distribution of assets and the nature of the resource base. The distinction between push and pull scenarios is in this sense a key aspect of farm nonfarm interaction not only for households but also regionally (Hazell et al., 2007). While the literature on rural income diversification generally shows the segmentation of nonfarm activities into low return - low entry activities on the one hand, and high return - high entry activities on the other, partly on gendered grounds (see Barrett & al., 2001; Lay & Mahmoud, 2008; Marenya, et al., 2003; Reardon et al., 2007) the interplay between regional (agrarian) production systems and nonfarm incomes are less studied. Gender aspects can in this context add important qualifiers to farm - nonfarm interactions and their connection to regionally gendered production systems.

3. METHODOLOGICAL APPROACHES

Most studies of gendered productivity differences use detailed individual level data (see Udry, 1996 for instance). While these point to often localized gendered production patterns and the importance of recognizing these, not the least in policy terms (Quisumbing & Pandolfelli, 2010), the multitude of methods, time- and sampling frames used in such studies hamper comparability across both regional and country settings (Quisumbing et al., 2001). The following study by contrast uses data from 21 regions in eight African countries. Using the perspectives outlined above, we aim to situate, explain and in some cases refute the existence of gender gaps.

Household level data from eight African countries collected in 2002 and 2008, respectively, are used to research inter-household gender gaps at the regional level using both cross-

sectional as well as panel level data. Although we are aware that the two terms are not synonymous the words female headed households and women are used interchangeably in the text to describe the situation of households headed by women.

In addition to quantitative data we draw indirectly on information gathered through a range of qualitative interviews carried out in Kenya (Andersson Djurfeldt, 2012; Andersson Djurfeldt & Wambugu, 2011), Malawi (Andersson, 2011), Ghana and Zambia, in interpreting patterns found in the quantitative data, although the interview results in themselves are not discussed in detail.

(a) Sampling criteria and data structure

The first round of quantitative data was collected in 2002 as part of a comparative project taking the Asian Green Revolution as its starting point (Djurfeldt et al., 2005). The focus was on the potential for intensified production, technology use and marketing of staple crops (grains, roots and tubers), with the major grain crops (maize, sorghum, rice, teff and wheat) being studied in most detail. Qualitative village level data was collected to supplement the survey data. A second round of this project was carried out in late 2007 and early 2008, when the households were resurveyed. Again, the primary purpose of the survey was to analyze the drivers of smallholder staple crop production in the villages in question (Djurfeldt et al., 2011a).

Sampling followed a multi stage purposive design. Eight countries in the African maize and cassava belt were sampled: Ethiopia, Ghana, Kenya, Malawi, Mozambique, Nigeria, Tanzania and Zambia.[1] Regions within countries were purposively sampled in areas that were deemed to be above the average in terms of agro-ecological conditions and market access, but excluding the most vibrant local rural economies, since these were considered outliers with respect to intensification potential in staple crops specifically. Sites within

countries were sampled to provide variety in terms of agricultural and economic dynamism. A purposive sample of dynamic and less dynamic regions was taken in each country and a number of villages were purposively sampled in each region, depending on the agronomic variability found within the country in question.

The regional sampling criteria in practice deviated in the case of Ethiopia and Malawi, however where four regions were sampled on the basis of the main staple crop grown in each region. A similar strategy was followed in Mozambique and Nigeria where a distinction was made on the basis of the differences in agrarian structure between different parts of the countries. Nonetheless the differences in income are sizeable among the regions also in these cases, with the sample in practice emulating the original criteria. The regional sample has been divided on the basis of average *cash* income per consumption unit for 2008: regions that had higher average cash incomes per consumption unit[2] than the national average of the sample have been designated "rich" and those below "poor".

Given the multi-dimensional nature of poverty, it is important to note that studying differences in income levels only captures one dimension of deprivation. More multifaceted studies of poverty are not possible in the context of our dataset, however although clearly relevant to an understanding of gendered patterns of deprivation, vulnerability and wellbeing.

While using *total* household income (including the value of produce used for own consumption) as income measure has advantages when studying households who are partially self-subsistent, it also has drawbacks related to general as well as gender specific problems of measuring income in developing country settings (Dwyer & Bruce, 1988). Converting retained production of grains into income discriminates against produce that is difficult to measure because of intermittent harvesting, such as cassava, vegetables and fruits – crops which are often grown by women. Including retained production in measures of income may

for this reason underestimate income especially among women in settings where grain cropping is dominated by men. Despite its drawbacks, cash income, which includes cash income from both farm and nonfarm sources, is therefore used as a more neutral measure of income in the article.

Table 1 contains a list of the regions covered by the sample.

TABLE 1 HERE

In each village farm households were sampled randomly with the sample being representative at this level. The use of the household as a unit for data collection is in some respects problematic presuming that decision making and control of resources is made on household basis (Chant, 1997; Guyer, 1981; Udry, 1996). Nonetheless, for comparative reasons, it is necessary to use the same unit of measurement, while collecting data on intra household differentiation among such a large number of households was not feasible due to financial and time constraints and possibilities of respondent fatigue. For these reasons the household, as defined by residence, has been used as the data collection unit, with interviews carried out with the farm manager, who is defined as the household head. Respondents themselves identified who was the farm manager. Female headed households therefore include both the de jure and de facto categories, whereas male headed households were headed by a resident adult man.[3]

Although using household headship as the starting point for gender analyses is problematic in relation to capturing the situation of women farmers in male headed households, the study of intra household gender gaps is beyond the scope of this paper. An additional advantage of the present approach is that it enables comparing both countries and regions.[4]

Data structure, availability and quality also provide restrictions on the types of analyses that can be carried out. Given the initial interest in intensification, the first survey questionnaire of 2002 prioritized reliability and focused on demographic characteristics, production volumes, agricultural techniques and crop patterns rather than prices and incomes. Data related to the institutional environment for technology adoption was also a crucial component of the first round of data collection. In the follow up survey (2008) more detailed data on prices, marketing and incomes were added. One of the most important limitations in the dataset therefore is the lack of detailed cash income data for 2002: although household participation in various types of farm and nonfarm activities is available, data on cash incomes raised from these activities was not collected until 2008. Moreover, production, price and marketing data is only available for the grain crops but not for tuberous staples.

(b) Measuring and analyzing gender gaps

As a starting point it is necessary to note that while the literature - perhaps especially policy related writing - using the concept of gender gaps is vast (United Nations, 2012; World Bank, 2011) the definition of the term varies. Traditionally developed within the field of comparative international labor economics it denotes differences in average daily or hourly male and female wages specifically (see Hertz et al., 2009; Ñopo et al. 2011). In practice its use varies, however with many studies using it to describe a general discrepancy in relation to resources, incomes, assets and social development indicators on the basis of gender, measured most commonly as income levels or participation rates (in education, labor markets and health care for example). In relation to agriculture and rural development specifically it has been defined by the FAO (2011) "as the difference between average daily male and female wages as a percentage of the average male wage. A positive wage gap means men are paid more than women. The rural wage gap includes farm and non-farm employment (p. 20)".

In the context of the following paper we use the concept of the gender gap as the difference between average household cash income per consumption unit between male and female headed households, by country and by region. The gender gap therefore does not describe the individual income gap between men and women, since it is not possible to calculate the incomes of individual household members (who may have a different sex than the head of household) given the structure of our data. Dividing household cash income by the number of consumption units in each household does however control for differences in the age composition and size of households and tells us whether the mean income of household members varies on the basis of the sex of head of household.

A positive gender gap means that male headed households on average have higher cash incomes per consumption unit than do female headed ones, whereas a negative one suggests higher cash incomes per consumption unit for female headed households. The size of the gap is calculated by taking female income in each country and region as a share of male income (hence assuming that male income is the norm), and then subtracting this from one, to give a fraction that indicates how much lower income per consumption unit is in female headed households relative to male headed households.

Since cash income data is only available for 2008 cross-sectional data are used to create derived means and gender gaps for cash income per consumption unit at the regional level. Small village level samples prevent the use of household data for quantitative analysis at the village level, since the number of female headed household generally is too small to enable statistical tests of differences in income.

Methodologically the analysis draws on two key approaches: (i) cross-sectional data are used to compare size and composition of cash income by gender of household head and (ii) a log-log multi-level mixed model is used to assess the factors accounting for variance in income.

Cross-sectional data are used to compare cash income and composition by gender of household head, nationally and regionally, while relating these patterns to gendered access to productive resources, technology and markets. The cross-sectional samples for 2002 and 2008 consists of two parts respectively: (1) the 2002 sample contains both (i) panel households, i.e. households re-interviewed in 2008 and (ii) attrition, i.e. households not re-interviewed (see Djurfeldt et al., 2011b for an analysis of attrition); (2) the 2008 sample similarly consists of (i) panel households and (ii) newly sampled households, drawn to retain representativity and a balanced panel design. When comparing means for the cross-sections, we have chosen to regard cross-sectional data as drawn from independent samples, although this does not hold for the panel households. This procedure underestimates the standard errors for comparisons between cross-sections, but not for comparisons between gender and region *within* cross-sections, which is the main method used below. Comparison between cross-sections implies an increased risk for false positives, which should be kept in mind in the instances below when we make such comparisons. Only statistically significant results are presented and discussed in the analysis.

To capture possible gender based differences in income patterns and the factors accounting for such patterns at the regional level, a log-log multi-level mixed model is used to model determinants of cash income per consumption unit for female and male headed households respectively as well as for rich and poor regions. The details of the model follow below.

(c) Model description

A log-log multi-level mixed model is used to model cash income per consumption unit. Using a multi-level model enables us to consider regional aspects related to differences in incomes as well as decompose variance in relation to country, region and household levels. The model specifications are as follows:

$$y_{ijk} \sim N(XB, \Omega)$$

$$y_{ijk} = \beta_{0ijk} x_0 + XB$$

$$\beta_{0ijk} = \beta_0 + v_{0k} + u_{0jk} + e_{0ijk}$$

$$[v_{0k}] \sim N(0, \Omega_v): \Omega_v = [\sigma_v^2]$$

$$[u_{0jk}] \sim N(0, \Omega_u): \Omega_u = [\sigma_u^2]$$

$$[e_{0ijk}] \sim N(\Omega_e): \Omega_e = [\sigma_e^2]$$

Where the dependent variable:

y_{iik} =*Cash* income per consumption unit 2008, PPP USD, logged. We model the cash income of all panel households together as well separately for male headed and female headed households, to account for any gender based differences in levels of income. A similar approach is used in modeling the influence of type of region on income.

The subscripts, *i,j,k* denote the three data levels: household (*i*), region (*j*) and country (*k*). The link function $\sim N$ is a simple equality.

The regression is a mixed model where the dependent variable is defined as a function of a vector of independent *fixed* effects (X) and an intercept $(\beta_{0iik}\, x_0)$ defined as the sum of a fixed effect (β_0), and three random effects: the individual (e_{0iik}), the regional (u_{0jk}) and country (v_{0k}) level residual or intercept. The intercepts are defined as normally distributed with zero means and variance Ω_v, Ω_u and Ω_e respectively. The latter are estimated by the sample variances σ_u^2, σ_v^2 and σ_e^2.

The vector of independent variables (*X*) contains a number of household level variables and one regional level variable (standardized gender gaps). The *X* variables are defined and listed below in connection with the results discussion. They are either logged ratio scales or dummies, except the gender gaps which is a standardized variable (m=0; s=1). In order to

simplify causal attribution and since we have panel data[5] where possible the independent variables refer either to a previous point in time (2002) or to a preceding period (2002 to 2008).

The models were fitted with the MLWin package (Rasbash et al., 2010) using a two-step procedure, first Iterative Generalized Likelihood (IGLS) estimation to arrive at a set of priors used in a subsequent Bayesian Markov Chain Monte Carlo (MCMC) estimation.

4. EMPIRICAL POINTS OF DEPARTURE – FROM THE NATIONAL TO THE REGIONAL

At the country level a number of differences as well as similarities can be noted with respect to the share of female headed households and access to particular sources of income (see Table 2). While the share of female headed households varies from only ten per cent in Nigeria to as much as 43 per cent in Malawi,[6] the share of households who have access to cash income does not differ on the basis of sex of head of household, with the exception of Mozambique. Turning to the types of cash income, more gender based differences emerge however: in Ghana, Malawi, Mozambique and Zambia female headed households have lower access to farm based cash income. In Zambia and Malawi male headed households are relatively speaking excluded from the nonfarm sector, however when compared with their female headed counterparts.

TABLE 2 HERE

To some extent these patterns are repeated also in relation to the relative size of incomes from particular sources. There are no statistically significant differences between male and female headed households at the national level in terms of cash income per consumption unit (see table 3). Distinguishing income further as farm and nonfarm income provides clues to the lack of gender gaps for cash income, however. As suggested by table 3, to the extent that gender based income gaps discriminate women, they are found in relation to farm incomes, rather than nonfarm incomes. Even here, however the picture is mixed: the income gap in favor of men in relation to cash income gained from farm sources is statistically significant for four countries: Ethiopia, Tanzania, Zambia and Malawi. In Tanzania, with the widest gap, female headed households would need to more than double their farm based cash income per consumption unit to reach the same level as their male headed counterparts. This suggests that in these countries commercialization in agriculture favors male headed households. By contrast there are no statistically significant gender gaps in nonfarm cash incomes at the country level.

TABLE 3 HERE

(a) Regional dynamics

Breaking down these figures by region type (poor or rich) brings forth the need for further disaggregation, however (Table 4). The *poor regions* have strongly significant gender based differences in cash incomes. The importance of the farm sector as a determinant of these differences is evident in these regions (in contrast to the rich regions where there are no gender based differences in farm incomes), suggesting that discrimination against female headed households in smallholder based agrarian systems differs geographically. In this sense, commercialization in agriculture benefits men rather than women in the poor regions.

Although women in the poor regions have access to nonfarm incomes to a larger degree than their male counterparts, the size of such incomes do not differ and nonfarm incomes therefore are not used to compensate for lower farm based incomes.

TABLE 4 HERE

In the *rich regions* by contrast there are no gender based income gaps, except in relation to access to nonfarm incomes, where the share of households who had access to such incomes is biased towards women. Although gender based differences in the *size* of nonfarm incomes are not statistically significant, it appears that the complementary role of nonfarm incomes for women, alongside more equal commercial opportunities in the farm sector, levels differences between male and female headed households in relation to total cash income. This is suggested by the lack of statistical significance for the differences in cash income among men and women.

In some respects higher nonfarm incomes among women in rich regions (when compared with poor regions) may be related to stronger purchasing power among both female and male headed households. In turn this suggests consumption patterns that may be geared towards more remunerative female nonfarm niches such as alcohol production and trade of consumer items as well as stronger linkages to the formal economy also among members of female headed households. Overall, the patterns point to a lack of discrimination against women in the nonfarm economy in both poor and rich regions, although women in the poor regions are likely to be driven into nonfarm activities by their relatively weaker footholds in local agrarian economies. Thus there seems to be a pattern of pull driven income diversification among members of female headed households in the rich regions while push based processes appear more likely in the poor regions (cf. Hazell et al., 2007).

These differences point to two key aspects of income generation that deserve attention in relation to gender: firstly, they suggest that patterns of income generation (and especially the role of nonfarm incomes) are affected by regional structures and secondly that income patterns are different between female and male headed households irrespective of regional characteristics. As suggested above, the role of nonfarm income distinguishes female and male income structures, although the underlying push and pull dynamics of earning nonfarm income may vary by region. To discuss the first issue (the regional structures of income generation) cross-sectional data will be used to consider gendered income patterns and their connection with differential access to resources at the regional level (section 5). The factors analyzed in this respect are resources normally associated with gender based disparities in the literature: labor, land, technology and market access. Methodologically this analysis constitutes the descriptive frame for treating the second question: whether patterns of income generation differ among male and female headed households.

With respect to this second point the ambition is to broaden the gender analysis from a focus on production dynamics *within* agriculture commonly found in the literature to include income generation within both the farm and the nonfarm sector. To this end a log-log multi-level model of cash income per consumption unit for male and female headed households respectively will be used to test whether the determinants of income generation differ by gender. Using a multivariate approach enables us to more adequately asses the contribution of different factors to levels of income than allowed by cruder treatment of cross-sectional data on the basis of bivariate correlations and analysis of variance of means. Modeling regional gender dynamics (splitting the sample on the basis of both region type as well as sex of head of households) is not possible, however since the sub-samples become too small to handle statistically and the cross-sectional analysis therefore constitutes a necessary complement to

assess the interplay between regional and gender based dynamics. The results from the model are presented in Section 6.

5. REGIONAL DYNAMICS

Analysis of variance for mean cash income per consumption unit for male headed and female headed households at the regional level shows the existence of statistically significant differences in income (whether cash income as a whole, farm based or nonfarm based) in only four regions: Yetmen (Ethiopia), Thiwi Lifidzi (Malawi), Kilombero (Tanzania) and Mkushi (Zambia). Hence the country-level gender gaps reported in Table 2, are closely related to one particular region in each country. All of these regions are defined as poor and gender gaps are tied to differences in farm based cash income for all of them. Two have general income gaps in cash income (as well as farm based cash income), whereas two (Kilombero and Thiwi Lifidzi) have gender gaps only in farm based cash income. On the basis of this distinction, the sample can be divided into three sub-samples: (i) Rich regions (where there are no statistically significant gender based income differences) (ii) Poor regions, *with* significant gender based income differences and finally (iii) Poor regions *without* such differences.

The analysis below looks at a set of factors commonly identified as critical to gender based disparities in income and compares household level changes in *the cross-sections* (i.e. not the panel) for female and male headed households in the three different sub-samples between 2002 and 2008.

(a) Rich regions (without gender gaps)

Rich regions reflect some of the expected gender based differences discussed in the literature but as shown by table 5 also suggests the need for qualification. Perhaps most importantly,

female headed households are much smaller than male headed households (they contain fewer consumption units in both 2002 and 2008). With respect to land, differences in cultivated area between female- and male headed households are remarkable and highly statistically significant. Importantly, however, while the absolute number of labor units is lower in the female headed households, the number of labor units in relation to cultivated area is much higher in the female headed households in both 2002 and 2008 (1.10 units per hectare compared with 1.48 units in 2008), suggesting that female headed households compensate for smaller cultivated areas through additional labor.[7] There are no differences in intensification tied to technology use (irrigation and fertilizer use) among men and women, however.

Rather discrimination appears to be related to institutional aspects such as access to land and to extension services. Despite generally improved access to extension since 2002, such improvements are biased towards male headed households: although gender based difference in access to extension is lowest in the rich regions when compared with the other two region types, women still had significantly lower access to extension than men in 2008.

In terms of commercialization, the pattern has shifted somewhat since 2002, with some tendencies being reproduced in 2008 while others have disappeared. Although both male and female headed households have increased their participation in markets for grains, gender based differences, although shrinking, persisted in 2008. Meanwhile, female entry into markets for other food crops and non-grain staples, has leveled differences between male and female market participation, with such differences being much smaller (and statistically significant only for non-grain staples) in 2008.

Entering these markets appears to be related to the withdrawal from the markets for non-food cash crops among both men and women in these regions, although male headed households

still engage in cash crop markets to a larger degree than female headed ones. A slight withdrawal has occurred also from markets for animal products, although this is more pronounced for men, for whom the difference is statistically significant over time, unlike for women.

Finally, as suggested earlier, female headed households participate in the nonfarm sector to a larger extent than male headed households, although again a withdrawal has occurred both for men and for women since 2002, possibly prompted by better earning opportunities within agriculture, and perhaps especially the grains and other food crops sectors. The explanation for a lack of gender gaps in income per consumption unit in the rich regions therefore appears to revolve around three main factors: smaller female headed households with a higher share of farm labor relative to cultivated area (mirroring more labor intensive land use), improved commercial opportunities in other food crops especially and finally female engagement in the nonfarm sector.[8]

TABLE 5 HERE

(b)Poor regions with gender gaps

Like in the rich regions, households in the poor regions with gender gaps have generally speaking small cultivated areas (see Table 6). Cultivated area among female headed households was on the average 0.37 hectares smaller than among male smallholders in 2002, a difference that had increased to 0.58 hectares in 2008. On the whole though, as in the rich regions, sizes of cultivated area have decreased for both household categories. Nonetheless also in these regions, female headed households are smaller than male headed ones.

The use of inorganic fertilizer on grains, at least when measured by the simple criterion of share of fertilizer users increased significantly among both male and female headed households during the period, but in favor of male headed households, suggested by a

statistically significant difference of 13 per cent in fertilizer use in 2008. Male headed households increased their fertilizer use quite radically with 65 per cent of the households using fertilizer in 2008.

Generally the rich regions are characterized by the engagement in a multitude of complementary markets, while poor regions with gender gaps in income are characterized by generally lower market participation both for female and male headed households. Although market participation in grains has increased among both female and male headed households in these poor regions, market participation is strongly skewed towards men.

TABLE 6 HERE

In the poor regions with gender gaps the drop in market participation in non-food cash crops has been compensated for through rapid entry into sale of animal products. Interestingly, while male headed households' participation in the nonfarm sector was stable in 2002 and 2008, female headed households increased their participation remarkably (by 14 per cent). In conjunction with an increase in land size differences between male and female headed households such patterns are suggestive of gender based agrarian polarization. To the extent that grain prices and prices of non-grain staples have increased since 2002 and improved commercial incentives for smallholder farmers also in the poor regions, these have disproportionately benefited male headed households. The discrimination against women in these poor regions lies in the combination of smaller cultivated areas and lack of labor with limited market participation.

(b)Poor regions without gender gaps

Patterns of gender based inequality in poor regions without gender gaps in cash income per consumption unit point in diverging directions (see Table 7). At first glance, however it may seem surprising that these regions are not characterized by income gaps, given very unequal

access to technology and commercial opportunities between male and female headed households.

The discrimination against women in terms of total cultivated area is evident also in poor regions without gender based income differences. Cultivated area has however not significantly declined for women but slightly so for men, so that the difference between the two household types is smaller in 2008 than in 2002. A decline in family labor has affected both genders about equally: both household types have lost more than half a unit of labor.

TABLE 7 HERE

In general differential access to technology has increased between men and women between 2002 and 2008 (with the exception of irrigation). This should be seen against a backdrop of large falls in the share of fertilizer use and extension for both men and women since 2002 (but with the decline disproportionately affecting women). A drop in the access to extension services has likewise been biased against female headed households.

Given the lack of gender based cash income gaps, the expectation would be that female and male market participation was roughly equal. However, this is not the case. Instead, male market participation is higher across the board, although participation rates in farm commodity markets have fallen (and except for the sale of animal products quite dramatically) since 2002, also for male headed households. Differential access to grain markets especially has grown, with the difference in market participation between male and female headed households increasing to 27 per cent in 2008.

In these regions, there seems to be a general withdrawal from both technology use and commercialization (except for markets for animal products where participation was stable) into subsistence based agriculture, although this decline affects female headed households

disproportionately. Likewise, women are withdrawing from the nonfarm sector rather than compensating for a lack of farm based income through engaging in nonfarm activities.

While women cultivate smaller areas and have more limited access to labor than men, smaller household units explain why gender gaps in cash income do not appear, when household size is controlled for. Compared with the poor regions *with* gender based differences in income levels, the poor regions without gender gaps in income are worse off: average incomes are lower, technology use is lower and commercialization is less pronounced and falling, whereas in the former type of regions market participation is increasing. The lack of gender gaps in poor regions therefore is explained by pervasive poverty that affects both female- and male-headed households, while reductions in family labor may be related to out-migration as a result of such pauperization processes.

6. MODELLING GENDER DYNAMICS OF INCOME

While the descriptive analysis suggests that regional dynamics carry different implications for female and male headed households depending on the type of region, we now triangulate the cross-sectional data by re-exploring the questions posed initially using panel data instead. To this end we use a number of log-log mixed multi-level models. The first one (Model 1) assesses the overall existence of a gender gap on the basis of the entire sample, looking at the factors accounting for variance in cash income per consumption unit, controlling for female headed households. In a second step (Models 1a and 1b), we split the sample into male (Model 1a) and female headed households (Model 1b) to consider whether the factors are different among male and female headed households. Finally, we discuss the regional characteristics and the gender gaps found in the cross-sectional data at regional level in relation to the region types identified above. This is presented through two regional models, one for rich regions (Model 2a), and one for poor ones (Model 2b) where the type of poor

region is controlled for. The purpose of these latter models is to see whether the gender gaps identified in the cross-sectional data can be verified in the panel data and also to analyze whether the factors accounting for variance in income differ by region type.

The models recycle the independent variables from the cross-sectional analysis in a panel and multivariate setup. Importantly the models do not enable straightforward causal attribution, since the income data is not panel based, rather they point to the association between levels of income and household and regional factors for all households as well as for male and female headed households separately.

(a) Variable descriptions

Two control variables have been included: age of the farm in 2002 (i.e. years since the farm came under its present manager) to capture the ageing of the panel and a dummy to control for generational shifts (whether the household is a descendent of a 2002 household or not).

The relationship between key productive assets, land and labor resources, and level of income is assessed through two sets of dummy variables, capturing the status of the household in 2002 and positive change since 2002. The same principle is applied for the technology and commercialization variables: measuring the position of the household in 2002 and change in the period 2002 to 2008. Whether household income is related to access to technology is evaluated through three variables: fertilizer use on grains, irrigation practices and indirectly through access to extension services.

Commercialization and income composition is discussed on the basis of market participation in grains, non-grain staple crops, other food crops, non-food crops and animal products. Income composition is measured through household access to nonfarm income.

To control for *distributional aspects* a dummy for households who belonged to the upper decile of smallholders ranked by size of cultivated area by village in 2002 (a proxy for the village elite) is included. A set of variables relevant to *gender* specifically are also added: a variable intended to capture the gender composition of household labor, a variable capturing change of household headship from male to female in the period and finally a dummy for female headed households.

For the variable covering the gender composition of the household labor, the structure of the dataset does not enable calculating the household sex ratio in detail, since the sex of household members below the age of fifteen and above the age of sixty have not been specified. The variable used instead is a dummy for households that were headed by women, while only containing women in the age group 16-60 years (defined as adult in the sample). Such households would be expected to suffer from the double burden of lacking adult males and being headed by women, constraining access to land in situations where tenure is vested in men, while also lacking labor. In addition to these we control for cases of a change of household headship from male headed to female headed since 2002, as households whose headship has been feminized over the period may have lower levels of income explained by a sudden shock tied to divorce or widowhood. Lastly, a dummy for female headed households enables assessing the gender gap. If these households have significantly lower cash incomes per consumption unit when compared with their male counterparts there are indications of a gender gap biased against members of female headed households.

Finally, a regional variable is added: the standardized size of the gender gap in cash income per consumption unit, between male and female headed households. The purpose is to triangulate the cross-sectional data while assessing whether the existence of a regional gender gap in itself affects income levels among female and male headed households.

The results are presented in Table 8.

TABLE 8 HERE

(b) Gender based differences

While the cross-sectional data suggested variations in patterns of income composition based on gender as well as regional characteristics, the results from the models only partly confirm this pattern.

Before discussing the results it should be pointed out that the sample of women headed households is comparatively small with 485 valid cases. Running the model for women only, the number of valid cases drops further as a result of missing cases bringing the total in the model to 325 cases, which makes for less than 10 cases per independent variable, if the random intercepts are counted. This makes for higher standard errors, making it more difficult to attain statistical significance.

With respect to the overarching purpose of this article: i.e. to assess whether there is a gender gap in cash incomes, we can conclude that for the sample as a whole (Model 1), the dummy for female headed households is statistically significant at 5% level and negative (β=-0.18). Expressed in words, all other things equal, female headed households have on the average exp(-0,18)=0,84, or 84 per cent of the income of male headed households. The gender gap hence is 16 per cent among the panel households. Since, we control for differences in land and labor resources, and access to technology and markets this must be taken to mean that there are income effects of gender, which are not related to these factors.

Looking further at the determinants of income and at the differences in the regression coefficients between male and female headed households (comparing Models1a and 1b), there is only one significant difference, which relates to increased farm size since 2002,

where the regression coefficient is high and statistically significant for men and non-significantly different from zero for women.[9] With this exception, it is striking how similar the two models are. Even if there are many regression coefficients which are highly statistically significant, the fact that these are fewer for women than for men does not in general point to differences between the household types, but are due to higher standard errors for the sample of female headed households.[10]

We can thus conclude that with the exception of increased farm size, the factors determining the level of cash income are largely the same for men and women. For female headed households increases in farm size do not translate into higher incomes pointing to a primarily subsistence, rather than commercially based process of farm expansion for these households, suggesting the possible exclusion of women from income earning opportunities within agriculture.

The results from Model 1 confirms some of our earlier work (see Andersson et al. 2011): A low elasticity of cash income per consumption unit to cultivated area and to increase in cultivated area, points to the small advantages of area increase *per se*, i.e. of extensification, and as we have seen, especially for women headed households. The regression coefficient for labor meanwhile is not significantly different from zero (-0.08) indicating that households well endowed with labor, all else equal, do not have significantly higher incomes per consumption unit than other households. When comparing the models for female (Model 1b) and male headed households (Model 1a), the lack of differences between the models suggests that the role of labor in income generation is the same regardless of sex of head of household. Note also that increased labor resources since 2002 do not add significantly to the level of income per consumption unit.

Technology use (irrigation, seed fertilizer technology and extension) need to be coupled with commercialization to realize their income earning potential, with collinearity between seed fertilizer technology and irrigation in the full model obscuring some of these dynamics.[11] As suggested by earlier work on maize production (Andersson et al., 2011) and agricultural growth processes more generally (Andersson Djurfeldt, 2013), the effects of commercialization on cash income are strong, at least for grains, non-food crops and animal husbandry. These effects however are largely undifferentiated by sex of head of household, suggesting that markets may be less segmented by gender than is often assumed.

Engagement in the nonfarm sector has a strong positive association with cash income, both for households who had such incomes in 2002 and for those who have acquired them since then. Households who were earning income from the nonfarm sector in 2008 had 44 per cent higher incomes per consumption unit than those who did not (exp. (0.37), $p<0.001$). Although it is difficult to establish causality in this context, it can be noted that households who have diversified their incomes out of agriculture since 2002 report 63 per cent higher incomes than others. This does not primarily point to distress driven diversification but rather towards a scenario where households are attracted by earning opportunities in the nonfarm sector. Comparing the models for male and female headed households does not support the received wisdom, that women are primarily constrained to low entry – low return nonfarm activities, since there are no significant differences between male and female headed households.

Earlier reported results (Andersson et al., 2011) show that, prior to 2002, maize markets for the sampled households were dominated by village elites. Having been part of the elite in 2002 was not, however an advantage in relation to cash income earned in 2008. Surprisingly, given the emphasis in the literature on women's poorer access to rural income earning opportunities, female headed households whose adult members were all female cannot be

shown to be disadvantaged in terms of cash income per consumption unit (the β-value for that indicator is non-significant). Moreover, households who have become female headed since 2002 do not appear to have lower incomes.

Living within a region characterized by wide gender gaps in income per consumption unit, is however negatively associated with income. The effect is not visible in the model for all households (Model 1), only in the model for female headed households (Model 1b). Women who live in regions with a standardized gender gap of one standard deviation above the mean, *ceteris paribus*, have almost 0.80 standard deviation lower incomes, which translates into about 10 per cent lower cash income per consumption unit than other female headed households. In regions where female headed households are disadvantaged, this appears therefore to be tied to structural exclusion of women rather than the individual characteristics of female headed households – something which was also suggested by the cross-sectional data from poor regions with gender gaps in income.

Importantly however, while the model suggests that the factors determining income are largely similar between male and female headed households, the model does not capture the exclusion or inclusion of women with respect to resources that enable income generation, except possibly in cultivated area.

(c) Regional differences

Models 2a and 2b in Table 8 contain model specifications according to region rather than gender. In terms of gender gaps the results from the model confirm some of the cross-sectional data, while contradicting other tendencies noted in relation to these findings.

Firstly, the lack of significance for the dummy for female headed households in rich regions means that we cannot establish a gender gap for these regions, in this sense reconfirming the

cross-sectional data. Secondly, while the ideal would have been to model the two different types of poor regions - with and without gender gaps - separately, this is not possible because the former category contains less than ten cases per variable. We therefore construct a model for all poor regions, distinguishing between the two subtypes through a dummy for regions with gender gaps, while estimating the interaction effect of region type and female household headship. As expected, the *poor regions without gender gaps* have significantly lower cash incomes per consumption unit, 44 per cent, when compared with the reference category, that is poor regions with gender gaps.

In this model female headed households do not have significantly lower incomes, which is not surprising since it includes households from poor regions with as well as without gender gaps in income. The interaction effect between poor regions with gender gaps and female headed households is statistically significant, however, reconfirming that female headed households in these regions have slightly higher (13 per cent) incomes than their counterparts in poor regions without gender gaps. This is in line with the cross-sectional data which suggests that the poor regions without gender gaps are the poorest of the three region types.

Finally, with respect to the differences between regression coefficients in rich and poor regions respectively, we see that the list of significant differences is as short as the corresponding one for gender. In these models the number of cases per variable are adequate,[12] which suggests that these minor differences (unlike in the gender models) are not related to wide standard errors as a result of small sample sizes. Rather they indicate that the factors determining levels of cash income per consumption unit are largely the same in all types of regions. The regional profiles of agriculture hence do not explain differences in income levels. The only exception is for having started to sell grains since 2002, which although significant for cash incomes both in rich and poor regions, is somewhat more important in terms of income levels in the poor regions. This is not surprising given the more

extensive production systems in these regions. Related to this is the result in the poor regions model that fertilizer use is significantly related to cash income per consumption units.Looking finally at the random components, only the variance among households is statistically significant for all the models. Variance among regions is statistically significant for all the models except for model 2b (which includes both types of poor regions). Variance among countries is not statistically significant for any model, suggesting again that variance in income is primarily related to household level and regional factors, rather than country level ones. This is underscored further by the intra-class correlation (in the case of model 1 estimated to account for 30 per cent of the total variance in log income), out of which the variance among regions accounts for as much as 93 per cent.

7. CONCLUSIONS

We return now to the three questions posed initially in the article: Firstly, can differences in income among male and female headed households be said to exist – i. e. are there gender gaps in income, whether at national or regional level? Secondly, can these gaps be traced to household level or regional characteristics commonly associated with gender based differences in income and productivity found in the literature? And thirdly, conversely, how can a lack of gender based differences in income, as shown by cross-sectional data, be understood, again in the context of these characteristics.

When controlling for household size as we have done throughout the article, the answer to the first question both refutes and confirms some of the received wisdoms in relation to smallholder farming in sub-Saharan Africa. At the national level statistically significant gender based gaps in cash income cannot be found among the sampled households, although such gaps appear in relation to *farm* based cash income in four countries: Ethiopia, Tanzania, Malawi and Zambia. Regional differences emerge: neither of the rich regions have

statistically significant gender gaps in cash income, while to a varying extent the poor regions do.

Tendencies towards gender based, regional differences in income composition provide the backdrop to the second question: are gender gaps in income tied to gender biases in factors commonly associated with variance in income and productivity found in the literature? The results from the log-log mixed multi-level model suggests that this is only to some extent the case: the general dynamics tied to income levels are highly similar regardless of gender. This confirms findings from the available literature in the sense that womens' lower incomes are tied to unequal access to resources rather than different patterns of income generation. Given the same opportunities with respect to technology, markets and productive resources incomes among members of female headed households would be expected to be the same as for their male headed counterparts.

Importantly, the model does not capture differences in the gendered access to such resources, however, whereas the cross-sectional data do. When regional tendencies are considered on cross-sectional basis, only four of the 21 regions had statistically significant gender based gaps in cash income per consumption unit. All these regions were classified as poor with gaps being tied to differences in farm based cash income.

This leads on to the third and final question: how the apparent lack of a gender gap in income in some regions can be understood against the backdrop of regional characteristics. The answer is twofold and points in widely divergent directions: in rich regions the absence of statistically significant gender gaps in income are tied to more equal opportunities for women in agriculture as well as complementary sources of income from the nonfarm sector. In poor regions without such gaps, by contrast a pauperization of the relatively speaking larger male headed households explains the lack of gender gaps, when household size is controlled for.

Although the results presented above call for a general contextualization of farming in relation to livelihoods in which income from nonfarm sources account for a considerable share of total cash income, tendencies towards spatial polarization also suggest the need for further geographical precision. In this regard, the results refute two notions prevalent in studies of rural development. Firstly, that growth (whether agricultural based or not) discriminates against women. In this perspective, accumulation of assets among wealthier households occurs through the appropriation of the productive base of weaker households with female headed households often assumed to be among the most vulnerable. On the whole members of female headed households were faring considerably better in absolute terms in rich regions than those in poor regions, at least in narrowly defined income terms.

Smallholder based agricultural growth, although discriminating against female headed households in some regions, still holds possibilities for improved production among both men and women in dynamic regions. Here recognizing gender based commercial complementarities, both within and outside agriculture is necessary to formulate policies that equalize opportunities both in relation to productive assets – especially land - and to a lesser extent market access. Such policy should recognize the twin demands on female headed households to grow staple crops to feed their families, while engaging commercially in non-staple markets and nonfarm activities.

The results also challenge a second notion, namely that female headed households are discriminated against in situations of poverty and distress in which women's already precarious foothold in the agrarian economy is gradually weakened. The situation in poor regions without gender based gaps in income conjures instead an image of a race to the bottom where poverty is persistent and cuts across household categories.

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NOTES

[1] A detailed account of sampling strategies and project methodology as well as attrition analysis between the two rounds can be found in Djurfeldt, G. et.al. (2011b).

[2] A consumption unit takes into consideration the age composition of the household, converting the number of household members into equivalent number of adults. Adult household members (between the ages of 16-60) are given a weight of one, whereas children (15 and below) are given a weight of 0.50 and older household members (61 and above) are weighted 0.75.

[3] We are aware that the headship typology is ambiguous since agreement is lacking on whether de facto or de jure headship should guide classification and whether a self-reported definition of headship or alternative definitions such as 'working heads' or 'cash heads' should be used. This has further obstructed the comparability of various studies (Quisumbing et al., 2001).

[4] As has been repeatedly shown, access to income and resources *within* the household may be stratified by gender (Chant, 2007; Udry, 1996). Also, interviewing only the household head

carries limitations that should be kept in mind when interpreting the results, as shown by (Fisher, Reimer, & Carr, 2010).

[5] Not for income though, since such data were not collected in the first panel wave.

[6] In the case of Malawi, matrilineal tenure systems may explain higher rates of female headed households.

[7] Cf. the discussion below of collinearity between labor resources, technology use, commercialization and pluriactivity

[8] This is also suggested in work which we have published elsewhere on the basis of the same data (Andersson et al., 2011).

[9] The difference between regression coefficients for male- and female-headed households and between regions have been tested with the approximately normal test variable (cf. table 8)

$$z = \frac{\beta_1 - \beta_2}{\sqrt{SE_{\beta_1}^2 + SE_{\beta_2}^2}}; (\sim N(0,1).$$

[10] To test this interpretation an interaction term between gender and farm size increased between 2002 and 2008 was included in the model before stratifying it by sex of head of household, the only term where we think there is a difference between male and female headed households, results in a non-significant regression coefficient for the interaction term. In other words, the cash income per consumption unit for female headed households that had increased their farm size is not significantly different from households that had not increased their farm size. This result is consistent with the one reported in Table 8, which says that for male-headed households, increased farm size since 2002 is associated with higher income, an association which does not hold for women headed households.

[11] Collinearity between the technology variables reduces their effects in the full model, with irrigation not being significant at all. If we run a reduced model containing only the variables related to demography, cultivated area and irrigation, we get a statistically significant effect (β=0.18, $p<0.05$) for having had access to irrigation in 2002. Thus, farmers with access to irrigation would, other things being equal, have about 20 per cent higher incomes than their peers. Interaction effects between irrigation, fertilizer use and commercialization may obscure this relationship in the full model. When we replace the irrigation variable with the fertilizer variables and run a similar reduced model, we get fairly high regression coefficients for both variables (0.41 and 0.34 respectively, significant at 0.1 and 1% level). In the full model, as is evident from Table 8, the corresponding β-values are 0.26 and 0.39 respectively (significant at 1 and 0.1 level), indicating that the full potential of seed-fertilizer technology is only realized with commercialization.

[12] That is more than 15 cases per variable.

Table 1: Mean household cash income per consumption unit by country and region (USD), 2008

	Poor regions	Mean cash income per CU	Rich Regions	Mean cash income per CU
Ethiopia	Bako	52	Bokoji	114
	Yetmen	60		
	Assebot	36		
Ghana	Upper Eastern	62	Eastern	245
Kenya	Kakamega	99	Nyeri	502
Malawi	Ntchisi RDP	69	Bwanje Valley	82
	Thiwi Lifidzi	52	Shire Highlands	77
Nigeria	Kaduna State	121	Osun State	148
Tanzania	Kilombero	88	Iringa	118
Zambia	Mkushi	82	Mazabuka	114
Mozambique	North	13	Center	86
	South	33		

Table 2: Key characteristics of the country samples: sex of head of household, sample sizes, access to sources of income by sex of head of household and share of female headed households. Statistical significance has been tested through analysis of variance of means.

Country	Sex of head of household	Sample size	Share of households with access to cash income	Sig.	Share of households with access to farm based cash income	Sig.	Share of households with access to nonfarm incomes	Sig.	Share female headed households
Ethiopia	Female	52	0,98		0,92		0,33		0,11
	Male	423	0,99		0,96		0,24		
	Total	475	0,99		0,96		0,25		
Ghana	Female	111	1,00		0,88	**	0,56		0,20
	Male	457	1,00		0,95		0,57		
	Total	568	1,00		0,94		0,57		
Kenya	Female	104	0,89		0,80		0,44		0,35
	Male	196	0,92		0,79		0,41		
	Total	300	0,91		0,79		0,42		
Malawi	Female	172	0,99		0,85	**	0,83	***	0,43
	Male	226	0,99		0,95		0,66		
	Total	398	0,99		0,91		0,74		
Nigeria	Female	43	0,81		0,79		0,35		0,10
	Male	382	0,86		0,84		0,36		
	Total	425	0,86		0,84		0,36		
Tanzania	Female	75	0,81		0,65		0,59		0,19
	Male	325	0,85		0,75		0,48		
	Total	400	0,84		0,74		0,50		
Zambia	Female	87	0,93		0,76	*	0,75	**	0,20

	Male	339	0,92		0,86		0,55	
	Total	426	0,92		0,84		0,59	
Mozambique	Female	122	0,77	**	0,38	***	0,52	0,30
	Male	281	0,90		0,58		0,49	
	Total	403	0,86		0,52		0,50	
Total	Female	766	0,91		0,75		0,60	0,23
	Male	2626	0,93		0,85		0,46	
	Total	3392	0,92		0,82		0,49	

*Note: Here and below statistical significance is denoted by * for 5 percent and below, ** for 1 percent level and *** for 0.1 percent level.*

Table 3. Gender gaps in income by country: the table shows average annual household cash income per consumption unit by sex of head of household and country (USD) for 2008

Country	Gender	Statistic	Total cash income per CU	Gender gap	Sig.	Farm based cash income per CU	Gender gap	Sig.	Nonfarm cash income per CU	Gender gap	Sig.
Ethiopia	Female	Mean	50	0,26		39	0,36	*	41	-0,20	
		N	51			48			17		
	Male	Mean	68			61			34		
		N	419			408			102		
Ghana	Female	Mean	151	0,00		108	0,00		99	-0,17	
		N	111			98			62		
	Male	Mean	151			108			85		
		N	456			435			262		
Kenya	Female	Mean	384	-0,25		274	-0,02		281	-0,67	
		N	93			83			46		
	Male	Mean	307			270			168		
		N	180			154			81		
Malawi	Female	Mean	63	0,17		25	0,47	**	49	-0,09	
		N	170			147			143		
	Male	Mean	75			47			45		
		N	224			214			150		
Nigeria	Female	Mean	190	-0,23		160	-0,35		82	0,12	
		N	35			34			15		
	Male	Mean	154			118			92		
		N	329			321			137		
Tanzania	Female	Mean	87	0,20		32	0,57	**	86	-0,12	
		N	61			49			44		
	Male	Mean	110			74			76		
		N	275			245			156		

Zambia	Female	Mean	81	0,25	49	0,38	*	52	0,10
		N	81		66			65	
	Male	Mean	108		79			57	
		N	312		291			187	
Mozambique	Female	Mean	54	-0,01	12	0,27		71	0,11
		N	94		46			64	
	Male	Mean	54		16			79	
		N	252		162			137	
Total	Female	Mean	125	0,01	85	0,10		85	-0,08
		N	790		653			506	
	Male	Mean	126		95			79	
		N	2742		2512			1368	

Note: a positive gender gap denotes higher incomes for members of male headed households, whereas a negative gender gap denotes higher incomes for members of female headed households

Table 4: Gender gaps in income by type of region: the table shows share of household who had access to cash income, average annual household cash income per consumption unit (USD), and access to and size of various types of cash income by region type, 2008

Type of region	Sex of head of household	Sample size	Share who had cash income	Sig.	Cash income per CU	Sig.	Share who had farm based cash income	Sig.	Farm based cash income per CU	Gender gap	Sig.	Share who had nonfarm income	Sig.	Nonfarm income per CU	Gender gap	Sig.
poor	Female	367	0,88	***	50	**	0,69	***	28	0,50	***	0,56	**	44	0,20	
	Male	1525	0,93		78		0,86		56			0,45		55		
rich	Female	399	0,93		196		0,79		134	0,07		0,63	***	122	-0,17	
	Male	1104	0,92		183		0,83		144			0,47		104		

Note: a positive gender gap denotes higher incomes for members of male headed households, whereas a negative gender gap denotes higher incomes for members of female headed households

Table 5: Share of households with access to resources, technology, markets and both and nonfarm income among male and female headed households in rich regions.

			Consumption units	Total cultivated area	Family labor	Irrigation use	Fertilizer use on grains	Extension services received	Grains sold	Non grain staples sold	Other food crops sold	Non-food cash crops sold	Animal products sold	Income from both farm and nonfarm sources
2002	Female	Mean	4,41	1,33	3,21	0,32	0,56	0,34	0,41	0,54	0,41	0,23	0,39	0,61
		Std. Error of Mean	0,15	0,07	0,14	0,02	0,03	0,03	0,03	0,03	0,03	0,02	0,02	0,02
		N	310	371	336	367	327	382	382	382	380	382	381	382
	Male	Mean	5,61	2,64	4,74	0,36	0,52	0,40	0,54	0,69	0,53	0,34	0,45	0,52
		Std. Error of Mean	0,11	0,08	0,11	0,02	0,02	0,04	0,01	0,01	0,02	0,01	0,01	0,02
		N	887	1084	1108	1023	1091	1109	1109	1109	1108	1109	1104	1109
		Diff means	-1,21	-1,31	-1,53	-0,04	0,04	-0,05	-0,13	-0,15	-0,12	-0,12	-0,07	0,09
		Sig.	***	***	***				***	***	***	***	*	**
2008	Female	Mean	4,30	1,16	3,47	0,25	0,63	0,49	0,55	0,67	0,45	0,17	0,32	0,48
		Std. Error of Mean	0,14	0,11	0,14	0,02	0,03	0,03	0,02	0,02	0,02	0,02	0,02	0,03
		N	390	399	399	335	207	397	399	399	399	399	396	399
	Male	Mean	5,79	2,48	4,59	0,30	0,57	0,63	0,65	0,73	0,48	0,26	0,41	0,40
		Std. Error of	0,10	0,12	0,10	0,02	0,02	0,01	0,01	0,01	0,02	0,01	0,01	0,01

Mean												
N	1078	1104	1099	877	549	1101	1104	1104	1104	1099	1102	1104
Diff means	-1,49	-1,32	-1,12	-0,05	0,06	-0,14	-0,10	-0,06	-0,04	-0,10	-0,10	0,08
Sig.	***	***	***			***	**	*		***	**	**

Note: A negative difference between means (diff means), indicates lower means for female headed households.

Table 6: Share of households with access to resources, technology, markets and both and nonfarm income among male and female headed households in poor regions with gender gaps

			Consumption units	Total cultivated area	Family labor	Irrigation use	Fertilizer use on grains	Extension services received	Grains sold	Non grain staples sold	Other food crops sold	Non-food cash crops sold	Animal products sold	Income from both farm and nonfarm sources
2002	Female	Mean	4,61	1,73	3,03	0,41	0,41	0,52	0,33	0,58	0,40	0,12	0,11	0,38
		Std. Error of Mean	0,25	0,14	0,19	0,04	0,04	0,04	0,04	0,04	0,04	0,03	0,03	0,04
		N	127	148	154	148	143	154	154	154	154	154	154	154
	Male	Mean	4,86	2,11	3,66	0,34	0,48	0,38	0,58	0,65	0,35	0,14	0,12	0,40
		Std. Error of Mean	0,13	0,09	0,12	0,02	0,02	0,04	0,02	0,02	0,02	0,02	0,02	0,02
		N	361	471	476	398	441	476	476	476	476	476	474	476
		Diff means	-0,25	-0,37	-0,63	0,07	-0,07	0,14	-0,25	-0,07	0,05	-0,03	-0,01	-0,01
		Sig.		*	**				***					
2008	Female	Mean	4,51	1,25	3,39	0,41	0,52	0,43	0,40	0,59	0,48	0,02	0,21	0,54
		Std. Error of Mean	0,20	0,17	0,16	0,05	0,06	0,04	0,04	0,04	0,04	0,01	0,04	0,04
		N	135	138	138	109	75	138	138	138	138	138	137	138
	Male	Mean	5,15	1,83	4,10	0,42	0,65	0,58	0,68	0,66	0,35	0,05	0,26	0,41

Std. Error of Mean	0,10	0,10	0,11	0,02	0,03	0,02	0,02	0,02	0,02	0,01	0,02	0,02
N	513	539	532	399	274	537	539	539	539	538	537	539
Diff means	-0,63	-0,58	-0,71	0,00	-0,13	-0,15	-0,28	-0,07	0,13	-0,03	-0,05	0,13
Sig.	**	**	**		*	**	***		**			**

Note: A negative difference between means (diff means), indicates lower means for female headed households.

Table 7: Share of households with access to resources, technology, markets and both and nonfarm income among male and female headed households in poor regions without gender gaps in cash income

			Consumption units	Total cultivated area	Family labor	Irrigation use	Fertilizer use on grains	Extension services received	Grains sold	Non grain staples sold	Other food crops sold	Non food cash crops sold	Animal products sold	Income from both farm and nonfarm sources
Poor regions without gaps														
2002	Female	Mean	5,03	1,71	3,67	0,11	0,51	0,37	0,48	0,48	0,42	0,26	0,30	0,40
		Std. Error of Mean	0,26	0,13	0,20	0,02	0,04	0,03	0,03	0,03	0,03	0,03	0,03	0,03
		N	137,00	232,00	191,00	227,00	187,00	237,00	237,00	237,00	236,00	237,00	235,00	237,00
	Male	Mean	6,91	3,10	5,04	0,22	0,54	0,53	0,61	0,72	0,51	0,28	0,44	0,38
		Std. Error of Mean	0,15	0,13	0,14	0,02	0,02	0,03	0,02	0,02	0,02	0,02	0,02	0,02
		N	575,00	812,00	817,00	726,00	765,00	818,00	818,00	818,00	815,00	818,00	816,00	818,00
		Diff means	-1,89	-1,39	-1,37	-0,11	-0,03	-0,16	-0,12	-0,25	-0,09	-0,01	-0,14	0,02
		Sig.	***	***	***	***		**	**	***	*		***	
2008	Female	Mean	4,56	1,48	3,01	0,14	0,31	0,25	0,26	0,38	0,31	0,15	0,26	0,26
		Std. Error of Mean	0,17	0,15	0,13	0,02	0,04	0,03	0,03	0,03	0,03	0,02	0,03	0,03

				229,0				229,0	229,0	228,0	228,0		
	N	227,00	229,00	0	222,00	141,00	229,00	0	0	0	0	228,00	229,00
Male	Mean	6,02	2,65	4,15	0,19	0,45	0,49	0,53	0,62	0,40	0,18	0,40	0,39
	Std. Error of Mean	0,11	0,12	0,10	0,01	0,02	0,02	0,02	0,02	0,02	0,01	0,02	0,02
				986,0				986,0	986,0	978,0	982,0		
	N	983,00	986,00	0	958,00	551,00	985,00	0	0	0	0	984,00	986,00
	Diff means	-1,46	-1,17	-1,15	-0,06	-0,13	-0,24	-0,27	-0,24	-0,10	-0,03	-0,14	-0,12
	Sig.	***	***	***	*	**	***	***	***	**		***	***

Note: A negative difference between means (diff means), indicates lower means for female headed households.

Table 8
(Note to editors: Excel source file is pasted as image below. The source file is available from the author:

Fixed effects:	Both genders		Male-headed house-holds		Female-headed house-holds		Difference between genders		Rich regions		Poor regions with dummy for subtype and interac-tion effect		Difference between rich and poor regions	
	Model 1		Model 1a		Model 1b				Model 2a		Model 2b			
Variable:	β	Sig.	β	Sig.	β	Sig.	β diff	Sig.	β	Sig.	β	Sig.	β diff	Sig.
Constant	3,55	***	3,46	***	3,23	***	0,23		3,89	***	3,28	***	-0,53	
Age of head of household, logged	-0,15	***	-0,16	***	-0,18	*	0,02		-0,13	*	-0,17	**	-0,01	
Descendant household, dummy	-0,05		-0,04		-0,34		0,30		-0,26		0,31		0,36	
Total farm size, 2002, logged	0,24	***	0,26	***	0,17		0,09		0,33	***	0,17		-0,07	
Total farm size increased since 2002, dummy	0,24	***	0,25	***	-0,08		0,34	§§	0,12		0,33	***	0,09	
Farm labour resources in 2002, logged	-0,08		-0,07		0,00		-0,07		-0,02		-0,08		0,00	
Increased family labour resources since 2002, dummy	-0,18	**	-0,19	**	-0,21		0,01		-0,20	*	-0,17		0,01	
Household that used irrigation in 2002, dummy	0,09		0,12		0,15		-0,03		0,02		0,07		-0,02	
Household started irrigating since 2002, dummy.	0,06		0,05		-0,07		0,12		0,00		0,03		-0,01	
Fertilizer used on grains, 2002, dummy	0,26	**	0,25	**	0,42	*	-0,17		0,13		0,38	**	0,13	
Started using fertilizer on grains since 2002, dummy	0,39	***	0,38	***	0,64	**	-0,26		0,37	*	0,44	**	0,05	
Extension services received, 2002, dummy	-0,10		-0,07		0,09		-0,16		0,05		-0,13		-0,03	
Started receiving extension since 2002, dummy	-0,12		-0,10		0,07		-0,17		0,06		-0,15		-0,03	
Sold grains in 2002, dummy	0,22	*	0,22	*	0,30		-0,08		0,18		0,32	**	0,10	
Started or increased sale of grains since 2002, dummy	0,45	***	0,46	***	0,32		0,14		0,21	*	0,72	***	0,27	§
Sold non grain staple crops 2002, dummy	-0,02		-0,01		0,06		-0,07		-0,12		0,06		0,07	
Started to sell non grain staples crops since 2002, dummy	-0,10		-0,11		-0,21		0,10		0,00		-0,14		-0,04	
Sold other food crops 2002, dummy	0,06		0,07		0,11		-0,04		0,17		-0,04		-0,10	
Started to sell other food crops since 2002, dummy	0,09		0,10		0,21		-0,11		0,35	*	-0,03		-0,12	
Sold non-food crops 2002, dummy	0,12		0,14		0,05		0,08		-0,12		0,27	*	0,14	
Started to sell non food crops since 2002, dummy	0,33	**	0,33	**	0,29		0,04		0,08		0,68	***	0,35	
Sale of animal products, 2002, dummy	0,45	***	0,43	***	0,25		0,18		0,41	***	0,55	***	0,10	
Started to sell animal products since 2002, dummy	0,39	***	0,39	***	0,25		0,14		0,34	*	0,46	***	0,07	
Households with both farm and nonfarm sources of cash income, 2002, dummy	0,37	***	0,33	***	0,35	*	-0,01		0,41	***	0,31	**	-0,05	
Households who have entered the nonfarm sector since 2002, dummy	0,49	***	0,47	***	0,57	**	-0,09		0,52	***	0,45	***	-0,04	
Farm size among 10% highest in village, 2002, dummy	-0,06		-0,07		0,36		-0,44		-0,15		-0,07		0,00	

Households headed by women with all adults being female, 2008, dummy	-0,11				-0,04									
Standardized gender gap in cash income per CU by region, 2008	-0,94		-0,87		-1,56	*	0,69							
Households that became (fe)male headed since 2002			-0,02		0,01		-0,03							
Female headed households, dummy	-0,18	*							-0,10		-0,26		-0,07	
Poor regions without gender gap, dummy											-0,58			
Interaction effect, poor region with gender gap * female-headed household											0,12	***		
N	1328		1016		325				584		744			
Missing %	39%		40%		33%				40%		39%			
Deviance null model	6982,46		5409,98		1577,26				3040,88		3980,25			
Deviance full model	3944,34		3987,91		979,90				1708,64		2238,518			
p-value of Chi^2	0,00		0,00		0,00				0,00		0,00			
Random effects by level	Estimate	Sig.	Estimate	Sig.	Estimate	Sig.			Estimate	Sig.	Estimate	Sig.		
Country	0,05		0,04		0,05				0,12		0,03			
Region	0,44	**	0,40	*	0,48	*			0,28	*	0,20			
Household	1,14	***	1,15	***	1,20	***			1,14	***	1,20	***		
Variance decomposition														
Intra-Class Correlation	0,30		0,28		0,31				0,26		0,16			
Level 3 (country) share of ICC	0,03		0,03		0,03				0,08		0,02			
Level 2 (region) share of ICC	0,28		0,26		0,28				0,20		0,14			
Note: Adding the variable 'Household became male-headed since 2002' to the males model and the corresponding variable to the females one make the models inestimable.														
The symbols §, §§, §§§ are used to denote levels of significance of differences between regression coefficient, denoting 5, 1 and 0.1 percent level of significance respectively														