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Research Article

GENDER GAP IN AGRICULTURAL PRODUCTIVITY IN MALAWI

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Abstract

This paper explores agricultural productivity differences in Malawi arising due to differences in the gender of the plot manager based on a gender disaggregated sample of 784 maize, 232 groundnut, 212 tobacco and 199 cotton plot managers. Decomposition techniques were used to identify the relative quantitative importance of factors explaining the gender gap at the mean of the agricultural productivity distribution. This was carried out using data from the fourth Malawi Integrated Household Survey (IHS 4), which was nationally representative and collected within a multi-topic framework with emphasis on gender disaggregation of crop farming preferences. The survey was conducted by the Malawi National Statistical Office from April 2016 to April 2017 and information was collected from a sample of 12,447 households. Empirical investigation based on the Oaxaca-Blinder regression-based mean decomposition showed that gender gaps exist where men are more productive in the cultivation of both male and female dominated crops. Large and significant gender disparities were seen not only in the use of inputs (particularly fertilizer and labour) but also in the returns to those inputs. Higher levels of household adult male labour on male-managed plots, in particular, widen the gender gap. The female structural disadvantage component of the gender gap is exacerbated by gender differences in the availability of time devoted to productive activities. This is because female managers, who are just as likely to be household heads or spouses, are more likely to combine farm management with household duties including child care in the Malawian social setting.

Keywords: Agriculture, Decomposition methods, Gender, Plot manager, Rural.

INTRODUCTION

Smallholder agriculture has been increasingly recognised as a means to address issues of poverty and nutrition insecurity in Malawi as the sector both feeds the population and employs the largest number of people in the country. There is near universal participation in agriculture by households throughout Malawi, with women responsible for a significant volume of the total labour. Approximately 97% of rural women in the country are engaged in subsistence farming (Koirala *et al.,* 2015). In terms of types of crops grown, it has been observed that female farmers in many instances grow lower value subsistence crops not necessarily because they prefer to do so but because they cannot access the resources that would permit them to do otherwise (Koirala *et al.,* 2015). Consequently, cash and export crops are frequently regarded as ‘men's crops’ and subsistence crops are regarded as ‘women's crops’. In Malawi, female farmers are less likely to cultivate the country’s primary cash crop, tobacco, compared to men. The crop is only planted on 1.3% of female-managed plots compared to 5.4% of male-managed plots (NSO, 2017). UN Women (2015) uncovered a 28% gender gap between women and men in the fraction of land devoted to export crops in Malawi. Gender differences in cash crop production create two key challenges: first, at the micro level, there is potential for widening income inequality arising from cash crops, grown mainly by men, which command higher market value than traditional staple crops, grown mainly by women. Second, at the macro level, failure to maximize the important contribution that women can make in cash crop production is costly to the national development agenda as it results in forgone aggregate agricultural output and incomes.

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Previous research highlighting the gender gap in agricultural production focused largely on women’s unequal access to key inputs, such as fertiliser, agricultural information and farm labour, concluding that if women had better access, they would be equally efficient (see Quisumbing, 1996; Udry, 1996; Quisumbing *et al.,* 2001; Horrell & Krishnan, 2007; Udry, 2008; Peterman *et al.,* 2011; and Vargas Hill & Vigneri, 2011). The methodology used in this paper looks not only at the quantity of resources that women use, but also assesses the returns that they receive from these resources, or how well these resources actually translate into increased agricultural productivity. It is possible that even if women had access to the same amount of inputs as men, this equal access would not automatically always achieve the same effect in terms of productivity. Such a paradox could result from broader norms, market failures or institutional constraints that alter the effectiveness of these resources for women. Furthermore, despite what could be perceived as a well-established base on the extent and proximate causes of the gender gap across sub-Saharan Africa, the overwhelming majority of empirical studies on the topic have used data from small-scale surveys that were limited in terms of geographic coverage, topic, or attention to intra-household dynamics (or in some cases, all three). The failure by previous studies to use nationally-representative, methodologically-sound data collected in heterogeneous settings has in turn inhibited the computation of rigorous estimates. This study seeks to fill this gap by providing a nationally-representative analysis of the gender gap in Malawi from the perspective of men’s and women’s crops using the Oaxaca-Blinder decomposition methodology. The substantively interesting question to be addressed is why productivity differences arise between men and women for a variety of crops, which have been designated as women’s and men’s crops.

What are women's and men's crops?

A body of literature exists that has categorized certain crops to be either women's crops or men's crops depending on the gender that dominates production. Domination in production of a specific crop by a particular gender has been found to be influenced by a number of contextual factors as well as unique properties of the crops themselves. There is a strong association between cassava cultivation and women in Sub-Saharan Africa where cassava is often referred to as a 'women's crop' (Forsythe *et al.,* 2015). The association is derived from several factors including the low market value of cassava as a traditional food that is mainly grown and consumed at home, along with characteristics such as its low input requirements. Prevailing climate change increases the importance of the crop as it is drought tolerant and can do well in poor soils and requires less strenuous management. Chiwona-Karltun (2005) noted that cassava has gained popularity as an important crop in view of the HIV and AIDS pandemic in which labour-constrained households find it ideal as it has minimal labour requirements compared to crops such as maize. thereby restricting the ability of low-income smallholders, many of whom are women farmers, to engage in the sector. Cotton is grown by approximately 300,000 smallholder farmers in Malawi and it is estimated that approximately 20% to 30% of these are female (i.e. those involved in decision-making in the production process on the farm) (Ussar, 2016). Many other women who are not involved in decision-making in the cotton production process work as labourers on their husband's cotton farms, or are employed as casual workers on other people's farms. Cotton is therefore also regarded as a men's crop. In Malawi, maize is the staple food crop cultivated on 73% of male-managed plots and 83% of female-managed plots (NSO, 2017). Orr et al (2016) observed that both men and women viewed maize as a crop where over 60% of decisions were non-dominated and where control was shared. Therefore, maize occupies the middle ground, with control shared fairly evenly between women and men and thus can be viewed as a gender neutral crop. Based on data availability for the variables of interest, this study will analyse agricultural productivity differences between male-managed and female-managed plots for maize, groundnut, tobacco and cotton farming.

Table 1. summarizes the classification of women's and men's crops from the foregoing overview

Crop	Gender domination	Explanation	Reference
Cassava	Female	Low-risk; low input requirement; does not require strenuous management.	Forsythe et al., (2015)
Groundnut	Female	Bulk of labour provided by women; women are involved to a large extent in management decisions in production.	Orr et al. (2016); Tsusaka et al. (2016)
Tobacco	Male	Men dominate decision-making process; considerable input requirements; strenuous management involved.	Makoka et al. (2016); NSO, (2017)
Cotton	Male	Men dominate decision-making process; considerable input requirements; strenuous management involved.	Ussar (2016); NSO, (2017)
Maize	Neutral	More than 60% of decision-making is non-dominated and control is generally shared.	NSO, (2017); Orr et al. (2016)

Practically, the low-risk and low-input requirements of cassava are particularly important for women who experience more severe constraints in accessing agricultural inputs in comparison to men, and also face more constraints in participating in alternative markets such as cash crops. Groundnut is also regarded as a women's crop primarily because much of the labour is provided by women, especially during the post-harvest handling such as stripping, and shelling (Tsusaka *et al.,* 2016). This has resulted in women perceiving greater control over groundnut production than men, where control extends to decision making at various steps in production (Orr *et al.,* 2016). This is consistent with Doss's (2001) argument that women's crops are defined not only by who controls the output but also by who makes the management decisions. As in many parts of Africa, men dominate the production and control of high-value cash crops in Malawi (Makoka et al. 2016). Malawi's primary cash crop is tobacco and the country is the world's most tobacco-dependent economy in the world (Otanez*et al*, 2009). The commodity contributed 52% of the total export value for the country in 2012. In the 2009/10 farming season tobacco was disproportionately cultivated on 10.4% of male-managed plots compared to 3.3% of female-managed plots (NSO, 2012). In the 2015/16 farming season, the crop was cultivated on 5.4% of male-managed plots and just 1.3% of female-managed plots (NSO, 2017). Although women are involved in a substantial amount of the labour associated with tobacco, they are less involved in decision-making in the production process (Makoka *et al.,* 2016). Cotton is a significant cash crop and the fourth largest agricultural export after tobacco, sugar, and tea in Malawi. Cotton requires considerable amount of inputs,

MATERIALS AND METHODS

Data

The economic, social and demographic data for this study are drawn from the fourth Malawi Integrated Household Survey (IHS 4). It is statistically designed to be representative at national, district, urban and rural levels. The survey was conducted by the Malawi National Statistical Office from April 2016 to April 2017. The survey collected information from a sample of 12,447 households; 2,272 (representing 18.3%) were urban households, and 10,175 (representing 81.7%) were rural households. The survey collected socio-economic data at the household level and on individuals within the households including highest education qualifications attained and gender of the plot manager. It also collected detailed data on farming activities including crop output, land usage, labour and other farming inputs. In rural Africa, plots are not necessarily managed at the household level but at individual level. It is not uncommon to have three generations living together and the person declared as the head of the household might just be the patriarch whose influence on productivity is in fact limited. The head of the household does not have identical observable and non-observable characteristics as the other household members. Therefore, the scope of the conclusions drawn from studies that aim to explain gender differences in agricultural productivity based on gender of the household head will likely be limited in terms of public policy. The method used in this study entails estimation of a production function with a gender dummy as an independent variable (in the pooled regression), with estimation at the plot level as opposed to the household level. This plot level approach outperforms the household level approach in that it is better able to isolate the differences in productivity caused by gender among all the factors that influence productivity.

Oaxaca-Blinder mean decomposition method

The Oaxaca-Blinder decomposition developed by Oaxaca (1973) and Blinder (1973) gained prominence through its initial application involving decomposition of wage earning gaps and the estimation of discrimination in gender earning differentials. The decomposition method calculates the gap between means of an outcome variable of two groups and identifies the contribution of each variable to the differences between the groups of interest. The gap or the result of the mean differences of the two groups is then divided between the explained component, i.e. the endowment effect, and the unexplained component, i.e. the structural effect. The explained component is the part of the differential in group outcomes due to group differences in the explanatory variables while the unexplained component is due to discrimination or omitted predictors (Oaxaca, 1973). To document the extent and drivers of the gender gap in Malawi for maize, groundnut, tobacco and cotton farming, I use the Oaxaca-Blinder decomposition approach and assume the log of an agricultural productivity measure (Y), namely gross agricultural output per acre, for male (M) and female (F) managed plots estimated as:

$$Y_G = \beta_{G0} + \sum_{k=1}^{K} X_{Gk}\beta_{Gk} + \varepsilon_G \qquad (1)$$

where G indicates the gender of the plot manager; X is a vector of the k observable, plot level explanatory variables; β is the associated vector of intercept and slope coefficients; and ε is the error term under the assumption that $E(\varepsilon_M) = E(\varepsilon_F) = 0$. The gender gap *'D'* is expressed as the mean outcome difference:

$$D = E(Y_M) - E(Y_F) \qquad (2)$$

Equations (1) and (2) imply that:

$$E(Y_M) = E(\beta_{M0} + \sum_{k=1}^{K} X_{Mk}\beta_{Mk} + \varepsilon_M) = \beta_{M0} + \sum_{k=1}^{K} E(X_{Mk})\beta_{Mk} \qquad (3)$$

$$E(Y_F) = E\left(\beta_{F0} + \sum_{k=1}^{K} X_{Fk}\beta_{Fk} + \varepsilon_F\right) = \beta_{F0} + \sum_{k=1}^{K} E(X_{Fk})\beta_{Fk} \qquad (4)$$

and equation (2) could be rewritten as:

$$D = \beta_{M0} + \sum_{k=1}^{K} E(X_{Mk})\beta_{Mk} - \beta_{F0} - \sum_{k=1}^{K} E(X_{Fk})\beta_{Fk} \qquad (5)$$

Subsequently, I define β^* as the vector of coefficients that is obtained from a regression of Y that is based on the pooled plot sample and includes the group membership identifier, which is a dummy variable identifying female-managed plots. The inclusion of the group membership identifier in the pooled regression for the estimation of β^* takes into account the possibility that the mean difference in plot-level productivity measure is explained by gender of the plot manager, avoiding a possible distortion of the decomposition results due to the residual group difference reflected in β^* (Jann, 2008; Kilic, 2015). Rearranging Equation (5) by adding and subtracting (i) the slope coefficient of the pooled regression β_0^*, and (ii) the return to the observable covariates of each group valued at $\beta^*(X_{MK}\beta_k^* \text{and} X_{FK}\beta_k^*)$, we obtain:

$$D = \underbrace{\sum_{k=1}^{K}[E(X_{Mk}) - E(X_{Fk})]\beta_k^*}_{\text{Component 1: Endowment effect}} + \underbrace{\underbrace{(\beta_{0M} - \beta_0^*) + \sum_{k=1}^{K}[E(X_{MK})(\beta_{MK} - \beta_k^*)]}_{\textit{Male structural advantage}} + \underbrace{(\beta_0^* - \beta_{0F}) + \sum_{k=1}^{K}[E(X_{FK})(\beta_{FK} - \beta_k^*)]}_{\textit{Female structural disadvantage}}}_{\text{Component 2 : Structure effect}} \qquad (6)$$

where $\beta_{M0}, \beta_{F0}, \beta_0^*, \beta_{MK}, \beta_{Fk}, \beta_k^* (k = 1 \ldots K)$ are the estimated intercept and slope coefficients of each covariate included in the regressions of the male-managed, female-managed and pooled plot samples.

Equation (6) is known as the aggregate decomposition. The first component is the endowment effect (i.e. the portion of the gender gap that is explained by differences in the levels of observable covariates between both groups). It is the sum across all covariates, of the differences by group, valued at the corresponding average return. The second component is the structure effect (i.e. the portion of the gender gap driven by deviations of each group's return from the corresponding average return). The first term of the structure effect, $(\beta_{0M} - \beta_0^*) + \sum_{k=1}^{K}[E(X_{MK})(\beta_{MK} - \beta_k^*)]$, represents the male structural advantage, which is equal to the portion of the gender gap accounted for by deviations of male regression coefficients from pooled counterparts. The second term of the structure effect, $(\beta_0^* - \beta_{0F}) + \sum_{k=1}^{K}[E(X_{FK})(\beta_{FK} - \beta_k^*)]$, represents the female structural disadvantage, which is equal to the portion of the gender gap driven by deviations of pooled regression coefficients from female counterparts.

For each of the 4 crop types equation 1 is estimated for (i) male-managed plots, (ii) female-managed plots, and (iii) the pooled plot sample. The resulting vector of coefficients β_M, β_F, and β^*, together with the mean values for each covariate for each group X_M and $X_F$are then used to compute the components of equation (6). Moving beyond the aggregate decomposition, the detailed decomposition involves subdividing the endowment and the structure effects into the respective contributions of each observable covariate which corresponds to the variable-specific subcomponents of the summations included in equations (6).

The questions attempted to be addressed by the Oaxaca-Blinder decomposition method require a strong set of assumptions. In particular, these methods follow a partial equilibrium approach, where observed outcomes for one group can be used to construct various counterfactual scenarios for the other group. A limitation is that while decompositions are useful for quantifying the contribution of various factors to a difference in an outcome across groups or a change in an outcome for a particular group over time, they are based on correlations, and hence cannot be interpreted as estimates of underlying causal parameters (Fortin *et al.,* 2011). However, decomposition methods do document the relative quantitative importance of factors in explaining an observed gap, thus suggesting priorities for further analysis and, ultimately, policy interventions.

Fortin *et al.* (2011) present a detailed account of the assumptions required to identify the population parameters of interest. Two crucial assumptions for the validity of aggregate decomposition are (i) overlapping support and (ii) ignorability. Overlapping support implies that no single value of $X = x$ or $\varepsilon = e$ exists to identify membership into one of the groups. Ignorability refers to the random assignment of female plot management conditional on observable attributes. The additional essential assumptions required by detailed decomposition to identify the individual contribution of each covariate include additive linearity and zero conditional mean. The latter implies that ε is independent of X. In other words, it is assumed that there is no unobservable heterogeneity that jointly determines the outcome and observable attributes. It should be noted that even if the additional assumptions required by detailed decomposition may not hold true, aggregate decomposition would remain valid as long as overlapping support and ignorability assumptions are tenable (Fortin *et al.,* 2011). The sensitivity analyses to determine if overlapping support and ignorability assumptions hold are presented later on.

RESULTS

Descriptive statistics

Descriptive statistics and results from tests and mean differences by gender of the plot manager are presented in Table 2. Plots were dropped that were missing production information, or where unit values could not be computed reliably for the crops reported to be cultivated on the plot, or where a clear manager of the plot could not be identified, or plots that had missing values among the independent variables of interest. These exclusions left us with the final analysis sample of 784 maize plots, 46% of which were managed by female famers; 232 groundnut plots, 48% of which were managed by female farmers; 212 tobacco plots, 35% of which were managed by female farmers; and 199 cotton plots, 36% of which were managed by female farmers. The average output per acre, which is the dependent variable and proxy for agricultural productivity, is seen to be lower across all the four crop types for the female managed plot samples. Gender productivity gaps for all four crops were statistically significant. Of the four crop types, the largest gender productivity gap was seen in tobacco production where average output per acre was 36% lower on female managed plots and the difference was statistically significant at the 1% level. The gender productivity gap was smallest in groundnut production where female managed plots produced 3% less output per acre on average compared to male managed plots. Female managed plots, on average, are overseen by individuals that are older and have slightly fewer years of schooling compared to their male-managed comparators across all the four crop types. The average GPS-based plot area for male farmers across all four crop types is 0.93 acres compared to 0.84 acres for female managed plots. Female-managed plots are, on average, 10% smaller than male-managed plots and the gender difference in plot sizes is statistically significant for all crop types. Tobacco farmers tend to have relatively large land sizes. In terms of land utilization, most farmers in Malawi allocate more land to maize and tobacco. Together, these two crops take up almost 85% of the total land under cultivation (NSO, 2017). It is in tobacco farming where the largest gender difference in plot size is seen where female managed plots are, on average, 18% smaller compared to male managed tobacco plots. The smallest gender differences in plot sizes were seen in groundnut and maize farming where female-managed plots were 3% and 4% smaller respectively compared to male managed plots. The incidence of organic or inorganic fertilizer application is lower on female managed plots across all four crop types but the difference is only statistically significant for maize farming. This trend could signal gender differences in Farm Input Fertilizer Subsidy Program (FISP) voucher distribution and redemption outcomes. Kilic *et al.* (2015) observe that based on data from the third Malawi Integrated Household Survey, the average number of fertilizer vouchers that were received among female-headed households were lower than the analogous statistic for male-headed households and the difference was statistically significant at the 1% level. Similarly, the average number of fertilizer vouchers that were redeemed by female-headed households was lower compared to male-headed households and the difference was again statistically significant at the 1% level. Female managed plots are associated with overall higher labour use (both household and hired) compared to male managed plots, and they are, on average, 4% less likely to be associated with households that receive agriculture extension services on topics that relate to crop production and marketing. Table 3 presents the naïve plot-level regression results on the gender gap in output where the dependent variable is the log of gross output per acre. The findings presented in panels (1), (2) and (3) of the table originate from regressions that, in addition to the dummy variable on female plot management, control only for agro-ecological zone, regional, and district fixed-effects, respectively.

The gender gap estimate ranges recorded were as follows: 11 to 14 percent for maize farming; 7 to 8 percent for groundnut farming; 18 to 22 percent for tobacco farming; and 14 to 18 percent for cotton farming. The gender gap estimates are statistically significant for maize, tobacco and cotton farming and statistically insignificant for groundnut farming. These results indicate a statistically and economically large difference between male and female farmers, particularly for men's crops (tobacco and cotton). Additional estimates of the gender gap were obtained this time conditional on additional covariates commonly found in the literature (see Peterman *et al.,* 2011; Kilic *et al.,* 2015). Base OLS regression results underlying the mean decomposition for the pooled, male-managed and female-managed plot samples can be found in the Annex to this paper. Results from the pooled regression that includes both male- and female-managed plots showed that once key factors of production are controlled for, the gender gap is reduced to 3.8 percent for maize farming; 1.5 percent for groundnut farming; 5.8 percent for tobacco farming; and 5.1 percent for cotton farming. The gender gaps are now statistically significant for all four crops. Unfortunately, this type of analysis does not allow us to delve deeper into the processes that underlie the movement from the relatively higher unconditional to the relatively lower conditional gender gaps for all the four crop types. In the following sections, a decomposition approach is applied that will allow unpacking the relative contributions of different factors towards this gap and to suggest priority areas for policy interventions.

Decomposition econometric results

The first step in the mean decomposition is the estimation of equation (1).

Table 2. Descriptive statistics and results from tests and mean differences by gender of the plot manager

Variable	Pooled sample				Male-managed plot sample				Female-managed plot sample				Difference			
	Maize	*G.Nut*	*Tobacco*	*Cotton*	*Maize*	*G.Nut*	*Tobacco*	*Cotton*	*Maize*	*G.Nut*	*Tobacco*	*Cotton*	*Maize*	*G.Nut*	*Tobacco*	*Cotton*
Outcome variable																
Output per acre (kg/ac)	651.96	418.92	212.82	143.44	667.89	425.25	259.44	163.23	635.37	413.83	166.15	123.94	32.52**	11.42*	93.29***	39.29***
Plot manager characteristics																
Age (years)	41.59	40.64	46.29	43.36	40.15	39.36	45.36	42.71	43.39	42.52	47.58	44.42	-3.24**	-3.16**	-2.22**	-1.71**
Years of schooling	5.42	6.08	7.43	6.94	6.55	6.68	7.89	7.16	4.87	5.13	6.94	6.29	1.68*	1.55*	0.95*	0.87*
Agriculture extension receipt δ	0.26	0.29	0.32	0.29	0.27	0.31	0.35	0.33	0.23	0.27	0.31	0.30	0.04	0.04	0.04*	0.03*
Household characteristics																
Household size	4.83	4.74	4.91	4.97	6.09	5.69	5.77	5.51	5.12	4.81	5.03	4.90	0.97*	0.88*	0.74*	0.61*
Child dependency ratio	0.65	0.66	0.68	0.63	0.67	0.69	0.69	0.64	0.71	0.74	0.72	0.68	-0.04*	-0.05*	-0.03*	-0.04*
Plot area																
Acres	0.83	0.74	1.22	0.73	0.84	0.75	1.35	0.76	0.81	0.73	1.11	0.69	0.03***	0.02***	0.24***	0.07*
Plot input use																
Incidence of fertilizer use (organic or inorganic) δ	0.48	0.04	0.98	0.99	0.49	0.04	0.99	0.99	0.46	0.03	0.97	0.98	0.03*	0.01	0.02	0.02
Household male labour use (days/ac)	18.12	19.04	28.41	26.15	21.95	22.13	30.17	31.28	12.52	15.62	20.98	22.62	9.43**	6.51*	9.19**	8.66*
Household female labour use (days/ac)	21.14	22.48	30.13	29.77	18.98	20.37	19.95	20.54	27.17	28.23	36.67	33.80	-8.19**	-7.86*	-16.72**	-13.26*
Incidence of hired labour use (days/ac)	8.12	7.68	12.88	10.39	7.33	8.19	10.70	9.51	9.59	9.37	11.82	12.07	-2.26**	-1.18**	-1.12*	-2.56*
Agro-ecological characteristics																
Sandy soil δ	0.217	0.223	0.207	0.200	0.219	0.226	0.198	0.205	0.213	0.224	0.219	0.210	0.006**	0.002*	-0.021*	-0.005**
Clay soil δ	0.135	0.126	0.153	0.117	0.129	0.120	0.112	0.103	0.141	0.129	0.121	0.102	-0.012**	-0.009*	-0.009*	0.001**
Sandy and clay (the base category) δ	0.648	0.651	0.640	0.683	0.652	0.654	0.690	0.692	0.646	0.647	0.660	0.688	0.006**	0.007*	0.03*	0.004**
Tropic-warm/semiarid δ	0.46	0.47	0.44	0.45	0.47	0.49	0.45	0.43	0.46	0.48	0.46	0.46	0.01	0.01	-0.01	-0.03
Tropic-warm/subhumid δ	0.32	0.38	0.45	0.46	0.37	0.40	0.46	0.46	0.31	0.35	0.44	0.45	0.06***	0.05***	0.02**	0.01**
Tropic-cool/semiarid δ	0.13	0.09	0.06	0.05	0.13	0.09	0.04	0.05	0.10	0.07	0.05	0.04	0.03	0.02	-0.01	0.01
Tropic-cool/subhumid δ	0.09	0.06	0.05	0.04	0.09	0.07	0.05	0.06	0.07	0.05	0.05	0.05	0.02***	0.02***	0.00	0.01
Observations	784	232	212	199	423	120	138	127	361	112	74	72	62	8	64	55

***/**/* indicate statistical significance at the 1/5/10 percent level, respectively. δ denotes a dummy variable.

Table 3. Naïve regression results on gender productivity differences in farming

	Dependent variable: Log[plot gross output / acre]											
	(1)				(2)				(3)			
	Maize	*G.Nut*	*Tobacco*	*Cotton*	*Maize*	*G.Nut*	*Tobacco*	*Cotton*	*Maize*	*G.Nut*	*Tobacco*	*Cotton*
Fixed effects	**Agro-Ecological Zones**				**Regions**				**Districts**			
Female Plot Management δ	-0.142 (0.021)	-0.083 (0.022)	-0.222** (0.023)	-0.175** (0.024)	-0.111 (0.021)	-0.067 (0.021)	-0.184** (0.022)	-0.156** (0.023)	-0.113 (0.020)	-0.072 (0.021)	-0.218** (0.020)	-0.141** (0.023)
Observations	784	232	212	199	784	232	212	199	784	232	212	199
R-Squared	0.019	0.016	0.022	0.024	0.024	0.021	0.029	0.031	0.066	0.057	0.068	0.064

Note: ***/**/* indicate statistical significance at the 1/5/10 percent level, respectively. δ denotes dummy variable.

Table 4 Decomposition of the gender differential in agricultural productivity

A. Mean Gender Differential												
	Maize	*G/Nuts*	*Tobacco*	*Cotton*								
Mean male-managed plot agricultural productivity	9.849** (0.020)	6.442 (0.031)	10.894*** (0.019)	9.109** (0.022)								
Mean female-managed plot agricultural productivity	9.706** (0.027)	6.359 (0.037)	10.671*** (0.026)	8.933** (0.028)								
Mean gender differential in agricultural productivity	0.143** (0.025)	0.083 (0.036)	0.223*** (0.024)	0.176** (0.030)								
B. Aggregate decomposition												
	Endowment effect				**Male structural advantage**				**Female structural disadvantage**			
	Maize	*G/Nuts*	*Tobacco*	*Cotton*	*Maize*	*G/Nuts*	*Tobacco*	*Cotton*	*Maize*	*G/Nuts*	*Tobacco*	*Cotton*
Total	0.102** (0.028)	0.051 (0.031)	0.179*** (0.023)	0.137** (0.029)	0.000 (0.002)	0.000 (0.003)	0.000 (0.002)	0.000 (0.003)	0.041** (0.030)	0.032 (0.032)	0.044*** (0.026)	0.039** (0.033)
Share of the gender differential	71%	61%	80%	78%	0%	0%	0%	0%	29%	39%	20%	22%
C. Detailed decomposition												
	Endowment effect				**Male structural advantage**				**Female structural disadvantage**			
	Maize	*G/Nuts*	*Tobacco*	*Cotton*	*Maize*	*G/Nuts*	*Tobacco*	*Cotton*	*Maize*	*G/Nuts*	*Tobacco*	*Cotton*
Plot manager characteristics												
Age(years)	0.007 (0.004)	0.004 (0.003)	0.011 (0.006)	0.009 (0.007)	-0.026 (0.021)	-0.011 (0.019)	-0.029 (0.022)	-0.031 (0.025)	-0.046 (0.042)	-0.023 (0.028)	-0.054 (0.036)	-0.050 (0.044)
Years of schooling	0.018** (0.009)	0.011* (0.008)	0.028** (0.013)	0.024* (0.016)	-0.013 (0.009)	-0.011 (0.007)	-0.017 (0.010)	-0.015 (0.011)	-0.029* (0.016)	-0.015* (0.014)	-0.036* (0.019)	-0.031* (0.022)
Agriculture extension receipt δ	0.006 (0.003)	0.003 (0.001)	0.010** (0.006)	0.008** (0.005)	-0.009 (0.004)	-0.006 (0.004)	-0.012* (0.009)	-0.010* (0.007)	-0.014 (0.008)	-0.010 (0.009)	-0.022** (0.010)	-0.019** (0.012)
Household characteristics												
Household size	0.013** (0.006)	0.010* (0.008)	0.018** (0.007)	0.016* (0.009)	-0.017 (0.013)	-0.013 (0.010)	-0.021 (0.015)	-0.019 (0.016)	-0.058* (0.023)	-0.051* (0.030)	-0.077** (0.035)	-0.068* (0.039)
Child dependency ratio	0.00 (0.001)	0.000 (0.002)	0.000 (0.001)	0.000 (0.002)	0.024** (0.012)	0.021* (0.014)	0.031** (0.013)	0.028* (0.016)	0.042** (0.015)	0.039* (0.018)	0.049** (0.016)	0.045* (0.017)
Plot area												
Log[GPS based plot area/ac]	-0.025*** (0.007)	-0.020* (0.011)	0.037*** (0.009)	0.030** (0.013)	-0.019 (0.015)	-0.015 (0.013)	0.027 (0.018)	0.021 (0.019)	-0.013 (0.044)	-0.010 (0.048)	0.021 (0.052)	0.018 (0.055)
Log[GPS based plot area/ac squared]	-0.013** (0.005)	-0.010* (0.007)	0.019*** (0.004)	0.016** (0.005)	-0.002 (0.011)	-0.002 (0.014)	0.001 (0.009)	0.002 (0.010)	0.004 (0.024)	0.003 (0.027)	-0.005 (0.025)	-0.004 (0.028)
Plot input use												
Incidence of fertilizer use (organic or inorganic) δ	0.011* (0.007)	0.004 (0.019)	0.015*** (0.004)	0.014** (0.006)	0.008* (0.005)	0.002 (0.009)	0.013** (0.007)	0.011** (0.008)	0.023* (0.016)	0.011 (0.013)	0.037* (0.018)	0.032* (0.019)
Log[Household male labour use (days/ac)]	0.084*** (0.019)	0.079*** (0.022)	0.097*** (0.017)	0.088*** (0.020)	0.171*** (0.059)	0.165*** (0.068)	0.193*** (0.047)	0.182*** (0.051)	0.044*** (0.014)	0.041*** (0.017)	0.058*** (0.012)	0.055*** (0.015)
Log[Household female labour use (days/ac)]	-0.013*** (0.006)	-0.010** (0.009)	-0.025*** (0.007)	-0.017* (0.013)	-0.060** (0.019)	-0.034* (0.023)	-0.081*** (0.017)	-0.070* (0.028)	-0.102* (0.064)	-0.055* (0.031)	-0.127* (0.071)	-0.094* (0.058)
Log[Hired labour use (days/ac)]	0.001 (0.003)	0.004 (0.007)	0.003 (0.005)	0.002 (0.004)	0.001 (0.003)	0.002 (0.004)	0.002 (0.003)	0.001 (0.003)	-0.004 (0.006)	-0.005 (0.008)	-0.007 (0.009)	-0.005 (0.007)
Number of observations	*Maize* 784			*Groundnut* 232			*Tobacco* 212				*Cotton* 199	

Note: ***/**/* indicate statistical significance at the 1/5/10 percent level, respectively. δ denotes dummy variable.

This is done separately for the pooled, male-managed and female-managed plot samples for each of the four crop types. Estimation results are reported in the Annex. The log of GPS-based plot area has a negative coefficient that is statistically significant in each of the three plot samples (i.e. pooled, male-managed and female-managed) for maize and groundnuts. This finding is consistent with recent studies that have provided support for the inverse yield hypothesis – the proposition that small farms are more productive than large farms particularly for staple crops in low resource settings (see Larson et al.). The pure cash crops (tobacco and cotton) have a positive coefficient that is statistically significant in each of the three plot samples. Years of schooling has a positive coefficient and is statistically significant only within female-managed plot samples, suggesting that if female plot managers acquired similar years of schooling as male counterparts, the mean gender gap in productivity could be reduced. Agriculture extension services receipt has a positive coefficient which is only statistically significant for tobacco and cotton farming for both male and female managed plots alike, suggesting that greater priority is placed on provision of extension services to plot managers that grow cash crops. A key variable that is positively associated with gross output per acre, irrespective of the plot sample and crop type, is fertilizer use per acre. The return to fertilizer use is higher within male-managed plot samples in comparison to the female-managed plot samples and this difference is statistically significant for all crop types except groundnut.

The log of household adult male labour hours per acre has a sizeable and positive coefficient that is statistically significant within the male-managed plot samples for all four crop types, while the comparable estimate within the female-managed plot samples is not statistically significant across all the four crop types. In contrast, the log of household adult female labour hours per acre has a positive and statistically significant coefficient across both male and female plot samples for all crop types, with a larger magnitude and statistical significance among female-managed plots. Although household size has a positive coefficient that is statistically significant irrespective of the plot sample, the magnitude of the coefficient within the female-managed plot samples is more than double that within the male-managed plot samples. The coefficient for child dependency ratio has a negative sign for female-managed plot samples across all crop types and the coefficient is consistently statistically significant. For each crop type, the coefficient is also more than double compared to the coefficient for male-managed plot samples. Conversely, the coefficient for child dependency ratio for male-managed plots is positive but statistically insignificant across all crop types. The gender differences in returns to household size and child dependency ratio imply that the burden of childcare is more likely to reduce female agricultural productivity. The decomposition of the mean gender gaps for the different crops, which were estimated at 14.3% for maize; 8.3% for groundnut; 22.3% for tobacco; and 17.6% for cotton, are presented in Panel A in Table 4. Panel B presents the aggregate decomposition components, namely the endowment effect, the male structural advantage, and female structural disadvantage. Panel C includes the results from the detailed decomposition. The aggregate decomposition indicates that the endowment effect (10.2% for maize; 5.1% for groundnut; 17.9% for tobacco; and 13.7% for cotton), i.e. the portion of the gender gap driven by differences in levels of observable attributes, accounts for 71%, 61%, 80% and 78% of the mean gender differential in agricultural productivity for maize, groundnut, tobacco and cotton farming respectively. The female structural disadvantage is estimated at 4.1% for maize; 3.2% for groundnut; 4.4% for tobacco; and 3.9% for cotton farming, explaining the remaining 29%, 39%, 20% and 22% of the gender gap for maize, groundnut, tobacco and cotton respectively. The aggregate decomposition reinforces the notion that large and significant gender disparities in access to inputs and asset ownership are central factors behind the gender gap particularly in the case of maize, tobacco and cotton farming where statistical significance is reported for the mean gender differential in agricultural productivity, the endowment effect and the female structural disadvantage. The key assumptions additionally required by the detailed decomposition are additive linearity and zero conditional mean. In trying to lend support to the ignorability and zero conditional mean assumptions, the methodology applied by Acemoglu *et al.* (2001) and Altonji *et al.* (2005) is used and incorporate into the base specification thematically-grouped control variables such that the results are compared to those from the base specification. The purpose is to gauge the stability of the key regression coefficients that underlie the decomposition results. If the coefficients on the covariates included in the base specification, including the female plot management dummy in the pooled regression, are stable subsequent to incorporation of the additional covariates, they are less likely to change if potentially missing omitted variables are taken into account. The following sets of variables are used to perform this analysis: (i) district fixed effects, (ii) plot geospatial characteristics, informed by GIS data, (iii) other plot characteristics solicited by IHS4, and (iv) additional household characteristic. Results from the regressions including the additional controls for the pooled, male-managed, and female-managed plot samples show that an overwhelming majority of the coefficients, with respect to the base specification, are stable across the specifications and the plot samples, and do not change sign or significance. This suggests that the assumptions of ignorability and zero conditional mean might not be unfounded.

DISCUSSION

Earlier when analysing the study data and descriptives, it was noted that male-managed plots tend to be overseen by individuals that have higher years of schooling and who access agricultural extension more frequently. Male-managed plots also exhibit higher incidence of fertilizer use and higher household adult male labour input per acre. In view of the positive correlation between these covariates and agricultural productivity, I find these variables to be contributing positively towards the endowment effect, thereby widening the gender gap. Conversely, the smaller plot areas farmed by female managers appear to be a contributing factor in shrinking the gender gap given that in these data there is an inverse relationship between cultivated plot area and agricultural productivity for maize and groundnut farming. Furthermore, the higher rate of household adult female labour provision within the female-managed plot samples contributes negatively towards the endowment effect, hence working to close the gender gap. It is not only the difference in the fertilizer endowment that contributes to the gender gap, but also relatively higher return to fertilizer among the male-managed plots in comparison to their female-managed counterparts, particularly for maize, tobacco and cotton farming. The same applies to the log of household adult male labour hours per acre for all four crops. The underlying causes of these findings could potentially be the subject of future research but may indicate household adult male labour supervision difficulties on female-managed plots. The fact that household adult male labour input is associated with a wider gender gap is, however, partially offset by the higher returns that household adult female labour provides on female-managed plots for all four crops. Regarding the child dependency ratio, although the contribution of this factor towards the endowment effect is zero, its contribution towards the female structural disadvantage is large and positive. This is driven by the sizeable and highly significant negative association between this variable and agricultural productivity solely within the female-managed plot samples for all four crops. This result highlights the differential productivity impacts of heterogeneous household roles assumed by male and female managers. Since female managers, who are just as likely to be household heads or spouses, are more likely to combine farm management with household duties particularly in the Malawian rural social setting, including child care, their pattern of time use is directly related to their low productivity outcomes. The structural effect measures the part of the productivity differential attributable to the differences in the returns of the covariates. A positive and significant value will imply that male managers have a structural advantage over female managers in regards to the specific covariate. Household adult female labour input is a key variable that is associated with negative and significant contributions towards both the endowment effect and the male structural advantage component. From Table 4 we see that the magnitude of the relationship between the variable and the endowment effect is higher for male-dominated crops (tobacco and cotton). It is economically significant for all crops and this indicates the importance of household female adult labour in the context of labour market failures and insufficient household male adult labour. The sustained negative contributions towards the male structural advantage components for all the crop types are driven by lower returns to household adult female labour on male-managed plots vis-à-vis pooled and female-managed plots.

Conclusion

The study offers a fresh look at gender differences in agricultural productivity in Malawi using decomposition techniques that identify the relative quantitative importance of factors explaining the gender gap at the mean of the agricultural productivity distribution. The study was carried out using nationally representative data, collected within a multi-topic framework and with emphasis on gender disaggregation of crop farming preferences. Significant gender gaps exist where men are more productive in the cultivation of both male and female dominated crops. The gender gap is estimated at 14.3%, 8.3%, 22.3%, and 17.6% at the mean for maize, groundnut, tobacco and cotton farming respectively. The findings support the view that large and significant gender disparities in use of inputs (particularly fertilizer and labour) is a central factor behind the gender gap. At the mean, the differences in observable covariates (i.e. the endowment effect) are associated with 71%, 61%, 80%, and 78% of the gender gap for maize, groundnut, tobacco and cotton farming respectively. The structure effect, which is driven by gender differences in returns to factors of production, explain 29%, 39%, 20%, and 22% of the gender gap for maize, groundnut, tobacco and cotton farming respectively. Higher levels of household adult male labour on male-managed plots, in particular, widen the gender gap; a result which was consistent for all four crops. These disparities appear to be compounded by gender differences in the availability of time devoted to productive activities, as negative returns to household child dependency ratio on female managed plots are found to exacerbate the female structural disadvantage component of the gender gap. In addition, lower and declining returns to household adult male labour on female managed plots vis-à-vis male managed counterparts across the four crop types might be suggestive of potential household adult male labour supervision difficulties on female managed plots. These mutually reinforcing constraints appear to generate a female productivity trap. This study shows a number of factors that seem to be driving the gender differences in agricultural productivity in Malawi. Diversification among female farmers into high-value agriculture with appropriate adoption support and risk mitigation mechanisms, and counteracting the effects of household male labour shortages on female-managed plots with enhanced access to fertilizer could lead to significant contractions in the agricultural productivity gender gap across several crops. However, this analysis alone is not enough to inform effective policy interventions that will ensure the realization of these outcomes. In other words, while it was possible to quantify the relative contributions of various factors towards the gender gap, it could not be determined why inequalities in time use, access and returns to agricultural inputs, and the like persist. Although this limitation is inherent in the use of decomposition methods, this empirical approach identifies the key inequalities that could be the focus of other worthwhile future research, which could seek to map out their determinants in order to inform policy interventions aimed at addressing the gender gap at its roots in Malawi and other parts of sub-Saharan Africa.

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