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Full Length Research Paper

Maize production differentials among Malawi rural households: A difference in difference estimation approach

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This paper assesses the impact of morbidity and mortality on maize production for affected and non-affected farm households using difference in difference estimation technique. Results show that both affected and non-affected households recorded significantly higher maize production during 2006/07 season compared to 2004/05 season. The results reveal gender discrepancies in production levels for both affected and non-affected households. In general, the difference in differences in maize production for affected and non-affected household over the two periods is not statistically significant. The policy implication is that for the majority of households, prime age mortality raises the demand for labour saving agricultural technology. Secondly, given the gender differentials in impact of morbidity and mortality, there is need to overcome gender barriers to women participation in training programs in crop husbandry practices and access to land.

Key words: Maize production differentials, small farm households, Malawi.

INTRODUCTION

The implications of HIV/AIDS for the demography of rural populations (age and sex composition of rural households, life expectancy of rural inhabitants, etc.) are well known. However, effects of the epidemic on agricultural production are still inadequately understood. One of the reasons is that comprehensive methods of measuring such effects of the epidemic have not been fully developed (Yamano and Jayne, 2004). This paper focuses on measuring the impacts of HIV/AIDS on smallholder agricultural production, as a necessary step in the development, monitoring and evaluation of mitigation efforts.

Malawi is a less developed country in Southern Africa. The agricultural performance from the late 1990s was complicated by difficulties in separating out the effects of poor rainfall and of the different policy changes responding to the perceptions of an imminent food crisis. Maize production increased through the 1990s and into the 2000s despite some years of low production and severe food shortages in the 2000s. Maize production rose at an annual rate of 2.1% per annum between 1990 and 2005. Major contributors to the reported growth in maize production between 1990 and 2000 are two years of very poor rainfall in 1991/92 and 1992/93 which were followed by the two years of good rainfall with universal distribution of small free fertiliser packs in 1998/9 and 1999/2000. According to Food and Agricultural Organization statistics, overall food production grew at a rate of 3.4% per year. On the other hand, per capita production grew at 1.9% per year. Fertilizer application has risen tremendously through the 1990s.In 2005/6, as a result of a poor harvest in 2004/5, the government decided to implement a fertilizer subsidy to promote accessibility and use of fertilizers in maize production in order to increase agricultural productivity and food security. Following a widespread public and government

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perception of largely successful outcomes from the 2005/6 input subsidy programme, there was a general consensus that the programme should be repeated in 2006/7, despite concerns about different aspects of the programme among agricultural input suppliers and opposition parties

Maize production during 2005/6 year was 2.6 million metric tonnes, if it was considered at the time that there was a record of maize crop for Malawi. This was an increase from 1.2 million metric tonnes during 2004/05 season. Production estimates during 2006/7 at 3.4 million metric tonnes showed a considerable further increase. The 2006/07 fertilizer subsidy programme was scaled up by 38,000 metric tonnes of fertilizers. Luckily, the 2006/07 season was blessed with good rains in most parts of the country. The good rains combined with access to fertilizers and improved seeds under the fertilizer subsidy program resulted in increased estimated harvests in the 2006/07 season for all major crops in Malawi

In Malawi, research into the impact of HIV/AIDS is still at an early stage. The only notable contributions on HIV/AIDS impact on agriculture in Malawi is the study by Arrehag et al. (2006). However, there is absence of discussion on the impact of HIV/AIDS on smallholder maize production in Malawi. One main research question arises from this gap: What are the differentials in maize production for the various categories of AIDS- affected households and non-affected households in rural Malawi?

Research objective and questions

The objective of this study is to assess the economic impact of AIDS and non- AIDS related prime-age adult morbidity and mortality on smallholder farm production using difference in difference estimation technique. Specifically, the study seeks to answer the following questions:

1. Does AIDS related morbidity and mortality affect agricultural production?
2. Does non-AIDS related morbidity and mortality affect agricultural production?
3. What are the differentials in maize production between affected and non-affected households?

HIV/AIDS AND SMALLHOLDER AGRICULTURE IN MALAWI

Malawi is one the countries highly affected by HIV/AIDS. It is ranked eighth in terms of highest global prevalence. The national adult HIV/AIDS prevalence in the productive age group of 15 to 49 years declined from 14.4% in 2003 to 11.9% in 2007. About 840,000 individuals are currently living with HIV/AIDS. Women are disproportionately affected by the epidemic. In 2007, about 490,000 women above the age of 14 were living with HIV/AIDS. The most common means of transmission are through multi-partner heterosexual sex and mother-to-child transmission. Prevalence rates are significantly higher in urban areas (20.4%) than in semi-urban (17.0%) and rural areas (13.0%). However, there is evidence that infection rates are growing in rural areas and going down in urban areas. At regional level, the Southern region of Malawi is the most densely populated and has the highest prevalence rate among pregnant women (21.7%). The prevalence rates for pregnant women in northern and central regions are at 14.0 and 14.3%, respectively (Arrehag et al., 2006).

Malawian smallholder agriculture is mostly dominated by large numbers of poor farmers. These farmers are usually engaged in low input maize production on small land holdings, about around 0.35 ha, without the application of chemical fertilizer. Maize production by these farmers is usually not adequate enough to meet annual consumption needs, and they depend upon casual labour and other income generating activities to meet their needs.

From 1998, first universal “starter packs” and then “targeted inputs” of free packs of fertiliser and matching maize seed for 0.1 ha of land were distributed. Maize production and prices fluctuated markedly. During the 2003/4 season, when targeted input programs (TIPs) were implemented, about 40% of smallholder households bought chemical fertilizer at commercial prices, with mean purchases of around 65 kg per household. Food insecurity problems for such farmers have worsened in recent years. This resulted in national food shortages and expensive food imports by government and consequently rising maize prices (MoAFS, 2008).

National maize production during 2004/05 season was low at 1.2 million tonnes. This was due to poor rainfall, late distribution and limited scale of the targeted inputs programme for the 2004/5 season. With slow official importation and emergency response measures, this low production resulted in very serious food shortages and high maize prices in 2005/6.

In 2005/06 season, government put in place a large-scale input subsidy with the objectives of promoting access to and use of fertilizers in maize production in order to increase agricultural productivity and food security. The main objective of the input subsidy program was to raise smallholder productivity, and food and cash crop production; and reducing vulnerability to food insecurity and hunger. Other objectives were to support food self-sufficiency, growth of the private sector input markets, and wider economic growth and development. About 2 million seeds and 3 million fertilizer coupons were initially planned for distribution to targeted households within districts and areas. This was followed by delivery of two sets of NPK and urea coupons. Village Development Committees were charged with the responsibility of assigning coupons to the targeted households at the rate of one NPK (23:21:0) and one urea coupon per household. In practice, allocation procedures varied from area to area, with some local authorities deciding to give one coupon each to a larger number of households. In some areas, there were reports that a large number of coupons were channeled to wrong people. Farmers were required to use fertilizer vouchers in buying fertilizer at MK 950 per 50 kg bag. This represents about 28% of the full cost, with government paying for the remaining 72% of the cost (MoAFS, 2008).

Altogether, about 75,000 t of fertilizer and 4,500 t of improved maize seed were distributed. However, distribution of inputs in the southern region was delayed for a number of reasons. These included late purchase of fertilizer, late issue of coupons, and late opening of markets. This, together with inadequate stocks in some markets, resulted in the majority of farmers spending long periods queuing up for their inputs. This resulted in late planting and/or fertilizer applications. The total expenditure amounted to MK 10.3 billion (about US$ 91 million) was spent, of which 87% came from the Malawi Government. As a result of supplementary coupons, fertilizer sales were 17% above budget while the Government expenditures were 25% over the budgeted cost (MoAFS, 2008).

The analysis of available evidence shows that the programme has a lot of potential to contribute positively to government's objectives of increasing crop production, food security and pro-poor growth. For instance, the 2005/06 and 2006/07 TIPs made a positive contribution toward the achievement of those objectives. However there are also several improvements that could increase the programme's effectiveness and efficiency. The Ministry of Agriculture and Food Security (MoAFS) (2008) estimated total maize production of 2.7 and 3.4 million tonnes during 2005/6 and 2006/7 respectively, both record harvests and markedly higher than the 1.2 million tonnes estimate for 2004/5. The increase in maize production that can be attributed to the 2006/7 subsidy is estimated at 670,000 t, with a low estimate of just over 5000,000 t and a high estimate of just below 900,000 t. The wide range is because the estimates are sensitive to estimated rates of displacement of commercial fertilizer sales by subsidized sales, and assumptions about the effectiveness of additional fertilizer and seed in improving yields

LITERATURE REVIEW AND STUDY FRAMEWORK

Empirical literature

A number of studies have analyzed the impact of HIV/AIDS on small-scale agricultural production. Thangata et al. (2007) assess the impact of HIV/AIDS on improved fallow adoption, food production and food security in Malawi. They use cross sectional data in central district of Malawi. They employed an ethnographic linear programming model for a representative household with three scenarios: No illness, adult female illness and adult male illness. The results indicate that gender of the patient is an important factor in determining the impact of HIV/AIDS on food production. Sickness and subsequent death of a male head of household results in reduction of available field labour is as family members are expected to care for him. As a result, less food and cash crops are produced, which creates a food insecure household. Yamano and Jayne (2004) use a two-year panel survey of 1,422 households between 1997 and 1998 to study the impact of prime-age adult mortality on farm production. They employ the difference-in-difference estimation technique. Among households suffering the death of a working age woman, the gross value of total output per acre increased significantly. On the other hand, households suffering the death of a working age man experienced a decline in total output by 57%, switching from high value crops to cereals after death of a prime-age man. Asingwire and Kyomuhendo (2003) analyze the impact of HIV/AIDS on agricultural (crop, fishing, and livestock) production in Uganda. They use cross-sectional data involving 313 households from three districts using both quantitative and qualitative methods. Their results show that 77% of the households reported reduction in agricultural production due to effects of HIV/AIDS. Over one-quarter of the affected households reported death of livestock due to lack of care and poor management practices as a result of sickness and death of household members. SADC FANR Vulnerability Assessment Committee (2003) investigates the extent of the contribution of HIV and AIDS to the depth of problems faced by rural households in Southern Africa in the context of the 2002 food emergency. They use data generated from emergency food security assessments conducted in Malawi and Zambia in August and December 2002 and from Zimbabwe in August 2002. Results show that affected households suffered from marked reductions in agricultural production and income generation, leading to earlier engagement in distress strategies, and, ultimately, a decline in food security. Manther 2004 examines the household responses to prime age mortality in rural Mozambique. He uses a nationally representative rural household panel survey for the period 1999 and 2002. Results show that 44% of affected households indicated crop area reduction while 22% indicate reduced weeding

In general, there is consensus in literature that among the adverse impacts of HIV/AIDS on smallholder agriculture is reduction in crop production.

Theoretical model

This study use difference in difference (DD) estimation method to investigate the impact of HIV/AIDS related morbidity and mortality on farm production.

Difference in difference model

Following influential work by Ashenfelter and Card (1985), the use of difference-in-differences methods has become very common. The most basic case of difference in difference estimation is where outcomes are observed for two groups for two time periods.

The standard case has outcomes which are observed for two groups. One of the groups is subjected to a treatment in the second period but not in the first period. On the other hand, the second group is not subjected to the treatment in either period. In cases where the same units within a group are observed during each time period (as in panel data), the average gain in the second (control) group is subtracted from the average gain in the first (treatment) group. This removes biases in second period from comparisons between the treatment and control group coming from permanent differences between those groups. It also removes biases from comparisons over time in the treatment group coming from trends (Yamano and Jayne, 2004).

We use a counterfactual framework approach in which each household has an outcome, either with or without treatment. The treatment group contains households affected by HIV/AIDS related chronic illness or death (Treat). The comparison group is made up of households affected by non-HIV/AIDS related chronic illness or death (Control). If it was possible, we would have preferred assessing the impact of HIV/AIDS on the same households under the same circumstances. However, this is not practical as a household cannot be in treatment and control groups at the same time (Chapoto and Jayne, 2005). Difference in difference estimates and standard errors for these estimates are estimated using Ordinary Least Squares (OLS) in repeated cross-sections (or a panel) of data on individuals in treatment and control groups for several years before and after a specific intervention. Assuming repeated cross sections, and assuming A is the control group, we can write the model for a standard member of any of groups as,

$$y = \alpha_0 + \alpha_1 dQ + \lambda_0 d2 + \lambda_1 d2 * dQ + u \tag{1}$$

where y is the variable of interest and *d*2 is a dummy variable for the second time period. The dummy variable dQ represents possible differences between the treatment and control groups before the change in policy. The time period dummy, *d*2, captures aggregate factors that would cause changes in *y* even in the absence of a policy change. The coefficient of interest, 1, multiplies the interaction term, $d2 * dQ$. This is the same as a dummy variable being equal to one for observations in the treatment group in the second period. The difference-in-differences estimate is λ_1 (Yamano and Jayne, 2004).

One way of getting unbiased estimates of prime-age adult morbidity and mortality is by using difference-in-differences (DID) estimation. In order to get the difference-in-differences estimator, we take the difference in one outcome before (t = 0) and after (t = 1) the prime-age adult morbidity or mortality within the treatment group e.g. $E(\Delta Y_{Treat}) = E(Y_{Treat1}) - R(Y_{Treat0})$. It is likely that this estimator may pick up time trends or impacts of shocks that are not related to HIV/AIDS. In order to remove these unrelated trends or impacts, we also take the difference in outcomes within the control group (*control*) over time and then take the difference-in-differences between the two groups (Yamano and Jayne, 2004):

$$E(DID) = E[(Y_{Treat1}) - E(Y_{Treat0})] - [E(Y_{Control1}) - E(Y_{Control0})]$$
$$= E(\Delta Y_{Treat}) - E(\Delta Y_{Control}) \tag{2}$$

Following Yamano and Jayne (2004), we can further analyze HIV/AIDS impact by the gender of the household head. Thus we have two treatment groups: Households with the male headed households (M) and female headed households (F). We estimate the DID for each treatment group:

$$E(DID^M) = E(\Delta Y^M_{Treat}) - E(\Delta Y^M_{Control}), \quad \text{and}$$
$$E(DID^F) = E(\Delta Y^F_{Treat}) - E(\Delta Y^F_{control}) \tag{3}$$

We assume that there are no changes in household-level variables that are exogenous to the impacts of adult morbidity and mortality in the household.

DATA SOURCES AND METHODOLOGY

This study used two-year panel data from Integrated Household Surveys that were conducted by the Malawi National Statistical Office in collaboration with the World Bank in 2004/05 and 2006/07.

The 2004/05 survey collected information from a nationally representative sample of 11,280 households. It was designed to cover a broad range of issues, with primary objective of providing a complete and integrated data set to better understand the socio-economic status of the population in Malawi (National Statistical Office (NSO), 2005). The questionnaire covered the socio-economic characteristics of the household on the following aspects: demographic, education, health, agriculture, and anthropometric information, among other attributes (Integrated Household Survey, 2004/05). The demographic characteristics observed include: Age, sex, relationship to household head, marital status and place of residence, household size, and deaths in the households (NSO, 2005).

Each of the twenty-seven districts in Malawi was treated as a separate sub-section of the main rural stratum (except for Likoma district). The household survey used a two-stage stratified sample selection process. The primary sampling units (PSU) were the

Table 1. Difference in difference estimations of maize production.

Maize production (no. of 50 kg bags)	Affected		Non-affected	
All household	**2004/05**	**2006/07**	**2004/05**	**2006/07**
All households	24.50(1.73)	57.26(3.90)	24.94(1.40)	54.09(2.63)
Female headed	21.57(2.47)	55.69(8.52)	18.51(2.89)	50.91(6.20)
Male headed	25.94(1.66)	57.71(4.40)	26.24(2.06)	55.03(2.87)
Mortality	23.43(4.16)	62.77(16.61)	18.50(1.43)	45.73(4.63)
Female headed	18.47(3.83)	76.09(26.53)	12.43(1.60)	27.68(6.38)
Male headed	28.03(7.13)	51.22(5.57)	20.19(1.75)	51.35(5.57)
Household head mortality	14.51(2.45)	68.85(38.27)	18.86(1.76)	45.33(5.57)
Female headed	16.02(3.48)	92.28(56.21)	13.98(2.40)	28.65(9.90)
Male headed	32.53(8.62)	58.53(26.17)	20.75(3.13)	56.89(11.24)
Adult child mortality	27.88(5.89)	59.89(17.32)	17.24(2.33)	46.15(8.01)
Female headed	23.6(6.99)	70.13(17.75)	10.85(2.08)	21.95(5.65)
Male headed	32.54(8.62)	58.53(26.18)	20.75(3.75)	56.89(11.24)
Morbidity	25.12(1.49)	56.70(3.97)	26.65(2.27)	56.82(3.34)
Female headed	22.31(2.93)	50.78(8.45)	20.74(3.88)	60.02(8.05)
Male headed	25.81(1.71)	58.15(4.49)	28.36(2.70)	56.32(3.35)
Household head morbidity	24.92(1.87)	48.67(4.25)	26.93(2.55)	56.59(3.33)
Female headed	20.88(3.38)	57.71(12.51)	21.30(4.13)	59.31(8.13)
Male headed	25.79(2.16)	46.74(4.43)	28.72(3.09)	55.72(3.56)
Adult child morbidity	25.50(2.44)	72.41(8.05)	24.80(3.70)	60.65(9.65)
Female headed	24.39(5.33)	40.70(9.88)	12.54(2.92)	70.54(45.87)
Male headed	25.85 (2.76))	82.24 (9.83))	26.30(4.08)	59.50(9.63)

The figures in brackets are standard errors.

Enumeration Areas (EAs). These were chosen for each stratum based on probability proportional to size (PPS). The second stage involved randomly selecting 20 households in each EA. Every listed household in an EA had the same chance of being selected to be enumerated (NSO, 2005).

Out of the total 11,280 households selected, 10,777 households were occupied and successfully interviewed, resulting in a response rate of 98%. Of the selected households, 507 replacements were made. The main reason for replacement was that the dwelling could be located but no household member was available after repeated attempts or the dwelling was not occupied. There were only 41 refusals from respondents (NSO, 2005).

A follow-up national survey was carried out in 2007. About 3,298 households were re-interviewed in 175 enumeration areas in 28 districts. Of these, 3,100 were previously sampled and interviewed in the 2004 Integrated Household Survey. Households and enumeration areas within each district were chosen randomly. After excluding households with missing information, obvious data errors, those who stated that they farmed over 20 ha of land, and those that could not be properly matched between the two surveys, the sample was reduced to 2,431 households (NSO, 2008).

Thus, final analysis is based on the balanced panel of 2,431 households in the smallholder sector that were both interviewed in 2006/07 and either 2002/03 or 2003/04. For 1,101 of these households, information on crop production and input use relates to the 2002/03 and 2006/07 years. Information on the remaining 1,330 households pertains to the 2003/04 and 2006/07 years (NSO, 2008).

Data used in the study will be input and output of production and social economic variables. Input variables include cultivated land area (in hectares, ha) or farm size. In Malawi, farm sizes have been described as small. Chirwa (2003) found that the average farm size was 0.35 ha. Labour (person-hours) constitutes the most important input in small-scale agriculture. Hence any constraint on availability of labour is detrimental to farm productivity. Labour input can be sourced from within the family (family labour) or from the commercial pool (hired labour). The amount of person-days of family labour that can be engaged by farmers depend on household size, the age structure of the household and the primary occupation of the household members if family labour is in short supply, farmers resort to hired labour. The amounts of persons-days of hired labour that can be committed to production depend on the availability of hired labour, farm wage rate among other factors. The quantity and type of seed applied depend on size of the farm, availability of seed, seed variety, price per kilograms. Fertilizer is measured in kilograms per hectare. Maize output is measured in kilograms per hectare.

Social-economic variables include age, gender and education. Education plays an important role in skill acquisition and technological transfer. Farmers with higher levels of education are likely to be more efficient in the use of inputs than their counterparts.

EMPIRICAL RESULTS

Results on mean production differences are shown in Tables 1 to 6. For all households, the difference in mean production between affected and non-affected households during the first year is statistically not significant, with both affected and non-affected recording mean maize harvests of 25 bags (of 50 kg) per hectare. For

Table 2. Difference in differences in mean production for all households.

Regress ly pt treat post			
Source	SS	df	MS
Model	218.280831	3	72.7602771
Residual	1824.57917	1543	1.18248812
Total	2042.86	1546	1.32138422

ly	Coef.	Std. Err.	t	P>|t|	[95% Conf. Interval]	
pt	-0.1126699	0.1135908	-0.99	0.321	-0.3354786	0.1101387
treat	0.089602	0. 0799503	1.12	0.263	-0.0672207	0.2464247
post	0.792019	0.0705652	11.22	0.000	0.6536052	0.9304329
_cons	2.695565	0.0496338	54.31	0.000	2.598208	2.792922

Number of obs = 1547; F(3, 1543) = 61.53; Prob > F = 0.0000; R-squared = 0.1069; Adj R-squared = 0.1051; Root MSE = 1.0874. ly=log of maize production/output; pt=difference in difference coefficient, pt = the difference in difference coefficient; The t-statistic represents t-test for equality of the differences. pt = post*treat; treat = 1 if the observation is in the treatment (affected) group, and 0 otherwise; post = 1 if the observation is in the post period (2006/07) and 0 otherwise. _const stands for the constant coefficient; the rest come from the difference in difference regression.

Table 3. Difference in mean production for female headed households.

Source	SS	df	MS
Model	48.4280463	3	16.1426821
Residual	436.478619	284	1.53689655
Total	484.906665	287	1.68957026

ly	Coef.	Std. Err.	t	P>|t|	[95% Conf. interval]	
pt	-0.2261871	0.3050217	-0.74	0.459	-0.8265773	0.374203
post	0.8961141	0.1896916	4.72	0.000	0.5227342	1.269494
treat	.3122289	0.2340012	1.33	0.183	-.1483679	.7728257
_cons	2.372684	0.146102	16.24	0.000	2.085104	2.660265

Number of obs = 288; F(3, 284) = 10.50; Prob > F = 0.0000; R^2 = 0.0999; Adj R^2 = 0.0904; Root MSE = 1.2397. ly=log of maize production/output; pt=difference in difference coefficient, pt = the difference in difference coefficient; The t-statistic represents t-test for equality of the differences. pt = post*treat; treat = 1 if the observation is in the treatment (affected) group, and 0 otherwise; post = 1 if the observation is in the post period (2006/07) and 0 otherwise. _const stands for the constant coefficient; the rest come from the difference in difference regression.

both affected and non-affected households, mean production is significantly higher in second year compared to first year, with affected and non-affected households realising maize harvests around 57 and 54 bags per hectare, respectively. Thus the difference in mean production during 2006/07 season between affected and non-affected households is not statistically significant. Similarly, the difference in differences in mean maize harvests between affected and non-affected households over the two periods is not statistically significant (Table 2).

By gender, female headed affected households recorded mean production of around 21 bags per hectare during 2004/05 season, three more bags than mean production level for their non-affected counterparts. During 2006/07 season, maize harvest for affected and non-affected rose significantly to 55 and 50 bags per hectare, respectively. However, the difference in differences in mean production between affected and non-affected households over the two periods is not statistically significant (Table 3).

For male headed households, affected households and non-affected households recorded almost similar mean production of about 26 bags per hectare during 2004/05 season. During 2006/07 sesaon, mean productions for female and male headed households increased significantly to 57 and 55 bags per hectare, respectively. However, the difference in difference in mean maize production over the two periods is not significant (Table 4). Thus in general, male headed households and affected households recorded higher maize production than female headed and non-affected households, respectively.

Results by mortality indicate that affected households recorded mean productions of around 23 and 62 bags per hectare during 2003/04 and 2006/07 sesaons,

Table 4. Difference in mean production for male headed households.

Regress ly pt post treat			
Source	**SS**	**df**	**MS**
Model	165.534375	3	55.1781248
Residual	1339.36182	1196	1.11986775
Total	1504.8962	1199	1.2551261

ly	Coef.	Std. Err.	t	P>|t|	[95% Conf. interval]	
pt	-0.1066982	0.1253669	-0.85	0.395	-0.3526617	0.1392652
post	0.7824135	0.0781252	10.01	0.000	0.6291358	0.9356912
treat	0.0425431	0.0882264	0.48	0.630	-0.1305528	0.2156389
_cons	2.777119	0.054941	50.55	0.000	2.669327	2.88491

Number of obs =1200; F(3, 1196) = 49.27; Prob > F = 0.0000; R^2 = 0.1100; Adj R^2 = 0.1078; Root MSE = 0582. ly=log of maize production/output; pt=difference in difference coefficient, pt = the difference in difference coefficient; The t-statistic represents t-test for equality of the differences. pt = post*treat; treat = 1 if the observation is in the treatment (affected) group, and 0 otherwise; post = 1 if the observation is in the post period (2006/07) and 0 otherwise. _const stands for the constant coefficient; the rest come from the difference in difference regression.

Table 5. Difference in differences by mortality.

Regress ly pt treat post			
Source	**SS**	**df**	**MS**
Model	50.6729812	3	16.8909937
Residual	323.99594	298	1.0872347
Total	374.668921	301	1.24474725

ly	Coef.	Std. Err.	t	P>|t|	[95% Conf. interval]	
pt	-0.0755409	0.3131662	-0.24	0.810	0.6918384	0.5407566
treat	0.1081288	0.2212822	0.49	0.625	-0.327345	0.5436026
post	.8303141	.132428	6.27	0.000	.5697015	1.090927
_cons	2.558578	.0932624	27.43	0.000	2.375041	2.742114

Number of obs = 302; F(3, 298) = 15.54; Prob > F = 0.0000; R^2 = 0.1352; Adj R^2 = 0.1265; Root MSE = 1.0427. ly=log of maize production/output; pt=difference in difference coefficient, pt = the difference in difference coefficient; The t-statistic represents t-test for equality of the differences. pt = post*treat; treat = 1 if the observation is in the treatment (affected) group, and 0 otherwise; post = 1 if the observation is in the post period (2006/07) and 0 otherwise. _const stands for the constant coefficient; the rest come from the difference in difference regression.

Table 6. Difference in differences by morbidity.

. reg ly pt treat post			
Source	**SS**	**df**	**MS**
Model	161.067721	3	53.6892403
Residual	1417.92842	1200	1.18160702
Total	1578.99614	1203	1.31254875

ly	Coef.	Std. Err.	t	P>|t|	[95% Conf. Interval]	
pt	-0.1064046	0.1260752	-0.84	0.399	-0.3537569	0.1409478
treat	0.0530402	0.0874123	0.61	0.544	-0.1184576	0.2245381
post	0.7784002	0.0847935	9.18	0.000	0.6120403	0.9447601
_cons	2.7438	.0576929	47.56	0.000	2.63061	2.85699

Number of obs = 1204; F(3, 1200) = 45.44; Prob > F = 0.0000; R^2 = 0.1020; Adj R^2 = 0.0998; Root MSE = 1.087. ly=log of maize production/output; pt=difference in difference coefficient, pt = the difference in difference coefficient; The t-statistic represents t-test for equality of the differences. pt = post*treat; treat = 1 if the observation is in the treatment (affected) group, and 0 otherwise; post = 1 if the observation is in the post period (2006/07) and 0 otherwise. _const stands for the constant coefficient; the rest come from the difference in difference regression.

respectively. This is higher than mean productions for non-affected households of around 18 bags per year and 45 bags per year during 2004/05 and 2006/07 seasons, respectively. Both affected and non-affected households recorded higher mean production during 2004/05 and 2006/07 seasons than productions for non-affected households. Households with household head mortality recorded higher mean production during 2006/07 compared to households with adult mortality. In general, the difference in differences in mean production levels over the two years is not statistically (Table 5).

Results by morbidity indicate that affected households and non-affected households recorded mean productions of around 25 and 56 bags per hectare during 2004/05 and 2006/07 agricultural seasons. Thus for both affected and non-affected households, mean productions during 2006/07 were significantly higher than the levels during 2004/05. Unlike households with mortality, households with adult morbidity recorded higher mean productions during the two periods compared to households with household head morbidity. In general, male headed households recorded higher production levels than their female headed counterparts. However, the difference in differences in mean production over the two periods is not significant (Table 6).

SUMMARY AND POLICY IMPLICATIONS

This study examines the impact of adult morbidity and mortality on farm production using difference in difference estimation technique.

The results show that the effects of morbidity and mortality on maize crop production are sensitive to the gender of the household head. Affected and non-affected male headed households recorded higher production compared to female headed households. Similarly, households with morbidity recorded higher production compared to those with mortality. A non-significance in difference in differences in mean production for affected and non-affected households under imply that over the years, both HIV/AIDS related and non-HIV/AIDS related mortality and morbidity have the same impact of stagnating production.

The results questions the usefulness of a uniform way of treating 'affected households,' especially when crafting proposals for targeted assistance. The implications of this heterogeneity are fundamental for the design of HIV/AIDS mitigation strategies, as well as for considering the HIV/AIDS epidemic within the context of rural poverty alleviation and growth strategies.

The results also reveal the value of representative survey research in assessing impacts of prime-age adult mortality and morbidity. An investigation of the characteristics of individuals and households affected, including demographic, morbidity, mortality and production data collected regularly in household surveys is a relatively cost-effective way of investigating characteristics of affected households and measure morbidity and mortality impacts.

Given the gender differentials in impact of morbidity and mortality, there is need to overcome gender barriers to women participation in training programs in crop husbandry practices. Given that female headed households possessed lower landholdings compared to male headed households, there is need to modify rules regarding women's rights and access to resources by working with communities to ensure that widows have access to land. Finally, for the majority of households, prime age mortality raises the demand for labour saving agricultural technology. This calls for more studies on the feasibility of alternative crop technologies especially for households facing labour and capital constraints from prime age mortality.

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