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TECHNICAL EFFICIENCY DIFFERENTIALS AMONG HIV/AIDS AFFECTED FARM HOUSEHOLDS IN MALAWI: EVIDENCE FROM TIME VARIANT AND INVARIANT INEFFICIENCY MODELS

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ABSTRACT

The Malawi Government has made various attempts to raise the productivity of the agricultural systems in the country. However, the impact of this effort within the context of HIV/AIDS epidemic has not been investigated. This paper examines the levels of efficiency for affected and non-affected small-scale farm households in Malawi. Time-variant and invariant inefficiency models of production were used. Results show that the technical efficiency levels for non-affected households were higher than those of the affected households. In general, Malawian farmers are technically efficient, implying that government policy of subsidising hybrid maize seeds and fertilisers since the 2006/06 agricultural season enhanced technical efficiency of small-scale farmers. Nevertheless, there was more scope for improvement of the productivity as some farm households, particularly affected female headed households that had cases of mortality of a prime adult member, were still operating at low levels of efficiency. Two main policy issues emerge from this study. First, all types of obstacles that could limit the use of farm inputs should be removed. This should include complete liberalisation of purchase and distribution of such inputs and the development of some low-cost technology to reduce labour constraints on the farm. Second, there is need to develop social capital in smallholder farming through the recommencement of farmers' clubs, or by setting up agricultural cooperatives.

Key Words: Fertilisers, social capital, subsidiary, technical efficiency

RÉSUMÉ

Le gouvernement de Malawi a plusieurs fois tenté d'augmenter la productivité des systèmes agricoles dans le pays. Cependant, l'impact de cet effort dans le contexte de l'épidémie du VIH/SIDA n'a pas été abordé. Cet article examine les niveaux de l'efficacité des ménages de petits fermiers affectés et non affectés au Malawi. Les modèles de production du *Time-variant and invariant inefficiency* étaient utilisés. Les résultats montrent que les niveaux d'efficacité technique de ménages non affectésétaient plus élevés que ceux des ménages affectés. En général, les fermiers malawites sont techniquement efficients, impliquant que la politique gouvernementale en matière de subsides des semences hybrides de maïs et fertilisants depuis la saison culturale Juin 2006 a amélioré l'efficience technique des petits fermiers. Néanmoins, il n'avait aucune possibilité d'amélioration de la productivité comme c'est le cas de quelques ménages des fermiers, particulièrementles femmes responsables des ménages affectés par la mortalité de leurs partenaires, avec des niveaux bas d'efficience. Deux problèmes liés à la politique agricole ont été évoqués dans cette étude : d'une part, tous les obstacles limitant l'usage des intrants agricoles devront être enrayés. Ceci implique une complète libéralisation d'achat et distribution d'intrants et le développement des technologies moins chères afin de réduire les contraintes de la main d'œuvre. D'autre part, il est impérieux de développer le capital social dans les petites exploitations par la création des clubs des fermiers, ou par établissent des coopératives agricoles.

Mots Clés: Fertilisants, capital social, subside, efficience technique

INTRODUCTION

The prevention and mitigation of human immunodeficiency virus (HIV/AIDS) requires a multisectoral approach. Research into the socio-economic impact of HIV/AIDS on households and communities is essential for formulation of policies and intervention strategies intended to mitigate this impact. HIV/AIDS is known to severe agriculture and rural welfare. There is need to distinguish between mortality and morbidity that is HIV/AIDS related and that which is not. Empirical knowledge on how rural households respond to HIV/AIDS remains weak.

Several studies in Africa are beginning to offer micro-level insights on the impacts of HIV/AIDS on farm households and their responses (Chamunika, 2006; Adeoti and Adeoti, 2008; Nguthi and Niohoff, 2008). However, most of these studies are faced with at least three major problems. First, they use data from specific geographical sites, deliberately chosen because they were associated with high infection rates. Although they suggest valuable insights into how affected households respond to the disease, such studies are limited in their ability to generalise understanding of national level impacts (Chapoto and Jayne, 2005).

Second, only a few studies on this topic are based on panel data (Mather 2004; Yamano and Jayne, 2004; Chapoto and Jayne, 2005; Donovan and Manther, 2008). Unfortunately, cross-sectional surveys cannot adequately measure the dynamic effects of mortality and morbidity, let alone control for unobserved heterogeneity. Almost all quantitative micro-level studies to-date have estimated the effects of mortality in affected households compared to non-affected households (Chamunika, 2006; Adeoti and Adeoti, 2008; Nguthi and Niohoff, 2008). However, there are no studies that distinguish morbidity and mortality that is HIV/AIDS related, from one that is not. Furthermore, relatively few studies provide adequate focus and empirical technical efficiency of production and gender aspects of the HIV/AIDS impact on households (Chapoto and Jayne, 2005).

In Malawi, research into the impact of HIV/AIDS is still at an early stages. The only notable contributions on HIV/AIDS impact on agriculture in Malawi is by Arrehag *et al.* (2006). Their findings show that poor households with small economic buffers are particularly exposed to the economic consequences of HIV/AIDS. For these, illness and death in the family due to HIV/AIDS often entails economic disaster as they are forced to sell off precious productive assets such as land and cattle. However, there is absence of discussion on the impact of HIV/AIDS on technical efficiency of farmers. This paper addresses the impact of HIV/AIDS related and non- HIV/AIDS related prime-age adult morbidity and mortality on the technical efficiency of smallholder agricultural farmers in Malawi.

METHODOLOGY

The survey. This study used 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 agricultural seasons.

The 2004/05 survey collected information from a national representative sample of 11,280 households. It was designed to cover a broad range of issues, with the primary objective of providing a complete and integrated dataset to better understand the socio-economic status of the population in Malawi, including HIV/AIDS affected and non-affected households .

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

Out of the 11,280 households, 10,777 households were successfully interviewed, resulting in a response rate of 98 percent. Of the selected households, 507 replacements were made. This was due to the fact that the dwelling could be located but no household member was available to participate after repeated attempts to meet them, or the dwelling was not occupied. A follow-up national survey was carried out in 2007. A total of 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 hectares of land, and those that could not be properly matched between the two surveys, the sample was reduced to 2,431 households (NSO and World Bank, 2008).

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

Model. In this study, we followed Battese and Coelli (1988) stochastic production frontier for panel data. The general functional form for the stochastic frontier model is the trans-logarithmic function (Battese and Coelli, 1988):

$$\ln y_{it} = \beta_0 + \beta_0^* D_{it} + \beta_1 \sum_{j=1}^{5} \beta_j x_{jit} + \sum_{j\leq}^{5} \sum_{k=1}^{5} \beta_{jk} x_{jit} x_{kit} + (v_{it} - u_{it})$$

.... (1)

where:

(i) Subscripts *i* and *t* represents the *i*-th farm household and the *t*-th year of observation, respectively;

(ii) y stands for the logarithm of quantity of maize harvested (in kilogrammes);

(iii) *D* is the dummy variable for use of hybrid maize, which takes the value of 1 if hybrid maize was used; and 0 otherwise;

(iv) x_1 stands for the logarithm of the total amount of land (in hectares) on which maize was grown;

(v) x_2 is the logarithm of the total amount of labour (in man days) from both family and hired labour;

(vi) x_3 is the logarithm of the amount of fertiliser (kg) applied to the maize field;

(vii) x_4 is the logarithm of the quantity of maize seed sown (in kg);

(viii) x_5 is the year of observation, accounts for Hicksian neutral technological change; where x_5=1, 2 for years, 2004/05 and 2006/07, respectively; and

(ix) v_{it} and μ_{it} are the random variables defined above.

The disturbance term in a stochastic frontier model is assumed to have two components. The model is based on the following assumptions about the error terms: one component is assumed to have a strictly nonnegative distribution, while the other is assumed to have a symmetric distribution. The nonnegative component is usually referred to as the inefficiency term Battese and Coelli (1988).

The first-order terms in the translog frontier, defined by Equation (1), are included in the modified Cobb-Douglas frontier considered in Battese *et al*. (1996), but this frontier includes additional variables involving the ratio of hired labour to total labour, the logarithm of land preparation, the logarithm of the number of ploughings and dummy variables associated with the use of mechanical traction and the tenancy status of farmers. The model for the technical inefficiency effects in the stochastic frontier of Equation (1), is defined by:

$$u_{it} = \delta_0 + \delta_1(age_{it}) + \delta_2(edu_{it}) + \delta_3(t_i) + w_{it}$$

.... (2)

where age_{it} and edu_{it} represent, respectively, the age and years of formal education of the primary decision maker at the t-th year of observation.

RESULTS AND DISCUSSION

Technical efficiency. Table 1 presents the technical efficiency levels of HIV/AIDS-affected and non-affected households in Malawi. The mean technical efficiencies of non-affected households under time varying and invariant models were at 73 and 75%, respectively. These efficiency levels were higher than those of HIV/AIDS-affected households, under both models, at 69 and 71%, respectively (P<0.1). The results are in line with the findings on technical efficiency levels of Adeoti and Adeoti (2008) and Yusuf *et al.* (2007), in which the technical efficiency levels of HIV/AIDS-affected households were lower than those of non-affected households. Male headed households were technically more efficient than female headed ones for both affected and non-affected households. Similarly, households with morbidity were technically more efficient than those with mortality.

In general, Malawian farmers were technically efficient and the mean technical efficiency levels of over 65% were relatively higher than those obtained in Tchale (2009) using national survey for 2004/04, and in Chirwa (2003 Unpublished) for a cross-section of Malawian farmers in one district in Southern Malawi. This could be attributed to the role of the enhanced Government fertiliser subsidy programme. Nevertheless, the mean technical efficiency levels were comparable with those obtained for other African countries, whose means ranged from 55 to 79% (Obwona, 2006; Ogundele, 2006; Nchare, 2007; Yusuf *et al.*, 2007; Adeoti and Adeoti, 2008; Al-Hassan, 2008). These studies were conducted on farm households in African countries. For instance Yusuf *et al.* (2007) and Adeoti and Adeoti (2008) conducted studies on HIV/AIDS-affected and non-affected farm households in Nigeria. Other studies estimated technical efficiency of farmers in Malawi without examining their health status (Chirwa, 2007; Tchale, 2009).

It is also clear that female headed households had lower technical efficiency levels compared to male headed ones, for both HIVAIDS-affected and non-affected households with both morbidity and mortality. For both HIV/AIDS-affected and non-affected households, the mean technical efficiency levels of the households with morbidity were statistically higher than the levels of households with mortality. The lowest mean technical efficiency recorded was for HIV/AIDS-

TABLE 1. Technical efficiency levels for HIVAIDS-affected and non-affected farm households in Malawi

Attribute	Time-varying model		Time- invariant model		t-test
	Affected	Non-affected	Affected	Non-affected	H0: diff=0; Prob (|T|>0 Ha: diff>0 Ho:diff=0; prob (|T|>|t|)
All households	0.693 (0.006)	0.731 (0.119)	0.7129 (0.082)	0.7524 (0.142)	0.04 (0.9564)
Female headed	0.652 (0.02)	0.701 (0.012)	0.67159 (0.1982)	0.7255 (0.106)	0.05 (0.9521)
Male headed	0.726 (0.21)	0.758 (0.022)	0.78003 (0.125)	0.812 (0.0504)	0.032 (0.9608)
Mortality	0.456 (0.044)	0.526 (0.048)	0.51358 (0.0639)	0.6574 (0.052)	0.071 (0.9451)
Female headed	0.296 (0.072)	0.325 (0.057)	0.3015 (0.223)	0.3371 (0.184)	0.029 (0.9643)
Male headed	0.521 (0.056)	0.601 (0.073)	0.5562 (0.067)	0.664 (0.085)	0.081 (0.9315)
Morbidity	0.725 (0.007)	0.733 (0.014)	0.754 (0.092)	0.7684 (0.0671)	0.008 (0.9688)
Female headed	0.648 (0.025)	0.711 (0.012)	0.70285 (0.0127)	0.7448 (0.027)	0.063 (0.9507)
Male headed	0.742 (0.006)	0.753 (0.022)	0.7673 (0.008)	0.775 (0.069)	0.011 (0.9685)

Figures in brackets are standard errors; **; * means significant at 5 and 10% levels, respectively affected female headed households with mortality at 29%. At this level, these households were technically inefficient.

Determinants of technical efficiency. Fertiliser, labour, seeds and age contributed most to technical efficiency for affected households under both time varying and invariant models (Tables 2-4). These results are largely attributed to female affected households as land and fertiliser were the only significant variables for affected male headed households. The insignificance of land variable among female headed households could be attributed to the fact that among patrilineal families, only male family members have inheritance rights to land. On the other hand, only fertiliser and land contributed significantly to technical efficiency of non-affected smallholder farmers under time varying model. Again, this is mainly attributable to male headed households due to inheritance rights to land. The findings differ with other studies on Malawi by Tchale (2009), whose study showed that only education level of household head was significant. They also differ with Chirwa (2007) who used a small sample of smallholder farmers in one of the districts in Southern Malawi, and found labour as the only statistically significant variable. Obwona (2006) in Uganda indicated that education had a significant impact on technical.

TABLE 2. AIDS-affected households – time varying inefficiency model results for households in Malawi

Time-varying decay inefficiency model	Number of obs =	410
Group variable: id	Number of groups =	263
Time variable: t	Obs per group: min =	1
	avg =	1.6
	max =	2
	Wald chi2(8) =	196.51
Log likelihood = -515.64965	Prob > chi2 =	0.0000

ly |	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
lh |	.1059402	.1031257	1.03	0.304	-.0961825	.3080629
lb |	.2973416	.0896894	1.31	0.191	-.0584464	.2931296
lf |	.4318217	.0441411	9.78**	0.000	.3453068	.5183367
ls |	.2530484	.0914311	1.67*	0.094	-.0261534	.3322501
t |	.2125243	.1411019	1.79	0.074	-.0240303	.5290789
sex |	.0596876	.114341	0.52	0.602	-.1644166	.2837919
age |	.0012207	.0027493	0.44	0.657	-.0041679	.0066093
edu |	-.0653894	.0735749	-0.89	0.374	-.2095936	.0788147
_cons	4.229109	.4277983	9.89	0.000	3.390639	5.067578
/mu |	-2.513486	8.383145	-0.30	0.764	-18.94415	13.91718
/eta |	-.4898009	.3190093	-1.54	0.125	-1.115048	.1354459
/lnsigma2 |	.8361765	1.670105	0.50	0.617	-2.43717	4.109523
/ilgtgamma |	1.100469	2.203094	0.50	0.617	-3.217515	5.418454
sigma2 |	2.307527	3.853814			.0874079	60.91765
gamma |	.750348	.4126965			.0385119	.9955856
sigma_u2 |	1.731449	3.84247			-5.799655	9.262552
sigma_v2 |	.5760787	.0635129			.4515958	.7005617

*significant at 10% level; sex (female=1, male=2); education (no education=0)

TABLE 3. AIDS-affected households - time invariant inefficiency model results for households in Malawi

Time-invariant inefficiency model				Number of obs	=	410
Group variable: id				Number of groups	=	263
				Obs per group: min	=	1
				avg	=	1.6
				max	=	2
				Wald chi2(8)	=	186.90
Log likelihood = -516.93128				Prob > chi2	=	0.0000

ly |	Coef.	Std. Err.	z	P>|z|	[95% Conf. Interval]	
lh |	.1007392	.102612	0.98	0.326	-.1003765	.301855
lb |	.2525327	.0901766	1.20	0.229	-.0682102	.2852757
lf |	.4336891	.04524	9.59**	0.000	.3450203	.5223579
ls |	.2577066	.0912915	1.73*	0.084	-.0212215	.3366346
t |	.0893292	.0980233	0.91	0.362	-.102793	.2814514
sex |	.0694879	.1141588	0.61	0.543	-.1542593	.2932351
age |	.0013903	.0027628	0.50	0.615	-.0040248	.0068053
edu |	-.0549349	.0735401	-0.75	0.455	-.1990709	.0892011
_cons |	4.349331	.4160277	10.45	0.000	3.533932	5.16473
/mu |	-15.52872	103.0175	-0.15	0.880	-217.4393	186.3818
/lnsigma2 |	1.854568	5.608098	0.33	0.741	-9.137102	12.84624
/ilgtgamma |	2.231164	6.199783	0.36	0.719	-9.920186	14.38251
sigma2 |	6.388936	35.82978			.0001076	379358.7
gamma |	.9030134	.5429784			.0000492	.9999994
sigma_u2 |	5.769295	35.82332			-64.44312	75.98171
sigma_v2 |	.6196414	.0624205			.4972995	.7419834

*(**) significant at 10% level and 5% level of significance; significant at 10% level; sex (female=1, male=2); education (no education=0)

This implies that determinants of technical efficiency of production depend on the size of sample used and also vary from country to country depending on culture and government policies.

CONCLUSION

It is clear that the Malawian Government policy of subsiding hybrid maize seeds and fertilisers has enhanced technical efficiency of both HIV/AIDS affected and non-affected households. Nevertheless, there is still scope for improvement of the productivity of small-scale farmers, as some farm households, particularly female headed households, are still operating at low levels of efficiency.

The results of this study questions the usefulness of the homogenous conceptualisation of the "affected households" and "non-affected households" especially in the context of proposal for targeted assistance and other policies. As has been seen, within the non- affected households, there are some vulnerable sections of households that require assistance as much as the AIDS-affected households.

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TABLE 4. Non-affected households – time varying inefficiency model results for households in Malawi

Time-varying decay inefficiency model				Number of obs	=	120
Group variable: id				Number of groups	=	86
Time variable: t				Obs per group: min	=	1
				avg	=	1.3
				max	=	2
				Wald chi2(7)	=	12.13
Log likelihood = -109.91634				Prob > chi2	=	0.0963

ly |	Coef.	Std. Err.	z	P>|z|	[95% Conf. Interval]	
age |	.0053903	.0017628	0.60	0.515	-.0030346	.0078549
edu |	-.0277003	.2596591	-0.11	0.915	-.5366228	.4812221
lh |	.0213395	.2104826	0.10	0.919	-.3911989	.4338779
lb |	.3961175	.2981535	1.33	0.184	-.1882526	.9804875
lf |	.7920051	.0226711	8.57**	0.000	-.048426	.4324361
ls |	.1387257	.1391391	1.00	0.319	-.133982	.4114334
t |	-.0122531	.3185195	-0.04	0.969	-.6365399	.6120338
sex |	.1434649	.2675285	0.54	0.592	-.3808814	.6678111
_cons |	4.933464	.8611172	5.73	0.000	3.245705	6.621223
/mu |	-5.591935	119.6798	-0.05	0.963	-240.16	228.9762
/eta |	.5060411	1.112504	0.45	0.649	-1.674427	2.686509
/lnsigma2 |	1.088286	12.71114	0.09	0.932	-23.82509	26.00166
/ilgtgamma |	.9810913	17.25328	0.06	0.955	-32.83472	34.79691
sigma2 |	2.969179	37.74165			4.50e-11	1.96e+11
gamma |	.7273247	3.421731			5.50e-15	1
sigma_u2 |	2.159557	37.60863			-71.55201	75.87112
sigma_v2 |	.8096218	.2462347			.3270107	1.292233

*(**) significant at 10% level and 5% level of significance; significant at 10% level; sex (female=1, male=2); education (no education=0)

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TABLE 5. Non-affected households –time invariant inefficiency model results for households in Malawi

Time-invariant inefficiency model			Number of obs	=	120
Group variable: id			Number of groups	=	86
			Obs per group: min	=	1
			avg	=	1.4
			max	=	2
			Wald chi2(6)	=	36.98
Log likelihood = -516.93128			Prob > chi2	=	0.0000

ly |	Coef.	Std. Err.	z	P>|z|	[95% Conf. Interval]	
lh |	.1529719	.174869	0.87	0.382	-.1897649	.4957088
lb |	.2215137	.1875177	1.18	0.237	-.1460143	.5890417
lf |	.4705726	.0387773	3.13**	0.002	.1377733	.6033719
ls |	-.0170625	.1050737	-0.16	0.871	-.2230032	.1888781
edu |	.0839356	.1743479	0.48	0.630	-.25778	.4256513
t |	.3222047	.274804	1.17	0.241	-.2164012	.8608106
_cons |	3.981378	.6149625	6.47	0.000	2.776074	5.186683
/mu |	-7.218936	462.2765	-0.02	0.988	-913.2643	898.8264
/lnsigma2 |	.1975602	3.345199	0.06	0.953	-6.358909	6.75403
/ilgtgamma |	-3.03209	72.74732	-0.04	0.967	-145.6142	139.55
sigma2 |	1.218426	4.075879			.0017313	857.5072
gamma |	.045997	3.192246			5.76e-64	1
sigma_u2 |	.056044	4.076862			-7.934459	8.046547
sigma_v2 |	1.162382	.1502299			.8679373	1.456828

*(**) significant at 10% level and 5% level of significance; significant at 10% level; sex (female=1, male=2); education (no education=0)

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