Unexploited Profit among Smallholder Farmers in Central Malawi: What are the Sources?

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Abstract: The purposes of this research were to measure the profit efficiency of sample Irish potato farms and subsequently to explore determinants of profit inefficiency in the Dedza district of Malawi. Flexible Stochastic Profit Frontier Analysis was used to measure profit efficiency. Farmers from 200 randomly selected farmers were interviewed for plot level data. Research results revealed that the average profit of Irish potato farmers in Dedza could increase by 26% under prevailing technology. The profit efficiency of the sample Irish potato farms ranged from 0.31 to 0.99 (0.74 average). Policy variables like non-farm employment, education, extension visits, credit status, farm Experience, degree of specialization, and frequency of weeding negatively affected profit inefficiency. Conversely, age affected profit inefficiency positively.

Keywords: Frontier, Malawi, normalized, profit efficiency, smallholder

JEL Classification: D21, D24

1. Introduction

The agricultural sector is primal to economic activities in Malawi accounting for 35-40 percent of real gross domestic product, more than 90 percent of the country's foreign exchange earnings and provides paid and self-employment to 92 percent of the population and it contributes about 33.6 percent to the economic growth. The government distinguishes between smallholder farmers and estate farmers, in which the latter are large-scale commercial farmers (GoM, 2007). Tobacco has been the major export earner contributing approximately 65% of the country's export earnings; however, international anti-smoking campaign has threatened prices and the future of this crop. The result of this has been a deterioration of incomes for smallholder farmers especially those from central Malawi who rely on Tobacco. Central Malawi has a comparative advantage in Irish potato production. Despite this, production of Irish potato has not been given priority attention as an alternative.

The thrust of this study is to augment the existing empirical body of literature on the economics of the smallholder horticultural production in Central Malawi by focusing on the profit efficiency and factors that influence the profit efficiency of Irish potato production on smallholder farms. With respect to public policy, the government has pursued strategies to improve smallholder farmers' income (MoAFS, 2010) and this study will provide an indication of the level of profit efficiency that these efforts have achieved. Thus, the study worked to identify sources of profit efficiency which government further need to address in order to maximize income among the many smallholder farmers. The specific objectives of the study are; to estimate mean and plot-specific profit efficiency levels in smallholder farms and determine the relative role non-farm employment, education, extension visits, credit status, farm experience, degree of specialization, age, household size and frequency of weeding in determining profit efficiency.

2. Literature Survey

Analysis of the potential of potato farming in improving farmers' incomes in Malawi revealed that with quality planting materials, use of good cultural practices and guaranteed market, farmers can realize tuber yields of up to 20t ha^{-1} and a mean net return on their labour of US$ 481 per season of 4 months from an average land size cropped of 0.18 ha (Demo et al., 2009). However, their study was deficient in determining efficiency and its sources in obtaining returns.

Horward (1999) analyses the relationship between farm size and productivity in smallholder agriculture in Malawi and provides evidence of a positive relationship between farm size and productivity. Edriss and Simtowe (2002) estimated efficiency of groundnut production in Malawi and Tchale (2007) studied efficiency of smallholder agriculture in Malawi but their studies only focused on technical aspect. Maganga (2012) analyzed technical efficiency of Irish potato production in Malawi. Chirwa (2003) focused on technical efficiency of maize production in southern Malawi while incorporating significance of technology adoption, farming systems and farmer education. Technical efficiency is derived from production function which is possible to achieve while realizing sub-optimal profit. Thus, a technically efficient farmer can be kicked out of the market due to failure to achieve profit. On the other hand, in profit measure, we take care of input costs and output prices.

This apparent lack of empirical research on profit efficiency of smallholder farmers in Malawian agricultural sector drives the heart of this research. To augment profit aspect, it may in fact be entirely appropriate to consider profit efficiency given that most efficiency studies in Malawi have focused on technical efficiency.

3. Data

The data used in this study were collected from Dedza district in Malawi, which is one of high Irish potato producing districts. Dedza is a district in the Central Region of Malawi. It covers an area of 3,624 km² to the south of the Malawi capital, Lilongwe, between Mozambique and Lake Malawi with 145,878 households (NSO, 2008). The landscape is a mixture of grassland with granite outcrops, natural woodland and commercial pine plantations on the mountains and some bamboo forest nearer the Lake (DDA, 2001). The wet season is November to April with almost no rainfall at other times. The higher altitudes have moderate temperatures and can be cold in June and July (DDA, 2001).

A survey of the production practices, marketing and household characteristics of smallholder Irish potato producers was conducted in 2011. Data were obtained from 200 smallholder Irish potato farmers. A Multi-stage sampling technique was used. The district was clustered into Extension Planning Areas (EPAs) from which one EPA was randomly selected from the District. Secondly, a simple random sampling technique was used to sample two sections from the sampled EPA as secondary sampling units. Thirdly, sections were clustered into villages whereby villages were randomly sampled from each sampled section. Fourthly, from each sampled village, simple random sampling technique was used to select Irish potato farmers proportionately to size (Edriss, 2003). Data were collected using a structured questionnaire and focus group discussions. The questionnaire was designed and pre-tested in the field for its validity and content and to make overall improvement of the same and in line with the objectives of the study. Data were collected on output, input use, prices, socio-economic and institutional variables.

4. Theoretical and Econometric Construct

We use the stochastic profit frontier approach in estimating the profit function and the determinants of profit efficiency among smallholder Irish potato farmers in Central Malawi. Stochastic estimations of profit efficiency incorporate a measure of random error, which is one component of the composite error term of a stochastic profit frontier. This model acknowledges the fact that factors, which are outside the farmers' control, can also affect the level of profit. So, it made possible to find out whether the deviations in profit from the profit frontier are due to firm specific factors or due to external random factors. The stochastic frontier attributes part of the deviations to random errors, reflecting measurement errors and statistical noise, and farm specific inefficiency (Forsund et al., 1980; Battese & Coelli, 1995; Coelli et al., 1998).

Thus, a stochastic profit function approach is deemed appropriate for this study. This study adopts the Ali and Flinn's model of 1989 specified in equation 1 as:

$$\tilde{\pi}_j = f(\mathbf{p}_{ij}, \mathbf{z}_{\kappa j}).\exp e_j \qquad (1)$$

Where, $\tilde{\pi}_j$ = normalized profit of j^{th} farm defined as gross revenue less variable cost, divided by commodity prices from farm j, p_{ij} = prices of the variable inputs on j^{th} farm, $z_{\kappa j}$ = k^{th} fixed factors on j^{th} farm and e_j = an error term, and j = 1,…,n, is the number of farms in the sample.

To attain frontier, an appropriate error structure is appended to equation 1. Following Kmenta (1986), the study by Ali and Flinn (1989) proved that the same error term as that used in production function frontier analysis was relevant to profit frontier. Thus the following error term specified in equation 2 was used:

$$e_j = \nu_j - u_j \qquad (2)$$

Where, ν_j and u_j are random error terms and inefficiency effects of the farm j, respectively. When $u_j = 0$, the farm lies on the frontier but if $u_j > 0$ the farm is profit inefficient and incurring losses.

Since by a trivial transformation of vectors **p** and **z** yields $\exp(\ln\mathbf{p}_{ti})$ and $\exp(\ln\mathbf{z}_{kq})$, respectively, Equation 1 is interpreted as a function of the logarithms of the regressors. Thus,

$$\ln\tilde{\pi}_j = f(\ln\mathbf{p}_{ij}, \ln\mathbf{z}_{\kappa j}).\exp e_j \qquad (3)$$

We expand equation 2 in second-order Taylor series around the point **p**, **z** = [1, 1,….1]' so that at the expansion point, the log of each variable is a convenient zero. The disturbance is assumed to embody familiar factors and error of approximation of the profit function. Since the flexible Translog profit equation and its derivatives evaluated at the fixed value 0 are constants, Green (2002) interprets them as coefficients and yields:

$$\ln\tilde{\pi} = \beta_0 + \sum \beta_t \ln p_t + \tfrac{1}{2}\sum\sum \gamma_{tk} \ln p_t \ln p_k + \sum\sum \phi_{ti} \ln p_t \ln z_i + \sum \theta_l \ln z_i +$$

$$\tfrac{1}{2}\sum\sum \varphi_{iq} \ln z_i \ln z_q + v_i - u_i \qquad (4)$$

Where: k, l = input 1, …, m ; v denotes the traditional error component and u the non-negative inefficiency component. v_i is assumed to be independently and identically distributed (iid), symmetric and distributed independently of u_i. Thus the error term $\varepsilon_i = v_i - u_i$ is asymmetric, since u_i= 0. Symmetry is imposed by constraining 4 according to: $\gamma_{tk} = \gamma_{kt}$ for all k, t. By a simultaneous one-stage estimation approach the inefficiency estimates are related to the exogenous factors of Irish potato production.

The inefficiency effects (u_j) in equation 4 which are non-negative random variables are assumed to be identically and independently distributed such that u_js defined by the truncation (at zero) of the normal distribution with a mean of $u_j = \delta_0 + \sum_{d=1}^{n} \delta_d z_{dj} + \eta$ and variance σ_u^2 where z_{dj} are the variables representing socio-economic characteristics of farm j to explain inefficiency and δ_0 and δ_d are the unknown parameters to be estimated. The profit efficiency of the farm in the context of stochastic frontier is given by:

$$\zeta_j = E[\exp(-u_j)|e^j] = E[\exp(-\delta_0 + \sum_{\delta=1}^{i} \delta_d z_{dj})] \qquad (5)$$

Where, ζ_j is profit efficiency of farmer j and lies between 0 and 1 and is inversely related to the level of profit inefficiency and E is the expectation operator. This is achieved by obtaining the expressions for the conditional expectation μ_j upon observed value of ζ_j.

5. Empirical Results

5.1 Descriptive Statistics

The average statistics of the sampled Irish potato farmers are presented in Table 1. On the average, a typical Irish potato farmer in the district is 45 years old, with 4 years of education, 19 years of farming experience and an average household size of 5 persons. The average Irish potato farmer cultivated 0.6 ha, made an average of 1.4 extension contacts in the year, used about 254kg of fertilizer and 1852kg of Irish potato, employed 176 person-days of labour and produced an output of 12,371kg of Irish potato per annum. Irish potato production in the district is a male dominated occupation as about 62% of the farmers were males.

5.2 Estimation of Translog Frontier Profit Function

In Table 2, the dependent variable was restricted profit from an output of one season. All linear terms of translog were significant at least at 5%, except for farm size. Most of the interactive and quadratic terms are significant ascertaining suitability of translog model. The diagnostic statistics of the Translog profit function showed a total variance of 0.23, being statistically significant at 1% risk level. This parameter estimates goodness of fit and the correctness of the specified distributional assumption of the composite error term. The model reported a Wald chi-square statistic of 1332 which was significant at 1% denoting that the model was jointly significant. The variables included were tested for multicollinearity using Variance Inflation Factor (VIF). The mean VIF of 2.91 was found and this showed that there was no serious problem of multicollinearity in the model (Edriss, 2003). In addition, Breusch Pagan (BP) test revealed safety of heteroskedasticity as justified by a value of 0.544 (p =0.7883>0.1). The estimate of gamma (variance ratio) was 0.988 indicating that 98.8% of disturbance in the system is due to profit inefficiency, one-sided error and therefore 1.2% is due to stochastic disturbance with two-sided error, supported by a high significance of 1% (Flemming et al., 2004).

Farmers exhibited varied profit efficiency estimates, ranging from 31% to 99% with a mean of 74%. The minimum efficiency of 31% showed gross underutilization of resources and loss of income while the best economically efficient farmer operated almost on the frontier. The frequency distribution of farm-specific profit efficiency scores for the Irish potato farmers is presented Figure 1. The figure reveals that the frequency of occurrence of the predicted profit efficiencies in decile ranges indicate a clustering of profit efficiencies in the region of 0.71 – 0.80 efficiencies range.

There is a yawning gap between the profit efficiency level of best and the worst farmer. To bridge the gap, the average farmer needs a cost saving of 25% i.e. [1- (0.73/0.98)×100] to attain the frontier while the least profit efficient farmer requires a cost saving of 68% i.e. [1 – (0.31/0.98)×100] to become the best efficient farmer in the sample. The fact that none of Dedza farmers operated on the frontier (efficiency ratio is less than one), it depicts that more than the profit maximizing level of the input vector was employed (Onyenweaku et al., 1991).

5.3 Sources of Farm-Specific Profit Inefficiency

Having the information about the existence profit inefficiency and measuring its magnitude, scrutinizing the major factors causing this inefficiency level was the next most important step of the study. From the very beginning, about nine socio-economic and institutional variables were hypothesized to affect level of profit efficiency of Irish potato growing farmers of the study area. The coefficients of these variables included in the model were estimated simultaneously by the ML procedure using the estimated level of profit efficiency as dependent variable. One important point to be considered is that the dependent variable is the inefficiency component of the total error term estimated in combination with the profit frontier. Hence, the coefficients should be read as the effect of each variable on the level of inefficiency instead of efficiency. However, one can read the estimated coefficients directly as the effect of the variable on profit efficiency by taking the opposite sign of respective coefficients (Table 3).

The coefficient of non-farm employment variable entered into the profit inefficiency effect model indicated that the variable affects level of profit inefficiency in Irish potato production negatively. In other words, those farmers engaged in some off-farm activities were less profit inefficient relative to those who were not engaged in off-farm activities other than their farm operation. Abdulai and Huffman (2000) reported similar results for rice farmers in Northern Ghana. Ali and Flinn (1989), Wang et al., (1996b) and Rahman (2002, 2003) reported similar results for farmers in Pakistan, China and Bangladesh, respectively. The results indicate that having non-farm work provides the income to buy inputs needed to raise productivity, and hence reducing inefficiency.

The variable of education was negative and highly statistically significant ($p<0.01$). This means that more years spent in education will increase profit efficiency in Irish potato production. This result is consistent with Abdulai and Huffman (2000) for rice farmers in Ghana. The result implies that giving education to Irish potato farmers in particular would be very beneficial in terms of reducing profit inefficiency among Irish potato producers. Similarly, extension services significantly determined profit efficiency. Augmenting education variable, the result show that access to extension advice by Irish potato farmers help to reduce the profit inefficiency in Irish potato production. The results are also consistent with findings obtained by other researchers (Rahman, 2002). Policy thrust need to focus on establishing innovative institutional arrangements that enhance extension and farmer training.

Experience significantly ($p<0.01$) influenced profit efficiency. The positive influence implies that profit efficiency increases with the number of years spent by the household head in Irish potato marketing which suggests that efficiency in Irish potato farming in the study area is highly dependent on the experience of farmers. Experience in Irish potato production may lead to better managerial skills being acquired over time and eliminated unnecessary transaction cost. Age of a farmer agrees with a prior expectation that increasing age would lead to decrease in efficiency. An ageing farmer would be less energetic to work in the farm (Abaelu, 1998; Akinsami, 1975) resulting in reduced productivity, revenues and in turn profits.

The result of this study shows that access to credit in the study area increased profit efficiency ($p<0.05$). Credit access is expected to ease the financial constraint, enhance the acquisition of the much-needed inputs, and improve revenue and, subsequently, profits. The finding of this study imply that institutional arrangements that aim at reducing transaction costs of providing farmers greater access to credit would have the potential of increasing profit efficiency. From the findings of this study, it is apparent that policy makers need to introduce appropriate legislation that encourages commercial and microfinance institutions to accommodate small agricultural producers.

In this study a negative and statistically significant relationship between the degree of specialization in the Irish potato production profit inefficiency was observed at 1% significance level. The efficiency may be gained from economies of scale as degree of specialization increases. Abdulai and Huffman (2000) registered similar results for rice producers in Northern

Ghana. Frequency of weeding registered significant result (p<0.01) in determining profit inefficiency. Similarly, Tamado (2001) reported that there was sorghum grain yields loss with increased density infestation of weed in sorghum field. The result implies that keeping other determinants constant, there is a possibility of improving the efficiency level of those who do not engage in frequent weeding without searching for any other external inputs or new and costly technologies.

6. Conclusion and Policy Implications

The core contribution of this paper rests in the use of flexible translog profit function in one stage estimation of sources of profit efficiency in Dedza district, central Malawi. The study that employed stochastic profit function approach has shown that Irish potato farmers in Dedza district, Central Malawi are not operating at full profit efficiency level. Among the policy variables identified to have huge influence on profit efficiency in Irish potato production are non-farm employment, education, extension visits, credit status, farm Experience, degree of specialization, age and frequency of weeding. Household size, though not significant reduced efficiency and as such there is a need to introduce birth control policies as well as encourage the current family planning programme in Malawi.

The results indicate a significant variation in profit efficiency ranging from 0.31 to 0.99 with a mean of, 0.74, which implies considerable profit inefficiency exists in Irish potato production in the study area. Nevertheless, these results show that there is a substantial potential for enhancing profitability by reducing costs through improved efficiency. To operate on full profit efficiency levels, on average, the sample producers would need to reduce their costs by about 26%. To redress policy, there is need to focus on bringing microfinance institutions closer and accessible to farmers to enhance their ability in purchasing much needed farm inputs. Alternatively, Public works programs can provide a portfolio off-farm income to buy inputs needed to raise productivity, and hence reduce inefficiency.

Endnotes

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Table 1: Definition of variables and descriptive statistics

Variable	Units	Average	Minimum	Maximum
Age	Years	44.5	28	60
Education	Years	3.5	0	7
Farming Experience	Years	19.7	3	36
Potato plot	Hectares	0.60	0.09	1.38
Land size	Hectares	1.25	0.45	2.13
Land rent	Imputed cost of land(MK)	3329	2952	3538
Extension visit	No. of visits	1.4	0	3
Fertilizer	Kg/ha	254	7.6	561
Price of fertilizer	Malawi Kwacha/kg	23	16	31
Labour	Person-days/ha/year	176	97	300
Wage rate	Price of labour/month	2700	1145	4284
Irish potato Yield	Kg/ha	12371	8084	19468
Irish potato price	Malawi Kwacha/kg	60	45	75
Household size	No of persons	4.25	2	9
Seed price	Malawi Kwacha/kg	215	67	325
Seed quantity	Kg	1852	1134	2652
Gender of household head	1=Male; =otherwise	-	0	1
Hoes	Number of hoes	3	1	6
Cost of hoes	Total cost of hoes	684	100	2860
Experience	Years in farming	19	3	36
Credit status	1=access 0 = otherwise	0.34	0	1
Degree of specialization	Potato plot/Total crop acreage	0.31	0.12	0.78
Weeding frequency	Number of times/year	1	0	2
Non-farm employment	1=yes; 0 = Otherwise	-	0	1
Farmer organization membership	1=yes; 0 = Otherwise	-	0	1

1USD = 167 Malawi Kwacha (MK)

Table 2: Estimated Translog Stochastic Frontier Profit Function for Irish Potato in Dedza District, Malawi

Variables	Parameter	Coefficient	Std. Err.	t-value	p > |t|
Constant	β_0	211***	12.15	17.37	0.000
Log of normalized price of Fertilizer per kg (p_1)	β_1	0.663***	0.21	3.14	0.002
Log of normalized price of seed tuber per kg (p_2)	β_2	0.243**	0.14	2.08	0.039
Log of normalized wage rate (p_3)	β_3	0.949***	0.12	8.22	0.000
Log of Farm size(z_1)	β_4	0.213	0.41	0.51	0.610
Capital (z_2)	β_5	0.184***	0.052	3.49	0.001
$\ln p_1 \times \ln p_2$	γ_{12}	0.196***	0.02	12.64	0.000
$\ln p_1 \times \ln p_3$	γ_{13}	0.216***	0.04	5.40	0.000
$\ln p_1 \times \ln z_1$	γ_{14}	1.323	0.98	1.35	0.178
$\ln p_1 \times \ln z_2$	γ_{15}	0.108***	0.041	2.63	0.009
$\ln p_2 \times \ln p_3$	γ_{23}	0.688***	0.074	9.30	0.000
$\ln p_2 \times \ln z_1$	γ_{24}	0.049***	0.099	4.94	0.000

Variables	Parameter	Coefficient	Std. Err.	t-value	p > |t|
$\ln p_2 \times \ln z_2$	γ_{25}	0.164***	0.050	3.31	0.001
$\ln p_3 \times \ln z_1$	γ_{31}	0.752***	0.221	3.41	0.001
$\ln p_3 \times \ln z_2$	γ_{32}	0.265**	0.131	2.02	0.044
$\ln z_1 \times \ln z_2$	θ_{12}	0.770**	0.350	2.20	0.029
$0.5 \ln p_1 \times \ln p_1$	β_{11}	0.138	0.146	0.95	0.343
$0.5 \ln p_2 \times \ln p_2$	β_{22}	0.852	0.621	1.37	0.172
$0.5 \ln p_3 \times \ln p_3$	β_{33}	0.329***	0.118	2.79	0.005
$0.5 \ln z_1 \times \ln z_1$	θ_{11}	0.634*	0.328	1.93	0.055
$0.5 \ln z_2 \times \ln z_1$	θ_{22}	0.751***	0.74	4.14	0.000
Total variance	σ^2	0.282***	0.033	8.52	0.000
Variance ratio	γ	0.988***	0.007	140	0.000

Variables	Parameter	Coefficient	Std. Err.	t-value	p > |t|
Log likelihood		71.09			
Wald chi2(20)		1332			0.000
Mean VIF		2.91			
Breusch Pagan		0.544			0.788

***, **, *, mean, 1, 5, and 10% significance level, respectively

Figure 1: Frequency Distribution of Profit Efficiency

Table 3: Determinants of Profit Inefficiency for Irish Potato farmers

Variable	Coefficient	Std. Error	t-value	p-value
Intercept term	1.87***	0.76	2.46	0.0098
Non-farm employment	-0.054***	0.015	-3.60	0.0004
Education	-0.161***	0.041	-3.93	0.0001
Extension visits	-0.29**	0.188	-1.54	0.0280
Credit status	-0.23**	0.094	-2.45	0.0152
Farm Experience	-0.35***	0.126	-2.78	0.0060
Degree of specialization	-0.812***	0.23	-3.53	0.0005
Age	0.751**	0.315	2.38	0.0184
Household size	-0.012	0.752	-0.02	0.9840
Frequency of weeding	-0.241***	0.022	-10.95	0.0000

Values in parenthesis are standard errors.*,** and *** means significant at 10%, 5% and 1% levels, respectively. A negative coefficient means it affects profit efficiency positively.