Technical Efficiency in Vietnamese Agricultural Production: A Bayesian Approach

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Abstract

Since agricultural production in Vietnam plays an important part in economy, there is a compelling interest in measuring and understanding efficiency in the pursuit of the government's objectives. This study is an attempt to use a stochastic frontier analysis (SFA) in Bayesian estimation to analyze the technical efficiency of Vietnamese agricultural production at household level. The estimation is conducted on cross-sectional data from the Vietnam Access to Resources Household Survey (VARHS) in the two year of 2012 and 2014. The results show that in the period of 2012 and 2014, the average technical efficiency in crop cultivation was 0.83 while in livestock and aquaculture the mean score was approximately 0.65 and 0.69 respectively. Agricultural production in Vietnam still has rooms to increase efficiency, indicating considerable scope for increasing output with the currently available inputs and existing technology.

Introduction

Agricultural production in developing countries amounts to significant shares of GDP and Vietnam is no exception. Although the proportion of agriculture in Vietnam's GDP declined from 18.38% in 2010 to 15.35% in 2016, the number of labors working in agricultural sector still accounted significantly in total labor force as 49.5% in 2010 and 41.9% in 2016 (GSO, 2018). According to data from World Bank national accounts data, and OECD National Accounts, the Vietnam's annual growth of value added in agriculture in the period 2011-2016 had highest rate at 4.23% in 2011 and then decreased in the next two year as 2.92% and 2.63% before bounced to 3.44% in 2014 and decreased again in the year 2015, 2016 as 2.41% and 1.36%. Vietnam had unstable growth of value added in agriculture in the period 2011-2016 and was in average rates in ASEAN countries. The objective of this study is to apply stochastic production frontier model in Bayesian estimation to analyze the technical efficiency of Vietnamese households' agricultural production on three sub-sectors as crops, livestock and aquaculture. One of the major benefits of the Bayesian approach over the frequentist approach is the ability to incorporate prior information which expresses knowledge or beliefs about the values of the parameters before examing the data. The analysis will utilize data from the Vietnam Access to Resources Household Survey (VARHS) in 2012 and 2014.

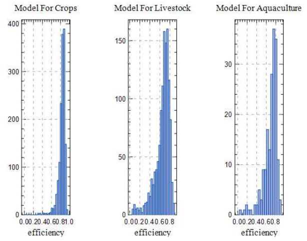

Figure 1. Posterior probability for technical efficiency

Method and Data

1. A general stochastic production frontier model is

$$\ln Y_i = f(\ln X_i) + (V_i - U_i)$$

Where Yi is the output produced by household i, Xi is a vector of K inputs, Vi is the stochastic error term and Ui is a one-sided error representing the technical inefficiency of household i. Both Vi and Ui are assumed to be independently and identically distributed as Vi ~N(0, σ2v) and Ui ~F(.). F(.) is a generic family of distributions with x ∈ R+. In this research, the F(.)s are used as exponential and half normal distributions for Ui.

2. Bayes' inference is often expressed as:

$$\pi(\theta \mid y) \propto p(y \mid \theta).p(\theta)$$

Where : θ is parameters of a stochastic model and y is the data; π(θ|y) is the posterior density. It updates about the values of the model's parameters after seeing the data y; p(y|θ) is the likelihood function which is the density of the data given the values of the model's parameters; p(θ) is the prior density of the model's parameters.

3. The estimation is conducted on cross-sectional data from the Vietnam Access to Resources Household Survey (VARHS) database in the two year of 2012 and 2014.

Results

For crop cultivation, production inputs, days of labor, land area, savings, and the dummy variable year14 had effects on outputs. Every increase by one percent of production inputs, days of labor, land area and savings increased the average outputs 0.68%, 0.10%, 0.18% and 0.03% respectively. The output value in the year 2014 was higher than one in 2012 by 100*[exp(0.09)-1]=10%. For livestock raising, the outputs were higher by 0.26%, 0.11%, 0.04% for one percent increase of inputs, days of labor and household's credits. An additional member in household increased the output rate in livestock by approximately 5.34%, but had no significant impact on crop cultivation and aquaculture. In aquaculture sector, production inputs, labor days and household's savings contributed to outputs. If production inputs, labor days and savings went up one percent, expected outputs increased approximately 0.79%, 0.20% and 0.08%. The distributions of efficiency scores from three models had the typical long tail to the left (Fig. 1). The average technical efficiency in crop cultivation was 0.83 while in livestock and aquaculture the mean score was approximately 0.65 and 0.69.

Table 1. Summary statistics

Variable		Obs	Mean	Std. Dev.
cropoutput_r (1000 VND)	Crop output	6,286	27,114.77	52,039.71
liveoutput_r (1000 VND)	Livestock output	4,466	3,678.44	25,201.22
aquaoutput_r (1000 VND)	Aquaculture output	588	16,121.35	54,684.93
cropinput_r (1000 VND)	Crop input	6,195	23,912.15	50,304.16
liveinput_r (1000 VND)	Livestock input	4,996	10,433.34	39,932.64
aquainput_r (1000 VND)	Aquaculture input	587	8,070.72	33,003.28
cropday (days in year)	Crop days	5,121	133.13	130.82
liveday (days in year)	Livestock days	4,905	88.54	81.14
aquaday (days in year)	Aquaculture days	731	60.97	68.99
savings_r (1000 VND)	Savings	6,074	25,433.17	72,473.98
credits_r (1000 VND)	Credits	2,465	31,874.83	106,197.20
land_area (m^2)	Land area	7,352	9,542.83	17,449.84
nmember (persons)	HH members	7,240	4.49	1.85

Source: VARHS 2012 and 2014

Table 2. Exponential Stochastic Production Frontier Model for Crops

Variable	Mean	Sd.dev.	5%	95%
constant	1.122	0.146	0.883	1.361
lncropinput_r	0.677	0.013	0.655	0.698
lncropday	0.102	0.013	0.081	0.123
lnland_area	0.176	0.015	0.151	0.201
lnsavings_r	0.032	0.008	0.020	0.045
lncredits_r	0.004	0.010	-0.012	0.020
nmember	0.004	0.006	-0.007	0.014
year14	0.096	0.026	0.052	0.139
province1	-0.185	0.055	-0.275	-0.093
province2	0.021	0.056	-0.072	0.113
province3	-0.280	0.057	-0.374	-0.186
province4	0.288	0.065	0.182	0.393
province5	0.290	0.059	0.193	0.387
province6	-0.166	0.056	-0.258	-0.074
province7	-0.156	0.062	-0.259	-0.054
province8	0.088	0.098	-0.072	0.250
province9	0.057	0.046	-0.019	0.134
province10	0.016	0.049	-0.066	0.096
province11	0.120	0.065	0.014	0.229
tau	8.846	0.528	8.013	9.750
lambda	4.824	0.394	4.222	5.517
sigma_v	0.337	0.010	0.320	0.353
sigma_u	0.209	0.017	0.181	0.237
# of observations:		1456		
total retained draws:		20000		
burnin (draws/chain):		10000		

Table 3. The Technical Efficiency (TE)

Variable	Obs	Mean	Std. Dev.	Min	Max
TE_crop	1456	0.829	0.081	0.021	0.963
TE_livestock	1243	0.651	0.150	0.046	0.893
TE_aquaculture	180	0.691	0.145	0.034	0.914

Sources: Extracts from BayES software

Discussion

In general, agricultural production in Vietnam still has rooms to increase efficiency. However, there are lots of works needed to be done. Smallholders play a prominent role in commercial value chains while only a very small proportion of exported commodities is aggregated by cooperative or other formal entities serving commercial purposes. Small scale farms having not utilized the economy of scale may be a reason for low technical efficiency.

In crop cultivation, farmers apply inefficient use of fertilizer, chemicals, and other inputs to achieve the mixed record of Vietnam's agricultural volumes. For example, in Mekong Delta provinces, farmers have cultivated two or three seasons of rice in a year, which makes soil rapidly deteriorated. For livestock and aquaculture, farmers have faced high cost of feed because most of feed have been provided by a few of foreign companies and from import. Moreover, expensive seed supply and poor quality of seed have been perceived as the major constraints to crops, livestock and aquaculture.

Conclusions

This study uses a stochastic frontier analysis (SFA) in Bayesian estimation to analyze the technical efficiency of Vietnamese agricultural production at household level. The estimation is conducted on cross-sectional data from the Vietnam Access to Resources Household Survey (VARHS) in the two year of 2012 and 2014. The results show that in the period of 2012 and 2014, the average technical efficiency in crop cultivation was 0.83 while in livestock and aquaculture the mean score was approximately 0.65 and 0.69 respectively. One limitation of this study is not to compare the technical efficient (TE) scores for the two year 2012 and 2014 because of the inadequate data for variables involving to aquaculture activity.

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