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Research Article
Fiscal Decentralization and Agricultural Field: Empirical Evidence from Vietnam

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Abstract

Objective: The purpose of study is to shed more light on the relationship of fiscal decentralization and agricultural field. **Materials and Methods:** To do so, an analytical model has been established by integrating Cobb-Douglas function into Stochastic frontier model with 2 scenarios were built to determine the relationship between fiscal decentralization and agricultural field, namely; (i) a non-interactive model and (ii) an interactive model and then apply to the context of Vietnam. **Result:** The results of empirical analysis have indicated that the interactive model was more appreciated and has higher reliability than the non-interactive model in interpreting the relationship of fiscal decentralization and agricultural field. Additionally, fiscal decentralization has an indirect and significant influence on agricultural field through the technical efficiency. **Conclusion:** Fiscal decentralization was an element that could improve technical efficiency in agricultural sector as whole. However, in order to fiscal decentralization become a factor that has a positive impact on technical efficiency, it needs to be implemented in an appropriate proportion consistent with local needs for every kind of public goods and services.

Key words: Agricultural field, fiscal decentralization, public goods and services

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INTRODUCTION

Nowadays, agriculture continues to play an important role in many nations in the world, especially in poor and developing countries. Agriculture didn't only provide daily meals, but also contributed considerably to the national revenue, created employment opportunities and enhanced income. At the same time, agriculture was also regarded as a major source of materials for industry, strengthened foreign exchanges, reduced social inequality and improved rural welfare[1]. So that, searching solutions to improve productive, quality, efficiency in agricultural field usually become a pursuit objective of policymakers, managers and scientists.

So far, although, many solutions for agricultural development have been launched, nevertheless one seems to be neglected in previous literatures as fiscal decentralization. According to Vo[2], fiscal decentralization was a transfer of financial power and an assignment of responsibility, from central government to local government for provision of public goods and services. In agricultural sector, the public goods and services were defined as rural road system, education, healthcare services, communication system, services of water and electricity, environmental protection so on Vaidyanathan[3], which have a strong influence on agricultural field[4-9]. However, Hanh *et al.*[10] have noted profoundly that, the public goods and services would become inefficiency if there was an occurring incompatibility between the financial power and assignment of responsibility or the packages of public goods and services weren't suitable with the actual needs of locality. So that in order to the packages become up efficiency and factors stimulating agricultural development, it was necessary to make fiscal decentralization reasonably in agricultural field.

Relating to fiscal decentralization, although many academic literatures have indicated that fiscal decentralization was 1 of the factors that has a decisive significance on the output of politics[11,12], economics[13,14], education[15,16], health[17,18]. However, it didn't have any study that indicates the relationship between fiscal decentralization and agricultural field yet. So that, this study was conducted to shed more light on these relationships to help the authorities, managers make their decisions on fiscal decentralization towards agricultural development.

MATERIALS AND METHODS

General model: In order to analyze the impact of fiscal decentralization on output of agriculture, we begin by a traditional Cobb-Douglass production function with an assumption that the output of *i*th province of Vietnam, at the time (t) is affected by two inputs to be capital (K) and labor (L)[19], given as follows:

$$Y_i(t) = A_i(t)K_i(t)^{\beta_1} L_i(t)^{\beta_2} \quad (1)$$

where, β_1 and β_2 are coefficients of capital, $K_i(t)$ and labor $L_i(t)$, $Y_i(t)$ is the output of agriculture of the ith province at a time (t) and $A_i(t)$ is technical efficiency. Equation 1 shows that an increasing in physical capital or/and labor will lead to an increasing in the output and vice versa, spectively. This implies that the output will increase if there is an increasing in the physical capital as a more investment of warehouse, machinery, equipment, road and other infrastructure services or an increasing in the size of employees or both[20]. In this study, we extend the model by more adding a factor of land, D(t), which is particularly important in the process of economic restructuring in Vietnam, Eq. 1 is written as:

$$Y(t) = A(t)K(t)^{\beta_1} L(t)^{\beta_2} D(t)^{\beta_3} \quad (2)$$

where, θ is a coefficient of D(t), $0<\beta_1+\beta_2+\beta_3<1$. Taking the natural log in both sides of the Eq. 2 and first derivative over time, we find the growth rates following:

$$Y'(t) = A'(t) + \beta_1 K'(t) + \beta_2 L'(t) + \beta_3 D'(t) \quad (3)$$

Equation 3 implies that the output of agriculture depends on four factors like; the growth rate of physical capital, labor, land and an advance in technology. According to Lin and Liu[21], the concept of A'(t)doesn't only reflect the technical efficiency, but it also reflects the environmental condition and the policy and mechanisms covering many different areas over time as well as other characteristics that isn't observed. So that in this study the technical efficiency of A(t) is assumed to be affected by fiscal decentralization that reflects the policy and mechanism and the public goods and services that comprises of road network, water-electrical services, education services and public healthcare services that are defined as a condition of the physical environment. This is particularly important in conversion process of centralized production to the market economy in Vietnam.

Assume that the relationship of the technical efficiency of A(t) with fiscal decentralization of Z(t) and factors representing for the physical environment of S(t) at the time (t) is an exponential function, A(t) = exp[-g(Z(t), S(t), e(t))]. In which, Z(t) reflects the change of fiscal decentralization over time and cross section, which influences on the technical efficiency. This

implies that A(t)>0 with any Z(t), so that Y(t)>0, even when financial decentralization isn't implemented, with the exception of K(t) = 0, L(t) = 0 or D(t) = 0. This is an important specification, because fiscal decentralization influence negatively on the productive efficiency, but its output is usually difference with zero, even it doesn't take place. The e is defined as an error term that reflects the unobservable factors over time and cross sections. Replace A(t) = exp[-g(Z(t), S(t), e)] into Eq. 2 and summarize it, we have a function as:

$$Y(t) = f\,[K(t), L(t), D(t), \beta].\exp\left(-g\left[Z(t); S(t), \alpha, \theta, e\right]\right) \quad (4)$$

where, α and θ are coefficients of Z(t) and S(t). From Eq. 3, notice that the output of production process isn't only affected by the factors of labor, capital, land, environmental and economic condition but it is also influenced by the unobservable factors. So that, exp(ε(t)) is put into Eq. 4 to be an error term that influence on the output of the production process. The Eq. 4 is rewritten as follows:

$$Y(t) = f\,[K(t), L(t), D(t), \beta].\exp\left[-g\left(Z(t); S(t), \alpha, \theta, e\right)\right].\exp[\varepsilon(t)] \quad (5)$$

For public goods and services, they are defined as both indirect and direct inputs. Therefore, Eq. 5 can extend by more adding S(t) into f(.) and is arranged as follows:

$$\begin{aligned} Y(t) &= f\,[K(t), L(t), D(t), S(t), \beta, \eta].\\ &\exp\left[-g\left(Z(t); S(t), \alpha, \theta, e\right)\right].\exp[\varepsilon(t)] \end{aligned} \quad (6)$$

where, η is a coefficient of S(t) in f(.). Summarize Eq. 6, we have an equation as:

$$Y(t) = f(.).\exp(-g(.)).\exp(\varepsilon(t)) \quad (7)$$

From Eq. 7, A(t) = exp[-g(.)] can be defined as the technical efficiency in the model of stochastic production frontier suggested by Battese and Coelli[22], it is in the interval of [0, 1] and defined as follows:

$$TE(t) = \frac{Y(t)}{f(.).\exp(\varepsilon(t))} \quad (8)$$

If $TE_{it} = 1$, output achieves its maximum feasible value of f(.).exp(-g(.)).exp(ε(t)). If TE <1, it measures technical efficiency with random shocks exp(ε(t)) incorporated. Technical efficiency can be estimated by using Eq. 7 or 8, with g(Z(t); S(t), α, θ, e) is defined as the technical inefficiency in the model of stochastic production frontier. Equation 7 underlying the Cobb-Douglas production function. Taking the logarithm of both sides of Eq. 7 can be written as:

$$LnY(t) = Lnf(.)+V \quad (9)$$

where, V ≡ ε(t)-g(.), with the ε(t) is a random variable assumed to be independent and identically distributed, $N\left(0, \sigma_{\varepsilon}^2\right)$ and independent of the g(.), which are non-negative random variables which are assumed to account for technical inefficiency in production and are assumed to be independently distributed as truncation at the zero of the $N\left(\left[Z(t); S(t), \alpha, \theta\right], \sigma_g^2\right)$ of which e is assumed as a random variable distributed as a truncated normal distribution with zero mean and variance of g(.). Maximum likelihood estimation can be used to take into consideration the asymmetric distribution of the inefficiency term. Greene[23] argues that the only distribution which provides a maximum likelihood estimator with all desirable properties is the gamma distribution. However, following Van den Broeck *et al.*[24], the truncated distribution function is preferred, which better distinguishes between statistical noise and inefficiency terms. Technical efficiency of ith province at time t is:

$$TE(t) = \exp[-g(.)] \quad (10)$$

Jondrow *et al.*[25] suggest "a measure of efficiency based on the distribution of inefficiency conditional to the composite error term, g(.)|e (where, V = ε(t)-g(.)). The distribution contains all the information that V_{it} yields about g(.). The expected value of the distribution can therefore be used as a point estimate of g(.). When the distribution of the inefficiency component is a truncated distribution, a point estimating for technical efficiency of TE_{it} is given by Kumbhakar and Lovell[26] and Battese and Coelli[22] to be:

$$E\left(TE_{it}\right) = E\left[\exp\left(g(.)\right)|e_{it}\right] = \frac{\Phi\left[-\sigma_* + \frac{\mu_{it}}{\sigma_*}\right]}{\Phi\left(\frac{\mu_{it}}{\sigma_*}\right)}.\exp\left[-\mu_{it} + \frac{1}{2}\sigma_*^2\right] \quad (11)$$

Where:

$$\mu_i t = (\sigma_\varepsilon^2 g[Z(t); S(t), \alpha, \theta] - \sigma_g^2 e_{it})/(\sigma_\varepsilon^2 + \sigma_g^2) \text{ and } \sigma_*^2 = \sigma_\varepsilon^2 \sigma_g^2/(\sigma_\varepsilon^2+\sigma_g^2).\Phi(.)$$

is a standard normal cumulative density function. Implementing this procedure requires estimates of μ_{it} and

σ_*^2. In other words, we need estimates of the variances of the inefficiency, random components and of the residuals, $\hat{\varepsilon}_{it} = y_{it} - f(.)$.

By replacing the unknown parameters in Eq. 11 with the maximum likelihood estimates an operational predictor for the technical efficiency of ith province in the time period of t is obtained. As opposed to the models in the previous section, this measure of technical efficiency includes the influence of explanatory factors. The g(.) contains a shift parameter α_0, which is constant across production units. The model treats multiple observations of the same unit as being obtained from independent samples.

Empirical model: For empirical analysis, variables in component of f(.) included are agricultural labor (L), land areas (D), capital (K), a number of households using electric $(S(t)_1)$ and communes with over 50% asphalted/concrete roads inter-village $(S(t)_2)$, a number of high schools/communes $(S(t)_3)$ and a number of health clinics/communes $(S(t)_4)$ with a Cobb-Douglas production function form Eq. 9 is written as follows:

$$\begin{aligned}LnY(t) = \beta_0 + \beta_1 Ln\left[K(t)\right] + \beta_2 Ln\left[L(t)\right] + \beta_3 Ln\left[D(t)\right] + \eta_1 Ln\left[S(t)_1\right] + \\ \eta_2 Ln\left[S(t)_2\right] + \eta_3 Ln\left[S(t)_3\right] + \eta_4 Ln\left[S(t)_4\right] + \varepsilon(t) - g(.)\end{aligned} \tag{12}$$

For variables in the component of g (.), we use two forms of function. In which, first form (I) that traditional function form in previous literatures, variables are treated independently of each other that influence on technical efficiency and written as follows:

$$g(.) = \alpha_0 + \sum_{i=1}^{4} \alpha_i S(t)_i + \alpha_5 Z(t) \tag{13}$$

and second form (II), we allow variable of fiscal decentralization operating interactively with other variables and assume that it is a square function and is written as follows:

$$g(.) = \alpha_0 + \sum_{i=1}^{4} \alpha_i S(t)_i + Z(t).\sum_{i=5}^{8} \alpha_i S(t)_i + \sum_{i=9}^{12} \alpha_i S(t)_i^2 + \alpha_{13} Z(t) + \alpha_{14} Z(t)^2 \tag{14}$$

Comparing between form (II) and form (I), we can see that the form (I) is only a special case of form (II), where, $\alpha_6 = \alpha_7 = \alpha_{8,} = ... =_{,} \alpha_{14} = 0$. This means that the form (II) can be considered as an overall form and it can define optimal points of fiscal decentralization, by $\partial g(.)/\partial Z(t)$ and permits the fiscal decentralization act as a control variable.

Data and variable definition: In this study, output of agriculture is measured by the total value of cultivation and livestock of provinces in Vietnam provided by the GSO and fiscal decentralization index suggested by Vo[2] is applied for the purpose's study as:

$$Z_i = \sqrt{\left(\frac{E_i}{TE}\right).\left(\frac{OSR_i}{E_i}\right)}$$

where, Z_i is fiscal decentralization index of ith province, E_i and OSR_i are total expenditure and revenue of ith local government for public goods and services. The TE is total expenditure of central government. All are provided by the Ministry of Finance.

For variables like agricultural labor, capital, land, electrical service, rural road network, education and healthcare service are defined as in Table 1, which collected from reports about preliminary census results of the rural, agriculture and fisheries in 2001, 2006 and 2011, provided by GSO and the Ministry of Agriculture and rural development.

The results of survey in Table 1 indicated that the mean value of Z increases slightly from 0.1818 (2000)-0.1845 (2005) and relatively strong from 0.1845 (2005)-0.1939 (2011). This is due to that, since 2007 Vietnam has become a member of WTO and expands trade relations with the foreign countries as well as strengthens the attracting FDI. In this period, the government has issued some policies that enhance the degree of fiscal autonomy to local governments for providing the public goods and services that is the foundation to attract direct investors from abroad. Table 1 also shows that although both of land areas and a number of labor have a downward trend during the period from 2000-2011, nevertheless the agricultural output still tends to increase strongly from 1.8416×10^3 billion VND in 2000 to 3.1191×10^3 billion VND in 2011. The fact that, in during from 2000 to 2011, the Vietnam's economy has a strong structural transformation with the proportion of agriculture decreased, which leads to the decline of labors and land in agricultural sector. At the same time, Vietnam has applied the scientific and technical progress for production, improved the infrastructure such as electrical services, irrigation system, rural road network, education and health service, etc., which have resulted in the growth of productivity (Table 1).

Table 1: Variable definition

Variables	Units	Mean	Minimum	Maximum	N
V1-2000	1000 billion VND	1.8416	0.170	6.000	56
V2-2000	1000,000 billion VND	5311.9207	248.640	32821.460	56
V3-2000	1000,000 ha	308.0493	53.300	998.940	56
V4-2000	1000, 000 labor	523.3163	73.800	1566.000	56
V5-2000	1000 households	166.2232	25.360	601.460	56
V6-2000	Number of communes with over 50% asphalted/concrete roads inter-village	26.5536	0.000	142.000	56
V7-2000	Number of high schools/communes	11.7679	0.000	48.000	56
V8-2000	Number of health clinics/communes	84.1786	4.000	400.000	56
V9-2000	Fiscal decentralization index	0.1818	0.080	1.000	56
V1-2005	1000 billion VND	2.2511	0.220	6.450	56
V2-2005	1000,000 billion VND	9015.5409	414.410	66620.000	56
V3-2005	1000,000 ha	184.7871	29.340	671.000	56
V4-2005	1000, 000 labor	432.7386	68.890	1484.570	56
V5-2005	1000 households	207.2414	25.400	705.160	56
V6-2005	Number of communes with over 50% asphalted / concrete roads inter-village	65.3311	0.000	267.000	56
V7-2005	Number of high schools/communes	15.6786	3.000	54.000	56
V8-2005	Number of health clinics/communes	140.3214	11.000	580.000	56
V9-2005	Fiscal decentralization index	0.1845	0.070	1.000	56
V1-2011	1000 billion VND	3.1191	0.190	8.990	56
V2-2011	1000,000 billion VND	13352.7409	975.990	71561.330	56
V3-2011	1000,000 ha	124.5468	10.850	618.000	56
V4-2011	1000, 000 labor	322.0102	28.410	1070.880	56
V5-2011	1000 households	253.2161	30.160	942.500	56
V6-2011	Number of communes with over 50% asphalted/concrete roads inter-village	133.2143	11.000	522.000	56
V7-2011	Number of high schools/communes	17.2271	3.000	59.000	56
V8-2011	Number of health clinics/communes	149.8929	14.000	584.000	56
V9-2011	Fiscal decentralization index	0.1939	0.090	1.0000	56

RESULTS AND DISCUSSION

Estimation results: Estimation results were reported in Table 2, which indicated that four parameter estimates in standard Cobb-Douglass production function were found to be statistically significant at the 5% level including labor, capital, education and healthcare service. Both non-interactive and interactive models statistically dominate the Cobb-Douglas specification. The LLF value of -0.13E+03 and the LR test value of 0.43E+02 obtained in the non-interactive model were less than the LLF of -0.11E+03 and the LR test value of 0.78E+02 in an interactive model, which mean that the interactive model was more appreciated and has higher reliability than to explain the variation in the analytical model. Both σ^2 and γ in interactive model have statistically significant with correlation coefficients of 0.24 and 0.21, which imply that there exists technical inefficiency.

As an empirical evidence indicated in Table 2, almost the interactive variables of fiscal decentralization with public goods and services were found to be statistically significant with excepting the interactive variable of fiscal decentralization with education. In which, the interaction of fiscal decentralization with public electrical and healthcare services have a negative effect to the technical inefficiency with correlation coefficients of -0.28E-02 and 0.26E+00, which imply that an increasing in interactive relation of fiscal decentralization with electrical and healthcare services will lead to an increasing in the technical efficiency and consequently the output of agricultural production will go up. This is interpreted by the fact that when the local needs of electrical services for the agricultural production increase while the degree of fiscal decentralization incremates in an appropriate proportion and the packages of electrical services provided by local government are suitable with the fiscal decentralization becomes an element that could enhance the technical efficiency[10] due to upgrading the rural electrical services that could strengthen the ability to apply modern technology for agricultural field, which lead to an increase productive[4,5]. Likewise, improving the quality of public health care services was suitable to the actual needs of the locality, which were rooted in extending the degree of fiscal decentralization[10] at a reasonable level. This would raise farmer's health that could prolong working time and enhance labor productive[17]and the technical efficiency go up.

Opposite, the interaction of fiscal decentralization and rural road network in the current scenario of Vietnam was found to be a positive influence on the technical inefficiency with correlation coefficients of 0.17E+00 (Table 2), which have revealed that an increasing in interactive relation of fiscal decentralization with road network will be a cause of

Table 2: Estimation result

	Model					
	Cobb-Douglas function		Non-interactive		Interactive	
Variables	Coefficient	T-ratio	Coefficient	T-ratio	Coefficient	T-ratio
Const	0.55E+01	23.19	0.68E+01	18.99	0.76E+01	19.93
Ln(V2)	-0.78E-03	-4.58	-0.98E-03	- 5.96	-0.10E-02	-5.79
Ln(V3)	0.24E+00	5.00	0.15E+00	3.27	0.78E-01	1.49
Ln(V4)	-0.43E-04	-0.24	-0.44E-04	- 0.26	-0.12E-03	-0.71
Ln(V5)	-0.35E-01	-0.42	0.85E-01	1.05	0.16E+00	19.26
Ln(V6)	-0.61E-04	-0.36	0.95E-04	5.57	0.35E-04	2.15
Ln(V7)	0.87E+00	9.61	0.51E+00	4.85	0.35E+00	3.45
Ln(V8)	0.77E-03	4.21	0.41E-03	2.11	0.21E-03	1.17
Const	-	-	0.83E+00	2.57	0.81E+00	1.64
V5	-	-	-0.96E+00	- 3.62	-0.72E+00	-3.31
V6	-	-	-0.21E-03	- 0.98	-0.12E-03	-0.53
V7	-	-	-0.59E-01	- 2.44	-0.55E-01	-2.31
V8	-	-	-0.43E-04	- 0.22	0.22E-05	0.01
V9	-	-	0.61E-01	1.12	-0.28E-02	-0.04
V5×V9	-	-	-	-	-0.71E-03	-3.83
V6×V9	-	-	-	-	0.17E+00	1.78
V7×V9	-	-	-	-	0.36E-03	1.47
V8×V9	-	-	-	-	-0.26E+00	-2.09
V5×V5	-	-	-	-	-0.42E-03	-1.67
V6×V6	-	-	-	-	-0.21E-02	-1.53
V7×V7	-	-	-	-	-0.29E-02	-1.23
V8×V8	-	-	-	-	0.37E-01	2.71
V9×V9	-	-	-	-	0.11E-02	1.15
σ^2	-	-	0.29E+00	8.22	0.24E+00	7.61
γ	-	-	0.13E+00	1.65	0.21E+00	1.67
LLF	-0.15E+03		-0.13E+03		-0.11E+03	
LR test			0.43E+02		0.78E+02	
M. efficiency			0.62E+00		0.53E+00	
N	168		168		168	

reduction in the technical efficiency. This was caused by that the rural road network in Vietnam has been invested significantly by the programs of central governments as well as the local governments. The quantity and quality of rural road networks increased markedly and they have an important role in enhancing the quality of life, stimulating the economic growth and development because of strengthening the capacity of cargo traffic to market, the provision of inputs to production process and serving the travel needs of people. However, the rural road network in current status only focused on at the level of inter-village and communal roads, which has a small impact on the process of agricultural production[27]. The fact that the needs of rural road systems for agricultural production are the roads running across the fields that can implement and apply modern equipments and machineries into the production process as well as transport the agricultural products from pasturages to main roads like inter-village and communal roads[27]. So that, even the degree of fiscal decentralization was extended in recent years, but they still upwards inefficiencies in the agricultural production, which has been noted by Hanh *et al.*[10]. This is a reason why interpreting the interaction of fiscal decentralization and rural road network has a negative impact on output of agricultural production.

Productive efficiency: The efficiency of agricultural production in Vietnam within a current scenario of the relationship of fiscal decentralization and agricultural output in Vietnam across provinces was described in Table 3. It has indicated that the technical efficiency of agricultural production trend upward. The number of provinces with the technical efficiency of agricultural production is less than 25% with 12 provinces accounted for 21.43% in 2000, while in 2005 only with 6 provinces and in 2011 is 2 provinces. The numbers of provinces with the technical efficiency are more than 75%, which increase significantly, especially from 2005-2012 with the number of provinces increases from 9-23 provinces. This is caused by that in during from 2000-2012, Vietnam has many preferential policies of agricultural and rural development. Annually, the government's budget spends for

Table 3: Estimation of technical efficiency

	2000		2005		2012	
Technical efficiency	Frequency	Percentage	Frequency	Percentage	Frequency	Percentage
00<efficiency≤25	12	21.43	6	10.71	2	3.57
25<efficiency≤50	27	48.21	23	41.07	15	26.79
50<efficiency≤75	11	19.64	18	32.14	16	28.57
75<efficiency≤100	6	10.71	9	16.07	23	41.07
Total	56	100	56	100	56	100

building the infrastructure in agricultural and rural areas like rural road networks, rural electric systems, irrigation systems, education services and healthcare services were, relatively large. In this stage, Vietnam government also enacted numerous policies to attract foreign investment and technology transfer[27]. At the same time, the authority on financial revenue and expenditure as well as responsibility for providing the public goods and services of local government were also expanded[27]. All of these are cause of improving the efficiency of the production process, which lead to the agricultural output increase.

CONCLUSION

By empirical analysis, we have investigated that fiscal decentralization was an element that could improve technical efficiency as whole, which leads to increase output in agricultural field through the packages of public goods and services by local government. However, when make fiscal decentralization in the agricultural sector, it is necessary to be implemented in an appropriate proportion, consistent with local needs for every kind of public goods and services. Additionally, when consider the relationship of fiscal decentralization with agricultural field in a particular context, it needs to be placed in an interactive relationship with every kind of public goods.

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