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Market and Other Factors Affecting Farm Specific Production Efficiency in Pig Production in Vietnam

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ABSTRACT. In developing country production environment, farm production efficiency is often measured in terms of on-farm resources and producer characteristics. In this paper we postulate that input and output market related factors also influence farm production decisions hence its efficiency. Stochastic frontier production function was used to assess technical efficiency and its determinants including input and output market variables for a sample of 1962 pig farms in Vietnam with data collected in 1999. There are significant differences in production behavior and efficiency level between the North and the South, among farms producing different breeds, between mixed and specialized farms, between household and commercial farms, and

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among producers located in different agro-ecological regions. Access to better output market, land size, herd size, and education of household head significantly reduced inefficiency, while access to government supplied inputs, age of household head, female headed households and family supplied crude feeds significantly increased inefficiency in both the regions. The direction of influence on efficiency differs between the two regions for access to credit, proportion of output sold at market rather than at farm gate and family labor supply. Generally, market related factors had more consistent influence on production efficiency in the South of Vietnam where the experience of market economics is longer compared to the North. Policy actions on providing better extension, more timely access to better quality inputs through the private sector, making credit more easily accessible to smallholders and opportunity to sell output at better priced secondary markets are expected to increase productivity and reduce inefficiency.

KEYWORDS. Frontier function, market factors, Pig, production efficiency, Vietnam

INTRODUCTION

The government of Vietnam has recently adopted an agricultural diversification program in which development of the livestock sector has been given substantial priority as a slowdown in rice production, the main economic enterprise, in recent years has indicated the limited prospect for growth through rice alone (IFPRI 2001). This strategy is in line with agricultural diversification policies in developing countries that give priority to livestock sector in response to lower real prices of cereals and a shift in food demand pattern towards higher value foods with higher income elasticity of demand like animal products due to rising average income, population growth and urbanization (Goletti, 1999; Delgado, Rosegrant, Steinfeld, Ehui, and Courbois, 1999). However, two questions are pertinent to the Vietnamese diversification strategy through livestock to work effectively. First, with increased economic liberalization and the opening of the domestic market to competition, whether livestock production will remain sufficiently efficient and competitive with the outside world in order to play a significant role in rural income diversification. Second, whether smallholders, who currently dominate

the sector, will remain efficient and competitive to stay in business and reap the benefits of the rapid demand growth for livestock products given that larger commercial enterprises are entering the market under liberal economic policies and larger farms may be more cost effective in production and marketing. Livestock products have long been a pathway for income generation by the poor and rapidly growing and changing livestock markets in the developing world provide real opportunities as well as challenges to participation of the poor, due to the increasing integration of national and world markets, the increasing demand for better quality and safe food in cities, and a changing regulatory environment on the one hand, and on the other, constraints to smallholders' inability to produce high quality products due to the lack of better technology, inputs, services and information (Delgado et al., 1999; Delgado, Narrod, and Tiongco, 2003; Burke, Jayne, Freeman, and Kristjanson, 2007).

A recent analysis of pig and poultry production in Vietnam using policy Analysis matrix (PAM) showed that some technologies/enterprises are generally more competitive than others, e.g., local and crossbred pigs in the North are more competitive than exotic breeds, whilst exotic breeds are more competitive in the South (Akter, Jabbar, and Ehui, 2004). Part of the explanation for this difference lies in the differences between the North and the South in terms input and outputs market conditions. Currently the producers in the South are apparently benefiting more due to market conditions and policy that make input cost higher and output price lower in the North compared to the South. Since PAM results are basically based on the performance of the average farm, in reality, differences in technical and economic efficiency may vary widely across individual farms and this may also vary for different breeds. Thus, at the individual farm level, the ability to compete within a liberalized economic environment may vary widely- some may be highly competitive while others may not be so. Akter et al. (2004) therefore recommended that a detailed farm-specific efficiency analysis might shed more light on the production and profit frontiers and their determinants for poultry and pig farms in the country.

Moreover, Le Goulven (2001) reported earlier that hog market institutions are public in the North and private in the South, and that producer and retail prices of hog in the North did not show a common long-run equilibrium as price transmission between the two levels was asymmetric. But in the South prices showed long-run equilibrium as price movements were symmetric. This indicates that

hog production in the South was more responsive to market signals and producers had more incentive to diversify into hog production based on market opportunities compared to producers in the North where supply shocks were not transmitted as efficiently. These differences in market structure and price transmission process might also contribute to differences in farm level production efficiency. Market failure has been considered an important reason for the declining food production in the sub-Saharan Africa region since the 1970s (Holden and Binswanger, 1998). So, analysis of market access variables has wider implication for searching policy options for enhanced production efficiency in developing countries.

Primary production decisions by farm households involve not only questions on what product(s) to produce, how much to produce, what inputs and resources to use at what level but also where to buy and sell inputs, services and products. Although these last set of questions relate to market, they may have profound influence on choices of products to be produced and inputs and services to be used and on the overall efficiency in farm production (Bishop and Toussaint, 1966; Mosher, 1966). Access to better quality inputs, services and information is a major constraint or barrier for smallholders in the developing countries to produce better quality products to enter expanding higher priced product markets on a competitive basis with larger scale producers (Delgado et al., 1999; Holloway and Ehui, 2002; Lapar, Holloway, and Ehui, 2002; Lapar, Binh, and Ehui, 2003; Delgado et al., 2003; Boughton et al., 2007). Thus farm level efficiency analyses need to consider both on-farm resources, farmer characteristics as well as the nature and extent of participation by smallholders in input and output markets. In the context of Vietnam, the importance of this type of analysis lies in the fact that Vietnam has been recently passing though a transition from command and control type economic management to a more market oriented economy. Since the South of Vietnam was under a market economy before the integration and has picked up more quickly than the North after the liberalization policies have been introduced, the impact of input and output market factors on producer behavior and efficiency may be expected to be somewhat different.

The specific objectives of this study are:

- to measure farm specific technical efficiency in pig production
- to measure the effects of the factors determining efficiency, including effects of input and output market related factors

- to suggest options for reducing farm level inefficiency as means to increase competitiveness of smallholders in the market.

Pig meat represents about 75% of total meat production in Vietnam. Pigs are raised throughout Vietnam as an important component of all types of farms, and large-scale commercial production is a more recent phenomenon. Also local, cross, and exotic breeds are raised. So efficiency in pig production has implications for producer and consumer welfare in the country. Suggested options, in general, should have implications for smallholder agriculture facing similar market access problems globally.

In section 2, methodology and data are described, in section 3 the results are discussed with conclusions at the end.

METHODOLOGY AND DATA

Analytical Framework

The stochastic frontier production function approach was used for measuring efficiency and its determinants in this study. Theoretical and empirical literature on this approach is quite extensive. In short, the stochastic frontier approach incorporates a composed error structure with a one-sided inefficiency component and a two-sided symmetric random component. The inefficiency component is used to obtain firm specific or average efficiency and the random component picks up the effect of uncontrolled random shocks, such as weather, measurement error, disease and other statistical noise. There are many variants in model specification and distribution of the unknown variance of the inefficiency component (Aigner, Lovell, and Schmidt, 1977; Meeusen and Van Den Broeck, 1977; Jondrow, Lovell, Meterov, and Schmidt, 1982; Battese and Coelli, 1988).

In this study, a modified Cobb-Douglas specification was assumed and the following frontier production and inefficiency models that are variants of Coelli and Battese (1996) were specified:

$$\ln\,(Y_i) = \alpha_0 + \Sigma\beta_j \ln\,(X_{ij}) + \Sigma\alpha_j D_j + v_i - u_i \qquad (1)$$

$$\mu_i = \delta_0 + \Sigma\delta_k Z_{ik} \qquad (2)$$

where the subscripts i, j, k and p refer to the i-th farmer, the jth and

the kth parameter or variable respectively ($i = 1\ldots n$, $j = 1\ldots J$, $k = 1\ldots K$); ln represents the natural logarithm; Y, X and Z are variables to be defined below.

The α_0, β_j, α_j, δ_0 and δ_k are unknown parameters to be estimated; the v_{is} are assumed to be independently and identically distributed random errors with distribution $N(0, \sigma_v^2)$; the u_{is} are non-negative technical inefficiency effects independently distributed and arise by truncation at zero of the normal distribution $N(\mu_i, \sigma_u^2)$, where the unknown variance σ_u^2 is defined by

$$\sigma^2 = \sigma_u^2 + \sigma_v^2 \tag{3}$$

$$\gamma = \sigma_u^2 + \sigma^2 \tag{4}$$

and the mean μ_i is defined by equation (5) below[1]. The value of the parameter γ lies between zero and one. When the frontier production function is defined for the logarithm of production, then the suggested measure of technical efficiency for the *i*th farm is

$$TE = \exp(-u_1) \tag{5}$$

Thus, given the specification of the stochastic frontier model (1) and (2), the technical efficiency of the ith farm can be obtained by using equation (5) (Battese and Coelli, 1993).

In addition to measuring the level of efficiency, differences in efficiency levels and their causes are also explained. Empirical studies to explain differences in efficiency of farms used either a two-stage or a single-stage approach. In the two-stage approach, the first stage involves the estimation of a stochastic frontier function and the prediction of farm specific technical inefficiency or efficiency effects. The second stage estimates the effects of the factors explaining technical efficiency using ordinary least squares regression. This approach is criticised on the ground that the assumption of independent and identical distribution of the inefficiency effects is violated in the second stage when they are made to be a function of the farm specific factors (Kumbhakar, Ghosh, and McGuckin, 1991; Reifschneider and Stevenson, 1991; Kumbhakar and Lovell, 2000). The single-stage approach specifies stochastic frontiers and models for the technical inefficiency effects and simultaneously estimates all the parameters involved. We apply this one-stage approach because it leads to more efficient inference with respect to the parameters involved (Coelli and

Battese, 1996). Frontier version 4.1 software was used to analyse the data (Coelli, 1994).

Source of Data and Definition of Variables

The set of data consisted of a nationwide stratified sample survey of 1962 pig farms drawn separately from the two regions (North and South) covering a total 29 provinces. Other stratification criteria used in sampling were farm size (small, medium, and large) and breed (local, crossbred, and exotic). Data were collected during August 1999 to January 2000 through a single visit survey using detailed questionnaire. Trained Vietnamese field staff conducted the survey (for details see, IFPRI, 2001).

In general, the North and the South of the country differ significantly in terms of agricultural production practices, prices and income, e.g. prices and income are generally higher in the South. The differences are attributable to a great extent on market conditions, as the South has had a longer experience of market economics than the North. There are also significant differences in terms of production of pig, e.g. producers in the North produce more local and crossbred pigs while those in the South produce more exotic and crossbreeds. Average sizes of pig farms are also higher in the South. Difference in the structure of hog market in the two regions has been mentioned earlier. Therefore, separate analyses were done for the North and the South regions.

Variables included in the empirical estimation of equations (1) and (2) are described in Table 1. The X variables are in the production function and the Z variables are in the inefficiency function. Explanation on the definition of some variables and hypotheses about their expected influence are given below.

Most important inputs in pig production are breeding and young stocks, labor, and feed. The feed inputs consist of various crude materials and fodder crops (purchased from the market and produced at home) and concentrate feed. Crude materials and fodder crops are of lower quality than concentrates. In order to capture the effects of feed quality on production performance, the ratio of crude materials and fodder crops to total feeds is used as a separate variable.

Productivity may also differ according to agro-climatic variations representing differences in production potential, population density and market infrastructure as higher population settlement occurs in higher potential areas and better market infrastructures are built to

TABLE 1. Variables Included in the Stochastic Frontier Function for Pig Production

Variable	Description of the Variable	Average Values	
		North	South
Output (Y)	Value of output plus change in inventories (000′D per farm)	37728	226445
Stock (X1)	Value of stocks in 000′D per farm	10985	100278
Labor use (X2)	Annual labor (person days) spent for production	226	442
Feed (X3)	Total feed (kilogram per household)	12778	41149
Crude feed ratio (X4)	Ratio of crude materials and fodder crops to total feed	0.96	0.64
Housing (X5)	Housing area (sq. meter per household)	86	217
Veterinary cost (X6)	Annual cost on veterinary fees and drugs (000′D per farm)	238	3819
Farm type (D1)	Dummy for business type:1 = commercial farm, 0 = family farm	0.42	0.37
Crossbred (D2)	Dummy for breed: 1 for crossbred, 0 otherwise *	0.48	0.42
Exotic breed (D3)	Dummy for breed: 1 for exotic breed, 0 otherwise*	0.02	0.47
Mixed breeds (D4)	Dummy for breed: 1 for mixed breeds, 0 otherwise*	0.49	0.04
Enterprise mix (D5)	Dummy for mixes of livestock types: 1 = pig and other livestock , 0 = only pig	0.78	0.27
Northeast region (D6)	Regional dummy, 1 for North East**	0.34	
Northwest region (D7)	Regional dummy, 1 for North West**	0.11	
North central coast (D8)	Regional dummy, 1 for North Central Coast**	0.22	
Central highlands (D9)	Regional dummy, 1 for Central Highlands**		0.13
Northeast south (D10)	Regional dummy, 1 for North East South**		0.21
Mekong River delta (D11)	Regional dummy, 1 for Mekong River Delta**		0.33
Producer age (Z1)	Age of the producer (years)	45	46
Labor supply (Z2)	Number of adult persons available for farm work	2.43	2.10

(Continued)

TABLE 1. Continued

Variable	Description of the Variable	Average Values	
		North	South
Land size (Z3)	Total cultivated land (hectare per household)	0.34	0.52
Herd size (Z4)	Number of animals in the entire herd	100	237
Credit use (Z5)	Dummy for credit: Received credit for pig production = 1, No = 0	0.24	0.24
Education (Z6)	Highest level of education of household head	3.3	3.2
Gender (Z7)	Dummy for gender of the household head: 1 = female, 0 = male	0.20	0.26
Market distance (Z8)	Distance of the farm from nearest major market (km)	1.5	6.9
Sale at market place (Z9)	% product sold at the market place rather than at farm gate	0.5	2
Gov't. inputs (Z10)	% veterinary inputs and stocks received from government enterprises, department of agriculture or cooperatives	32	20
Visits by gov't. service providers (Z11)	Number of visits/inspections by the providers of services by government and quasi government organizations and cooperatives	4.0	7.9
Home produced crude material (Z12)	Ratio of home produced crude materials and fodder crops to total crude materials and fodder crops	0.56	0.18

Notes: US$ 1 = 14008 D (Vietnam Dong) in 1999.
*The base is the producer having local breed.
**The base zone in the North region is Red River Delta and in the South is South Central Coast.
Source: Field survey 1999.

support higher population density (Okike, Jabbar, Manyong, Smith, and Ehui, 2004; Sherlund, Barret, and Adesina, 2002). In this study agro-ecological dummy variables were included in each regional equation. Producers of improved breeds are expected to be on the higher production frontier than the producers of local breeds as improved breeds are adopted in response to market demand and

semi-subsistence smallholders may change slowly from local breeds as they serve multiple functions in the household economy including food, manure, and opportunity to use cheap family labor (Burke et al., 2007, Boughton et al., 2007). Market related variables of particular interest for productivity include farm type and business type. Commercial farms are expected to be on the higher production frontier than the household farms as the former are expected to respond more to market signals in making decisions on what types of products to produce, what types of inputs and services to use and where to buy inputs and services and sell products as quality and prices may differ (Lapar et al., 2002; Lapar et al., 2003). The producers who are specialized in pig production are expected to be on the higher production frontier than the producers who simultaneously produce a number of different types of livestock as the former may be more skilled and efficient managing a few things and more oriented towards market and profit making than those who spread their efforts to several aspects so may not be able to everything equally efficiently.

In addition to influencing productivity, market related factors also may increase efficiency or reduce inefficiency directly (Rahman 2003; Ahmed and Hossain, 1990). Market infrastructure, missing markets, market failure and problems of poor roads are thought to be important constraints for households to benefit from livestock production (Holden and Binswanger, 1998; Kristjanson, Krishna, Radeny, and Nindo, 2004). Wood, Sebastian, Nachtergaele, Nielsen, and Dai. (1999) classified market access as high or low based on three characteristics such as quality of road access, degree of urbanization and population size. Sometimes distance from households to paved roads, or to nearest market, or road density per square kilometre is used as a proxy for degree of market access as this affects the time and cost of travel to market for inputs and products, thereby influencing market participation and efficiency (Bagamba, Burger, Ruben, and Kuyvenhoven, 2006; Holloway and Ehui, 2002; Lapar et al., 2002; Lapar et al., 2003; Lapar and Jabbar, 2003). In this study market related variables explaining inefficiency include access to credit, distance to the nearest major market (secondary market,), sales outlet (farm gate or market place) for output, and sources of production inputs. Access to credit for pig production may increase the ability to use better quality inputs and services in adequate quantity at appropriate time, hence reduce inefficiency (Binam, Tonyé, Wandji, Nyambi, and Akoa, 2004). Sale at market rather than at farm gate (either to visiting buyers or as a part

of contract with processing enterprises) may also influence efficiency (Jabbar et al., 2005). If the distance of the nearest major market (secondary market) where the producers may sell their product or buy their inputs is long, transaction costs may be higher contributing to inefficiency. On the other hand, if prices of output and input in distant major markets in relation to local markets are such that they more than compensate the higher transactions costs, then access to distant markets may contribute to reduce inefficiency.

The supply of inputs from government sources is expected to reduce inefficiency if quality is better and farmers get them at a lower price than other sources. The outcome may be opposite if the quality is poor and/or the inputs and services are not supplied at the optimal time. Access to information, extension and veterinary services, and frequent visits by the government organizations and cooperatives at times of need to address specific production constraints are expected to reduce inefficiency, because such services are expected to promote adoption of new technology and improve technical knowledge and management skills of the producers (Jabbar et al., 2005). Home produced feeds (crude materials and fodder crops) are likely to be of poorer quality than standard feeds bought from the market, so a higher share of home produced feed use may increase inefficiency.

Other household characteristics that may influence inefficiency include scale of operation through economies of scale, education and training, and age and gender of household head. Higher levels of formal education and training are expected to reduce inefficiency through better knowledge, information and skills. Female-headed farms may be less efficient due to less education, training and management skills. Existence of non-agricultural sources of income implies greater access to assets and liquidity to acquire productive inputs. Higher non-agricultural income therefore may contribute to reduce inefficiency. It may also increase inefficiency if less attention is given to farming due to less dependence on farming compared to other activities.

Results and Discussion

Pig Production Behavior and Inefficiency Effects

The maximum-likelihood estimates of the parameters in the stochastic frontier and inefficiency model for the producers in the North and the South are presented in Tables 2 and 3 respectively.

TABLE 2. Maximum Likelihood Estimates for Parameters of the Stochastic Frontier and Inefficiency Models for Pig Production, North Vietnam

Production factors	Coefficients	Inefficiency factors	Coefficients
Constant	2.123***(0.195)	Constant	−0.251 (0.312)
Stock (LnX1)	0.255***(0.017)	Producer age (Z1)	0.009***(0.004)
Labor use (LnX2)	0.050***(0.023)	Labor supply (Z2)	−0.027 (0.033)
Feed (LnX3)	0.546***(0.023)	Land size (Z3)	−0.596***(0.213)
Crude feed ratio (LnX4)	−0.009 (0.025)	Herd size (Z4)	−0.0005***(0.0001)
Housing (LnX5)	0.049***(0.016)	Credit use (Z5)	0.006 (0.079)
Vet cost (LnX6)	0.043***(0.011)	Education of hh head (Z6)	−0.082***(0.041)
Farm type (D1)	0.160***(0.031)	Gender of hh head (Z7)	0.134**(0.081)
Crossbred (D2)	0.661***(0.060)	Distance to major market (Z8)	−0.271***(0.024)
Exotic breed (D3)	0.411***(0.124)	Sale at market place (Z9)	0.010***(0.004)
Mixed breeds (D4)	0.419***(0.059)	Govt inputs (Z10)	0.003***(0.001)
Enterprise mix (D5)	−0.055*(0.038)	Visits by govt service providers (Z11)	−0.015*(0.011)
Northeast (D6)	−0.085***(0.038)	Home supplied crude feed (Z12)	1.190***(0.153)
Northwest (D7)	−0.157***(0.055)		
North central coast (D8)	0.041 (0.044)		

Notes: Variance($= \sigma^2$) = 0.307***(0.031) ; $\sigma^2_u / \sigma^2 = \gamma = 0.617$***(0.046);
Log-likelihood function = −630.92; Test statistic λ (df = 14) = 165.40***;
***, ** and * show statistical significance at the 1 percent, 5 percent and 10 percent level respectively; Figures in parentheses are standard errors.
Source: Field survey 1999.

The values of the σ^2, γ, log likelihood function and test statistic λ and their significance level indicate that inefficiency effects of a stochastic nature exist at a higher degree in the North than in the South. The predicted mean efficiency for the sample in the North is about 73% (median 76.3, standard deviation 14) and in the South is 78% (median 81.7, SD 13.4).

The estimated coefficients of the input variables of the frontier production function are all positive except the coefficient of the ratio of crude materials and fodder crops to total feed, which has a negative coefficient. All the coefficients are significant at the 1% level except for veterinary costs in the South. The sizes of all input elasticities are small and their sum equals less than unity indicating decreasing returns to scale.

TABLE 3. Maximum Likelihood Estimates for Parameters of the Stochastic Frontier and Inefficiency Models, Pig Production, South Vietnam

Production factors	Coefficients	Inefficiency factors	Coefficients
Constant	2.070***(0.158)	Constant	−4.569***(1.057)
Stock (LnX1)	0.081***(0.017)	Producer age (Z1)	0.036***(0.010)
Labor use (LnX2)	0.072***(0.023)	Labor supply (Z2)	0.133***(0.067)
Feed (LnX3)	0.755***(0.023)	Land size (Z3)	−0.266***(0.106)
Crude feed ratio (LnX4)	−0.023***(0.007)	Herd size (Z4)	−0.0002***(0.00001)
Housing (LnX5)	0.026***(0.013)	Credit use (Z5)	−1.823***(0.482)
Vet cost (LnX6)	0.005 (0.007)	Education of hh head (Z6)	−0.288***(0.085)
Farm type (D1)	0.150***(0.036)	Gender of hh head (Z7)	0.437***(0.193)
Crossbred (D2)	0.266***(0.068)	Distance to major market (Z8)	−0.009***(0.001)
Exotic breed (D3)	0.448***(0.081)	Sale at market place (Z9)	−0.039***(0.011)
Mixed breed (D4)	−0.011 (0.095)	Govt inputs (Z10)	0.010***(0.002)
Enterprise mix (D5)	−0.055*(0.039)	Visits by govt service providers (Z11)	0.019***(0.006)
Central highlands (D9)	0.272***(0.053)	Home supplied crude feed (Z12)	1.735***(0.430)
Northeast south (D10)	0.380***(0.064)		
Mekong Delta (D11)	0.390***(0.052)		

Notes: Variance $= \sigma^2 = 1.167^{***}(0.165)$; $\sigma^2_u/\ \sigma^2 = \gamma = 0.923^{***}(0.011)$;
Log-likelihood function $= -316.10$; Test statistic λ (df $= 14$) $= 182.24^{***}$;
***, ** and * show statistical significance at the 1 percent, 5 percent and 10 percent level respectively; Figures in parentheses are standard errors.
Source: Field survey 1999.

In the South the coefficient of veterinary cost is positive but not significant implying that producers perhaps over spend on veterinary fees and drugs. About 70% of the cost was due to vaccination and 19% was due to artificial insemination compared to 52% and 6%, respectively, for these two items in the North. Artificial insemination for pig production is very expensive in Vietnam (IFPRI 2001). By contrast, spending on disinfection and internal parasite control, which are directly related to productivity, is much higher in the North (26% of total veterinary cost compared to 6% in the South).

The coefficient of the ratio of crude materials and fodder crops to total feed is negative in both regions, indicating that concentrate feeds are more productive than crude feed materials and fodder crops. The positive and significant coefficient for farm type dummy (D1) in both

regions indicates that business farms are more productive than household farms. The coefficients of dummies representing cross and exotic breeds indicate that the improved breeds, especially crossbreds in the North and exotic breeds in the South, are more productive than local breeds. Specialized pig producers are more productive than those mixing pig with other livestock species in both regions.

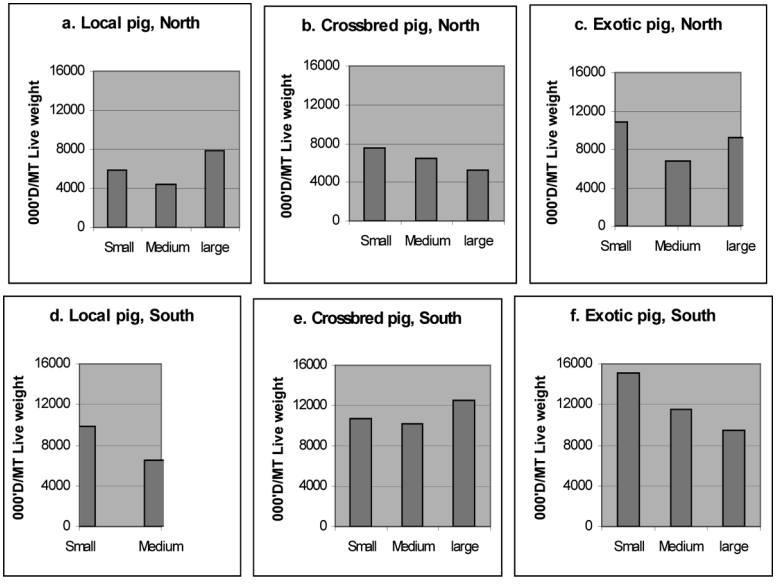
In the North, producers in the Red River Delta and North Central Coast are more productive than those in the Northeast and Northwest regions. In the South, compared to producers in the South Central Coast, those in all the other three regions are significantly more productive.

Among the 12 factors considered for explaining inefficiency, all are significant at 10% level or less in the South and 10 are significant in the North (Tables 2 and 3). Market distance, land size, herd size, education of household head significantly reduced inefficiency, while increased access to government supplied inputs, age of household head, female headed households and higher proportion of family supplied crude feed materials significantly increased inefficiency in both the regions.

On average, scale economies exist for crossbred pig in the North and local and exotic pig in the South; in case of other enterprises medium farms had the lowest cost (Figure 1). In the North, large local pig farmers were merely breaking even and small farms producing exotic breeds were making losses. A comparison of cost components by size of operation show that cost economies were derived from labor in all cases and from feed in some cases. Stock purchases and veterinary cost increased with the herd size. However, lower veterinary expenses by small farms may not be a reflection of cost economy but rather their inability to spend enough in this important input to enhance productivity due to lack of cash or lack of information.

Longer distance to the major market (secondary markets) where producers sold output and/or bought inputs decreased inefficiency in both the regions. Because of very high density of population in Vietnam, rural markets are not always very far from one another (Lapar and Jabbar, 2003). Prices in the larger secondary markets, which are fewer in number than local primary markets, are expected to be better than in local markets. But not every one uses the secondary markets or can afford to access these markets because of one or the other reason, e.g. lack of proper transport, lack of adequate volume of business to justify the journey, capital constraint, lack of information about

FIGURE 1. Average Cost of Production Per Ton Live Weight for Pig by Breed, Herd Size and Region, Vietnam.



inter-market price differences to guide decision on where to sell. In this sample, average distance to the nearest market was 1.9 Km in the North and 6.9 Km in the South. And only less than 1% and about 2% of the total output in the North and South respectively were sold in distant (secondary) markets, especially by those who produced exotic or cross-bred animals. The results imply that small number of producers who sold outputs and bought inputs at secondary markets rather than at local markets were able to get better prices that more than compensated their possible higher transactions costs leading to reduced inefficiency.

Female household heads are less efficient perhaps because of lower education, and less access to other resources and information. In the sample of pig farmers in the North, 20% of the household heads are females. About 25% of the female heads have education above middle school compared to 32% of the male heads. In the South, 37% of the male heads have education above middle school compared to 25% of the female heads.

The direction of influence of some other factors differs between the two regions. Access to credit significantly reduced inefficiency in the

South, perhaps by allowing purchase of better quality inputs and services, but it had no effect in the North. Higher proportion of sale of output at the market place rather than at farm gate significantly reduced inefficiency in the South, but had an opposite effect in the North, perhaps because of lower prices received at the market and/or or higher transactions costs incurred in relation to the final price received. Higher number of visits by government and formal organizations providing extension and veterinary services significantly increased inefficiency in the South, but had the opposite effect in the North perhaps because of the differences in the quality and timeliness of the services provided. Increased family labor supply significantly increased inefficiency in the South, perhaps because available labor could not be fully used, but it had no effect in the North.

Characteristics of Most and Least Efficient Farms

The analysis of factors influencing inefficiency helps to identify which factor influence inefficiency and how. It may also be useful to compare differences between the actual dimensions of these factors for best and least performing farms so that poor performing farms may observe where opportunities for improvement lie for increasing the level of efficiency. Policy makers may also identify where support may be needed to help less efficient farms to be more efficient. Therefore, we classify the top 10% of the farms to be most efficient and the bottom 10% to be least efficient. Thus, the groups constitute a thick frontier at the top and another thick frontier at the bottom.

The characteristics of the least and most efficient farms in the North are presented in Table 4. The mean values of all the inputs per animal unit is higher for the least efficient farms except concentrate feed, which is lower than most efficient farms. Among the factors which affect efficiency, the most efficient farms have more cultivated land, larger herd size, use higher amount of credit, travel longer distance (i.e. access secondary markets) to sell products (perhaps larger volume allows them to do so), and get more frequent visits from the government organizations and cooperatives service providers. By contrast, the least efficient farms have older household heads, more adult members for farm work, sell proportionately more output in the market place, and use more inputs from government sources.

In the South, input use per animal unit shows the same pattern as in the North, but unlike in the North, the least efficient farms in the

TABLE 4. Selected Characteristics of Least Efficient and Most Efficient Pig Farms, North Vietnam

Variables/characteristics	Least efficient farms (n = 112)	All farms (n = 1120)	Most efficient farms (n = 112)	p > t/ p < t
Mean efficiency (%)	43	73	90	0.00
Value of output (000'D/household)	6415	37728	147779	0.00
Value of parent stocks (000'D/animal)	98	91	88	0.14
Annual labor (days /animal)	10.7	5.3	2.6	0.00
Total feed (kg/animal)	282	220	151	0.00
Crude feed purchased (kg/animal)	276	214	138	0.00
Concentrate feed (kg/animal)	5.9	6.7	13.1	0.04
Home feed (kg/animal)	207	127	41	0.00
Housing area (sq.m/animal)	0.9	0.8	0.5	0.07
Veterinary cost (000'D/ animal)	2.24	2.23	1.82	0.22
Age of the producer (years)	49	44	41	0.01
Adult members for farm work (persons/ household)	2.5	2.4	2.3	0.10
Cultivated land (hectare/household)	0.30	0.34	0.50	0.03
Credit for pig (000'D/animal)	3527	13796	8273	0.14
Average education level (yrs of schooling)	3.0	3.3	3.4	0.00
Distance to nearest major market (km)	1.4	1.5	1.7	0.07
Output sold in the market (percent)	2.3	0.5	0.5	0.03
Vet. inputs and stocks from govt/ cooperatives (%)	44	32	20	0.00
Herd size (number of animal)	58	100	687	0.00
Average no. of visit by govt. service providers	3.1	4.0	4.9	0.01

Note: The last column shows the level of significance for t-test for testing the differences of mean characteristics between least efficient and most efficient farms.
Source: Field survey 1999.

South also use higher quantities of concentrate feed per animal (Table 5). Among the variables that influence efficiency, the most noteworthy difference between the North and the South is observed in the use of credit and market. Unlike in the North, the most efficient farms in the South use less credit and sell proportionately more in the market rather than at farm gate.

In line with productivity effects of various farm types shown in Tables 2–3, distribution of most and least efficient farms according to farm types suggest that most farms producing exotic breeds were in the most efficient category, those producing crossbreds were in

TABLE 5. Selected Characteristics of Least Efficient and Most Efficient Pig Farms, South Vietnam

Variables/characteristics	Least efficient farms (n = 63)	All farms (n = 631)	Most efficient farms (n = 63)	p > t/ p < t
Mean efficiency (%)	45	78	91	0.00
Value of output (000'D/household)	29943	226445	1087103	0.04
Value of parent stocks (000'D/animal)	276	283	227	0.06
Annual labor (days /animal)	10.0	5.5	3.8	0.00
Total feed (kg/animal)	385	213	142	0.01
Crude materials, fodder crops (kg/animal)	245	141	103	0.00
Concentrate feed (kg/animal)	140	72	39	0.17
Home produced feed (kg/animal)	84	30	6	0.00
Housing area (sq. m/animal)	3.7	1.3	0.9	0.04
Veterinary cost (000'D/animal)	5.1	7.9	5.2	0.57
Age of the producer (years)	50	46	44	0.01
Adult members for farm work (persons/household)	2.4	2.1	1.9	0.01
Cultivated land (hectare/household)	0.45	0.52	0.57	0.41
Credit for pig (000'D/animal)	67888	17482	6510	0.25
Average education level (yrs schooling)	2.8	3.2	3.3	0.01
Distance from the nearest major market (km)	5.7	6.9	16.9	0.15
Output sold in the market (percent)	0.9	1.8	9.5	0.01
Vet. inputs and stocks from govt/ cooperatives (%)	30	20	17	0.02
Herd size (number of animal/household)	58	237	1059	0.05
Average no. of visit by providers of govt. service	7.8	7.9	5.4	0.04

Note: The last column shows the level of significance for t-test for testing the differences of mean characteristics between least efficient and most efficient farms.
Source: Field survey 1999.

the medium performance category, those producing mixed breeds were evenly distributed along the performance scale while most local breed producers were in the least efficient category (Table 6). Most specialized pig farms were in the most efficient category while most mixed livestock producers were in the least efficient category; and most business farms were in the most efficient category while most household farms were in the least efficient category.

The distribution of most efficient and least efficient farms by agro-ecological regions show that some regions have higher shares of most efficient farms compared to other regions. Especially North East and

TABLE 6. Distribution of the Least Efficient and Most Efficient Pig Farms by Farm Types, Vietnam

Farm types	North (percent)			South (percent)		
	Sample	Least Efficient	Most Efficient	Sample	Least Efficient	Most Efficient
Breeds						
Local only	6	14	5	7	16	8
Crossbred only	48	33	36	42	49	45
Exotic only	2	2	7	47	25	41
Mixed	44	51	52	4	10	6
Total	100	100	100	100	100	100
Enterprise mix						
Pig only	22	12	38	73	60	73
Pig and other livestock	78	88	62	27	40	27
Total	100	100	100	100	100	100
Business type						
Household farm	58	68	36	63	68	49
Business farm	42	32	64	37	32	51
Total	100	100	100	100	100	100

Notes: Source: Field survey 1999.

North West regions in the North had proportionally more efficient farms compared to others though these regions were previously shown to be less productive compared to other regions. Thus, it appears that higher efficiency may be attained at lower level of productivity, in which case productivity improving technology has to be used to get out of lower income categories.

Summary and Conclusions

In general, there are significant differences in the production behavior and efficiency level between the North and the South, among farms producing different breeds of pig, between mixed and specialized pig farms, between household and business farms, and among producers located in different agro-ecological regions. Land size, herd size, education of household head, and access to secondary market significantly reduced inefficiency, while age of household head, female headed household, access to government supplied inputs and extension services, and family supplied crude feed materials increased inefficiency in both regions. Access to credit significantly reduced inefficiency in the South. Exotic and local pig production

in the South and crossbred pig in the North exhibited economies of scale, while medium size farms were most cost efficient for exotic and local pig in the North and crossbred pig in the South.

The use of better quality feed improved efficiency as would be expected but a significant proportion of crude materials and fodder crops were still being used. Moreover, a higher dependence on home produced crude materials reduced efficiency due to their poor quality. Therefore, to attain the production potential of improved breeds in smallholder conditions, much can be gained by improving feed quality and management and feed market supplying standard feed may play important role in this regard.

Education significantly improved efficiency level, so that more access to formal and informal education may help smallholders to become more skilled, efficient and competitive. Especially education and extension support should help female headed farms to be more efficient. Access to credit generally improved efficiency by leveraging cash constraint to buy better quality inputs and services. Longer distance to major (secondary) markets reduced inefficiency perhaps because of better prices than local markets that more than compensated transactions costs. Increased dependence on government supplied inputs such as feeds, stocks, and drugs reduced efficiency perhaps because of the poor quality and/or untimely delivery of such inputs. On the other hand, increased number of extension visits has improved efficiency. Private extension delivery is still not available. Therefore to optimize public investment for improving productivity and efficiency, especially of the smallholders, the government should fully withdraw from input supply businesses consistent with the policy of liberalization. Instead, public expenditure on extension and education and specialized training should be expanded as these have significant positive effect on efficiency and there are no alternative suppliers. Overall, policy support to attain this goal may be the key to alleviate poverty among smallholders and let them participate in the market-driven rural development process.

The results have several implications for policy. Inefficiency in farming systems can be reduced significantly by adopting the following measures:

Enhanced market liberalization along with measures to improve technology: A market liberalization policy that will lower input prices may improve efficiency and competitiveness in pig production in the North by increasing herd sizes. However, it may cause inefficiency

in the South if the pig farms become too large and lose the cost advantage due to lower technical performance. This means that investment on research towards existing technology adoption and new technology development along with steps to market liberalization could reduce inefficiency in the South. This is supported by a more consistent and expected influence of market related factors on efficiency in the South where open market operations has longer history. The differences in the hog market structure – private in the South and public in the North- have provided different contexts and environments for the market related factors to influence production efficiency differently. Government should disengage from the supply of inputs (vet medicine, improved stock, feed etc.) as they appear to be a source of inefficiency although services like vaccination which has public good character should be retained in the public sector.

Improving the quality of extension services: Higher number of visits by government and formal organizations providing extension services significantly increased inefficiency in the South, but had the opposite weaker effect in the North indicating differences in the quality and timeliness of the services provided. The messages taken to the farmer in the South may not always be appropriate or need based but some messages taken to the farmers in the North might be more relevant. Exchange of lessons or experiences between the two regions may be beneficial for both. Regarding the quality of services, a number of development agencies, including the world Bank, are promoting more effective extension methods such as farmer field schools (FFS) to extend science-based knowledge and practices (Binam et al., 2004, Quizon, Feder, and Murgai, 2001, Hanson and Just, 2001). Such best practices should be considered to complement existing service methods to achieve greater efficiency. Since educated farmers are more efficient, FFS aimed at training farmers with appropriate knowledge and practices could reduce inefficiency to a greater extent.

Providing farmers with greater access to credit: Given that the necessary complementary resources and economic environment are not yet in place for access to formal credit for smallholder farmers in many countries and Vietnam is not an exception, a cautious and gradual strategy should be taken for expansion of the services of rural financial institutions to smallholder livestock producers along with steps to market liberalization. The effect of credit is more

visible in the South where market economy is more mature. The government should provide adequate legal and regulatory support to innovative financial institutions performing elsewhere as best practices to reduce transaction costs in providing savings, credit and insurance services to the rural clientele. Livestock being a high value commodity, access to credit for smallholder livestock production should be seen as one of the instruments to help poor get out of poverty.

Improving infrastructure to ease farmer access to secondary market: Market access could be improved by public investment in physical infrastructure such as road, transportation, communication in both within and between regions and this is crucial to improving smallholder farmers' efficiency. Infrastructure development could also improve economic efficiency of other complementary enterprises.

NOTE

1. Coelli and Battese (1996) used this formulation for a time variant model. Here we use cross-section data and therefore specify the formulation as required.

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