Technical Efficiency and Land Markets: Do the Most Efficient Really Get The Land?

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Prepared for delivery at the 1997 meeting of the Latin American Studies Association,
Continental Plaza Hotel, Guadalajara, Mexico
April 17-19, 1997

It is widely accepted in economic theory that properly functioning markets serve to transfer factors of production from less efficient to more efficient producers. Increasingly, policy makers are relying on the market to allocate resources in the hope that this will improve efficiency. This paper will examine a coffee producing region in Honduras to determine the efficacy of the market there in the allocation of land.

Theoretical background

With perfectly functioning markets, the agent who expects to earn the most from a resource (*i.e.* the most productive agent) will be willing to pay more for that resource than other, less productive, agents and will therefore bid resources away from these less productive producers. This factor mobility ensures that resources will flow to their most productive use, facilitating increased efficiency and production.

In many parts of the world, market reforms are suggested to improve resource allocation and even to redistribute unequally distributed resources such as land. However, Binswanger and Elgin (1990) suggest that even under perfect market conditions, the market will not shift land to the landless or land poor. The market price of land should reflect the present value of its agricultural production, capitalized at the opportunity cost of capital. This means that if the purchaser borrows money to buy the parcel at market rates, the income from the parcel will just pay the interest, so consumption and repayment of the principal would have to be financed by labor, meaning the level of consumption would be lower than if the land had not been purchased and the individual had simply worked in the labor market. In addition, the expected future appreciation of land is capitalized into the market price, driving it above the value of the flow of agricultural income. These capital gains cannot be realized without selling the land, which is unfeasible for a small producer. Therefore, "the larger the expected capital gains components of land income and land price, the higher the equity required to buy land, or the higher the non-farm income required to finance consumption and mortgage payments" (Shearer *et al.*1991:35).

The Binswanger model applies to perfect markets, but markets for land are never perfect, especially not in developing countries. The conditions required for a perfect market are (Stringer 1989):

1. a substantial number of buyers and sellers so that one individual's demand or supply will not affect prices and no single purchase will influence the price;

2. homogeneous units so that participants in the market are indifferent as to from whom they buy or to whom they sell;

3. open and equal access for buyers and sellers to information about current transactions, including prices and bids;

4. no influence of traditional or institutional rules on the distribution of resources among the prospective buyers or on the land being sold to the highest bidder;

5. freedom of entry and exit from the market for both sellers and buyers; free movement of resources to their most efficient use, replacing inefficient resource users with efficient ones.

However, in land markets, particularly those in the developing world, none of these conditions hold: one purchase can influence prices, the units are always heterogeneous, information is limited, customary and institutional factors greatly influence transactions of land, and barriers to entry and exit exist.

In bimodal land ownership systems, as are generally found in Latin America, the market for land is divided into two sub-markets, one for large and another for small units. Generally small farmers sell land to other small farmers and large farmers sell to other large farmers, although the large-unit market controls the majority of the land and is less active than the small. Large units are usually not subdivided, limiting the amount of land within the price range of small producers. Social and cultural factors also limit the movement of land from one sub-market to the other (Dorner and Saliba 1981).

There are two competing hypotheses for the effect of an active land market on the structure of landholdings under imperfect market conditions. The first is that the market will promote a more efficient allocation of resources between small and large producers and will gradually transform the agrarian structure by transferring land to the land poor. Due to higher utilization of labor and lower labor costs on small farms, smaller producers will be able to outbid larger producers because of the widely-documented inverse relationship between size and land productivity (Dovring 1970; Barraclough 1970; Griffin 1976; Berry and Cline 1979; de Janvry and Sadoulet 1989; Thiesenhusen 1989). The second hypothesis is that, with multiple imperfect markets, market activation will shift resources to farms of the scale of production which are best positioned to expand because of advantages in other markets, particularly capital markets.

Carter and Mesbah (1990) explain the Carter-Kalfayan model which suggests that the second hypothesis is more likely to be true. Although imperfect labor markets favor small farmers, these advantages may be outweighed by imperfect capital markets. The advantage of large farms in capital markets is brought about by several factors. First, this advantage is created by government subsidies for credit which generally flow to large producers because they have the access to information required to take advantage of these subsidies. Secondly, within the credit market, the perceived risk and relatively higher transaction costs of lending to small farms make lenders reluctant to offer credit to small producers. When the advantages of the credit market to large producers are greater than those of the labor market to small producers, increased activity in land markets could lead to increased concentration of land holdings. In addition, fixed transaction costs favor purchasers of large units of land because they increase the per unit price of land in small units, thereby providing an additional force toward increased concentration of land ownership.

Honduran land markets

Unlike its Central American neighbors, Honduras has maintained *ejidal*, or community, and national lands. Although large private land grants have been made since the conquest, because of limited commercial agricultural development, agricultural laws and policies have always attempted to reserve a significant proportion of the land for *campesinos* (small farmers). *Ejidal* land was owned by the community, but plots were granted to individual families for their use. Over time, these “owners” gradually developed nearly full ownership rights and a market in *ejidal* land developed. Although legally only the improvements on the land and the rights to the use of the land were sold, this subtle distinction is not usually recognized in the countryside and the holders of these rights are generally considered to be the lands' owners. A similar situation developed on national land (land that had never been granted to individuals or communities) where land that was claimed and cleared essentially came to be considered privately-owned land by those using it and their communities, although these rights were not recognized by the State. This led to a large proportion of farmers operating under insecure tenure. In 1980 it was estimated that some 75 percent of Honduran farmers lacked full, legal title to the land they were working. There farms were still bought and sold through an informal or customary market, rather than through formal market mechanisms. This informal market was sufficient for transfers within the community, but it presented difficulties for transfers to purchasers outside the community and for formal financing.

These limitations (among others) were meant to be addressed by the Land Titling Project, a program started in 1983 . This program granted some 38,000 titles, primarily to coffee producers on national and *ejidal* land. This program was started in Santa Bárbara, a department in northwestern Honduras included in this study.

Land markets in present day Honduras have multiple imperfections -- land, information and financing are all limited. Stringer (1989) notes that because most of the land is in large holdings, the availability of small plots is restricted. In addition, the market for these large tracts of land is limited because few buyers have the finances required to purchase them. Although these plots could be subdivided and sold, there is little tradition of this in Honduras. In a study of land markets in the departments of Santa Bárbara and Colon, Salgado *et al.* (1994) discovered higher prices per *manzana* for smaller plots, even when land quality was held constant. They also noted that small farmers buy land from other small farmers and large farmers from other large farmers, further indicating a fragmented land market.

There is also little exchange of information about the sale of these large farms. Estate agents are rarely used in rural areas, so prospective buyers and sellers of land have to rely on informal means such as word of mouth to exchange information about land sales (Instituto Nacional Agrario and Centro de

Tenencia de la Tierra 1990). In addition, the cost and complexity of legal procedures surrounding the sale of land further depress the market for land.

Limited financing is a fundamental problem in the land market of Honduras. Most rural banks have a policy of not making loans for the purchase of agricultural land because it is considered to be too risky (personal interview)[1]. This lack of long-term financing means that *campesinos* have to save for years before buying land. Sometimes the seller finances the purchase, allowing the purchaser to make a down-payment on the land and then pay off the debt to the previous owner with each crop. Most loans for small farmers are short term. This study found that most loans were granted for about three years. Salgado *et al.* (1994) found that 74 per cent of land purchases were financed by the buyer's own resources, 19 per cent were financed through informal loans, often from the seller, and the remaining seven per cent were financed by loans from banks.

After land reform programs in the 1960s and 1970s, Honduras is now relying on market mechanisms to distribute land. Salgado *et al.* (1994) found that some farmers are able to accumulate land through market mechanisms, but those who start with the least amount of land (less than five hectares) are generally unable to do so. When considering the effects of the land market on the distribution of land in Paraguay, Carter *et al.* (1992) found that small farmers are no less, or more, commercially competitive than large farmers. However, without mortgage financing and the elimination of transaction cost barriers, they are less competitive in the market for land than are farmers with larger units of land.

Description of the Study Regions

In 1983, the government of Honduras initiated a land titling project in seven departments. The primary goals of the project were to increase security of tenure and therefore investment and to facilitate access

[1] Personal interview with Edgardo Puerto O., Loan Officer and BANCAFE, Santa Bárbara, 29 January 1993.

to formal credit and technical assistance for the beneficiaries. The 235 farms in this sample represent titled farms from Santa Bárbara (177) and a control group of untitled farms from Ocotepeque (58).

Most of the farmers surveyed own small farms; the 1993 median size was 4.5 hectares (mean 10.8 ha.), a slight increase from the median 1983 farm size of 4.4 hectares (mean 9.8 ha.). In 1993 the vast majority of the farmers surveyed (92.3%) produced coffee, 36.4% also produced maize and 21.0% beans. These numbers show slight changes since 1983 when 93.7% produced coffee, 39.2% maize and 14.7% beans. Other crops grown include cocoa, bananas, other fruit, rice, sugar cane, vegetables and cardamom. The farmers are, in general, poorly educated, with a median of 1.0 year of education (mean 2.0), and use basic agricultural techniques. While in 1993 49.7% used fertilizer, only 26.6% used herbicide and 2.7% owned a tractor. These figures show increases from 1983 when 30.8% used fertilizer, 17.5% used herbicides and none owned a tractor. The mean productivity of coffee in 1993, at 7.2 quintals (100 pound units)/manzana[2] remained essentially unchanged since 1983 when productivity was 7.1 qs./mz. and is below the national average of 12 quintals/manzana.

Descriptive Statistics of Land Sales

The data used in this study were collected in a series of surveys carried out in 1983, 1988 and 1993. As mentioned, the surveys took place in Santa Bárbara, a department that received government titles in 1983, and in Ocotepeque, where most farmers have informal documentation for their land. The survey followed the plots through time, rather than the owners and was primarily concerned with assessing the effects of the land titling project.

Significantly, in both regions most farmers had bought their land. The land market had been slightly more active in Santa Bárbara where 65.8 per cent of the farmers bought their land on the market and an additional 2.7 per cent bought their land with concessions from their parents. In

[2] One manzana equals approximately 0.697 hectares.

Ocotepeque the statistics were 53.3 per cent and 8.3 per cent respectively. These data indicate a historically active land market.

Between 1988 and 1993 16.2 per cent of the farms surveyed in Santa Bárbara and 19.7 per cent of those in Ocotepeque changed hands. In Santa Bárbara, farms of between 2.6 and five hectares had the highest rate of transfer, while in Ocotepeque most transfers were of farms with less than 2.5 hectares. In Santa Bárbara, 61.3 per cent of these transfers were sales (as opposed to inheritances) while the corresponding figure for Ocotepeque was 75.0 per cent.

When the previous owners could not be found, the new owners were asked why the sale had taken place. In roughly 40 per cent of the cases, the new owner did not know. Of the new owners that knew, the most common reason for the sale in the five years before 1993, was that the previous owner had been ill or had died. These cases accounted for about 15 per cent of transfers. The second most common reason was that the owner needed money. In 1988, emigration was the main reason given in both regions. These data indicate that it is unlikely that titling has changed the rate of land sales. This is supported by the findings of Coles (1988) who reviewed the records of land sales in the four *municipios* (townships) of Santa Bárbara included in the study from 1964 to the late 1980s and found that, although there was great variation among the years and regions, the overall patterns of land sales remained unchanged. Also working from the property registry in Santa Bárbara, Salgado *et al.* (1994) found that from 1987 to 1992, 2,274 transactions of agricultural land were registered, comprising 46,214 mz. Based on data from the 1974 agricultural census, this is 14.1 per cent of the number of farms and 12.1 per cent of the agricultural land in the department. It is surprising that this rate of farm sales is so similar to that found in the survey for Santa Bárbara for the same time period since so few of the sales were reported as registered. It is possible that the number of farms in the department has increased since 1974 (which would mean their data actually represent less than 14 per cent) or that larger farms, not included in this study, had a higher rate of registering land transfers.

Of the sales in Santa Bárbara, only 34.5 per cent were notarized (witnessed by a legal notary) and 20.7 per cent registered at the municipal offices. The corresponding figures for Ocotepeque were 27.3 per cent and 36.4 per cent. This does not bode well for the long-term validity of these titles.

Measurement of Technical Efficiency

The goal of estimating technical efficiency first for industries as a whole and then for individual firms has been pursued for many years (Farrell 1957; Timmer 1971). Measuring technical efficiency basically entails evaluating the use of resources; technical inefficiency being the failure to produce to maximum possible output given a set of inputs. This is distinguished from allocative efficiency, which involves the choice of the combination of inputs, given a set of prices.

In 1957, Farrell developed the idea of using a frontier production function to estimate technical efficiency for an industry, but it was not until 1977 that a more satisfactory means of estimating technical efficiency was created. In that year, both Aigner *et al.* (1977) and Meeusen and van den Broeck (1977) developed a frontier production function with a composed error disturbance term. The error term consists of two components, one of which is systematically distributed and accounts for events outside the farmer's control, measurement error and other 'statistical noise'. The second component is non-negative and represents the firm's technical inefficiency. This model was used for several years to estimate industry-wide technical efficiency, but it was not until 1982 that Jondrow et al. (1982) made it possible to estimate technical efficiency for each individual firm or farm.

A. The stochastic frontier production function

The most widely-used method to estimate technical efficiency incorporates a stochastic frontier production function with a composed error disturbance term, developed independently by Aigner *et al.* (1977) and Meeusen and van den Broeck (1977). Consider the stochastic production function of the form

$$Y_{it} = X_{it}B + \varepsilon_{it}, \qquad (1)$$

where

$$\varepsilon_{it} = v_{it} - u_i. \qquad (2)$$

Y_{it} represents the production for the *i*th farm in the *t*th time period; X_{it} is a vector of the inputs for the *i*th farm in the *t*th time period (the first element is usually unity to account for the constant term); B is a vector of the coefficients for these independent variables; ε_{it} is the composed error term, consisting of v_{it}, the usual error term that is assumed to be independent and identically distributed with a normal distribution $N(0,\sigma^2_v)$, and u_i, which represents systematic variations in Y due to factors specific to the farm or its owner. u_i is assumed to be non-negative, independent and identically distributed with a half-normal distribution (Aigner *et al.* 1977).

B. Farm technical efficiency

The primary advantage of a stochastic frontier production function is that it enables one to estimate u_i and therefore also to estimate an index of technical efficiency for each farm. The half-normal model to estimate u_i conditional on e_i is (Jondrow *et al.* 1982)

$$E(u_i \mid \varepsilon_i) = \sigma_u\sigma_v/\sigma\ [\phi(\varepsilon\lambda/\sigma)/\{1-\Phi(\varepsilon\lambda/\sigma)\} - \varepsilon\lambda/\sigma] \qquad (3)$$

where f represents the standard normal density function, F represents the cumulative density function and λ denotes the ratio of the error of u to the error of v, i.e. σ_u/σ_v. If output were measured in the original units, 1 - u_i would also be the measure of technical efficiency. However, as Battese and Coelli (1988) point out, when output is measured in logarithms the appropriate measure of technical efficiency is

$$TE_i = \exp(-u_i) \qquad (4)$$

They also explain that this measure of technical efficiency is equivalent to the ratio of the production for the *i*th farm in period *t*,

$$\exp(Y_{it}) = \exp(X_{it}\beta + v_{it} - u_i,) \qquad (5)$$

to the corresponding production value if the firm effect u_i were zero,

$$\exp(Y_{it}) = \exp(X_{it}\beta + v_{it}). \qquad (6)$$

This technical efficiency measure is not dependent on the level of the factor inputs for the given farm.

It is generally assumed that a farmer's technical efficiency remains constant over time (Battese and Coelli 1988; Dawson and Lingard 1989; Dawson *et al.* 1991; Kalirajan and Shand 1989; Lingard *et al.* 1983), while intuitively it seems likely that the farmer would learn and improve his or her efficiency. In addition, it is assumed that the panel data can provide more robust measures of technical efficiency as many investments have returns only in the long-run and estimates based on data from one year may be influenced by conditions specific to that year (Dawson 1985).

Empirical Results

A. Methodology

In order to estimate u_i and therefore farm-level technical efficiency, a stochastic frontier production function was used to regress the value of total farm production on measures of land, labor, fertilizer and dummy variables for 1983 and 1988. The frontier production function is specified as

$$Q_{it} = \beta_0 + \beta_1 LD_{it} + \beta_2 L_{it} + \beta_3 F_{it} + \beta_4 Y83_{it} + \beta_4 Y88_{it} + v_{it} - u_i \qquad (7)$$

where the subscript i (i = 1,2...N) represents the ith sample farm and the subscript t (t = 1,2,3) represents the year. Q represents the total value of crop production (coffee, cocoa, bananas, fruits, maize, red beans, rice, sugar cane and vegetables[3]) for the year for each farm, in logarithms and in 1992 prices[4]; LD denotes the area of land in *manzanas* devoted to crops, in logarithms; L represents an estimate of farm labor input in logarithms based on family size and time spent working off the farm; F is a dummy variable for the use of fertilizer, and Y83 and Y88 are the dummy variables for 1983 and

[3] As Kalirajan and Shand (1988) note, it would be preferable to calculate a production function and technical efficiency score for each crop, but as coffee forms the bulk of the output on these farms, it was considered that combining the crops would result in only minor errors.

[4] These farms are all in the same general region and prices for inputs and produce do not differ significantly between farms.

1988, respectively. The random variables v and u are assumed to have the properties explained above[5]. Dummy variables for the use of pesticides and genetically improved or treated seeds or seedlings were dropped because they were not statistically significant even at ten per cent. Human capital, technical assistance and the use of credit are not included in the production function because they are likely to affect production indirectly (*i.e*. through the use of inputs) rather than directly. One could receive training or credit and not necessarily change farming practices. Human capital and technical assistance, along with credit, were also hypothesized to be primary determinants of technical efficiency and are explored in a separate paper. The estimates were derived by maximum likelihood rather than ordinary least squares (Aigner, Lovell and Schmidt,1977; Battese and Corra 1977; Forsund *et al.* 1980; Kalirajan and Shand 1989; Meeusen and van den Broeck 1977)[6].

The estimated production function is[7]:

$$Q_{it} = 6.7313 + 0.80773LD_{it} + 0.13246L_{it} + 0.73674F_{it} + 0.43625Y83_{it} - 0.014252Y88_{it} + v_{it} - u_i$$

(51.610)** (19.782)** (1.735)* (7.401)** (3.717)** (0.126)

As anticipated, the coefficients for land, labor and fertilizer use are all positive and significant at at least five per cent. The dummy variable for 1983 is also positive and significant. The maximum likelihood estimate for σ^2_v is 0.91173 and for σ^2_u is 0.45340. The log likelihood for the equation is -882.4440.

The technical efficiency scores generated by this regression were quite low, ranging from 0.1946 to 0.8364, with a mean of 0.6138. This means the average farm produced only 61 per cent of the potential production from its land, and even the most efficient only produced 84 per cent of its

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5 Exponential and truncated distributions of u were also tried, but the half-normal distribution produced the best fit.

6 Various forms were attempted, and equation 7 provided the best fit.

7 * denotes one-tailed significance at 5% and ** denotes one-tailed significance at 1%.

potential. In a separate analysis, we found education and technical assistance to be the primary factors affecting technical efficiency.

In order to determine the effect of technical efficiency on land sales, these scores, along with other factors, were regressed on land sales, using a probit regression[8]. The equation was estimated as

$$S_i = \Psi_0 + \Psi_1 TE_i + \Psi_3 T_i + \Psi_4 FS_i + u_8 \quad (8)$$

where S is a dummy variable denoting a sale in the previous five years, TE is the farm's technical efficiency index, T is a dummy variable that indicates if the land was titled, and FS denotes the total farm size in logarithms. If the market is a viable mechanism for moving land from less efficient to more efficient producers, the variable for technical efficiency should indicate that less efficient farmers are more likely to sell. The titling variable (T) was included to determine if titling increases sales, by facilitating the transfer process and reducing risk, or decreases sales, by enhancing tenure security and making the owner feel more tied to the land. The variable for farm size (FS) was included to determine if small farmers were more likely to sell their land, possibly indicating distress sales.

The regression was run for the data as grouped, cross-sectional data. The fitted equation for land sales is (level of significance in ()):

$$\underset{(.0111)}{S = -1.2134} + \underset{(.7125)}{0.2780TE} + \underset{(.3426)}{0.16543T} - \underset{(.00957)}{0.14992FS}.$$

As can be seen, the variable for technical efficiency is insignificant. For this group of farmers, it seems that technical efficiency is not a significant factor in determining sales. Only the variable for farm size is significant, indicating that farmers with less land are more likely to sell.

It was also thought that small farmers would be bought out by larger neighbors, or those outside the community. Comparing the buyers and sellers of land, it was found that of the land sold from 1982 to 1987, sellers had mean size of 12.28 mz. and buyers a mean size of 13.08 mz. A t-test showed that this difference was not statistically significant even at ten per cent. Of land sold from 1988 to 1992, sellers

[8] A logit regression was also used and yielded similar results.

had mean size of 8.36 mz. and buyers a mean of 6.78 mz. This difference is found to be statistically significant at one per cent, but contrary to what had been expected, the buyers had the smaller mean farm size.

Conclusions

A stochastic frontier production function was used to generate technical efficiency scores for 235 small farmers in coffee-producing regions of Honduras. These technical efficiency scores were then regressed, along with other variables, on land sales. This study found that the indices of technical efficiency for these farms were insignificant in determining sales.

Land markets in these regions are far from perfect. Credit to facilitate the purchase of land is extremely limited, as is information regarding the sale of land. Further restricting land sales in the department of Santa Bárbara was a law prohibiting the sale of farms in the land titling project with less than 17 hectares, without government approval. Although informal sales took place in violation of this law, it did restrict the availability of land.

This study indicates that in areas with imperfect land and credit markets, liberalizing or improving land markets without improvements in the credit market cannot be expected to enhance agricultural productivity or production by transferring resources to the most efficient producers. In addition, the low technical efficiency scores indicate tremendous potential for increased production for even these farmers with limited resources. For policy makers concerned with increasing the efficiency of agricultural production, improving the technical efficiency of current owners of the land through education and technical assistance could be a more direct route to that goal than land market liberalization.

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