

**Rural Development, Poverty, and
Agricultural Land Use in El Salvador**

Jorge Rodríguez-Meza,
Douglas Southgate, and
Claudio González-Vega*

8 October 2002

* Post-Doctoral Research Associate, Professor, and Professor
Department of Agricultural, Environmental, and Development Economics
The Ohio State University

2120 Fyffe Road, Columbus, Ohio 43210

Corresponding author: Douglas Southgate at 614-292-2432 and southgate.1@osu.edu.

Abstract

For rural households in the developing world, an Environmental Kuznets Curve (EKC) relating income per capita to agricultural land use has to do with a pair of linkages between these two variables. First, poor households have a precautionary demand for land that can be used for subsistence farming; as a rule, this demand declines as income rises. Second, there is an increasing relationship between a household's ability to acquire agricultural land and its income.

In addition to addressing the microeconomic underpinnings of the EKC, we have carried out a statistical analysis of factors influencing agricultural land use in the Salvadoran countryside, using a panel of data collected during the middle and late 1990s in three biennial surveys of a nationally representative sample of rural households. We find that the relationship between income per capita and the area farmed by a household indeed takes the shape of an EKC.

1. Introduction

Linkages between rural poverty and environmental deterioration in the developing world long have been the subject of debate and concern. For some, the relationship could hardly be more direct. Fifteen years ago, the Brundtland Commission argued that low living standards in the countryside contribute to increased pressure on natural resources, which in turn aggravates poverty (WCED, 1987). Contrasting with the idea of a downward spiral is the conviction shared by many that environmental damage always mounts as people put poverty behind them and grow more affluent.

One way to reconcile these two perspectives is to posit an Environmental Kuznets Curve —EKC (Dasgupta *et al.*, 2002). Accepting that economic growth is initially detrimental for natural resources in developing countries but eventually becomes environmentally beneficial, economists have investigated the specific dimensions of EKCs corresponding to various kinds of resource degradation, including agricultural land clearing, in different parts of the world (Barbier, 2001). By determining whether the peak of the EKC occurs at a low level or at a high level of income, this research clarifies the environmental consequences of economic growth.

Cropper and Griffiths (1994), for example, find that the threshold at which the relationship between income and forest conservation becomes positive is well above GDP per capita in the vast majority of the African and Latin American countries with extensive tracts of tree-covered land. This finding implies that, all else remaining the same, development in those two continents is likely to coincide with widespread loss of natural habitats for some time to come.

Barbier (2001) points out that attempts to estimate a general EKC for agricultural land clearing, one that could be applied throughout Africa, Asia, and Latin America, have met with little success. This is in keeping with much of the economics literature addressing tropical deforestation. In a comprehensive review of 150 empirical studies, Kaimowitz and Angelsen (1998) conclude that exceptions are frequent to general claims about the forces driving the loss of tree-covered habitats in the tropics. They concede that increases in non-agricultural employment in the countryside, which enhance living standards, usually ease pressure on forests. However, the introduction of improved agricultural technology and other aspects of rural development, which are generally reckoned to diminish the clearing of natural habitats, do not always have this effect.

One reason why insights are still lacking into linkages between low standards of living in the countryside, on the one hand, and deforestation, on the other, is that much of the empirical literature consists of cross-country studies. A comparison of average incomes, rates of land-use change, and other national aggregates does not allow for a very nuanced view of why individual households in rural areas happen to be poor, the success or failure of policies for alleviating their plight, the strategies they employ to cope with poverty and with fluctuations in their incomes, and the part that converting forests into agricultural land plays in these strategies.

Another way to examine linkages between poverty and agricultural land clearing is to analyze data collected in household surveys. For example, 419 households were surveyed during the early 1990s in the Amazonian lowlands of northeastern Ecuador (Pichón, 1997; Pichón *et al.*, 2001). In addition to information on economic activities and educational attainment, the investigators gathered data needed to study farmers'

choices among production systems. They found little evidence of a “peasant pioneer cycle,” in which everyone follows the same sequence of land clearing and agricultural activities after initially occupying a forested parcel. Instead, a wide array of farming practices, ranging from intensive use of a limited area to extensive systems associated with rapid encroachment on forests, was observed. Individual choices among these practices were found to be influenced by a diverse set of factors, including soil quality, tenure security, market access, and educational attainment.

Shively and Martinez (2001) used panel data to analyze land use changes at the household level, in a study undertaken in southwestern Palawan, Philippines. Part of the sample interviewed in 1995, 1997, 1999, and 2001 comprised 56 farm households in a lowland area. Another 42 farm households were interviewed in a nearby upland area that is experiencing active deforestation. Irrigation was developed in the lowland area in 1997. The resulting increase in the derived demand for labor was sufficient to drive up the opportunity cost of human resources at higher elevations, which encouraged a switch to farming systems that save labor, are more capital-intensive, and reduce agricultural land clearing (Shively, 2001).

This finding is consistent with the argument that improved opportunities for non-agricultural employment in the countryside tend to reduce the rate at which natural habitats are converted into farmland, presumably because such an improvement raises the opportunity cost of labor required for deforestation (Southgate, 1990). Among others, Bluffstone (1993), Holden (1993), Ozório de Almeida and Campari (1995), and Pichón (1997) offer empirical evidence of this linkage. However, access to jobs outside the farming sector is highly uneven among rural households. This raises the possibility that

some people will experience market conditions that induce them to ease off on land clearing exactly while others are facing precisely the opposite incentives.

The study described in this paper focuses on the decisions of individual households about agricultural land use in El Salvador. This is a country where recent economic growth has mainly benefited a non-poor minority of the rural population and where many of the rural poor have cleared land for subsistence farming, in an effort to forestall declines in consumption. This matters, because most of the land that the rural poor have cleared for farming has been in the upper watersheds, the deterioration of which represents a long-term threat to water supplies and socioeconomic progress in the country (Panayotou, Faris, and Restrepo, 1997).

The paper begins with a brief discussion of the conceptual foundations for the existence of an EKC and a description of the Salvadoran countryside. Next, we describe the longitudinal survey of rural households that has yielded the panel data used in our study. After that, the results of regression analysis of the linkage between agricultural land use and income are presented. These results suggest that this linkage takes the form of an EKC.

2. Environmental Kuznets Curve and Rural El Salvador

The complex relationships that generate an EKC respond to two conflicting effects of increases in household income per capita on the demand for land for cultivation. One effect has to do with changes in the *willingness* to hold land for

precautionary purposes.¹ The other effect relates to the *ability* to acquire land when the institutional infrastructure needed to support perfect land market transactions is missing.

To understand the first effect, bear in mind that many rural households in places like El Salvador use land mainly for subsistence farming, to cushion consumption in the face of market and environmental shocks. This precautionary demand for land declines as income per capita rises. Households that are better off are less exposed to shocks because of income diversification, which is facilitated by greater access to peri-urban labor markets and by migration abroad. The precautionary demand for land also declines with income because other tools for consumption smoothing, such as the use of accumulated savings and access to loans, are available to the non-poor. In addition, better-off households enjoy consumption sufficiently above subsistence levels and are thus willing to accept some reductions in consumption rather than devote large efforts to low-yielding agriculture.

The second effect of income on farmed area relates to a household's ability to acquire real estate, which goes up as earnings rise. Regardless of how it is accomplished—through purchases or colonization—acquiring land is costly. Moreover, given asymmetric information in credit markets, loans for land acquisitions are available only to households with incomes above certain thresholds. Thus, living standards and the ability to increase farmed area are positively correlated.

¹ There is also a willingness to hold land under cultivation in order to exploit comparative advantages in farming. Given the very unfavorable terms of trade for agriculture, overvaluation of the domestic currency, and sectoral shortcomings, such opportunities for profitable farming are rare in El Salvador. To simplify the issue, we assume that the households in the sample do not possess such comparative advantages and that they cultivate land only for precautionary purposes. When land is demanded in order to pursue profitable opportunities, area will most likely increase with income, although diminishing marginal returns are likely to appear soon in an environment like the Salvadoran countryside.

Given these conflicting effects, the applicability of the EKC to settings like rural El Salvador becomes clear. At the poorest extreme of the rural population are those people whose demand for land as a site for subsistence farming is very strong. Given their very limited means, however, they have no prospects of getting land. Near the other end of the EKC are those still cultivating land who have ready access to real estate, but who have little or no need to engage in subsistence farming. Beyond the EKC are the richest rural households, which have remunerative non-agricultural jobs. Between these extremes are rural households with demand as well as access to land. These households are clustered in the middle of an EKC shaped like an inverted *U*.

The most densely populated country on the American mainland, El Salvador turns out to be an excellent setting for the analysis of linkages among development, poverty, and the environment in rural areas.

One reason for this is the duress that the country's farmers have experienced in recent years —duress not unlike what farmers elsewhere in the developing world have suffered. Some of the stress has been environmental. Drought struck in 1997, when the last *El Niño* was at its peak. In early 1999, Tropical Storm Mitch unleashed torrential rains, which flooded low-lying areas and destroyed roads and bridges. Dry conditions returned in 2001, which began with a pair of earthquakes. Even more devastating than these environmental shocks has been the steep decline in the price of coffee —the traditional mainstay of Salvadoran agriculture. After peaking at \$2.00/pound in late 1997, the international price fell to \$1.00 in 1999 and then halved again during the next two years. A pound of coffee currently changes hands in international markets for \$0.50.

By and large, the non-poor in rural areas have been able to withstand droughts, storms, and declining prices for commodities. Possessing human capital as well as good access to markets and jobs, they have succeeded in diversifying their incomes. Indeed, increases in non-agricultural earnings resulting, for example, from the recent expansion of *maquilas* —factories where domestic laborers make clothing and assemble other goods for international markets out of imported materials— have more than compensated for whatever farming losses people above the poverty line have suffered (Beneke de Sanfeliú, 2000). Accordingly, their incomes have risen in spite of the environmental and market shocks that have depressed agriculture.

It is the poor, then, who have shouldered the burden of farming's decline, which explains why rural poverty has proved to be stubbornly persistent. Because of limited education, high transactions costs resulting from inadequate infrastructure, and policy-induced inefficiencies in markets for labor, land, and financial services, in the rural areas households below the poverty line have found it difficult to compete for non-agricultural work (Lardé de Palomo and Argüello de Morera, 2000). In addition, the rural poor, who earn much of their meager incomes as wage laborers on other people's farms, have suffered as agricultural employment has contracted. With coffee priced at \$0.50/pound, for example, Central American growers cannot cover variable costs. They therefore have scaled back or abandoned operations. This has cost thousands of unskilled farmhands their jobs (Fritsch, 2002).

With little chance of encountering alternative employment, many of the rural poor have responded to the loss of agricultural wages by dedicating more labor effort and land area to subsistence crop (*i.e.*, basic grains) production. This response is observed even

though newly cleared fields are typically in places where risks of erosion and other forms of land degradation are acute. This explains why El Salvador, where deforestation reached an advanced cumulative stage long ago, has experienced an increase in agricultural land use at the expense of tree-covered habitats in recent years (WRI, 1998). This is also why El Salvador is a good place to estimate an EKC.

3. The Longitudinal Survey of Rural Households

Testing hypotheses about the relationship between income per capita and farmed area at the household level is possible in El Salvador thanks to a longitudinal survey that has been carried out in the country since the middle 1990s. The survey, funded by USAID, began as a component of the collaboration between the Fundación Salvadoreña para el Desarrollo Económico y Social (FUSADES) and the World Bank, in the development of a Rural Sector Strategy for El Salvador (World Bank and FUSADES, 1997). By using a questionnaire adapted from the World Bank's Living Standards Measurement Survey, a carefully selected, nationally representative, stratified random sample of rural households was interviewed in early 1996 about sources of income, employment, land use and so forth during the preceding calendar —and crop— year (López, 1997).

FUSADES and a team of researchers from The Ohio State University carried out three additional rounds of the longitudinal survey in 1998, 2000 and 2002 (BASIS CRSP, 2001). Data for 2001, collected in the most recent series of interviews, will not be fully processed until late 2002. As it currently stands, however, the panel of data is sizable and already offers critical insights.

The rural households that have participated in all three biennial surveys number 470, of which 351 farmed their own land in at least one of the three survey-years. Furthermore, the period covered by the longitudinal survey turns out to have been very eventful. The initial year, 1995, was characterized by normal prices and good growing conditions. In contrast, 1997 was dry, due to *El Niño*. This was the year, however, when the price of coffee peaked at \$2.00/pound. Two years later (1999), this price was 50 percent lower. Salvadoran rural households experienced wide fluctuations in incomes and enjoyed differential access to mechanisms to smooth their consumption in response to the cumulative effects of the shocks.

To summarize, longitudinal surveying of a nationally representative sample of rural households in El Salvador has coincided with a series of pronounced environmental and market shocks. As a result, a unique opportunity has arisen to examine household decisions about agricultural land use and the range of factors, including income per capita, influencing these decisions.

4. Regression Model

Despite the complexity of circumstances that have shaped the behavior and performance of different types of rural households since the middle 1990s in El Salvador, some simple but powerful relationships can be identified. We are particularly interested in testing the hypothesis that the relationship between income per capita and agricultural land use in El Salvador is characterized by an EKC. For this purpose, we use the following stylized model and estimate it with panel data obtained from the household surveys:

$$l_{it} = c + \beta_1 \hat{y}_{it} + \beta_2 \hat{y}_{it}^2 + \alpha x_{it} + v_i + \mu_{it} \quad (1)$$

where:

l_{it} = area of cultivated land, measured in hectares;

c = constant term;

\hat{y}_{it} = permanent income per capita;

x_{it} = a vector of time-varying, household characteristics;

v_i = a vector of time-invariant, household-specific unobserved characteristics;

μ_{it} = error term.

Equation (1) explains the extension of land cultivated each year, for each household, as a quadratic function of permanent income per capita and of a set of observable and unobservable household characteristics. Given the underlying EKC hypothesis, it is expected that the coefficients β_1 and β_2 should be positive and negative, respectively. The vector α includes the coefficients for observable household characteristics that shift the EKC. The set of unobservable characteristics v_i are household-specific attributes that also influence the areas cultivated by individual households. It is assumed that these characteristics, which include farming abilities, the technology used, and the degree of household's risk aversion, have not changed during the period under study.

The approach followed here is to treat unobserved heterogeneity as a set of random variables, which are assumed to be uncorrelated to the time-varying explanatory variables. This assumption provides the basis for using the random-effects estimator (Wooldridge, 2000). The assumption is tested and, if rejected, the fixed-effects estimator

is used instead. As the model does not include time-invariant observable regressors, the choice between these two estimators hinges on this assumption (Hsiao, 1986).

Equation (1) explains the area of land cultivated as a function of permanent income per capita. The latter variable, however, is not directly observed. Instead, permanent income for each household is treated here as the predicted income obtained from the estimated equation for income per capita, for each year over the period under study:

$$y_{it} = c + \delta z_{it} + v_i + \varepsilon_{it} \quad (2)$$

where:

y_{it} = current income per capita net of remittances and subsidies;

c = overall constant term;

z_{it} = a vector of exogenous time-varying explanatory variables;

v_i = a vector of time-invariant exogenous household-specific unobserved characteristics;

ε_{it} = error term

According to the above specification, $\hat{y}_{it} = E[y_{it}/Z_{it}]$. That is, permanent income per capita is the predicted value obtained from equation (2) for each household, in each period.²

5. Estimation Results

A balanced data panel was used to estimate this model with information for the Salvadoran rural households. As indicated, the total panel contains 470 rural households. The panel used in the estimations consists, however, of 351 households that cultivated

² Strictly, $\hat{y}_{it} = E[y_{it}/Z_{it}, v_i]$, but provided that the regression includes an overall constant $E[v_i] = 0$ and since Z and v are uncorrelated, $\hat{y}_{it} = E[y_{it}/Z_{it}]$

land at least one of the three years for which the survey was conducted (1995, 1997 and 1999). The remaining 119 households in the original panel did not engage in cultivation in any one of those years. This latter group, which was found on average to earn incomes considerably above those of the rest of the sample, had probably abandoned agriculture years before or had never farmed. Since data for these households would not help to define the relationship between farmland and permanent income, they were excluded from this regression analysis.

Two separate equations were estimated. Equation (3) below, which corresponds to equation (2), is used to generate a predicted value of per capita income for each household for each year. The deterministic portion of observed income according to this forecast is then used as permanent income in equation (4). In turn, equation (4), which corresponds to theoretical equation (1), relates the extension of cultivated land to this estimate of permanent income and other explanatory variables.

$$y_{it} = c + \delta_1 \text{eductotal} + \delta_2 \text{assets} + \delta_3 \text{road} + \delta_4 \text{nmicro} + \delta_5 \text{nout} + \delta_6 \text{animalv} + \delta_7 \text{nin} + \delta_8 \text{crowding} + \delta_9 \text{assist} + v_i + \varepsilon_{it} \quad (3)$$

$$l_{it} = c + \beta_1 \hat{y}_{it} + \beta_2 \hat{y}_{it}^2 + \alpha_1 \text{nin} + \alpha_2 \text{nout} + \alpha_3 \text{animalv} + \alpha_4 \text{ext_noag} + \alpha_5 \text{y97} + v_i + \mu_{it} \quad (4)$$

The dependent variable in equation (3) is the annual income per capita of the household (measured in Salvadoran colones), net of remittances and subsidies. The questionnaire used for the survey was specifically designed to measure this variable, with account taken for the seasonality of the activities of rural households (Deaton, 1997). Cash and in-kind wage earnings were reported for every permanent or temporary job held during the year. For each on-farm and off-farm production activity of the household, net income was computed from a detailed account of revenues and expenses. The

household's consumption of its own production was carefully imputed for agricultural and non-agricultural activities. Income from livestock activities was computed as the gain in the value of the stock of animals throughout the year. Earnings from renting land and other assets were also included.

Equation (3) explains income per capita as a function of the wealth, asset holdings, activity diversification, and market participation of the household. The explanatory variables are:

- *eductotal* is the stock of education of the household's labor force actually employed during the year. It measures, as the summation of years of schooling for all working members, the stock of human capital of the household members that participated in income-generating activities. Minimum human capital credentials are needed to engage in better-paid occupations.
- *assets* is an index of ownership of 22 durable household assets, ranging from radios and televisions to vehicles and water pumps. It is a proxy for the household's wealth. Each asset owned is weighted according to its likely replacement value.
- *road* measures the distance, in minutes, to the nearest paved road, which serves as a proxy for the household's access to urban markets and jobs.
- *nmicro* is the number of microenterprises operated by the household, which is a mechanism to achieve earnings diversification.
- *nout* is the number of members of the household who are employed outside the household's farm and microenterprises; this is another measure of earnings diversification.

- *animalv* is the value of the stock of animals at the end of the year, which indicates the extent to which crop farming is complemented by livestock production by the household.
- *nin* is the number of members of the household who participate in production activities within the household.
- *crowding* is an index of the number of people per room in the home; this serves as a proxy for living conditions, including a healthy environment.
- *assist* is a dummy variable for the use of agricultural technical assistance services.

An important diversification option for the household not included explicitly as a regressor is farming. Insofar as this alternative is reflected by the variables *nin* and *assist*, no direct measure of the farming variable was included in the model, to avoid collinearity.

Table 1 presents the results of the estimation of equation 3 using the random-effects estimator.

Table 1**Estimation of Income Equation Using Random-Effects**

Variable	Coef.	St.Error	p-value	95%conf.interval	
eductotal	88.31	18.98	0.000	51.3	125.3
Assets	119.43	19.66	0.000	80.9	158.0
Road	-7.28	4.18	0.081	-15.5	0.91
Nmicro	2173.18	364.06	0.000	1460	2887
Nout	403.95	128.40	0.002	152.3	655.6
Animalv	0.09	0.012	0.000	0.067	0.112
Nin	-478.41	117.37	0.000	-708.4	-248.4
crowding	-275.36	65.53	0.000	-403.8	-146.9
Assist	931.52	332.47	0.005	279.9	1583.1
constant	2554.10	428.38	0.000	1714.5	3393.7
Overall R-square:			0.2539		
p-value Wald chi2:			0.0000		
Number of observations:			1033		
Number of groups:			3		
p-value Haussman test:			0.0872		

Equation (3) is estimated mainly for the purpose of forecasting permanent income per capita. The overall predictive power of the equation and the significance of each one of the coefficients in this specification provide a good foundation for such forecasting. Additionally, the Haussman test shows that there is no statistically significant evidence to

reject the null hypothesis of absence of correlation between the unobserved heterogeneity and the time-varying explanatory variables. Thus, there is no evidence to reject the use of the random-effects estimator for this specification of the equation.

All the coefficients in the estimated equation (3) exhibit the expected signs. Higher levels of human capital and of wealth are associated with higher incomes. The more isolated the household is and the less healthy its environment is (as indicated, for example, by greater crowding), the lower income is. A greater number of microenterprises, out-of-household jobs, and livestock activities result in higher incomes. This reflects the greater income-earning and income-smoothing abilities of the household. Year-specific dummy variables were not significant.

To estimate equation (4), which explains the area of land cultivated, several variables that capture income diversification options for the household were included, in addition to the permanent income regressors generated by equation (3). Additionally, dummy variables for each year were included, to capture year-specific effects. So was the total extension of land in pastures, forests or unused status (*ext_noag*), in order to capture ready access to land for subsistence farming as a cushion for consumption-smoothing purposes. Both the latter variable and the dependent variable are measured in square meters. Table 2 presents the results of estimating equation (4) using the fixed-effects estimator, after several specifications were tested.

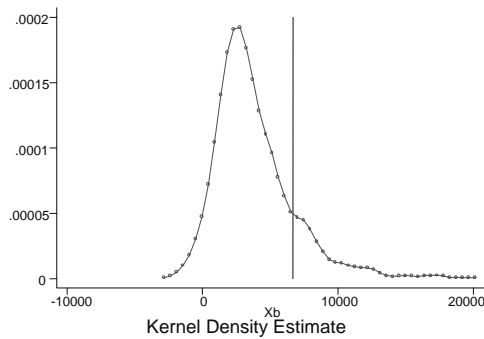
Table 2**Estimation of Agricultural Land Use Using Fixed-Effects**

Variable	Coef.	St.Error	p-value	95% conf.interval	
p-inc	1.605	0.442	0.000	0.737	2.474
p-inc ²	-0.00012	0.00003	0.000	-0.0002	-0.00006
Y97	1860.1	662.1	0.005	560.1	3160.1
nin	1633.6	261.5	0.000	1120.3	2147.0
nout	-815.9	381.5	0.033	-1565.1	-66.8
animalv	0.107	0.044	0.017	0.193	0.195
ext_noag	0.027	0.015	0.068	-0.002	0.056
constant	1829.2	1244.2	0.142	-613.9	4272.2
Overall R-square:		0.1801			
p-value F:		0.0000			
Number of observ:		1033			
Number of groups:		3			

Equation (4) was first estimated using the random-effects estimator. However, the Hausman test could not reject the null hypothesis of lack of correlation between the unobserved effects and the remaining explanatory variables. Consequently, the model was re-estimated using the fixed-effects estimator, which is consistent even in the presence of such correlation. The results are presented in Table 2.

The coefficients for the permanent income variable and its squared value show the expected signs. A positive relationship between land cultivated and permanent income is

confirmed at low levels of income. This relationship, however, exhibits a decreasing rate of increase, reaching a threshold for a level of income per capita beyond which further increases in income result in reductions of cultivated land. For the values of the coefficients of the estimated model, this threshold occurs at 6,687.5 colones.³ Represented by the vertical line in Figure 1, this level of income is well above the earnings of most of the households in the sample. To be specific, it falls in the ninth decile of the predicted income per-capita distribution, between 5,569 and 7,455 colones.



The coefficient for the dummy variable for the year 1997 is significant, and it indicates a positive effect on the extension of land cultivated all else being equal. As explained above, this effect is to be expected, as 1997 was an adverse year for rural households and, therefore, many households would have increased the area of farmed land to smooth consumption. The dummy variable for the year 1999, however, was not significant. By that time, rural households apparently had found alternative strategies to cope with the accumulated impacts of the adverse shocks or had exhausted their access to additional land at reasonable costs.

³ For ax^2+bx+c , the threshold point is reached at $-b/2a$

Among the portfolio of activities available to households, only the coefficient for the number of microenterprises of the household was not significant. The number of members of the household working outside shows a negative coefficient, which indicates a weaker relationship between income and cultivated land for households with greater participation in the labor market. This is particularly true of households with non-agricultural jobs.

The dependence of the household on its own labor force, *nin*, exhibits a positive relationship with cultivated land. This indicates that production activities within the household that employ its own members lead to a stronger relationship between income and cultivated land. The positive coefficient for *animalv* is not surprising, given that most households that raise animals also engage in crop production and that livestock activities tend to be land-extensive. Finally, larger areas of unused land also bring about a stronger relationship between income per capita and cultivated land, as idle land offers more opportunities to increase the area allocated to farming, at lower transaction costs than transactions in land markets, given the incomplete institutional framework for such transactions.

6. Summary and Conclusions

Various investigators have attempted to estimate an EKC for tropical deforestation. Sometimes this research focuses on a specific region or a particular group of countries. At other times, an attempt is made to estimate a single curve for all countries located on or near the equator. Sometimes these efforts meet with success. But sometimes not, particularly when the data being used consist of national aggregates for a

diverse set of places. Furthermore, the conceptual foundations for EKC-estimation are not always apparent, regardless of statistical evidence for the curve's existence.

This study is based on simple, fundamental reasons for an EKC curve for agricultural land clearing. In addition, the relationship between income and land use we have estimated, using a panel of data collected in a longitudinal survey of a nationally representative sample in rural El Salvador, addresses choices made at the household level. We find that the relationship between living standards and deforestation is, indeed, described by a function shaped like an inverted *U*.

The study continues. As reported in this paper, data collected in the most recent biennial survey are still being processed and will be analyzed in the near future. We also hope to continue adding to our panel data set during the years to come and also collect data needed for careful analysis of the ability of poor households to acquire land for subsistence farming. The results presented in this paper suggest that this is an important topic for research.

Finally, the purpose of this study has not been merely to plot out an EKC for El Salvador. Of even greater importance are our findings about factors that shift such a curve. It is significant, for example, that off-farm employment, which diversifies sources of income, diminishes a household's inclination to clear land, presumably for the sake of subsistence farming. This sort of finding has significant implications for a strategy aimed at economic development that is environmentally as well as socially sustainable.

References

- Barbier, E. (2001), 'The Economics of Tropical Deforestation and Land Use', *Land Economics* 77: 155-171.
- BASIS CRSP (2001), 'Fifth Annual Report', Collaborative Research Support Program on Broadening Access and Strengthening Input Market Systems, University of Wisconsin, Madison.
- Beneke de Sanfeliú, M. (2000), 'Dinámica del ingreso de las familias rurales en El Salvador. Estudio de Panel 1995-1997', Documento de Investigación BASIS no. 1, Fundación Salvadoreño para el Desarrollo Económico y Social, San Salvador.
- Bluffstone, R. (1993), 'Reliance on Forests: Household Labor Supply Decisions, Agricultural Systems, and Deforestation in Nepal', Ph.D. Thesis, Boston University.
- Cheng, H. (1986), *Analysis of Panel Data*, Cambridge, Cambridge University Press.
- Cropper, M. and C. Griffiths (1994), 'The Interaction of Population Growth and Environmental Quality', *American Economic Review* 84: 250-254.
- Dasgupta, S., B. Laplante, H. Wang, and D. Wheeler (2002), 'Confronting the Environmental Kuznets Curve', *Journal of Economic Perspectives* 16: 147-168.
- Deaton, A. (1998), *The Analysis of Household Surveys: A Microeconomic Approach to Development Policy*, Baltimore, Johns Hopkins University Press.
- Fritsch, P. (2002), 'An Oversupply of Coffee Beans Deepens Latin America's Woes', *The Wall Street Journal* 8 July: A1&A10.
- Holden, S. (1993), 'Peasant Household Modeling: Farming Systems Evolution and Sustainability in Northern Zambia', *Agricultural Economics* 9: 241-267.
- Kaimowitz, D. and A. Angelsen (1998), *Economic Models of Tropical Deforestation: A Review*, Bogor, Center for International Forestry Research.
- Lardé de Palomo, A. and A. Argüello de Morera (2000), 'Integración al mercado de los hogares rurales y generación de ingresos', Documento de Investigación BASIS no. 3, Fundación Salvadoreño para el Desarrollo Económico y Social, San Salvador.
- López, R. (1997), 'Rural Poverty in El Salvador: A Quantitative Analysis', Report 16253-ES, World Bank, Washington.
- Ozório de Almeida, A. and J. Campari (1995), *Sustainable Settlement in the Brazilian Amazon*, Oxford, Oxford University Press.

Panayotou, T., R. Faris, and C. Restrepo (1997), *El Desafío Salvadoreño: De la Paz al Desarrollo Sostenible*, San Salvador, Fundación Salvadoreña del Desarrollo Económico y Social.

Pichón, F. (1997), 'Colonist Allocation Decisions, Land Use, and Deforestation in the Ecuadorian Amazon Frontier', *Economic Development and Cultural Change* 45: 707-744.

Pichón, F., C. Marquette, L. Murphy, and R. Bilsborrow (2001), 'Land Use, Agricultural Technology, and Deforestation among Settlers in the Ecuadorian Amazon', in Angelsen and Kaimowitz (eds.), *Agricultural Technologies and Tropical Deforestation*, Wallingford, CABI Publishing.

Shively, G. (2001), 'Agricultural Change, Rural Labor Markets, and Forest Clearing: An Illustrative Case from the Philippines', *Land Economics* 77: 268-284.

Shively, G. and E. Martinez (2001), 'Deforestation, Irrigation, Employment, and Cautious Optimism in Southern Palawan, the Philippines', in Angelsen and Kaimowitz (eds.), *Agricultural Technologies and Tropical Deforestation*, Wallingford, CABI Publishing.

Southgate, D. (1990), 'The Causes of Land Degradation along "Spontaneously" Expanding Agricultural Frontiers in the Third World', *Land Economics* 66: 93-101.

Wooldridge, J. (2002), *Econometric Analysis of Cross Section and Panel Data*, Cambridge, Massachusetts Institute of Technology Press.

World Bank and Fundación Salvadoreña del Desarrollo Económico y Social (FUSADES) (1997), *El Salvador: Rural Development Study*, Washington, World Bank.

World Commission on Environment and Development (WCED), (1987), *Our Common Future*, New York, Oxford University Press.

World Resources Institute (WRI), (2002), *World Resources: A Guide to the Environment*, New York, Oxford University Press.