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Rice Production in the Philippines and the Inverted U (Environmental Kuznets Curve) Hypothesis

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Abstract - Proponents of the EKC hypothesis say that economic growth brings both improving and worsening environmental performance at different phases of the development process. At low-income level, the environmental impact per dollar GDP increases with increasing GDP per capita, while at high income it declines. Nobel Prize winner Kenneth Arrow and a few critics more conceded the validity of the hypothesis explaining that this has to be valid only for pollutants involving local short-term costs. Redefining such framework, variables on population, land area used for rice production, temperature, average rainfall and amount of particulates in the atmosphere were regressed to find each individual and collective impact to the country's rice production trend from 1991-2004. Results supported the Environmental Kuznets Curve hypothesis showing that rice production increased over time as rainfall and temperature accelerate but reversed its direction as these factors escalate excessively.

Keywords - Inverted U Hypothesis, Environmental Kuznets Curve, Rice Production

INTRODUCTION

The Environmental Kuznets Curve (EKC) has now become the standard groundwork among technical conversations about environmental policy since Grossman and Krueger presented their environmental study in 1991. Grossman and Krueger showed how some important indicators of environmental quality such as the concentrations of sulfur dioxide and particulates in the air actually improved as incomes and levels of consumption go up. This blissful outcome occurred when incomes were higher. Before that point, however, at lower income levels, environmental quality deteriorated as incomes began to rise (Grossman and Krueger, 1995).

The trend is similar to that of Simon Kuznets on growth and inequality noticing that in the short run, as the economy grows, the level of inequality rises but which extent slows down as the economy reaches maturity. Thus, extending similar trend to environmental concerns the theory 'Environmental Kuznets Curve' is conceptualized.

But how should growth respond to variations of particulates in the air? How should agriculture behave given environmental changes in climate? Modifying the inverted U construct and converting production as a function to environmental quality, this study specific on rice production in the Philippines is made.

OBJECTIVES OF THE STUDY

This study endeavored to determine the changes in rice production in terms of land area (in '000 hectares), population (median assumption projection), pollution emission measured in terms of total suspended particulates (tsp in ug/NCM), temperature (in degree centigrade), and rainfall (in millimeters). This is to assess the effect of environmental stressors, land and population pressures to rice production.

The study presupposes that variations in the environmental stressors and in land and population pressures are individually

and collectively too little to affect rice production variations in the Philippines. Further it is hypothesized that production trend does not assume an inverted U shaped curve as believed in the model.

FRAMEWORK

The Inverted U Hypothesis (Environmental Kuznets Curve)

> *"We examine the reduced-form relationship between per capita income and various environmental indicators. Our study covers four types of indicators: urban air pollution, the state of the oxygen regime in river basins, fecal contamination of river basins, and contamination of river basins by heavy metals. We find no evidence that environmental quality deteriorates steadily with economic growth. Rather, for most indicators, economic growth brings an initial phase of deterioration followed by a subsequent phase of improvement. The turning points for the different pollutants vary, but in most cases they come before a country reaches a per capita income of $8000".*
>
> Abstract of Grossman and Krueger, 1995

The EKC hypothesis is shown in Figure 1a.

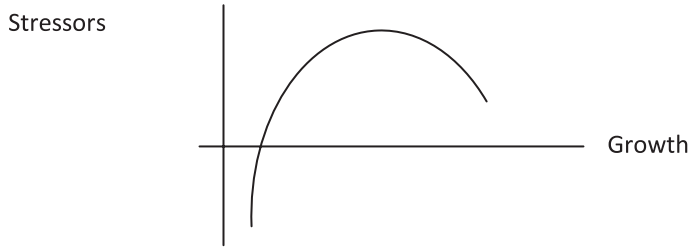

Figure 1. a. The inverted U line
(Environmental Kuznets Curve)

As the line suggests pollution should increase during early stages of economic development, reaches a maximum level and eventually starts to decrease as income further rises. This reversal is caused by the

ability now of the country to allocate enough funds for cleaning up its air and environment severely damaged by economic growth.

In this study however, the framework reverses the Inverted U Hypothesis and followed the graph that follows:

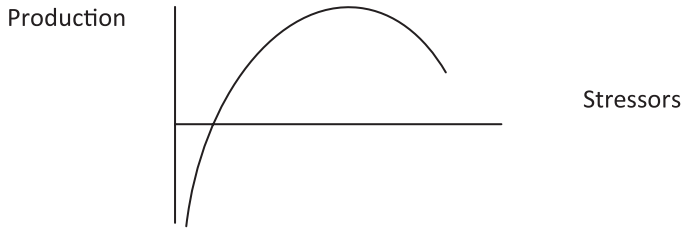

Figure 1.b. del-Prado's EKC Modification

The framework suggests that stressors like heat and rain are required factors to production but its quadratic rise shall eventually wreck output.

Theoretical Justification of the Variables

The variables considered in this study are basically factors external to the calculus decision of the firm. Labor, fertilizers, soil quality and technology are a few input components, which amount, cost and quality can be altered depending on the respective production and cost functions of any farm company. These however are excluded in the study.

The variable 'land' is included because competing land uses increase with urbanization. Rice production is expected to increase as land area planted with rice rises.

Also a regular meal comes with rice; thus an increase in population increases, demand for rice.

Total suspended particulates (TSP), temperature and rainfall are environmental externalities which degree and magnitudes are not within the full control of the firms. These three are equally important with other direct inputs in increasing rice productivity. Extremes in temperature and rainfall however, could lead to El Niño and La Niña phenomena - environmental excesses that certainly affect land-related

production. It is thus expected that intense temperature and TSP emissions in the air could bring imbalances to climate and thus bring detrimental effects to rice productivity.

Environmental Kuznets Curve: The Theory

EKC quickly generated extensive scholarship. The study on "The Environmental Kuznets Curve: A Primer," by Bruce Yandle, Maya Vijayaraghavan, and Madhusudan Bhattarai (2002) reveals that while there is no single relationship that fits all pollutants for all places and times but in many cases introduces the close relationship between nation's prosperity, governability and security and the improvement of the country's environment health. Because market operations will ultimately determine the price of environmental quality, policies that allow market forces to operate are expected to abate surmounting hazards brought about by environmental degradation.

Other studies are more interested in model building. It is observed that in most cases EKC literature deals with empirical studies where econometric estimations are based on ad hoc specifications even without any sound theoretical background (Bretschger and Egli, 2005) Particularly on EKC modeling, most works show the econometric relationship between environmental quality and economic development.

Karen Pittel (2005) in her paper "Integration, Growth and Pollution" focused on the impact of globalization – free trade, extensive integration and idea flows – on pollution and economic growth in the presence of environmental externalities This study exemplifies the fact that climate system and environment is a shared resource and thus pollution and other externalities do not only harm local resources but also endanger others' across borders. But a more comprehensive model is the climate-change model on RICE AND DICE developed by William Nordhaus.

The Rice and Dice Models, or the Regional Dynamic Integrated Model of Climate and the Environment provide forecasts about the interaction between economic growth and environmental degradation under different environmental scenarios (say, laissez faire, optimal carbon tax, implementing Kyoto protocol). This new Growth Theory suggests that allowing endogenous accumulation of knowledge

and considering positive spillovers will lead to optimistic growth possibilities.

Despite soundness of the theory Grossman and Krueger's paper is not without scrutiny. A group of economists including Nobel laureate economist Kenneth Arrow in Science asserted that the inverted-U curve is only valid for pollutants involving local short-term costs like sulfur, particulates, and fecal coliforms (Arrow et al., 1995). Also in the accumulation of stocks of waste or for pollutants involving long-term and more dispersed costs (such as CO2), which are often increasing functions of income, the theory is found to weakly hold. The critics finally expressed doubt that the curve applies to "resource stocks" where the feedback effects of resource stocks are significant, such as those involving soil and its cover, forests, and other ecosystems.

Methodologies Verifying EKZ

Lucas Bretschger and Hannes Egli worked on more appropriate econometrical estimation procedures. They maintain the use of time series data instead of cross country or panel data and employ estimation specifications in the style of error correction models. First, results show that the typical EKC pattern can only be confirmed for a few pollutants, so that doubts about the general suitability of the EKC approach are legitimate.

MATERIALS AND METHODS

The study is divided into two parts. The first part is pure description of data and the second part is statistical presentation of measurement results.

Data in the untransformed form are treated statistically using the OLS method. Raw data are found nearly linear. Also, information is not lagged for years because the study does not wish to quantify previous year's particulates' impact to current year's total rice production. Markovian first order autoregressive scheme AR (1) is neither used in the study since the Durbin Watson d statistic (DW= 2.5) lies within the boundary of no positive and negative autocorrelation areas ($1.152<d<2.848$). Finally variables in temperature and particulates are squared to denote the quadratic property of the Environmental Kuznets Curve.

The basic limitation of this study is its strict assumption that externalities are solely produced internally. Many theories in resource economics as well as in environmental economics still concentrate on the case of closed economies but with globalization the integration of national economies have been increasingly becoming evident; thus environmental problems as well are expected to spill over national borders. In this study, international pollution spills are excluded in the model construction, making the system still inadequate in identifying fully sources of environmental degradation.

RESULTS AND DISCUSSION

Rice Production in the Philippines

Rice is essential to the Filipino diet and one important food crop, a staple food in most of the country. Since 1991 to 2004, except in 1998, total rice production is growing at a fairly positive rate but declined in 1998 which was mainly caused by the unabated growth on population (2.5 percent per annum), diminishing rice production area (1.8 percent per annum) and leveling-off of rice yields [5 to 6 tonnes/ha during the dry season] (S.R. Obien, E.D. Redoña and F.M. Malabanan, 1998). El Nino problem also exacerbated the problem (Leocadio S. Sebastian, Pedro A. Alviola, Sergio R. Francisco, 1998).

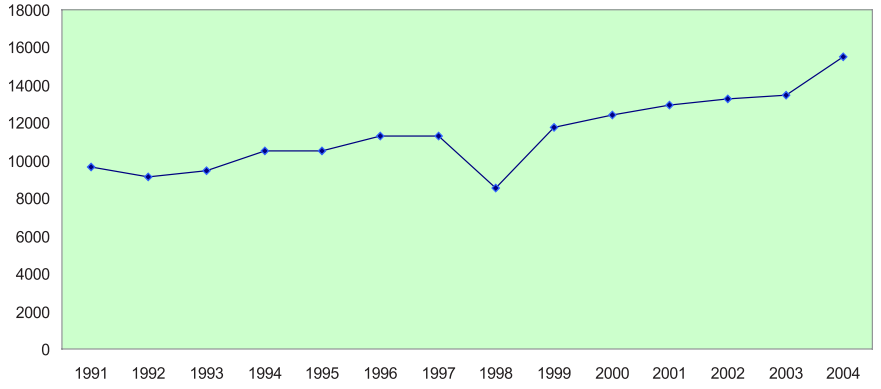

Figure 2. Rice production in the Philippines: 1991-2004

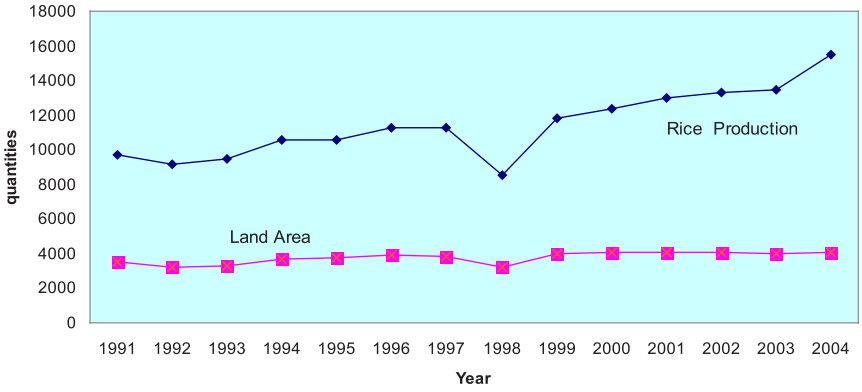

Figure 3. Rice production trends and total land area planted with rice: Philippines, 1991-2004

Such downward trend was immediately addressed by the implementation of food security policy through rice sufficiency. The trend is optimistic. Crop production, specifically in 2004 grew by 4.89 percent compared to 2003. In its totality, palay farm output reached a total output of 14.50 million metric tons in 2004 and which was 7.38 percent higher than that in 2003 (BAS, 2005).

The Philippines is growing annually at 2.33%. Considering the inability of the country to create jobs quickly, the additional number of people added yearly is over the economic carrying capacity of the country. This means that although agriculture has been able to increase rice production from 7.6 million tonnes in 1980 to 11.3 million tonnes in 1996, its growth has mostly lagged behind population growth. (S.R. Obien, E.D. Redoña and F.M. Malabanan, 1998). The projection is that by 2025, 40 to 50 percent more rice relative to current production levels will be needed to feed the Philippines' projected population of 100 million.

In preparation for such enormous task and in response to the increasing pressure to increase rice production, the government tries to modernize its agricultural research, development and extension delivery systems and infrastructure. In 1998, the government launched a national hybrid rice program. With this food security policy, based on rice self-sufficiency, the extra rice production should come abundant

without giving so much pressure on the demand for more land area, water, labor and pesticides.

It is noticed that production increases with a rather fixed land input. This reveals the increased productivity of land per hectare brought by the sophistication of direct inputs; and/or advances made in hybrid rice technology. Labor productivity could be a factor (though doubtful). Increased machinery per worker increases marginal efficiency per farm labor, making machine use more efficient in the machine-labor mix. However, it is also possible that production growth comes not from the heightened productivity per labor but on the increasing number of misplaced workers from other sectors (OFW returnee or a structural unemployment casualty) who now join farm work.

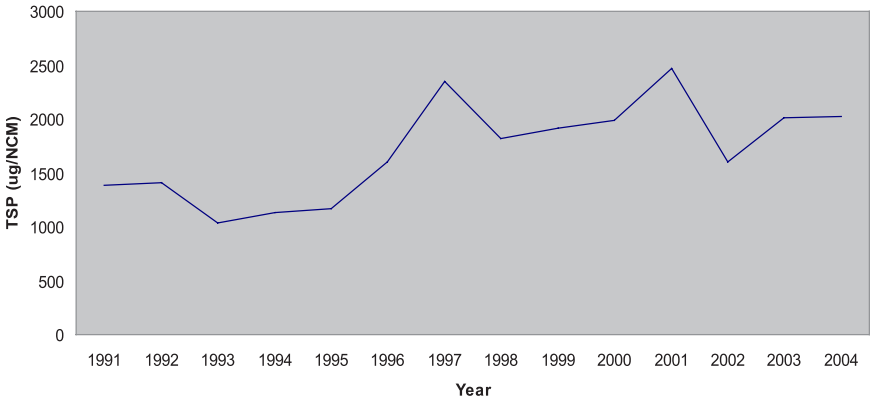

Figure 4. Total TSP magnitude in the atmosphere: 1991-2004

To counter the possible decline in general welfare caused by environmental pressures, the government enforces laws and ordinances that monitor, manage and control pollution as well as inform, rehabilitate, educate communities about cleanliness and implement action, strengthen network, hasten techniques to preserve ambient air quality. These include Solid Waste Management Act (RA9003), Clean Air Act (RA 8794), Toxic Substances and Hazardous and Nuclear Wastes Control Act of 1990 (RA 6969), PD No. 1151, PD No. 1152 and PD no. 856.

However, only a few cities responded seriously to these calls. Total particulates have not been totally abated, despite the existence of laws and ordinances.

Temperature follows the movement of with heavy rainfall (See Figures 5). Prolonged high temperature melts the iceberg in the poles and formed vapors would constitute the volume of rain. In some areas where rain is needed, rain is beneficial; in some where clogged drainage and garbage are a problem, it is detrimental. Heavy downpour causes sea level to raise, riverbanks to glut, dams to overflow, and finally deluge lower areas including farmlands. Or it could be that faulty drainage and surmounting amount of garbage causes canals to overflow and flood lower farm land areas. Either reason, production is damaged.

The equation shows that except for TSP and TSP in the second order, all factors attain statistical significance (a= 5%) in affecting rice production over time. As expected in economic theory, land variable is significant (p=0.0004) and its effect is positive (2.0828162). Also population pressures increase rice demand, the rate of which is less than that of population (slope of only 0.00016), ceteris paribus. Certainly possible rice shortages have to be expected in the nearest future.

One critical result to note is that adequate amount of temperature raises rice output remarkably by roughly 199821 metric tons per unit degree centigrade hotness, but a decline of 3649 metric tons is also noticed given intense and prolonged dryness. True enough the EKC modification is reflected.

F-test statistic value is 0.000000. This means that 99% of the variation of rice production is explained by the variables defined and the remaining 1% is attributed to all other factors not defined in the model.

TSP and TSP in the second degree came out insignificant in the model but are not removed from the equation because there have been some notable moves by the government and non-government organizations to abate pollution emission in the air. Pollution control devices have been installed to internalize the cost of pollution into their cost of production. Without the pollution control, effects from polluted environment could have been worse than expected. Thus, pollution

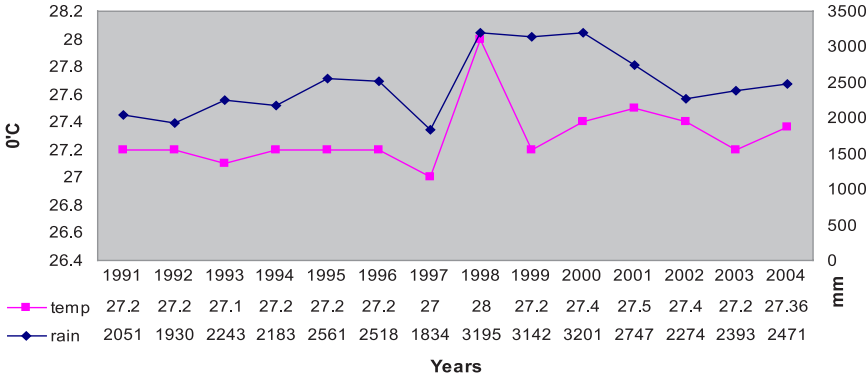

Figure 5. Changes in rainfall levels and temperature: Philippines, 1991-2004

emission variable measured by particulates is still, theoretically, a significant factor.

The Focal Point and the State of Urgency

The country is now severely pained by various crises it is experiencing – economic, social, political, peace and order, fiscal, etc. - all happening simultaneously. But what pains most is the fact that the target on food security is not achieved. Food supply is weakened by its own rising cost of production. Not only has unpredictable changes in climate and flashfloods 'thieved' directly and indirectly people's welfare, destroying farm investments too quickly and devastating status quo conditions rapidly. . Economic fate is becoming unfortunate for many Filipinos.

From the data, rain and drought are two environment externalities found to affect rice-growing activity significantly. The alternative actions to avert prolonged dry and rain seasons are not held concealed. They are not only to be implemented strictly. The obvious problem therefore that prevented solutions to work is the absence of a high-quality and superior rule of governance. Existing laws only need to be implemented strictly.

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