University of Wisconsin-Madison

November 1999 **Staff Paper No. 426**

Do National Markets and Price Policies Affect Land Use at the Forest Margin? Evidence from the Philippines

By

Ian Coxhead
and
Agnes Rola

AGRICULTURAL & APPLIED ECONOMICS

STAFF PAPER SERIES

Do national markets and price policies affect land use at the forest margin? Evidence from the Philippines*

Ian Coxhead, University of Wisconsin-Madison

Agnes Rola, University of the Philippines-Los Baños

Abstract

We examine linkages between national agricultural markets and the pattern of deforestation and agricultural development in an upland watershed. Growth in the watershed has been associated with deforestation as well as increasing evidence of agricultural land quality degradation, soil erosion and diminished watershed function. We ask to what extent forces external to the watershed and the local economy, and in particular market development and associated economic policies, might influence land use and resource management decisions. The evidence indicates that national markets -- and thus policies -- may play a much larger role in determining upland farmers' land allocation decisions than is commonly assumed in the design of upland "sustainable agriculture" projects and policies.

---

* This paper reports on research in progress; comments are welcome. Please contact the authors at coxhead@facstaff.wisc.edu. Funding support from USAID through the SANREM CRSP is gratefully acknowledged. We thank Kwansoo Kim for invaluable assistance with data management and econometric analysis.

Introduction

Poor farmers in developing countries are the primary managers of an increasingly scarce natural resource, productive agricultural land. Their decisions, while privately optimal, often conflict with social goals of resource conservation. This is clearly true when farmers engage in intensification of production on soils that are easily eroded, and when agricultural expansion takes place through the replacement of permanent ground cover, including forests, with seasonal crops. While some elements of farmers' behavior have been closely studied, the motivations for their actions are complex and poorly understood. This inhibits the effective design and implementation of programs and policies intended to reconcile social and private goals, especially in the area of upland natural resource management.

The empirical literature on this subject is rich with studies of resource use by households whose actions are constrained by poverty, institutional and market failures, and risk aversion (Anderson and Thampapillai 1990; Southgate 1988; Shively 1997). There are also several analytical models exploring the influence of broader economic forces such as price policies, relative price and wage trends in stylized fashion (Barbier 1990; Coxhead and Jayasuriya 1994). There are, however, surprisingly few studies that bring empirical evidence to bear on the broad policy and market aspects of upland agricultural resource use decisions. This imbalance of analytical attention has produced a literature in which potentially important contextual influences, such as those conveyed through intersectoral markets, are often given little weight. A lack of robust data linking upland farmers to the wider economy reinforces the widely-held notion that upland farmers exist largely outside of market systems. This in turn generates project and policy solutions to deforestation and "sustainable" agricultural development that focus primarily on direct intervention through technology transfer, institutional innovations and other

household-level actions. From a policy point of view, as we shall argue, neglect of the role of markets has restricted the domain of possible solutions to upland environmental problems.

The imbalance just described is partly a function of data availability. Detailed information on agronomic and economic practices at plot or farm level is not matched by equivalent information on prices and trade. In this paper we present analyses based on a data set containing both detailed measurements of farmers' resource use decisions, and also weekly prices of major crops and inputs recorded at the farm gate and in local and regional markets, over a period of almost 5 years. We believe that the latter part of this data set has no equal in studies of upland agriculture. Its existence enables us to test hypotheses about the nature and strength of upland farmers' links to the broader economy. We know of no prior tests of this kind making use of time series of primary data on upland agricultural commodity markets.

The paper begins with a brief review of broad indicators of rates of agricultural land quality degradation, soil erosion and water quality decline in the watershed from which our data are drawn, and summarizes the nature of agricultural intensification that has occurred over recent years. We then discuss linkages between agricultural development and environmental degradation in terms of the economic incentives and institutional constraints faced by upland farmers. Using time series analysis we establish that agricultural markets are integrated even in the relatively remote area from which our data are drawn. More importantly, we show that the direction of causation of prices always runs from the larger market to the watershed, and never in the opposite direction. Finally, we use the data to test whether price "shocks", such as those caused by policy reforms or altered macroeconomic conditions, have measurable effects on farm gate prices. When matched with quantitative evidence on farmers' land use decisions under uncertainty and risk aversion, our empirical findings contradict a frequently-offered assertion,

that yield-increasing technical progress could be a panacea for deforestation since supply expansion will drive down prices and thus reduce incentives to colonize new land. A broader implication of our findings is that the domain of national-level markets and policies, and thus the range of policy instruments potentially affecting upland land use, may be much greater than is commonly assumed.

Economic growth, deforestation and agricultural development in the Philippines

In Southeast Asia's 'tiger cub' economies— Malaysia, Thailand and Indonesia— rapid urbanization and non-agricultural income growth in the past generation has steadily reduced dependence on agriculture for subsistence, even in remote upland and highland areas. At the other end of the development spectrum, outright development failures such as Burma, Laos and Cambodia face continued pressure of expanding populations on upland land and forest resources. The Philippines, along with Indonesia, lies between these two extremes. The pace of aggregate economic growth has accelerated in recent years, but the degree of dependence on agriculture and natural resources remains high by regional standards. This is a function of earlier decades of slow growth and rapid population increase, which maintained a high level of dependence on agriculture. As a result, upland populations have long grown at rates higher than the national average, with concomitant pressures on forest and upland agricultural land resources.

In the early postwar years migration to heavily forested frontier areas in the Philippines was officially encouraged as a means of alleviating the economic and political pressures generated by increasing population and stagnating technology in the country's rice-growing heartlands. In subsequent decades continued internal migration has been fostered by low rates of non-agricultural labor absorption and a series of labor-saving technical changes in lowland

irrigated agriculture (Jayasuriya and Shand 1985) in the face of sustained high rates of overall labor force growth. The resulting increases in landlessness and open and disguised unemployment stimulated searches for open-access resources from which incomes, however tenuous, could be earned (property rights in the Philippine uplands are poorly defined and difficult to enforce). In short, much of the blame for creating the circumstances in which rapid migration to uplands took place must be attributed to a flawed development strategy and attendant rent-seeking, corruption and decay of regulatory institutions in the Philippines (Cruz and Repetto 1992; Boyce 1993). The outcome was a trebling of upland population between 1950 and 1985, from 5.8 million to 17.5, and annual growth rates of upland cropped area of greater than 7% over the same period (M. Cruz *et al.* 1992).

The study site

The research site is located in Lantapan, a municipality in central Bukidnon province, in northern Mindanao. Bukidnon is landlocked; its center consists of tablelands which descend towards the coast to the north, and in all other directions climb into some of the Philippines' highest mountain ranges. Lantapan is located in the upper Manupali river valley south of the provincial capital, and 130 km southeast of Cagayan de Oro, the closest major city and port. Lantapan's landscape climbs from river flats (500-600m) through a rolling middle section (600-1100m) to high-altitude, steeply sloped mountainsides (1100m-2200m). The northern boundary of the municipality is the boundary of a major forest reserve, the Mount Kitanglad Range Nature Park.

Lantapan's agricultural land area in 1980 totaled 14,400 hectares, nearly all rainfed. Low-lying flatlands are devoted to rice and sugar cane; corn-sugarcane systems dominate rolling country in mid-altitude areas, while at higher elevations corn is the predominant crop. At higher

elevations corn is planted alongside coffee and temperate-climate crops —beans, tomatoes, cabbages and potatoes. The latter two crops require cool nighttime temperatures and so are generally grown above 1000m in fields adjacent to and within the park boundary.

Agriculture dominates the local economy. In 1988, 71% of provincial employment was in agriculture, 5% in industry, and 23% in services, and agriculture provided the primary income source for 68% of households (NSO 1990). As is typical of a recently settled area, most farms (about 70%, covering 80% of total farm area) were owned or in "owner-like possession" in 1980, the last year for which published census data are available. Farm sizes are small by upland standards: in Lantapan in 1980, the modal farm size class (1-3 ha) contained 46% of farms, and 75% of all farms were smaller than 5 ha. Most households are poor by Philippine standards; in 1988 expenditures on food, fuel and clothing accounted for 60% of household budgets.

In both spontaneous migration and official programs since the 1950s, Bukidnon province was a major destination and watersheds like the Upper Manupali were choice locations. Sparsely settled at Independence in 1946, the population of the province has increased dramatically over the past half-century (Table 1). Population growth rates peaked at 10% per year in the 1950s, with most of the increase due to in-migration from economically depressed areas of the central and northern Philippines (NSO 1990). In the decade from 1970 Lantapan's population increased at an average annual rate of 4.6% (NSO 1990). Since 1980 the annual population growth rate has averaged 4%, far higher than the Philippine average of 2.4%.

Over time, markets have supplanted migration as the primary links between conditions in the national economy and resource use decisions in the watershed. In the 1950s, internal migrants introduced commercial cultivation of potato, cabbage, and other temperate-climate vegetables. More recently, improved integration of the Bukidnon economy in national markets,

coupled with increasing demand for vegetables and feed corn, has ensured that commercial agriculture in the province continues to adapt and thrive. Road and port improvements in Northern Mindanao have increased the profitability of growing these crops for processing or sale in national markets. Corn and vegetable production has flourished; these have become primarily commercial crops where formerly they had been little traded outside the locality.

Is there an environmental problem?

In Lantapan, agricultural expansion has occurred substantially at the expense of perennial crops, including forest (Table 2). Other things equal, the replacement of perennial land uses with short-season and annual crops on sloping lands is associated with rapid increases in soil erosion and land degradation. Field measurements and experiments with the cultivation of corn and vegetable crops under a range of management regimes in Lantapan confirm rapid soil erosion rates and depletion rates of soil nutrient and organic matter content in soils that are generally of poor initial quality (Midmore *et al.*, 1997). In spite of these negative effects of the spread of annual crops, few farmers display deep knowledge of soil degradation relationships (*ibid.*). Land fallowing and crop rotation is rare and usually undertaken only when yields decline to the point of economic losses in the current season. Although soil erosion and land degradation problems appear to be widespread, few farmers report significant investments in soil-conserving structures or technologies (Table 3; see also Midmore *et al.*, 1997). Table 3 suggests that failure to adopt soil conservation measures is related to tenure insecurity, and this is clearly an important factor in the system of three-year cash leases on fields, currently widely practiced in the watershed.

Agricultural intensification without adequate soil management has deleterious effects both on-site and off-site. Intensive cultivation of annual crops in general, and the increased use of fertilizer, pesticides and other chemicals on vegetable crops in particular, are likely to degrade

water quality and may create health problems for farm families and those living downstream. Lantapan-based water quality monitoring reveals both qualitative and quantitative evidence of water quality degradation (Deutsch *et al.* 1998). Perceptions of pesticide residues have made some residents reluctant to water animals in streams during or after heavy rain. Measures of total suspended solids (TSS) across sub-watersheds are considerably higher in those where agricultural cultivation is more widespread, in spite of much lower average slope, and seasonal TSS peaks coincide with months of intensive land preparation activity. Many of the more noticeable changes in water quality and seasonal flows have occurred "well within human memory" (Deutsch *et al.*, p.12).

Finally, the unchecked expansion of agricultural production at the margins of the remaining forest systems poses a potential threat to the integrity of those systems. Whereas in the early postwar years forest encroachment was driven mainly by commercial logging, in the past two decades the expansion of small corn and vegetable farms has been the primary impetus, with decisive contributions from road development and the lack of established property rights in land (Cairns 1995). Concerns arising from forest removal and degradation include such specific phenomena as loss of watershed function (especially with clearing in the headwaters of creeks), changes in the quantity and seasonal distribution of water flow in springs and rivers, loss of wildlife habitat, and reduced availability of forest-based foods and raw materials— as well as more general, and less easily quantified, phenomena such as biodiversity loss.

In summary, evidence on environmental problems in the watershed provides emphatic support for two arguments. First, the natural resource base of the watershed is undergoing degradation of a nature and at a rate without modern precedent. Second, much if not most of the

degradation can be attributed directly or indirectly to the spread of intensive agricultural systems based on corn and vegetables.

Markets, prices and land use decisions

The focus of this part of our research is on factors influencing land use in the middle to upper areas of the watershed, on relatively steep and easily eroded valley sides and at the forest margin. In this part of the watershed the major crops grown are corn (both for animal feed and for human consumption) and vegetables, especially cabbage, beans and potato. In the analysis that follows we concentrate on corn. This is by far the most important crop (in terms both of land use and of net farm incomes) within the study site. Nationally, too, the area planted to corn is second only to rice, and corn accounts for by far the greatest part of upland agricultural land use.

Market development and land use decisions

Data on agricultural production, input use, land use and sales for major crops were collected annually from a sample of 120 farms in four rounds between 1994 to 1998 (for full details see Coxhead 1995 and Rola and Coxhead 1997). An initial survey of the Lantapan site (PLLA 1993) had characterized agriculture in the upper watershed as 'subsistence' or 'semi-subsistence'. However, our data reveal clear commercial motivations for almost all farmers. More than 50% of corn production is destined for market, and vegetable crops such as cabbage, potato and beans strictly for sale, with home consumption accounting for less than 10% of production in each case (Coxhead 1995).

Econometric analysis of land use decisions using the Lantapan data (and reported in a separate study; see Coxhead *et al.* 1999) indicates that both the total area of land farmed, and its

allocation to different crops, are subject to influence from prices. Table 4 summarizes these findings in elasticity form.

The elasticity estimates show that farmers' land use decisions are influenced by household resource availability, physical and institutional constraints, and expected prices. Price variances are also important. Greater price variability encourages crop substitution, so an increase in the variance of corn prices causes land use to shift towards vegetable cultivation, and vice versa, suggesting that risk aversion is an important factor motivating farmers' land use decisions. Since vegetable prices are far more variable than corn prices, risk averse farmers would prefer to grow more corn, other things equal. However, greater risk is compensated by higher expected returns to vegetables in normal years. In the Philippines, corn prices are stabilized through policy interventions, and the data in Table 4 reveal that price stabilization encourages risk-averse farmers to increase corn area.

A question remains as to the relative importance of *markets*, as well as of national policies operating through them, as conditioning influences over farmers' decisions. If prices are important determinants of land use decisions, what are the determinants of prices?

Market integration and price causation

If markets within the watershed were isolated from or only weakly associated with regional markets (the 'semi-subsistence' hypothesis), we would expect to see seasonal or even longer-term divergence between trends in Lantapan prices and in regional prices and would conclude that the markets are not integrated. If markets are indeed integrated, we can also test whether prices in one market may be said to "cause" prices in another, implying that a shock from one market exerts short-run or long-run influence over prices in the other.

The tests of market integration and the direction of causation are important for both economic and environmental reasons. Under current production technologies corn, potato, cabbage and other intensive crops in Lantapan generate annual erosion and soil nutrient losses far in excess of natural regeneration rates. Remoteness and poor quality of infrastructure are frequently taken to indicate that market links to the rest of the economy are tenuous at best. This, if true, would have two important implications for policy and project design. It would mean that agricultural prices and trade policies— standard instruments for influencing agricultural resource allocation in lowlands— could be expected to have little or no effect in uplands. By extension, the most effective instruments for promoting sustainable agriculture in uplands would be direct interventions such as technology transfer, extension and education.

Alternatively, if markets are integrated but farm-gate prices are demonstrably influenced by local supply shocks, then supply and price in upland agriculture will tend to move in opposite directions. If an increase in local supply drives prices down, then the profit-maximizing level of local output will be lower than if prices were unaffected. In this case the price-reducing effects of local adoption of supply-increasing innovations such as new technologies or more efficient management practices might be expected to act as a "natural brake" on the expansion of agriculture at the forest margin.

Our econometric method proceeds as follows. We fit the data to a set of regression equations. Each equation has the price of a crop in one market as the dependent variable, and its own lagged values, as well as the current and lagged values of the prices of the same crop in other markets, as explanatory variables. Hypothesis tests on the coefficient estimates of these equations provide information about the direction of causation. As an example, for two markets A and B, when a price change in market A is shown to precede price changes in market B, we

describe the price in A as “Granger-causing” that in B. In our study, confirmation that the local price Granger-causes the regional price would provide support for the "natural brake" idea referred to above, that expanded production of a crop within the watershed will cause its price to fall, and thus deter farmers from increasing land area planted to it. Conversely, confirmation that the regional price causes the Lantapan price would indicate a need to focus on agricultural price and trade policies as influences over farmers’ land use and crop production decisions.

The test of causation is also a test of a sufficient condition for market integration, so long as at least one causal relationship is confirmed. For example, if the hypothesis that prices in A cause prices in B cannot be rejected, we also conclude that A and B are integrated. It is, however, important to note that strictly speaking, our method provides what is best described as circumstantial evidence on integration and causation. The conclusion of "causation" is reached by observing temporal precedence, but no causal mechanism can be spelled out.

We apply these tests to weekly corn, potato and cabbage prices in Lantapan and regional markets (the data series are summarized in Figures 1-3). Crop price data were collected weekly from traders at several points in Lantapan, from provincial centers and from the main regional wholesale trading point, the Agora market in Cagayan de Oro, the regional capital and port. Much of the produce sold in the Agora is shipped directly to Manila, the national capital and central market, either for processing or for sale; accordingly, Agora prices track the benchmark Manila prices. In this analysis we concentrate on the Lantapan-Agora market relationship.

To account for the time series properties of the data we employ a vector auto-regression (VAR) method (Sims 1980). The structural equations of the model (with 2-period lags, suppressing crop-specific subscripts) are:

$$PL_t = \alpha_1 PA_t + \beta_{11} PL_{t-1} + \beta_{12} PA_{t-1} + \gamma_{11} PL_{t-2} + \gamma_{12} PA_{t-2} + v_{PLt}$$

$$PA_t = \alpha_2 PL_t + \beta_{21} PL_{t-1} + \beta_{22} PA_{t-1} + \gamma_{21} PL_{t-2} + \gamma_{22} PA_{t-2} + v_{PAt},$$

where PL_t and PA_t are prices in Lantapan and in the Agora regional market respectively, and v_{PLt} and v_{Pat} are error terms, assumed serially and mutually uncorrelated. Eliminating current-period variables from the right-hand sides of these equations yields a reduced form, written as:

$$PL_t = \varphi_{11} PL_{t-1} + \varphi_{12} PA_{t-1} + \varphi_{13} PL_{t-2} + \varphi_{14} PA_{t-2} + \varepsilon_{1t}$$

$$PA_t = \varphi_{21} PA_{t-1} + \varphi_{22} PL_{t-1} + \varphi_{23} PA_{t-2} + \varphi_{24} PL_{t-2} + \varepsilon_{2t},$$

where ε_{1t} and ε_{2t} are unobservable variables which are the serially uncorrelated innovations in the PL and PA processes.

Granger causality tests utilize test statistics computed from the VARs. A variable (m_t) is said to *fail to Granger-cause* another variable y_t relative to an information set consisting of past values of m_t and y_t if

$$\hat{E}[y_t \mid y_{t-1}, m_{t-1}, y_{t-2}, m_{t-2}, \ldots] = \hat{E}[y_t \mid y_{t-1}, y_{t-2}, \ldots],$$

where $\hat{E}$ denotes a linear projection of the dependent variable. In our example, this means that PA does not Granger-cause PL relative to an information set consisting of past values of PA and PL if (and only if) the estimates of φ_{12} and φ_{14} are equal to zero. In practice, an F-test can be used to test the null that one variable does not Granger-cause another.

The results of these F-tests are summarized in table 5. All markets display some form of causation, and so we conclude that local and regional markets are integrated for all crops in the study. For *yellow corn* and *white corn*, the direction of causation runs from wholesale market to farm gate. Corn prices in the watershed are driven entirely by prices in provincial and national markets. For *potato*, weekly data indicate two-way causation: farm gate prices are influenced by

wholesale prices, but a local supply shock in Lantapan may also have a short-run effect in wholesale markets. Using biweekly data, however, we find a strong one-way relationship between Lantapan and Agora prices, with causality running from the latter to the former. For *cabbage*, the weekly data show a strong influence of Lantapan prices on wholesale prices, but monthly data show that when very short-term fluctuations are smoothed out, cabbage prices are determined in the regional market and not within the watershed.

To summarize, our results indicate that markets for the major crops grown in the watershed are integrated with broader regional markets. They also provide strong evidence for all crops that an expansion of supply within the watershed will have no measurable influence on its prices in wholesale markets, beyond a period of one or two weeks for vegetable crops. There is, therefore, no evidence that endogenous price changes will constrain the expansion of vegetable and corn cultivation in the watershed.

Agricultural policies and environmental implications

When markets are integrated, with prices determined in the broader regional and national economy rather than in the watershed, and when farmers' land use decisions are demonstrably price-responsive, agricultural price policy can exert a significant (though not immediately observable) influence on natural resource management. Our research in Lantapan, like that on related Philippine projects, has demonstrated the existence of a pervasive policy bias in favor of crops, such as corn and temperate vegetables, whose cultivation is most strongly associated with the agricultural land degradation, soil erosion and related water pollution in the watershed. This commodity bias emanates mainly from national-level economic policies, some of them unrelated to agriculture, has been complemented in the past by the allocation of agricultural research

resources, and appears not to be offset by effective policy measures in favor of more environment-friendly techniques for cultivation of corn and vegetables.

Agricultural price policies

Throughout the postwar era successive Philippine governments have pursued self-sufficiency in grains, along with cheap consumer cereals prices, as key components of food security and income redistribution strategies. Philippine cereal yields are low by Asian standards, and with relatively little spending on agricultural infrastructure and technology, yields have not risen as quickly as in comparable countries. Consequently, grain output growth has been due primarily to area expansion. Given the political import of self-sufficiency, grain imports (a monopoly of the National Food Authority, a state-owned corporation) have historically been very tightly circumscribed. The nominal protective rate (NPR, a measure of the amount by which domestic prices exceed the landed prices of imports) for corn has generally been much higher than for any other major agricultural product, especially after the mid-1970s when corn self-sufficiency was made a policy goal. The NPR averaged 18% in 1970-74, but rose to 42% by 1983-86 (Intal and Power), and to 62% by 1990 (David 1996); it has remained at about this level since.

Vegetable production has also received substantial policy support. Import bans imposed in 1950 on fresh potato, cabbage and garlic (and reiterated in subsequent legislation as recently as 1993) were repealed and replaced by tariffs only in 1996 (see below). Demand for these non-traditional foods grows with per capita income and urbanization. Since supply growth is limited by trade restrictions and climatic constraints, their prices have tended to rise more rapidly than the general price level, and certainly more rapidly than prices of most exportable crops and staple

grains. For potato, the ban raises Philippine *farm gate* prices to nearly double the c.i.f. (landed) Manila price of imports, if were they permitted (Coxhead 1997).

Through most of the postwar period, the Philippine currency was overvalued relative to its true purchasing power in world markets (Intal and Power 1990). This discouraged exports and strengthened arguments for tariffs and other trade barriers to protect import-competing industries (paradoxically, since protection is a factor contributing to overvaluation). In agriculture, exchange rate overvaluation has imposed the equivalent of an export tax on tree crop commodities such as coffee, formerly a major Lantapan farm product. For imports such as pesticides and fertilizers, exempted from significant protection because of their "essential" role in production, overvaluation is the equivalent of a subsidy. Pesticides have also been the targets of additional direct subsidies in domestic markets (Tjornhom and Norton 1996). These subsidies raise the profitability of vegetable crops, since these are highly pesticide-intensive under current technologies (Midmore *et al*. 1997).

The Agricultural Tariffication Act of 1996 brought Philippine agricultural policy into compliance with the Uruguay Round of the GATT. Quantitative restrictions on corn and vegetables were replaced by tariffs, and minimum access volumes (MAVs) were specified for each product. The MAV is the volume of a product that is allowed to be imported at a lower rate of duty than the maximum bound rate under the GATT. For the period to 2004, in-quota corn tariffs (those applying to MAV imports, which themselves cover roughly 50% of annual imports) remain at 35%. Out-quota tariff rates for corn, set at 100% in 1996 are scheduled to fall to 65% in 2000 (similar changes apply to vegetables). These reforms, although they constitute important steps in the direction of more open trade, ensure that upland farmers will continue to benefit from protection at significantly higher rates than most other sectors for the foreseeable future.[1]

Market and policy linkages in Lantapan

Having documented the key agricultural policies and reforms, we now make an initial attempt to quantify the effects of policy changes on farm-gate prices.

The data available to this study do not permit a full evaluation of the effects of national policies on farm-gate prices. Specifically, we cannot as yet evaluate the effects of changes in the trade policy regimes that underpin domestic market conditions for both corn and vegetables. For vegetables, import bans that prevailed until 1996 have been replaced with tariffs at prohibitive rates; as far as the domestic market is concerned, there has been no trade policy change. For corn, in spite of the shift from quantitative restrictions on corn imports to the MAV system with tariffs after 1996, it is difficult to construct a test of the influence of trade policy changes on corn prices. The announced trade policy changes are being introduced very gradually and are not scheduled to be completed before 2004. As the NPR figures cited earlier suggest, the trade policy changes themselves are best characterized as small relative to the overall degree of distortion in corn trade. Thus, while trade liberalization may induce significant structural changes in the Philippine corn market over the long run, in the shorter run domestic market conditions and interventions, and especially the actions of the NFA, are more likely to exert significant influence over markets.

The NFA announces support prices for grains, and attempts to defend them through procurement, storage and trade. Using national-level data on net procurement and support prices, we conducted a partial test of the importance of price supports by including a dummy variable to account for a one-time change in the official support price for corn (from pesos 4.5 to pesos 6.0 per kilogram, in July 1996) (information on net procurement was also included in the regression). The coefficient of support price dummy variable has the expected (positive) sign in

both the regional and the farm gate price series. Significance levels are low, however; the null hypothesis of no influence on the regional market is rejected only at p=0.15, and there is no measurable effect of price support on the farm gate price. The finding that price supports have little effect at the farm gate is consistent with earlier analyses of Philippine grain markets (Lantican and Unnevehr 1987).

Of potentially greater interest is the observation that income instability, the phenomenon that risk-averse farmers strive to avoid, appears to have intersectoral as well as local sources, even in a market such as corn which is subject to price stabilization. Our data span the recent economic crisis that engulfed Southeast Asian countries, beginning when the Thai currency collapsed in July 1997. While the crisis took different forms in each affected economy, there were three elements common to all. There was sharp drop in overall economic growth, and there were sudden, unexpected and repeated re-evaluations of regional exchange rates, most of which had previously been fixed, formally or otherwise, to the U.S. dollar (Philippine exchange rate data are shown in Figure 2). As a result there was a big increase in uncertainty among producers within the affected countries about final demand and prices, input prices, and even availability of key inputs such as credit.

By dividing our data into periods corresponding approximately to "pre-crisis" and "post-crisis", with September 1997 as the dividing point, we are able to make a preliminary identification of the effects of macroeconomic instability on the relationship between farm gate prices and those in national markets. We do this by calculating *impulse response functions*, which record the dynamic response of one data series to a one-time shock ("impulse") in another (see Greene 1993). The impulse response measures are computed from the same VAR model used earlier to test market relationships, only with the data divided into two sub-periods as noted.

Due to missing data we are able to undertake this test only for corn. The results, however, are revealing.

The dynamic response of Lantapan corn prices to a shock in the Agora regional market price is shown in Figure 5. The "impulse" is a one-peso per kilogram price shock, so the figures on the vertical axis of the graph are pesos per kilogram in the Lantapan market (the mean pre-shock corn price was about 6 pesos/kg, so this represents a shock of about 16%). In the pre-crisis period, a shock in the Agora price yields a maximum rise in local prices of about 5% (0.3 pesos). The impulse response peaks in 3 weeks and drops very sharply; by the 5th week after the shock, the impulse has fallen to 3%. Post-crisis, the peak is much larger (8%), and more sustained. It takes nearly 3 months (12 weeks) for the post-crisis impulse to decline to the point reached after only 5 weeks in the pre-crisis era. Comparing responses before and after the onset of the crisis, we see that in the post-crisis era the signal from the leading Agora price to the Lantapan price is very much more "noisy" than in the prior period.

While very preliminary in nature, the impulse response analysis suggests that in the Philippines, the effects of macroeconomic instability find their way into resource allocation decisions even in areas far from the main regions and sectors of economic activity.[2] Not only are national market and policy signals transmitted directly through commodity prices, but deeper and less direct phenomena are also manifested at the farm level through the same channels. The economic signals upon which upland farmers make resource allocation decisions are not independent of conditions in national markets and in the macroeconomy. More rigorous investigations of these relationships, for corn and for other crops, will become feasible as more data from the post-crises era become available.

Conclusions

Commodity market development, along with policy biases, has contributed to deforestation and the adoption and spread of relatively erosive crops, produced using relatively land-degrading technologies, in the upland Philippine watershed of our study. The environmental ill effects of these crops could be minimized by adoption of appropriate technologies, for example to reduce erosion and preserve soil quality. However, few farmers in the study site have adopted effective soil conservation measures, and while this is clearly related to tenure insecurity, there is also evidence that among all farmers, the choice of annual commercial crops, and the failure to adopt soil-conserving technologies, has economic as well as institutional roots.

We have demonstrated that in spite of remoteness, the farmers in our study area produce for markets that are well-integrated in the national agricultural market system. Supply shocks from the site have no effect on prices in broader markets, so there is no evidence that the sample farmers' actions can "cause" prices at all, let alone generate enough price movement to ensure that agricultural expansion will decelerate as prices endogenously decline. This finding means that an appropriate combination of project-specific and more general policy measures is called for if the former are to succeed in changing farmers' actions, and if the latter are not to discourage environmentally sustainable strategies.

While empirical tests of the effects of trade policies on prices cannot be conducted in the absence of substantive policy changes, it is nevertheless clear from the continuing high NPR values for corn that well-functioning markets convey the effects of trade policies to the farm gate, even in upland agriculture. Trade liberalization can be expected to reduce the prices of corn and vegetables, the two most environmentally damaging crops currently grown in the uplands of Lantapan and many similar Philippine watersheds.

Finally, anecdotal evidence of the importance of macroeconomic trends in driving upland migration and land use patterns is provided some additional contemporary support by our finding that the stability of market price relationships is a function of stability in the overall Philippine economy. During the "crisis" period from late 1997 to late 1998, we have found that enormous instability and uncertainty at the macroeconomic level was associated with a deterioration of farm gate-wholesale market price relationships. Future research on the links between deforestation and agricultural expansion should benefit from this exposure of the importance of markets and prices in a typical frontier area of a tropical developing country. At a policy level this research, if supported by counterpart studies from other sites, should provoke a reconsideration— and indeed a substantial broadening— of the set of policy instruments available to influence upland agricultural and forest land allocations.

References

Anderson, J. R. and J. Thampapillai. 1990. "Soil conservation in developing countries: project and policy intervention". Washington, D.C.: World Bank. Agriculture and Rural Development Department, Policy and Research Series, Paper No. 8.

Boyce, James K. 1993. *The Political Economy of Growth and Impoverishment in the Marcos Era* (Manila: Ateneo de Manila Press).

Barbier, E. B. 1990. "The farm-level economics of soil conservation: the uplands of Java". *Land Economics* 66(2), May., pp. 198-211.

Cairns, M. 1995. Ancestral domain and national park protection: mutually supportive paradigms? A case study of the Mt. Kitanglad Range National Park, Bukidnon, Philippines. Paper presented at a workshop on Buffer Zone Management and Agroforestry, Central Mindanao University, Musuan, August.

Coxhead, I. 1995. The Agricultural Economy of Lantapan Municipality, Bukidnon, Philippines: Results of A Baseline Survey. March 1995, rev. Aug. 1995. Sanrem Social Science Group Working Paper No. 95/1

Coxhead, I. 1997. Induced innovation and land degradation in developing country agriculture. *Austral. J. Agricultural and Resource Economics*, 43 (2), September.

Coxhead, I., and S. K. Jayasuriya. 1994. "Technical change in agriculture and land degradation in developing countries: a general equilibrium analysis". *Land Econ.* 70(1), Feb., pp. 20-37.

Coxhead, I. and G. Shively. 1998. Measuring the environmental impacts of economic change: the case of land degradation in Philippine agriculture. *Journal of Agricultural Economics and Development*, in press.

Coxhead,I., G. Shively and X. Shuai. 1999. Development policies, resource constraints and agricultural expansion on the Philippine land frontier. Madison, Wis.: University of Wisconsin-Madison Department of Agricultural and Applied Economics, Staff Paper Series No. 425, October.

Cruz, Maria C.; C. A. Meyer, R. Repetto and R. Woodward (1992). *Population Growth, Poverty, and Environmental Stress: Case Studies from the Philippines and Costa Rica* (Washington, DC: World Resources Institute).

Cruz, W., and R. Repetto. 1992. *The Environmental Effects of Stabilization andStructural Adjustment Programs: The Philippines Case* (Washington, DC: World Resources Institute).

Deutsch, W. G.; A.L. Busby, J.L. Orprecio, E. Cequina and J. Bago. 1998. Community-based water quality indicators and public policy in the rural Philippines (Manuscript, Auburn University).

Intal, P. and J. Power. 1990. *Trade, Exchange Rate and Agricultural Pricing Policies in the Philippines* (Washington, DC: World Bank).

Greene, W. H. 1993. *Econometric Analysis*. (Prentice-Hall).

Jayasuriya, S. and R. T. Shand (1986). "Technical change and labor absorption in Asian agriculture: some emerging trends" *World Development* 14(3), pp.415-428.

Lantican, F.A. and Unnevehr, L. J. (1987) Rice pricing and marketing policy. In *Policy Issues in the Philippine Rice Economy and Agricultural Trade*, ed. , pp. 31-72. University of the Philippines at Los Banos, Center for Policy and Development Studies, College, Laguna.

Li Bin. 1994. Impact assessment of land use changes in a watershed area using remote sensing and GIS: a case study of Manupali watershed, the Philippines. M.S. thesis: Asian Institute of Technology, Bangkok.

Midmore, D.; L. Ramos, W. Hargrove, D. Poudel, T. Nissen, F. Agragan, and G. Betono. 1997. Stabilizing commercial vegetable production in the Manupali watershed, the Philippines. SANREM CRSP-Philippines Phase I terminal report, August (mimeo).

National Statistics Office (1990). *Bukidnon Provincial Profile* (Manila: NSO).

Philippine Department of Agriculture. 1994. Grain Production Enhancement Program. Quezon City: Philippine Department of Agriculture.

Rola, A.C. and I. Coxhead. 1997. The Agricultural Economy of an Upland Community: A Revisit to Lantapan, Bukidnon, Philippines. June 1997. (Manuscript, UPLB, Los Banos, Laguna)

Shively, G. E. 1997. Consumption Risk, Farm Characteristics, and Soil Conservation Adoption Among Low-Income Farmers in the Philippines." *Agric. Econ.* 17(2):165-177.

Sims, C. 1980. Macroeconomics and reality. *Econometrica* 48(1), pp.1-48.

Southgate, D. 1988. "The economics of land degradation in the third world". Washington, D.C.: World Bank Environment Department, Working Paper No. 2, May.

Tjornhom, J.D., and G. W. Norton. 1996. Impacts of price and exchange rate policies on pesticide use in the Philippines. IPM CRSP Working Paper No. 96-4.

World Bank. (1989). Philippines: Environmental and Natural Resource Management Study. Washington, DC: The World Bank.

Table 1: Bukidnon province: population and growth rates, 1903-90

Census Year	Population	Growth Rate (% p.a.)	Density (per km^2)
1903	21,163	-	2.55
1918	46,519	5.39	5.61
1930	57,561	1.02	6.94
1948	63,470	1.09	7.65
1960	194,368	9.78	23.44
1970	414,762	7.87	50.01
1975	532,818	5.14	64.24
1980	631,634	3.46	76.16
1990	843,959	2.94	101.76

Source: NSO 1990.

Table 2: Land Use Changes, Municipality of Lantapan, 1973-94

Land use class	Area 1973 (ha.)	% of total (1973)	Area 1994 (ha)	% of total (1994)
Dense Forest	25970	51.43	14780	29.27
Corn and vegetable	8923	17.67	17270	34.20
Rubber trees or pasture	4181	8.28	111	0.22
Corn and sugarcane (mainly s'cane)	3691	7.31	4560	9.03
Shrub and tree (other distribution)	3287	6.51	3302	6.54
Corn and sugarcane (mainly corn)	1697	3.36	2585	5.12
River and creek	1364	2.70	1363	2.70
Shrub and tree (besides forest)	1252	2.48	5186	10.27
Bare soil	86	0.17	656	1.30
Lowland paddy field	45	0.09	682	1.35
Total	50946	100.00	50496	100.00

Source: Li Bin 1994, Tables 5.9 and 6.12

Table 3: Soil conservation practices by tenure of parcel, Lantapan farms 1994

Practice		Priv. Title	Share Own.	Tax Decl.	Share Ten.	Cash Rent	CLT	Other	Miss-ing	Total
None	N	19	1	9	18	25	3	4	1	80
	%[a]	17.12	16.67	24.32	28.57	48.08	60.00	13.33	50.00	26.14
Contour Farming	N	42	5	18	26	15	3	16	0	125
	%	37.84	83.33	48.65	41.27	28.85	60.00	53.33	0.00	40.85
Mulching	N	6	0	1	0	1	0	1	1	10
	%	5.41	0.00	2.70	0.00	1.92	0.00	3.33	50.00	3.27
Fallowing	N	8	1	4	2	0	0	1	0	16
	%	7.21	16.67	10.81	3.17	0.00	0.00	3.33	0.00	5.23
Contour Hedgerows	N	4	0	2	3	0	1	2	0	12
	%	3.60	0.00	5.41	4.76	0.00	20.00	6.67	0.00	3.92
Plant Perennials	N	27	0	10	10	3	0	15	0	65
	%	24.32	0.00	27.03	15.87	5.77	0.00	50.00	0.00	21.24
Grassy Boundary	N	33	1	7	14	8	0	2	1	66
	%	29.73	16.67	18.92	22.22	15.38	0.00	6.67	1.00	21.57
Dibble Planting	N	9	0	3	7	4	0	6	0	29
	%	8.11	0.00	8.11	11.11	11.54	0.00	20.00	0.00	9.48
Other	N	6	0	0	4	3	0	1	0	14
	%	5.41	0.00	0.00	6.35	5.77	0.00	3.33	0.00	4.58
Total	N	151	8	54	84	59	7	48	3	414
No. parcels	N	111	6	37	63	52	5	30	2	306

[a] Per cent of parcels in this tenure class on which the conservation practice was reported. Percentages add to more than 100 since more than one practice is reported on some parcels.

Notes: Private title, shared ownership and tax declaration constitute "owner-like" possession. Cash rental and share tenancy are less secure. CLT (Certificate of Land Transfer) is a document issued to some tenant farmers under the Philippine land tenure reform laws.

Source: Coxhead 1995.

Table 4: Estimated elasticities of Lantapan crop and farm area response functions

Variables	Corn Area (ha)	Vegetable Area (ha)	Farm Area Change (ha)
Expected corn price	0.3769	-0.7607	0.0089
	(0.428)	(-0.479)	(0.006)
Expected vegetable price	-0.6600	0.9789	0.1124
	(-1.575)	(1.329)	(0.161)
Expected corn yield	-0.1382	0.3016	0.6817
	(-0.452)	(0.543)	(1.312)
Expected vegetable yield	0.2320	0.2826	-0.8489
	(-.516)	(0.352)	(-1.171)
Variance of corn price	-1.3120	0.8564	-1.3173
	(-1.406)	(0.500)	(-0.812)
Variance of vegetable price	0.6983	-0.7432	0.5005
	(1.936)	(-1.126)	(0.803)
Corn yield variability	-1.4896	2.6042	1.1114
	(-2.736)	(2.664)	(1.183)
Vegetable yield variability	0.5321	-0.5766	-0.0657
	(3.475)	(-2.09)	(-0.248)
Price of N from inorganic fertilizer	-0.9027	-0.1407	0.5240
	(-3.407)	(-0.350)	(1.371)
Price of manure	0.4898	-3.7306	-1.3240
	(1.127)	(-4.923)	(-1.774)
Total farm area last year	0.9921	-0.0937	-1.1171
	(11.661)	(-0.560)	(-5.166)
Number of adults in the household	0.0010	0.7002	1.2998
	(0.007)	(2.649)	(5.090)
Average tenure of the farm	-0.0370	-0.2297	-0.6616
	(-0.314)	(-1.101)	(-3.261)
Credit constraint	-0.5564	-0.0931	-0.3407
	(-2.997)	(-2.736)	(-10.12)

Source: Coxhead, Shively and Shuai 1999. Figures in parentheses are t-statistics of underlying coefficient estimates.

Table 5: Summary of results of Granger causality tests for corn and vegetable prices

Crop	Test[a]	R^2	DW[b]	F (N; d.f.)	P value[c]	Comments
	Weekly data					
Yellow Corn	Agora → Lantapan	0.75	1.97	3.22 (182;2,176)	0.042	One-way
	Lantapan → Agora	0.86	2.04	0.91 (182;2,176)	0.403	causation
White Corn	Agora → Lantapan	0.89	1.95	8.25 (162;2,156)	0.004	One-way
	Lantapan → Agora	0.95	1.96	0.39 (162;2,156)	0.680	causation
Avg. Potato	Agora → Lantapan	0.81	1.95	6.61 (157;2,151)	0.002	Two-way
	Lantapan → Agora	0.84	2.08	7.17 (157;2,151)	0.001	causation
Cabbage	Agora → Lantapan	0.86	1.97	2.88 (170;2,164)	0.005	Two-way
	Lantapan → Agora	0.68	1.96	5.60 (170;2,164)	0.004	causation
	Monthly data					
Avg. Potato[d]	Agora → Lantapan	0.75	2.05	13.8 (83;2,76)	0.001	One-way
	Lantapan → Agora	0.83	2.12	0.77 (83;2,76)	0.470	causation
Cabbage	Agora → Lantapan	0.61	1.90	3.36 (41;2,35)	0.046	One-way
	Lantapan → Agora	0.56	1.99	0.34 (41;2,35)	0.710	causation

Notes:

[a] Arrows indicate the direction of causation being tested, so for example "Agora → Lantapan" indicates a test that Agora price Granger causes Lantapan price.

[b] Durbin-Watson statistic.

[c] $P < 0.01$ indicates rejection of the null hypothesis (no causation) at 1% significance level; $0.01 < P < 0.05$ indicates rejection at 5%; $0.05 < P < 0.1$ indicates rejection at 10%.

[d] Biweekly data for average prices of large and medium potatoes.

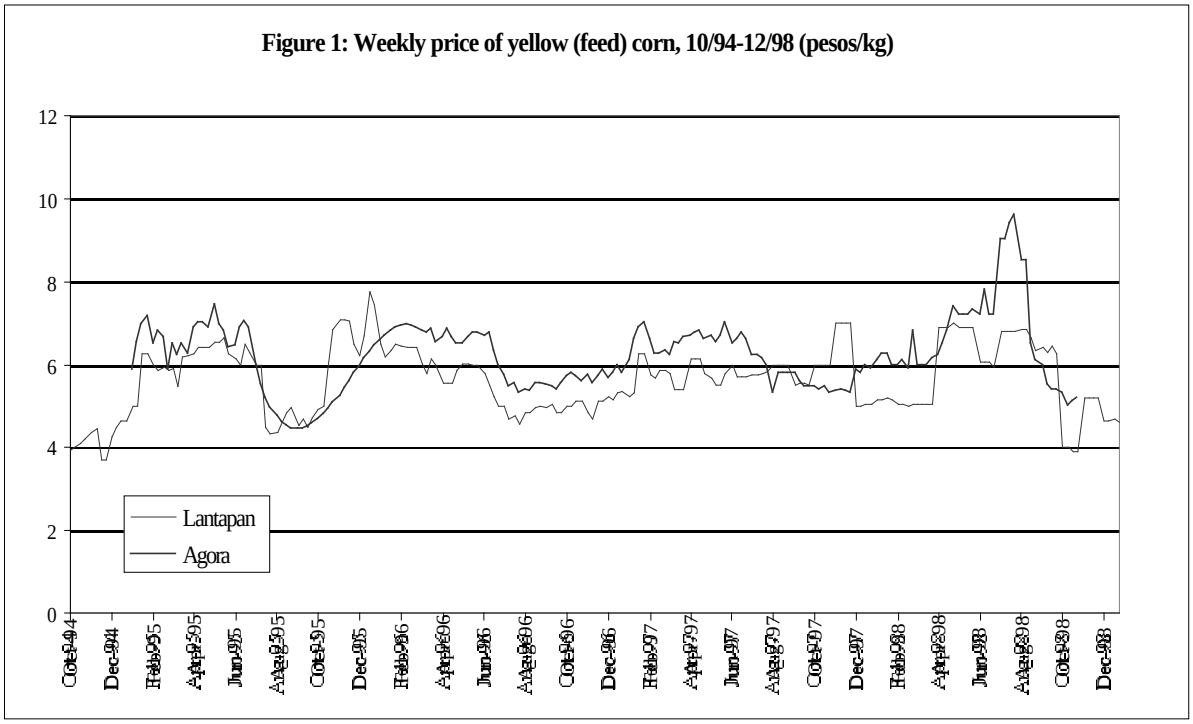

Figure 1. Weekly price of yellow (feed) corn, 10/94-12/98 (pesos/kg)

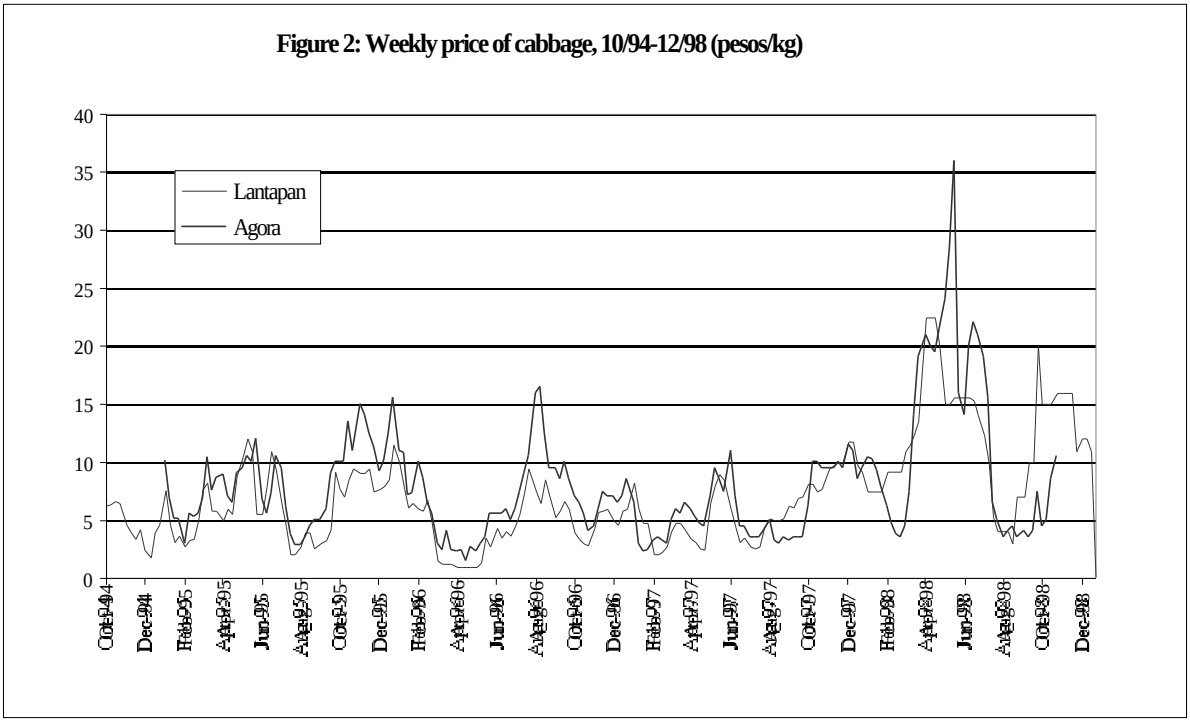

Figure 2. Weekly price of cabbage, 10/94-12/98 (pesos/kg)

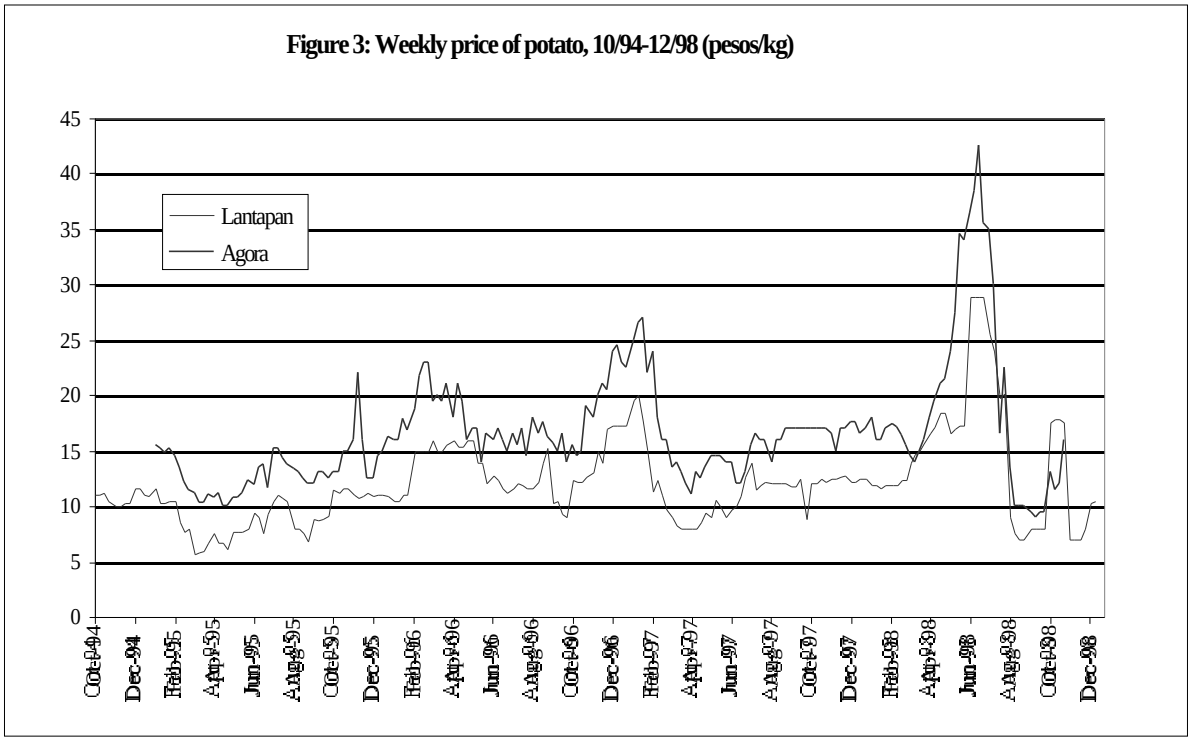

Figure 3. Weekly price of potato, 10/94-12/98 (pesos/kg)

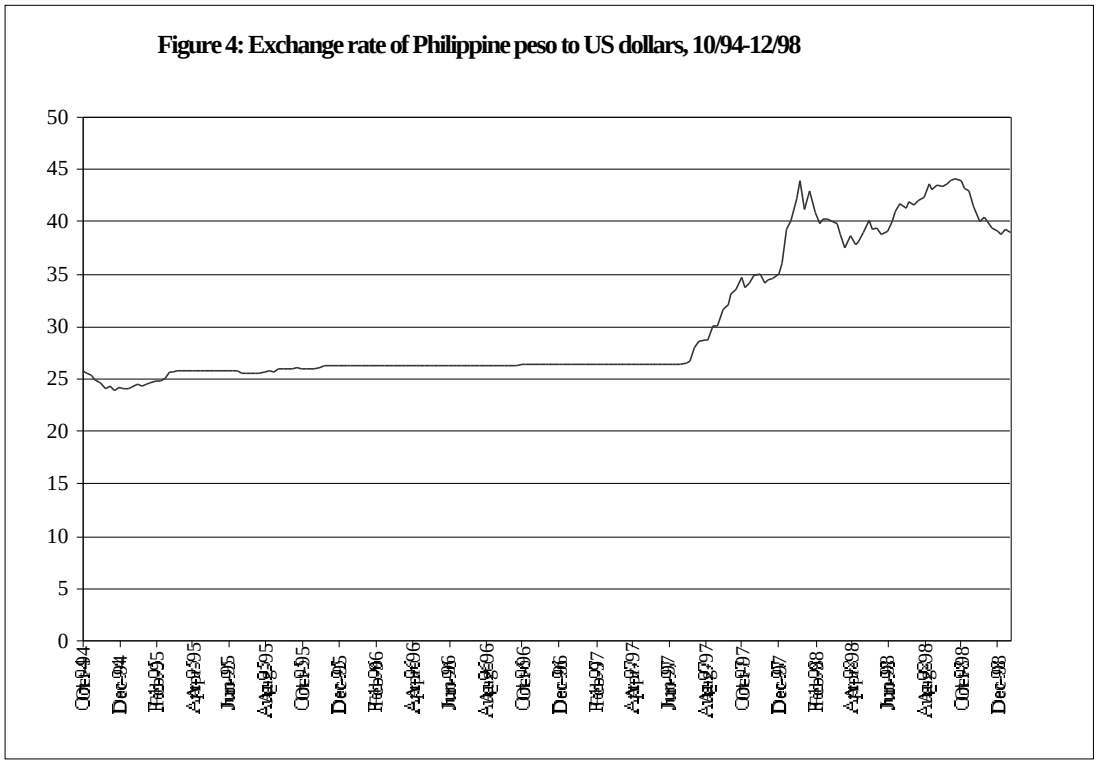

Figure 4. Exchange rate of Philippine peso to US dollars, 10/94-12/98 (weekly)

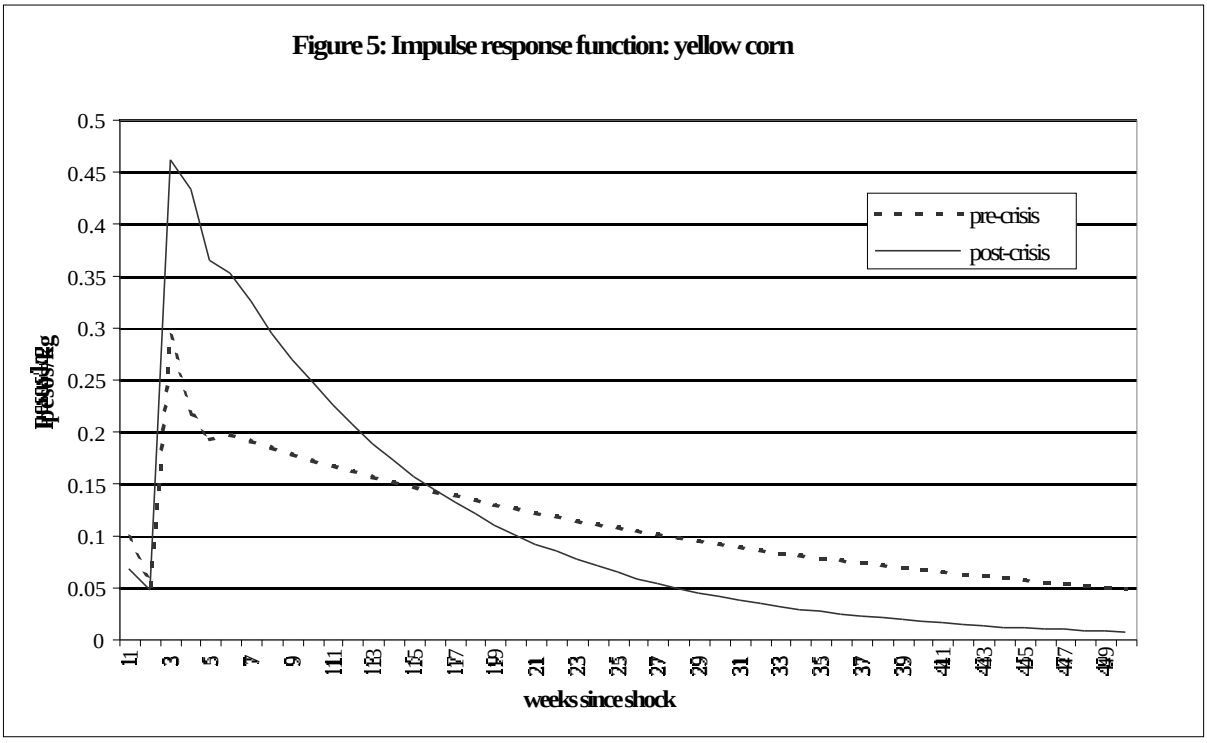

Figure 5. Impulse response function: yellow corn

Endnotes

[1] Trade and price policy biases are also reflected in the allocation of agricultural research funds. Most important among these in the Lantapan context are corn programs. Bukidnon has been designated as a 'key production area (KPA)' for corn in the Philippine government's Grain Production Enhancement Program (GPEP). Farmers in KPA areas are eligible for a range of subsidies and supports directed at increasing corn production, and are the first beneficiaries of research and development directed at increasing corn yields (Philippine Department of Agriculture 1994). Experiments with an economy-wide model of the Philippines indicate that at constant prices, technical progress in corn production, which has the same effects on farm profitability as a price rise, would increase the area planted to corn by a substantial margin (Coxhead and Shively 1998). We have seen that a local expansion of corn supply by upland farmers would have no measurable effect on corn prices. Thus if the GPEP were to result in productivity improvements in corn grown by Lantapan farmers, we would expect the area planted to this crop to expand. Temperate climate vegetable crops are also the targets of disproportionate research resource allocations (Coxhead 1997).

[2] The exact effects of price instability on land use by Lantapan farmers cannot currently be determined with any greater precision than is provided in this statement. One reason is that our land use response estimates in Table 4 are based only on pre-crisis data and may not be stable once post-crisis data are incorporated. The analysis of the effects of the crisis in Philippine upland agriculture is the subject of ongoing research as new data become available.