Chapter 3:
Philippine Development Strategies, Price Policies and National Markets: What are the Linkages in Lantapan?[1]

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Introduction

Poor farmers in developing countries are the primary managers of an increasingly scarce natural resource, productive agricultural land. Their decisions, while they may be privately optimal, often conflict with social goals of resource conservation. This is clearly true when farmers intensify production on soils that are easily eroded, and when agricultural expansion takes place through the conversion of forests and other permanent cover to seasonal crops.

The empirical literature on tropical deforestation and land degradation is rich with studies of resource use by households whose actions are constrained by poverty, market failures, and risk aversion (*e.g.* Anderson and Thampapillai 1990; Southgate 1988; Shively 1997). The literature typically locates such immediate motivational factors within a broader context of absence or non-enforcement of property rights (resulting in open-access forest lands and tenure insecurity on farmed lands), and population pressure. These are identified as providing the enabling environment for forest clearing and unsustainable patterns of agricultural land use by upland farmers (for an excellent survey of technical and economic issues within this tradition see Pingali 1997). There are also a number of analytical models exploring the influence of broader economic forces like price

[1] A version of this chapter is forthcoming in *Land Economics* (May 2001) as "How do national markets and price policies affect land use at the forest margin? Evidence from the Philippines."

policies and wage trends on elements of the upland agricultural decision set, such as soil conservation (Barbier 1990; Barrett 1991) and deforestation (Angelsen 1999). At the broadest level are general equilibrium papers in which intersectoral linkages, through factor markets, product markets and trade, are seen to influence upland decisions (Lopez and Niklitschek 1991; Deacon 1995; Coxhead and Jayasuriya 1994, 1995).

Looking across all the types of models one finds a wide array of assumptions about the economic links between upland economies and the national economies in which they are located (Angelsen 1999, in particular, explores many variations). The choice of market assumptions conditions the behavior of a model and thus the policy conclusions that are drawn from it. As an example, general equilibrium approaches to deforestation, by acknowledging labor mobility, conveys the idea that upland population "pressure" is a response to economic incentives, rather than an exogenous determinant of actions as in some of the other models.

Similarly, there is a great deal of variation in the assumptions commonly made about product markets. Given the importance to project and policy design of a correct understanding of market structure and pricing, there are surprisingly few studies that bring empirical evidence to bear on the market and policy aspects of upland agricultural resource use decisions. The goal of this paper is to encourage a move in that direction, as a complement to the existing body of household-level analyses.

It is our thesis that the design of upland projects directed at influencing smallholders' land conversion and land use decisions in the direction of "sustainability" could be greatly improved by a better integration of information on market- and sector-level incentives with information on household-level decisions and constraints. Perhaps because of a lack of data and empirical analysis, project solutions to deforestation and agricultural land degradation in developing countries focus mainly on direct interventions through technology transfer, institutional innovations and other household-level actions. The role of policy, (and especially its less direct manifestations through intersectoral product and factor markets) is generally given little emphasis.[2] The obverse of this problem is a general neglect at the

[2] In the Philippine case, a recent set of national government guidelines for watershed management (PCARRD 1999) makes only incidental reference to markets as influences on farmer behavior, and none to policies other than those which have direct effects on land use— zoning, tenure laws, and similar.

policy level of the intersectoral and environmental impacts of trade and agricultural pricing policies.[3] Both forms of myopia may have restricted the domain of possible project solutions to upland environmental problems, and indeed may have increased the probability that projects will fail because of conflicting messages contained in the direct and intersectoral signals from economic policies.

To illustrate this point, consider an upland economy producing two goods, one produced using a land-intensive technology and the other using a labor-intensive technology.[4] Define the relative price of the latter to the former as *P*, and price of the lowland good relative to the upland land-intensive good by *Q*. There are thus three product markets; two for upland goods and one for an aggregate lowland good. Assume that upland production uses land and labor, and that in order to be brought into production, land must first be cleared of forest, an activity that uses labor. Profit-maximizing upland producers will thus allocate labor to forest clearing and farming, and to one crop or the other, in response to *P*. If there are links to the lowland economy, then *Q* will also play a role in these decisions.

Suppose first that all three goods are freely traded with the rest of the world at given world prices, and that the world price of *Q* increases. Whether this change has any effect in uplands, and if so in what manner, will depend on interregional labor markets. If labor is immobile between regions, the increase in *Q* will have no effect. If it is mobile, the increase will raise labor productivity in lowlands relative to uplands and induce out-migration. Since labor is needed for forest clearing as well as farming, deforestation must decline. However, now suppose that the labor-intensive good in uplands is not traded, so its price depends on domestic demand

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[3] The following passage from a former undersecretary for policy and planning in the Philippine Department of Agriculture illustrates:

> Policymakers in the Philippines tend to examine economic problems from the perspective of individual consumers and firms, and thus, generate and propose actions and measures focused on directly supporting these entities. In no way have economic policies been evaluated on the basis of their environmental impacts. In rare cases, farmer interests are accounted for. For instance, price controls [on rice and corn] were defended on the basis of their effects on the consumers of staple commodities and the costs of raw materials to enterprises. Rarely were the adverse effects on supply responses as well as the welfare of producer— particularly of farmers and fishermen— considered. (Tolentino 1995).

[4] For formal developments of the model in this section, see Lopez and Niklitschek (1991); Deacon (1995); and Coxhead and Jayasuriya (2000).

and supply; thus $P = P(Q, \ldots)$. Now an increase in Q will have different effects on uplands depending on whether the goods are substitutes in consumption as well as supply side factors and income effects.

Similarly, imagine that Q is constant but that technical progress occurs in one upland crop. If products are freely traded at world prices, upland labor productivity will rise and both the share of land and the total area planted to the crop experiencing technical progress will increase; deforestation will rise in this case. On the other hand, if demand for the crop is downward-sloping (whether due to local or national non-tradability), then technical progress will alter P and the total area of upland, as well as the share planted to the labor-intensive crop, could rise or fall.

These simple illustrations highlight the sensitivity of deforestation and upland land use outcomes to market conditions. Under one set of assumptions, technical progress in an upland crop is predicted to increase deforestation; under another, deforestation could fall. Conversely, a national policy innovation that alters P or Q (or both) has the potential to induce changes in deforestation and land use even when the policy measure is not directly related to agriculture. This is so even when all goods' prices are exogenous, if labor is mobile between regions. Lastly, when upland farmers are risk-averse, the entire argument can be restated (with modifications as appropriate) using price variances as well as levels.

In the rest of the paper we focus on a case study from the SANREM study site in Lantapan, Bukidnon. We first provide a brief survey of major macroeconomic and policy trends in the Philippines and their possible effects on resource use decisions in an upland watershed like Lantapan. While we have information about macroeconomic and economy-wide phenomena, and about upland farmers' decision-making processes, we know little about the nature and strength of market links between the two. Accordingly, we then use econometric analysis to examine linkages between national and farm-gate prices on the basis of data collected in Lantapan over the period 1994-1999.

Growth, Policies, and Upland Resource Use in the Philippines

The pace of aggregate economic growth in the Philippines has accelerated in recent years, but the degree of dependence on agriculture and natural resources remains high by Southeast Asian 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. It

can thus be argued that the persistence of pressure on forest and upland agricultural land resources, is in part a consequence of poor macroeconomic performance.[5]

In the early postwar years migration to heavily forested frontier areas in the Philippines was officially encouraged as a means of alleviating economic and political pressures generated by increasing population and stagnating technology in the country's rice-growing heartlands. In subsequent decades, continued spontaneous internal migration has been fostered by low rates of non-agricultural labor absorption, as well as a series of labor-saving technical changes in lowland irrigated agriculture (Jayasuriya and Shand 1986), in the face of sustained high rates of overall labor force growth. The resulting increases in landlessness and unemployment stimulated searches for open-access resources from which incomes, however tenuous, could be earned (property rights to uncultivated lands in the Philippine uplands are poorly defined and difficult to enforce). The outcome was a trebling of upland population between 1950 and 1985, from 5.8 million to 17.5 million, and annual growth rates of upland cropped area of greater than 7% over the same period (M. Cruz *et al.* 1992). The evidence that macroeconomic instability and growth (or the lack of it) in non-agricultural sectors were major forces driving migration and upland land use decisions is compelling, if circumstantial (Cruz and Repetto 1992).

There is a strong suggestion that microeconomic and trade policies also promoted forest conversion and intensification in upland agriculture. In commercially-oriented upland agriculture – or even simply where labor is mobile into or out of upland areas— agricultural price policy can exert a significant, though not immediately observable, influence on natural resource management. In the Philippines there is evidence of a pervasive policy bias in favor of crops— such as corn and temperate vegetables— whose cultivation is most strongly associated with upland agricultural land degradation, soil erosion and related water pollution. This commodity bias emanates mainly from national-level economic policies, some of them unrelated to agriculture; it has been complemented in the past by the allocation of agricultural research resources; and it appears not to be offset by policy measures in favor of more environment-friendly cultivation techniques.

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[5] In Thailand, rapid economic growth and especially the expansion of labor-intensive manufacturing industries, was the major contributor to the stabilizing of agricultural land area during the "boom" years 1986-96, through outmigration from marginal upland and rural areas (Coxhead and Jiraporn 1999).

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 in uplands has been due primarily to area expansion. Given the political importance of self-sufficiency, grain imports are tightly circumscribed, and this in turn has maintained domestic producer prices at levels well above the domestic-currency equivalents of world prices.[6]

Vegetable production has also received substantial policy support. Import bans imposed in 1950 on fresh potato, cabbage and other horticultural crops (and reiterated in 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 imputed c.i.f. (landed) *wholesale* price of imports, if they were permitted (Coxhead 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

[6] The nominal protective rate (NPR, a measure of the amount by which domestic prices exceed landed import prices) for corn has generally been much higher than for any other major agricultural product, especially after the mid-1970s when corn sef-sufficiency was made a policy goal. The NPR averaged 18% in 1970-1974, but has since risen steadily to 60-100% (for details, see Coxhead *et al.* 2001).

at significantly higher rates than most other sectors for the foreseeable future.

Trade and price policy biases are also reflected in the allocation of agricultural research funds. Most important among these for uplands are corn programs. A number of provinces, including Bukidnon, have been designated as 'key production areas (KPAs)' for corn in the Philippine government's Grain Production Enhancement Program (GPEP). Farmers in KPA areas are eligible for 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). Similarly, temperate climate vegetable crops are also the targets of disproportionate research resource allocations (Coxhead 1997).

This brief review of Philippine growth strategy and policies has indicated a number of channels through which decisions concerning use of upland forest and farm land are likely to be influenced. In the longer term, a successful development strategy would have raised lowland and non-farm labor productivity faster than in uplands and diminished the economy's susceptibility to destabilizing macroeconomic shocks; all these should have reduced net migration to uplands and by extension, pressures on forest and land resources. Trade policy liberalization would in general have promoted growth of export-oriented non-agricultural sectors and might have preserved the profitability of some upland perennial export crops, such as coffee, relative to annual crops, and this in turn might have caused some redirection of input subsidy schemes and R&D resources away from import-competing crops and towards more promising sectors. Moreover, this review makes it clear that there are many potential policy changes at the macroeconomic level or in trade and agriculture sector policy that could affect upland resource allocation. On the basis of this evidence any project directed at influencing upland resource allocation toward a "sustainable" path should at least be cognizant of this broader setting, if not actively involved in trying to alter it.

The evidence we have reviewed, however, is strictly circumstantial. Questions remain as to the strength and nature of linkages between uplands and the national economy, and it is in this field of inquiry, as previously noted, that specific data and evidence are lacking. The gap creates room for competing hypotheses about the upland economy, and these in turn imply different diagnoses of upland environmental problems and their solutions. In the next part of the paper we describe the site from which primary data have been drawn in an attempt to fill this gap.

Data

Data for this research have been collected through two sets of surveys conducted in Lantapan since 1994. One set of surveys gathered data on farmers' land use, technology, input costs and product sales, and a variety of other farm-related variables as well as detailed demographic information on household composition, age, ethnicity, and so on (for descriptions of these surveys see Coxhead 1995 and Rola and Coxhead 1997). The original sample size for the farm survey was 190 farms, from which information was gathered on more than 300 individual plots. Over time, the size of the sample has been reduced both deliberately and through attrition. There have been four major production and input surveys, and several shorter surveys covering mainly land use, production and sales.

The second set of surveys was a price monitoring effort, begun in the watershed in October 1994. Sanrem researchers identified a group of traders active at several points within the watershed and visited them four times each month to ask about prices offered for major crops. These data were linked with price quotes in wholesale markets in two provincial trading centers (the Malaybalay and Valencia markets) as well as in the Agora market in Cagayan de Oro, the major wholesale produce market for Region X. Much of the produce sold in the Agora market 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. Wholesale price data were gathered by cooperators in the Bureau of Agricultural Statistics offices in Malaybalay and Cagayan de Oro. Together, the farm-gate and wholesale price series provide a picture of the evolution of prices of major commodities produced in Lantapan over the past five years: yellow and white corn, potato, cabbage and coffee.

Markets, Prices and Land Use Decisions

Our research focuses on factors influencing land use in the middle and upper watershed areas, on relatively steep and easily eroded valley sides and at the forest margin. The major crops grown are corn (both for feed and for human consumption) and vegetables— especially cabbage, beans and potato. In the analysis that follows we concentrate on corn, as 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.

An initial survey of the Lantapan site had characterized agriculture in the upper watershed as 'subsistence' or 'semi-subsistence' (Bellows 1995). However, our data reveal clear commercial motivations for almost all farmers.[7] 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).

An econometric analysis of land use decisions by upland farmers in a comparable Philippine location indicates that their land allocations respond to relative prices, and to the prices variability, in statistically significant ways (Shively 1998). A similar exercise using Lantapan land use data (Coxhead *et al.* 1999) reveals that farmers' decisions on total land area farmed and its allocation to crops are influenced in statistically significant ways by household resource availability, physical and institutional constraints, and the variances of expected revenues, the latter indicating risk-averse behavior.[8] The results with respect to planted area response to relative prices are somewhat weaker; although coefficients have the expected signs, they do not meet standard tests of statistical significance.

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 or their variability are important determinants of land use decisions, what are their determinants?

Market Integration and Price Causation

As argued earlier, understanding the nature of market links between uplands and the rest of the economy is critical to the efficiency of project and policy design. If markets within the study site 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 local and regional prices. Further, we would be unable to see evidence that local prices are driven by national prices.

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[7] Data on 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).

[8] In the Philippines, corn prices are stabilized through policy interventions, and the results of this exercise confirm that price stabilization encourages risk-averse farmers to increase corn area.

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 most significantly influenced by local production, 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. However, these effects (even if they were observed) are likely to obtain only in the short run, since integration with the larger market will likely neutralize local effects in the longer run.

Theory tells us that if two markets are linked through trade, then under normal circumstances, differences in prices net of margins between the two markets create opportunities for arbitrage. Goods will flow between the two markets— trade will occur— until the price difference is eliminated.[9] Although the properties of the data series prevent a formal test of long-run market integration,[10] our observation confirms that trade between Lantapan and Agora is regular, seasonally consistent, and consists of high volumes. We can assert statistically

[9] Statistically, if the prices in the tested markets are non-stationary (that is, that they are trending over time rather than merely following a random walk) then the markets are integrated if their price series are cointegrated, meaning that there is a (single) stationary long-run relationship between them.

[10] The test for stationarity is conducted with a Dickey-Fuller test of the null hypothesis that each price exhibits a unit root. For example, under an AR(2) representation of yellow corn prices (including seasonal dummy variables), the ADF

that the markets are integrated in the short run (Coxhead, Rola and Kim 2001).

Examining the short-run dynamics of the price series permits tests of the hypotheses that upland farmers are price-takers and that national market and policy signals affect local prices. Our econometric method proceeds as follows. We fit the data to a set of regression equations, each of which 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, at least in the short run. Conversely, confirmation that the regional price causes the Lantapan price would indicate a need to focus on agricultural price and trade policies as longer-run influences over farmers' land use and crop production decisions.[11] The test of causation is also a test of a sufficient condition for short-run market integration, so long as at least one causal relationship is confirmed.

We apply these tests to weekly corn, potato and cabbage prices in Lantapan and the main regional market. In this analysis we concentrate on the Lantapan-Agora market relationship; the data series are summarized in Figures 3.1-3.3 (Appendix 3.1 reports the details of the

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test statistics for this hypothesis are –4.818 for Agora and –5.307 for Lantapan. At the 5 percent significance level, the critical value for the test is –2.88, so we reject the null hypothesis. We obtain similar results for the other products; these results are robust with respect to different lag specifications. We conclude that these price series are stationary; therefore no meaningful statistical test of cointegration can be conducted on these series. Given the proximity and volume of trade between the two markets, however, a statistical finding of no integration would be a very great surprise. Studies using aggregate data have indicated clearly that Philippine grain markets are integrated across regions and provinces (Mendoza and Rosegrant 1993; Silvapulle and Jayasuriya 1994). For details of the econometric procedure see Coxhead, Rola and Kim (2001).

[11] Both Granger-causality and the test of transmission of shocks (impulse response function) are founded on the vector autoregression (VAR) specification of a price series. See Greene (1993) or another econometrics text for details.

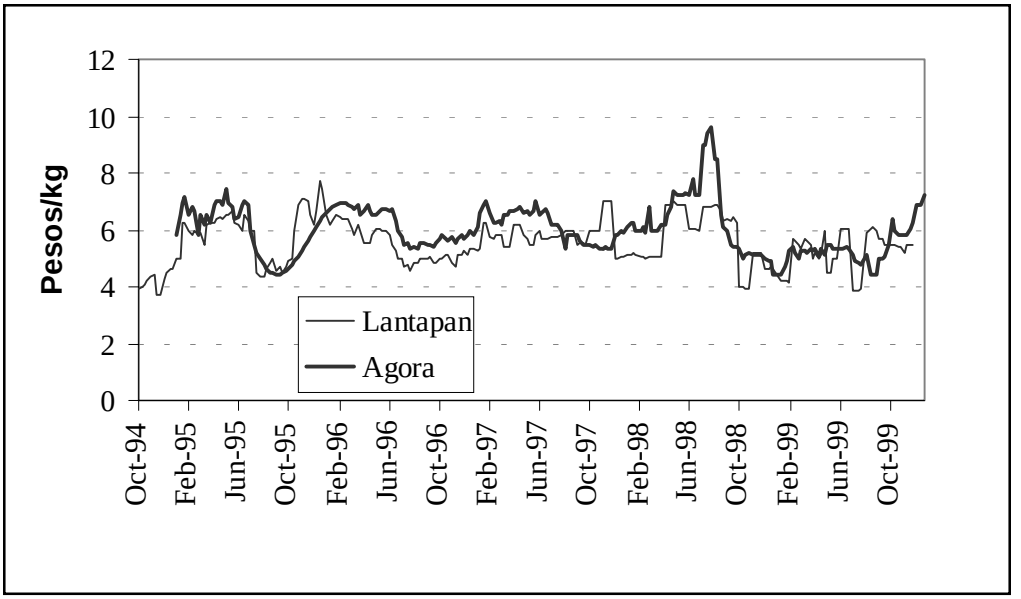

Fig. 3.1. Weekly price of yellow (feed) corn, October 1994-December 1999.

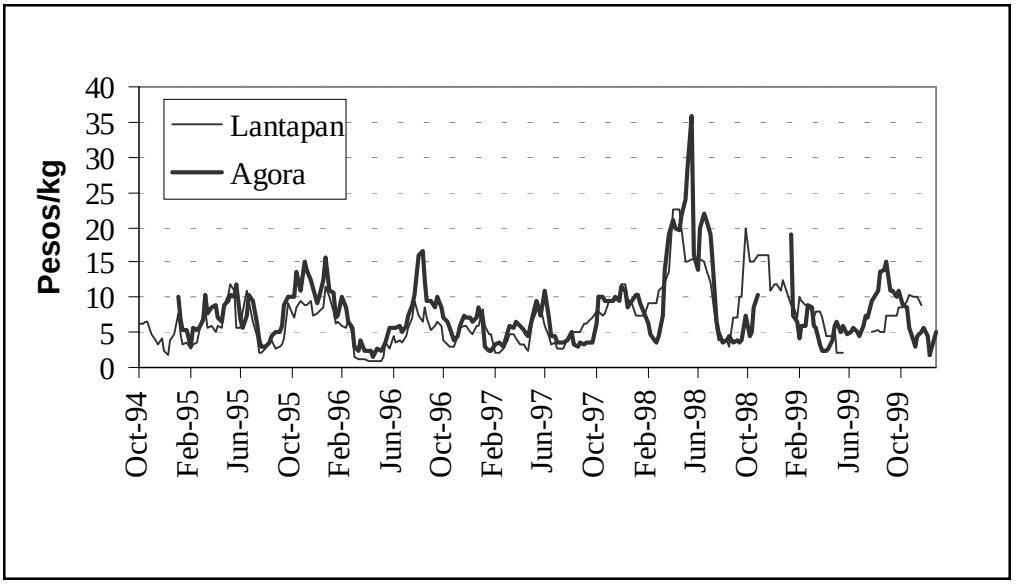

Fig. 3.2. Weekly price of cabbage, October 1994-December 1999.

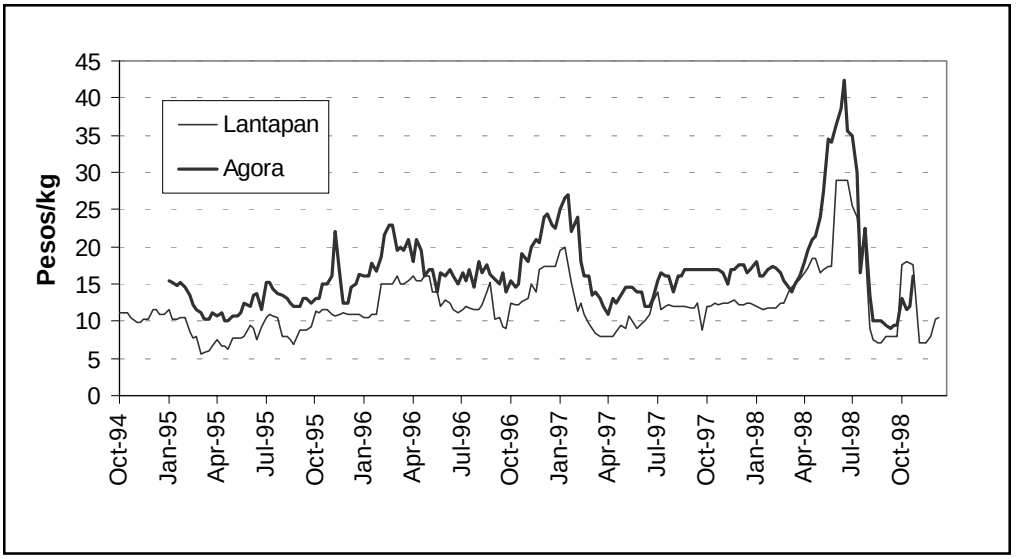

Fig. 3.3. Weekly price of potato, October 1994-December 1998.

econometric procedure). The results of these tests are summarized in Table 3.1. 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 in the short run 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. Rather, the evidence is that farmers in the watershed are price takers in regional and national markets.

Table 3.1. 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

[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.

Market and Policy Linkages in Lantapan

If markets are integrated as we have argued, and given that short-run causality runs only from regional to local market, what can we conclude about the implications of national policies for upland land use in Lantapan?

For the reasons indicated earlier, we cannot as yet quantify 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; in effect, there has been no trade policy change. For corn, in spite of the shift from quantitative restrictions to the MAV system with tariffs after 1996, announced trade policy changes are being introduced very gradually and are not scheduled to be completed before 2004. However, our finding that upland farmers are price-takers in regional markets makes it clear that any meaningful policy changes, were they to occur, would have direct effects on farm-gate prices in the uplands.

Of potentially greater interest is the observation that revenue instability, the phenomenon that risk-averse farmers strive to avoid, has 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 a sharp drop in overall economic growth, and there were sudden, unexpected and repeated re-evaluations of exchange rates that had previously been effectively pegged to the U.S. dollar. 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. Since trade policy renders Philippine corn prices largely independent of world prices in the short run, were upland markets affected by the macroeconomic instability reflected in the exchange rate?

We used information about exchange rate variability to define the endpoints of the Philippine economic crisis.[12] During the period August 1997 to November 1998, the daily peso-dollar rate fluctuated wildly, whereas before and after this episode, the mean daily change was a fraction of one per cent (Fig. 3.4). We use this criterion to divide our data into "pre-crisis", "crisis", and "post-crisis" periods; as Table 3.2 shows, the price variance of yellow corn, the major crop in Lantapan, increased substantially during the crisis, even through the mean price did not. We are then 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). For example, the dynamic response of a shock in Agora on the Lantapan price can be captured by $\partial PL_{t+j}/\partial v_{PAt}$.[13] The impulse response measures are, thus, computed from the same VAR model used earlier to test market relationships, only with the data divided into sub-periods as noted.

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[12] Although the values of the exchange rate are of direct interest in their own right, here we are using exchange rate fluctuations as a proxy for a more general set of macroeconomic conditions. In an open economy, exchange rate depreciation (as occurred during the early part of the crisis) serves as a proxy for (unobservable) inflationary expectations; exchange rate variability is then a proxy for general price instability.

[13] This algebraic deriviation involves successive substitution (Greene 1993).

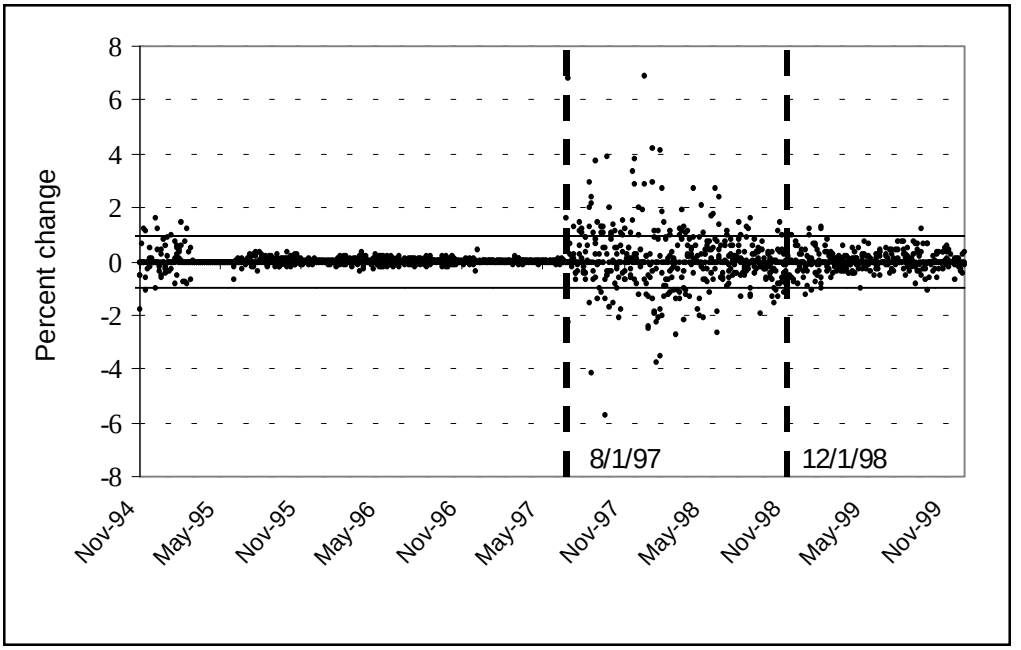

Fig. 3.4. Daily fluctuations of Philippine peso against US dollar.

Table 3.2. Moments of yellow corn prices before, during and after the exchange rate crisis.[a]

Item	Pre-crisis	Crisis	Post-crisis
Lantapan mean price (Pesos/kg)	5.57	5.85	5.19
Agora mean price (Pesos/kg)	6.15	6.25	5.23
Lantapan price variance	0.627	0.774	0.462
Agora price variance	0.526	1.277	0.221
Exchange rate (Pesos/USD)	25.9	38.7	38.9
Exchange rate variance	0.468	16.892	0.817

[a] Periods are as defined in text and illustrated in Figure 3.4.

The dynamic response of Lantapan corn prices to a shock in the Agora regional market price is shown for a two-period lag model in Fig. 3.4. 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 and post-crisis periods, a shock in the Agora price yields a maximum rise in local prices of about 3% (0.2 pesos). The impulse response peaks three weeks after the shock and drops very sharply to a negligible amount by the 5th week after the shock. During the crisis, the peak is much larger (6%), and is sustained over several months. Comparing responses during the crisis period and in the earlier and later periods, 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. The price dynamics indicate that during the crisis, a temporary disturbance in the Agora series induces a larger and longer-lived response in farm-gate prices.

While very preliminary in nature, the impulse response analysis suggests that the effects of macroeconomic instability find their way into the behavior of prices that guide farming decisions even in areas far from the main regions and sectors of economic activity.[14] 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-crisis 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-

[14] 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 land use response estimates such as in Coxhead, Shively and Shuai 2002 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.

effects of these crops could be minimized by adoption of appropriate technologies, for example to reduce erosion and preserve soil quality. However, only a 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. If market-driven incentives dominate in farmers' decisions, there is a case for broadening the range of policy instruments brought to bear on the upland environmental problem; moreover, project design may be improved by a different balance of local action and national-level information dissemination and policy advocacy.

We have demonstrated that in spite of remoteness, the farmers in our study area produce for markets that are integrated in the national system. Supply shocks from the site have no effect on prices in broader markets: farmers are price-takers in these markets. National markets transmit both price information and the effects of macroeconomic instability.

While empirical tests of the effects of trade policies on prices await substantive policy changes, it is nevertheless clear that agricultural markets convey the effects of trade policies to the farm gate, even in upland agriculture. Trade liberalization can therefore be expected to reduce the farm-gate prices of corn and vegetables, the two most environmentally damaging crops currently grown in 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 price stability in the overall Philippine economy. During the recent economic crisis, we find that instability at the macroeconomic level (as reflected in daily exchange rate movements) was associated with a noisier signal from wholesale to farm gate prices. 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. A 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. 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.

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Appendix 3.1

Econometric Procedure

To account for the time series properties of the data we employ a vector auto-regression (VAR) model (Sims 1980).[14] The structural equations of the VAR 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 that we assumed are serially and mutually uncorrelated. Eliminating current-period variables from the right-hand sides of these equations yields a reduced form:

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

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

in which e_{1t} and e_{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

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

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[15] The VAR approach to time series analysis is controversial. As Cooley and Leroy (1985) have pointed out, the VAR is "atheoretical" in the sense that it embodies no explicit economic theory. However, when restrictions in the VAR model, in terms of choices of variables and lag lengths, are weaker than the restrictions imposed on structural models, the VAR approach can provide a foundation for testing hypotheses based on *a priori* reasoning (Backus 1986). In our investigation of price relationships, we use both economic and econometric tools to choose variables and lag lengths. We thus view the VAR approach as a complement to the structural models implied by theory. Specifically in the case of Lantapan, the quality of transport infrastructure, high frequency of public and private travel, and the distance (130 km, or at most 5 hours) to the major market all suggest that price signals can be exchanged, and arbitrage occur, well within the two-week interval implied by a two-period lag structure.

where 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 f_{12} and f_{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 tests are summarized in Table 3.1.