I Introduction

The subject of this paper's title is potentially vast. In developing Asia as elsewhere, the connections between globalization (used here to mean the process of increasing integration with the global economy), poverty and environment are complex, multidirectional, and idiosyncratic. With such a broad topic there can be no consensus on methodologies with which to understand and analyze them, and nothing approaching a universal view of normative or policy implications. To avoid simply serving up a heavily qualified list of generalizations, the scope of this paper is thus restricted to a subset of issues that are arguably of relatively greater importance in developing Southeast Asia. The environmental focus will be on interactions between agricultural or aquacultural development and the natural resource base, excluding more specifically urban problems of air and water pollution and solid waste disposal, and global issues such as climate change.

Over time, the conversion of natural resources for use in agriculture and fisheries production has generated income growth, but at the same time has imposed significant costs on developing Asian economies in the form of diminished watershed and coastal ecosystem function, land degradation, biodiversity loss, and loss of amenities associated with the natural landscape (e.g. ADB 2000). In developing economies many issues revolve around changing incentives to exploit natural resources, a process which typically induces the movement of labor toward, or away from, natural resource stocks. This occurs in the context of overall population growth, itself an important element in the poverty-environment nexus. The discussion in this paper will address mainly the causes and consequences of population movements in relation to the resource base, and much less on less on the consequences (let alone the causes) of aggregate population growth and its relation to poverty and the demand for natural resources.

That economic growth leads to poverty alleviation is one of the most robust stylized facts of economic development. When exhaustible and depletable environmental and natural resource assets are treated as "factors of production" (Lopéz 1994), their exploitation contributes to economic growth and thus to poverty alleviation. This process, however, is understood to have costs as well as benefits. Computations of these costs in the aggregate—so-called "green accounting" exercises—vary widely. In Indonesia, one of the earliest such

exercises estimated that natural resource depletion shaved almost 3% from the annual growth rate of GNP (WRI 1989); contemporaneous studies using different methodologies estimated losses in Indonesia and the Philippines at 1–4% of GNP (World Bank 1989; 1990). Productivity losses from deforestation and soil erosion, plus the health costs of air and water pollution, were estimated in studies from the mid-1990s to cost 3.3% of GNP in Pakistan and 3.8-7.3% in China.[1]

Of course, these estimates must be treated with great caution, not least because they seldom allow for endogenous responses by agents and policymakers to resource depletion or environmental damage. But even if they are greatly overstated, they still represent substantial sacrifices of aggregate growth and poverty reduction: compounded over a generation (25 years), a one percent reduction in growth from a rate of 5% per year means that an initial income at the World Bank poverty line of $2/day grows in nominal terms not to $6.80, but to $5.30. If we assume that inflation also runs at 5% per year, this is the difference in real terms between remaining at the poverty line and falling to about $1.60. Clearly, the trade-off between economic growth and the environment in poor countries is very real and as such, economists have a responsibility to address it in ways that build understanding and lead to suggestions for policy.

Beyond the scale of the household (e.g. Perrings 1989; Barbier 1990) or the community (e.g. Baland and Platteau 2000), links between poverty and the environment have not received the attention they require. As a result, it is frequently the case that neither analysts nor policy specialists have a clear understanding of the economic mechanisms through which globalization affects poverty and the environment, and how the latter two interact. The primary goal of this paper is to present a unified framework for thinking about these phenomena. We develop a simple model and use it to think about recent events of importance to Asian agriculture, specifically the Green Revolution, sector-specific development policies (especially trade policies, from which we also construct a 'globalization' analysis), and the enforcement of property rights at the cultivated frontier.

The rest of this paper is structured as follows. In section II we make use of a very simple general equilibrium analytical structure to identify some less obvious linkages between aspects of economic growth and development policy, poverty and environment.

[1] These and other data derived from a variety of studies are cited and summarized in ADB 1997: 222-224.

Section III presents a highly abbreviated review of relevant historical experience, concentrating on the larger economies of Southeast Asia. Section IV collects several sets of cross-cutting thematic and methodological issues, such as the links between property rights and environmental degradation. Section V concludes with some lessons and sketches an agenda for future empirical and methodological research.

II Analytical model: the population-poverty-environment nexus[2]

In the popular mind, agricultural expansion at the expense of the natural environment is driven by three main causes: poverty, population growth, and the demand for agricultural land. Inquiry cannot end with such a statement, however. Poverty, population and the demand for land are all causally interrelated; moreover, they are also endogenous expressions of a broader economic, policy and institutional context. In this sense, statements such as "…today, the Asian and Pacific region's forests are under pressure from a rapidly expanding population, the need for development and the pressure for land from agriculture" (ESCAP and ADB 2000: 26) should be interpreted as reduced-form expressions of deeper development questions. To understand the links between poverty and environment, especially for the purpose of policy formulation, requires identification and analysis of structural models.

Most people in the developing world live in rural areas, and for the most part their livelihoods depend directly or indirectly on the exploitation of natural resources, especially soil, water, forests, animals, and fisheries. Households in poor, resource-dependent economies face a dilemma. On one hand, they need to exploit natural resources or exhaustible environmental assets—for many, the only directly productive capital to which they have access—but on the other hand, they also need to conserve the productive capacity of these assets in order to sustain livelihoods over the long term. Poverty, the lack of alternative opportunities, competition for resources, and uncorrected environmental externalities can drive them to act in ways that not only undermine the longer-term health of the natural resource base but also generate social costs at local, national and even global scales.

[2] Parts of the text in this section are adapted from Coxhead and Jayasuriya (2003).

Poverty is both a cause and an effect of natural resource depletion and environmental degradation. Initial poverty is a function of poor endowments of 'capital' (in its broadest sense, including environmental assets), and its alleviation depends on increases in the capital stock. Low rates of investment in reproducible forms of capital result in low growth rates of per capita income growth and of non-agricultural employment creation. In combination with rapid population increase, slow growth implies declining labor productivity throughout an economy. Low accumulation rates of physical capital are typically accompanied by underinvestment in education, or human capital. Together, both kinds of investment shortfall contribute to a low-level trap into which many developing countries, most notably (although by no means exclusively) in Sub-Saharan Africa, appear to have fallen.

Populations caught in this trap increasingly turn to the natural resource base as a source of productive factors with which unskilled labour may be combined to produce either subsistence goods or cash income. The search naturally concentrates on factors over which property rights are not well established, as they can be obtained or used at low cost. Open-access land at the frontier—at the upland forest or coastal margin, in much of the humid tropics—provides the easiest and sometimes the only opportunity. Thus poverty, combined with relatively low-cost access to forests and cultivable land near the frontier of settlement drives migration and land conversion at the frontier. By this means, once-stable forest and coastal ecosystems and bush-fallow or pastoral farming systems are converted to more intensive uses, and in particular to the production of food. Land colonization for food production thus entails two types of environmental damage: removal of the original forest cover, and the use of the land or water resource for food crops which—unlike forests, perennials and long-fallow systems—are typically associated with high rates of nutrient uptake and potential for pollution through erosion and other production-related processes. The open-access nature of resources at the frontier, together with the fact that part of the environmental damage caused by their use is exported as an externality, virtually guarantees that they will be exploited at a rate greater than is socially optimal.

Therefore, in economies that have experienced little economic progress, persistent poverty and the geographic expansion of impoverished agriculture are both symptomatic of a broader development failure. This failure is related to low rates of reproducible capital

formation, coupled with the availability of open-access resources and uncorrected environmental externalities.

If persistent poverty poses a direct threat to environmental resources, what is the effect of growth? As individuals get richer, they value natural capital and environmental services, both as economically productive factors and as sources of aesthetic satisfaction, more highly. At the community level, higher valuations are associated with increased propensity to conserve these resources, for example through the adoption of laws or conventions that constrain environmentally damaging activities. In addition to this preference shift, it is an intrinsic feature of sustained economic growth that the importance of agriculture, whether measured by its proportional contribution to national income, the ratio of farm employment to total employment, or food expenditures as a share of total consumption, declines. Economic growth thus diminishes—relatively if not absolutely—the degree to which incomes depend directly on environmental services and natural capital.

A macro model

Observation of these preference shifts and structural changes has led economists to posit a non-linear relationship between per capita income and the quality of the environment, in which economic growth initially causes rapid environmental degradation but later leads to rising expenditures on abatement and conservation. This inductive reasoning has been summarized in the 'environmental Kuznets' curve' or EKC, an inverse-U curve relating measures of environmental quality to per capita income. A given EKC reflects the observation that as per capita incomes increase, the intensity of emissions per unit of income will first rise, then later decline (Figure 1). However, the location of the EKC in environment-income space, and thus the extent of environmental damage associated with any given level of income, itself depends on many factors: environmental policies; sectoral and macroeconomic policies affecting the valuation of environmental assets; property rights and other legal institutions, and so on (Panayotou 1995). Thus the achievement of a "sustainable" rate of drawdown of environmental assets depends not only on growth of per capita income—as implied by the simplest population-poverty-environment models—but also, or alternatively, on the policy, market and institutional setting.

[Figure 1 about here]

The EKC concept conveys an inductive sense of *macro* relationships, but is silent on the structural or behavioral causes of changes in the population-income-environment relationship. Recent theoretical work has shown how the overall EKC effect can be decomposed into three components that are capable of formal economic explanation and testing: scale, income, and composition effects. The first captures increases in environmental damage associated with economic expansion; the second captures reductions due to income-elastic preferences for a cleaner environment; and the third the effects of changing demand for environmental assets, including natural resources, associated with shifts in policies, valuation, institutions and so on (Antweiler et al. 2001). Empirical tests for existence of an EKC when the dependent variable is deforestation or land degradation typically find no evidence of an income effect;[3] clearly, however, the composition effect is of prime importance. This leads us to theoretical questions about the underlying structural, or *micro* relationships.

A micro model

With a focus on poverty, environment and structural change it makes sense to examine the economy through a labor market lens. Labor is the main income source for the poor. Environmental and natural resource assets are typically fixed in location, so any increase in the rate of their exploitation, other than the least labor-intensive forms of commercial forestry, usually involves migration. The same typically applies to industrial development. Many types of fixed investment are located where infrastructure is best, and/or close to markets or ports, and output expansion involves migration of workers from the less-developed hinterland.

The most versatile general model of a developing-economy labor market is the Harris-Todaro (HT) model (Harris and Todaro 1970). While HT obviously oversimplifies many important economic relationships, it is a convenient analytical vehicle for several reasons. It captures persistent sectoral differences in labor productivity along with intersectoral migration—both phenomena consistent with the stylized facts of developing Asia (Larson and Mundlak 1997; Mundlak, Larson and Butzer 2004). Its stylizations of institutional wage-setting in industrial/urban sectors versus marginal productivity rules in

[3] For a comprehensive survey of the empirical EKC literature, see Dinda 2004.

agricultural/rural sectors are broadly plausible. It can be used to generate poverty and income distributional measures (Fields 2005, and see below). Above all, it is capable of a wide range of general equilibrium interpretations (Corden and Findlay 1975; Neary 1981; Marjit and Beladi 1996; Marjit and Beladi 2003, and many others). These clarify both the economy-wide impacts of development policies, and also the simultaneity of growth with environmental and poverty outcomes.

We will work with a version of HT due to Corden and Findlay (1975). We assume that in a two-sector economy, wages in industry are fixed by some institutional mechanism; profit-maximizing employers in that sector hire labor up to the point where the value of its marginal product equals the institutional wage, w_m.[4] In agriculture, wages (w_a) are determined by marginal productivity alone, and are initially lower than in industry. Labor is costlessly mobile between sectors. Given $w_m/w_a > 1$, there is excess supply of labor to industry, giving rise to urban unemployment. Workers migrate from rural to urban areas (i.e. from agriculture to industry) until in equilibrium the *expected* industrial wage (calculated as the nominal wage times the probability of industrial employment), is just equal to the agricultural wage. Formally, if L_m is employment in industry, U is urban unemployment, their sum is the supply of labor to industry, and the structure of aggregate employment is $L = L_m + L_a + U$, the HT condition is written as:

$$w_a = w_m \frac{L_m}{L - L_a}, \tag{1}$$

The original HT model, as Fields (2005) reminds us, had two famous conclusions. First, so long as industrial (equivalently, urban) wages exceed those in agriculture, any increase in industrial employment is as likely to *raise* urban unemployment as it to reduce it.[5] Second, it follows that one solution to the problem of urban unemployment is rural development, i.e., raising w_a. In developing Asia, the second conclusion ratified both official efforts to expand at the land frontier—land colonization, development and internal migration schemes were implemented with varying degrees of subsidization and compulsion by almost

[4] Given uncertainty about the true nature or extent of wage rigidity, it helps to interpret this assumption as saying that the output and employment decisions of industrialists are unaffected by developments in the agricultural economy or the labor market. This stylization may be consistent with conditions in economies where the industrial sector is subject to a high degree of policy intervention, for example through a mix of state-owned enterprises, protection, and subsidies.

[5] As can be seen by solving (1) for $L_a = L - \frac{w_m}{w_a} L_m$ and finding $|\partial L_a/\partial L_m| > 1$.

all SE Asian governments, starting in the 1950s—and also the millions of individual decisions to migrate from densely populated urban and lowland areas to the frontier in search of productive factors complementary with unskilled agricultural labor. It was also consistent at a macroeconomic level with development theories in which growth is generated by exploitation of unused or underused resources for commercial production—so-called "vent for surplus" theory (Myint 1959).

Figure 2 provides a general equilibrium exposition of the HT model. The width of the figure measures population (or equivalently, total labor supply) at any point in time, and the vertical axes measure wages and the value marginal product of labor in each sector. Agricultural employment is measured from right to left with initial origin 0_a; the value of marginal product curve V^a shows agricultural labor demand. Industrial employment is measured in the usual way from the left, and that sector's labor demand curve is labeled V^m. By assumption, industrial wages are fixed at w_m; given this, the industry sector hires 0_mL_m workers. The figure then shows how equilibrium agricultural employment, rural wage, and urban unemployment are determined. The key to the analysis is equation (1), the condition which must be satisfied for a labor market equilibrium. For fixed values of w_m and L_m, equation (1) is seen to be a rectangular hyperbola such as *hh,* the so-called "Harris-Todaro curve".[6] Given industrial employers' choice of L_m, equilibrium is satisfied only by the intersection of this line with V^a. In this way the agricultural wage, farm employment (0_aL_a), and the fraction of the labor force that migrates and remains unemployed ($U = L_mL_a$) are seen to depend on non-agricultural wages and employment.

[Figure 2 about here]

Manipulations of this simple model enable us to pinpoint some key relationships between population, growth-related changes in sectoral incentives, property rights, and the environment—here represented by the quantity of agricultural land, which we assume to be obtained by forest-clearing and other forms of natural resource despoliation.

Population growth

[6] A rectangular hyperbola is defined by $ab = k$, where a, b are variables and k a constant. In the model, w_mL_m is constant by assumption, so from eq. (1), equilibrium requires that the product of variables $w_a(L–L_a)$ be a point on a rectangular hyperbola through the intersection of w_m and L_m. By profit maximization in agriculture, this point will be where *hh* intersects the agricultural labor demand curve V_a.

The model provides a fundamental expression of the link between population growth, poverty, and the demand for land at the frontier. So long as industrial wages and employment are fixed, any increase in the *total* labor force must be matched by a combination of declines in the agricultural wage and/or increases in agricultural employment. This is seen in Figure 2, where labor force growth (an increase in L) is shown as a lengthening of the horizontal axis; this moves the former intercept for agricultural employment rightward to $0_a'$. Other things equal, the intersection of hh with the displaced labor demand curve V_a' is now at a lower value of w_a, higher L_a, and higher U.

Population growth also worsens poverty (for a proof, see the appendix). With product prices and other factor endowments unchanged, the ratio of urban to rural wages is higher; urban poverty is higher by the increase in unemployment; and rural poverty cannot fall.[7] These trends create a separate set of political economy pressures on the state to expand land at the frontier.[8] Within the rural economy, the expanded labor supply raises the real return on land;[9] it follows that income distribution is worsened unambiguously if the distribution of land ownership is initially skewed in favor of the rich.

We have assumed so far that land is fixed, and under this assumption, population growth raises the return on land. The higher return, however, is a signal that agents have incentives to acquire new land. Suppose new land was freely available, perhaps only at the cost of clearing; then population growth would stimulate land expansion. Land colonization, by increasing the endowment of a factor complementary with labor, will displace V_a upwards and so dampen the fall in w_a, thereby reducing the poverty effect of population growth. But any such increase in farmed area must occur at the expense of some other land use, possibly one with high conservation value such as forest. So population growth, in this model with fixed employment and earnings in industry and an open land frontier, increases both poverty and deforestation.[10]

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[7] With only labor mobile among sectors, the rural wage falls and the increase in rural employment is less than the rise in the total labor force.

[8] Fields (2005) provides a detailed analysis of the distributional implications of other forms of growth such as urban sector enlargement and rural development, within the original HT framework.

[9] With output price fixed, the assumption of non-increasing returns to scale requires that the price of farm output be equal to $a_{La}w_a + a_{Ka}r_a$, where a_{La}, a_{Ka} are unit input requirements and r_a is the unit return on farmed land. Since w_a falls where the labor force increases, r_a must rise.

[10] An exactly analogous story can of course be told of the other 'frontier' to which poor people turn, the expansion of coastal and estuarine fisheries.

Recalling the estimates of growth forgone through environmental damage (see section I), it is worth noting that unless the social costs of deforestation are internalized through policy or institutional changes, our model predicts that population growth will give rise not only to a *static* welfare loss but also to a *dynamic* one. Over time, resource depletion will lower V_a, reducing w_a and driving the economy into a trap in which increasing amounts of labor are applied to an ever-diminishing resource base.

Agricultural development

Asia's green revolution set in motion an economic process which, for given agricultural prices, would unambiguously have reduced both total poverty *and* pressure on resources at the frontier, by raising the productivity of labor in lowland agriculture. The spatially unequal distribution of productivity gains made possible by green revolution technology is well known: the greatest yield gains by far occurred in lowlands, where irrigation and other complementary inputs were available to farmers (David and Otsuka 1993). Higher productivity in lowlands induced rural-to-rural migration from less-favored areas (Kikuchi and Hayami 1983; Coxhead and Jayasuriya 1994). Higher labor productivity in lowlands would also have reduced incentives to migrate to urban areas in search of industry sector jobs—once again, had agricultural prices remained constant.

The green revolution scenario can be seen in our model by noting that the agricultural labor demand curve is the horizontal sum of labor demands in each agricultural sub-sector. In Figure 3, the labor demand curve for frontier agriculture is labeled V_f, and the horizontal sum of this and labor demand in lowland areas give the total curve, V_f. Then productivity growth in lowland raises overall agricultural labor productivity, displacing V_a upwards by an amount proportional to lowland's initial share in farm employment, to V_a'. At the original agricultural prices, farm wages rise to w_a'. At the new, higher wage there are fewer migrants to the urban area, and in addition, migration occurs from less-favored rural areas to the lowlands. Employment in lowlands expands, and that in frontier areas diminishes from L_f to L_f'. Since agricultural prices by assumption have not changed, the rent on land at the frontier must have fallen as a result of the green revolution; accordingly, incentives to clear land and

intensify production at the frontier must also have diminished. In this respect the green revolution was good for the environment.[11]

[Figure 3 about here]

Clearly, the numbers of the poor will drop in this scenario if the new farm wage w_a' is now above the poverty line. Even if it is not, however, it is still unambiguously clear that the *severity* of poverty will be reduced as farm wages and employment rise (see appendix).

The assumption of constant farm prices is crucial to the green revolution story. It presents in stylized form the poverty and labor market impacts of technical progress in the agricultural sector of a small open economy facing given world prices (or less probably, one in which farm prices are fixed by government fiat). What if farm prices were instead determined by domestic demand and supply conditions, as was true to a very great extent in the big food-importing nations of Southeast Asia, the Philippines and Indonesia, during the green revolution era, or if the supplying country is large enough in relation to world markets to move prices? To the extent that higher yields reduce farm prices, the model overstates the environmental benefits of technical progress in lowland agriculture (Coxhead 2000). In our model, a price change in any sector vertically displaces the corresponding labor demand curve. By inspection of Figure 3, a price reduction for agricultural output lowers V_a', thereby diminishing (or in the limit, eliminating) any labor market changes caused by the original productivity gain. To the extent that Bulog in Indonesia and the NFA in the Philippines were unable to defend rice price floors during periods of rapid yield growth, the environmental benefits of the green revolution were undercut by falling farm prices.[12] Poverty, however, could still have fallen as lower cereals prices translated into higher real wages, especially for the poor.

This version of the HT model can be used to represent a variety of other agricultural policy changes. For example, other policies that raised lowland profitability relative to other agricultural subsectors can readily be seen to have effects broadly similar to those of the green revolution. We leave investigations of other policy scenarios to the reader.

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[11] This conclusion obviously excludes consideration of environmental damages in lowland agriculture, a point to which we return in section III.

[12] Lower output prices would also reduce labor demand (and thus environmentally-damaging agricultural activity) in the upland, so restoring some environmental gains. In practice, how large these are will depend on how willing farmers in uplands are to move away from subsistence.

Industrial development policies

Industrial promotion policies have been the keystones of Asian growth strategies for more than four decades. Well into the 1990s, manufacturing sector tariffs were the central policy instruments of this strategy. Figure 4 illustrates the effects of a change in such policies.

[Figure 4 about here]

In our model, a tariff or subsidy in manufacturing raises V_m, increasing the optimal employment level in that sector. This may either raise or reduce unemployment, as Harris and Todaro showed, but it will unambiguously reduce agricultural employment and increase w_a. In this simple model, and in some more highly structured analyses, industry protection policies are thus associated with a reduction of pressures on frontier land (e.g. Deacon 1995). The headcount measure of poverty must fall in this analysis, but whether the aggregate poverty gap diminishes or widens will depend whether the rise in agricultural wages dominates, or is dominated by, any rise in urban unemployment. The appendix shows that a sufficient condition for poverty to decrease is that the agricultural labor demand curve be inelastic in the region of equilibrium.

From more general models, however, it is readily seen that these environmental and poverty change predictions are not robust with respect to a slight relaxation of assumptions. Suppose, for example, that industry comprises two subsectors, one inward-oriented and capital-intensive and the other export-oriented and labor-intensive. (This is a stylized replication of many developing-country manufacturing sectors.) When capital is mobile between these, protection awarded to the capital-intensive subsector will cause it to expand. Through Lerner symmetry effects, however, the labor-intensive subsector must then contract.[13] This would be the equivalent in Figure 4 of industrial expansion accompanied by structural change such that total industry employment actually falls, with both V_m and *hh* moving to the left. In this case, the expansion of industrial output would *reduce* the economy-wide wage, and instead of drawing labor away from the frontier, will drive it toward it (Coxhead and Jayasuriya 2005). Moreover, if the agricultural labor demand curve

[13] This refers to the symmetry of an import tariff and an export tax. In a two-sector economy facing given world prices, a tariff of $(1+t_m)$ applied to import-competing goods has the same effect on the domestic price ratio of importables to exportables as an export tax of $1/(1+t_x)$. In other words, an import tariff that promotes one subsector acts like a tax on exports from others.

is less than unit-elastic (as seems reasonable), then the aggregate poverty gap must increase, not decline as in the earlier prediction.

Combining the latter variant with population growth, the amended model can replicate, in stylized form, trends observed in the Philippines during its import-substituting industrialization phase. From 1960 to 1980, the labor force share of manufacturing remained constant at a little over 10% while the population doubled; as a result, millions of new workers were forced to seek employment in the urban informal sector (equivalent to unemployment in our model) or to migrate in search of new resources at the frontier. During this period, the population of upland areas in the Philippines expanded at well over double the national rate of population growth, and so too did cropped area in uplands (Cruz and Francisco 1993). Thus high and persistent protection for ISI industries, a feature of Philippine trade policy, contributed to declining real wages, reduced non-farm job growth, and increased pressure on the natural resource base.

Globalization

By globalization, we mean increasing integration of the domestic economy with world markets. This happens mainly through trade, although international factor flows and the associated income streams are increasingly important. Within our simple model we can consider both types of trend.

In tropical Asia, globalization since the mid-1980s has seen big inflows of domestic and foreign investment into labor-intensive manufacturing and export-oriented agricultural and natural resource sectors. These investments have been associated with policy liberalization, especially trade reforms, that raise the relative prices of tradables in general and of these "comparative advantage" sectors in particular. Price and investment-driven booms in these sectors have predictable effects in our model. In industry, they raise V_m, inducing industry sector employment growth. In agriculture they raise V_a, raising farm sector output and employment. Both types of boom therefore raise w_a and reduce poverty. However, they have different environmental effects. Job growth in manufacturing pulls labor out of agriculture, raising the cost of forest conversion and land colonization and reducing returns to these activities. An agricultural or resource sector boom, however, has the opposite effect. If the legal and institutional barriers to land colonization are low, a price

increase or investment inflow will lead to more environmental damage, as larger areas of land are converted. There is a tradeoff between poverty alleviation and the environment.

Enforcing property rights at the frontier

The final experiment is an institutional change, the assertion of property rights in resources at the frontier. When these are absent, the schedule labeled V_f in figure 3 should be interpreted as the *average*, not the *marginal* curve for labor at the frontier (Gordon 1954; Coxhead and Jayasuriya 2005). Enforcing property rights restores the *marginal* productivity condition for equilibrium, meaning that the new level of employment in frontier farming or fisheries is lower than L_f. This in turn means that V_a moves in toward the origin. Agricultural wages fall, and there is additional migration to the city. With L_m unchanged, headcount poverty will not increase, but clearly the aggregate poverty gap will grow. In this case there is a tradeoff between poverty reduction and protecting the environment.

In the 1950s and 1960s, when natural resources such as forests were considered abundant and their valuations were correspondingly low, most Asian states traded them for poverty reduction through internal migration and land colonization. Since the 1990s, willingness to pay for preservation of such resources has risen. The tradeoff between poverty alleviation and forest protection is most acutely felt in economies where the pace of industrial and lowland farm job creation has failed to keep pace with the rate of labor force growth. Economies experiencing rapid growth of labor-intensive industries, by contrast, are experiencing a 'virtuous circle' of declining poverty and reduced pressure on frontier resources, except where these are central to export booms.[14]

III Historical experiences[15]

Early modern growth

Until the 1970s, Asian economies were dominated by agriculture and other primary sectors. Since then, most countries in the region have grown very rapidly by developing-country standards, and have experienced remarkable poverty decline. Along with that growth there

[14] Of course, these broad-brush conclusions are modified in every located and time by context-specific conditions and trends, among which the most important are land tenure institutions and the potential for collective action by communities to protect and preserve natural resources that generate local public goods. For a discussion, see Otsuka (2006).

[15] This section draws upon some material in Coxhead (2003)

has been a tremendous expansion of industrial activity in general, and of manufacturing in particular. The latter has been rapid both in absolute terms and relative to GDP, and has been matched by a corresponding decline in the relative importance of agriculture.

In the early years of development, policies governing trade, investment, and exchange rates were highly influential in determining the nature of change in industrial output and the rate and structure of employment creation. Import-substituting industrialization (ISI) policies, the preeminent tools of industrial growth until the 1980s, conferred benefits mainly on capital-intensive industries producing for the home market, thereby depressing job growth outside agriculture. The impacts of ISI were also transmitted to other sectors through factor and product market adjustments, and through their influences on aggregate growth. While relatively mild ISI regimes had only minor effects on other sectors, more far-reaching policies penalized the growth of traditional tradables industries—in practice, mainly labor-intensive agricultural and natural resource sectors. As a consequence, labor force growth was spatially uneven, being concentrated in urban areas (where new entrants joined the informal services sectors) and at the frontier of agricultural cultivation—as predicted in our simple model in section II. It is not surprising that in the countries with the most severe and persistent import substitution policies, internal migration to rural areas peaked during the high tide of protectionism, contributing to a doubling and redoubling of the numbers dependent on frontier agriculture, and increasing pressures for deforestation (Roche 1988; Barbier 1990; Southgate 1988; Cruz and Francisco 1993).

Agricultural and rural development in the early years of modern economic growth was focused on natural resource extraction. Commercial timber harvesting was once a significant share of GDP and a major export earner for all the large countries of the region, and continues to be so for economies, such as Cambodia and Myanmar, that have failed to diversify into other activities. As recently as the late 1980s, three Southeast Asian countries were the world's leading exporters of timber and timber products: Malaysia with 48.6% of world exports; Indonesia with 26.7%, and the Philippines with 3.2%.[16] However, commercial timber extraction has been estimated to be *directly* responsible for only about one quarter of forest loss (Braga 1992). Its indirect effects are clearly greater, of course, since commercial logging is known to create access to forests by farmers, whose actions

[16] Braga 1992. The other leading exporters were Cote d'Ivoire (2.4%), Brazil (2.4%) and Gabon (2%).

(often with the support or facilitation of state-sponsored land colonization programs) are held responsible for well over half the area deforested (Angelsen 1995).

More than thirty years ago, the green revolution helped tropical Asia to forestall widespread poverty and slowed the rate of expansion into forested frontier lands. In the three decades after World War II, a period during which the region's population more than doubled, pressures on the agricultural resource base began to climb, domestic food production per capita began to decline, and the share of food in the value of imports to rise—all accompanied by persistently high poverty. Initially, states responded by sponsoring land colonization through internal migration, often supported by through public provision of services such as land clearing, irrigation, and the establishment of market and physical infrastructure. However, it was the introduction of green revolution technology that most markedly alleviated land scarcity. In the three decades following the release of modern rice varieties, rice output and yields in most of the region's economies have risen rapidly, while land area has increased much more slowly (Table 1).

[Table 1 about here]

At the same time, however, governments also enshrined food security—or more strongly, self-sufficiency in cereals—as a basic plank of development policy (Barker and Herdt 1985; David and Huang 1996). The key instruments of self-sufficiency in food-importing countries were quantitative restrictions on food trade (more recently converted to tariffs to comply with WTO rules) usually with monopoly control over imports assigned to a state agency. A consequence of these restrictions was the de-linking of domestic cereal markets from global markets.

In this policy environment, while the direct impacts of infrastructural investments and green revolution technologies outside of irrigated areas were generally small, yield gains in lowlands almost certainly diminished pressures for expansion of food production in uplands by driving down relative grain prices. Evaluated at more-or-less constant food prices, the rise in labor productivity and labor demand in lowland agriculture reduced incentives for migration to uplands; but with considerable slack in labor markets, the big impacts were transmitted through relative product price changes (Hayami and Kikuchi 2000, Coxhead

2000). These indirect impacts of the green revolution conferred environmental benefits by raising the opportunity cost of deforestation and land conversion.[17]

Other aspects of food policy, as well as the general direction of policy change, had different impacts on the expansion of upland and frontier agriculture (Tongpan and Panayotou 1990; Panayotou and Sungsuwan 1994). In most of tropical Asia, expansion of corn and coarse grains and of temperate climate vegetable crops—the spread of which is associated with very high rates of land use change and soil erosion in upland and highland areas—received significant support from policies that both raised and stabilized their prices, thus greatly increasing the area over which they could profitably be grown for the market. In low-growth countries, such measures interacted with downward pressures on labor costs driven by population growth and inward-oriented industrialization. Recent empirical work in Philippine uplands indicates that higher wages in non-agricultural and lowland employment would have had significant land use effects (Coxhead and Demeke 2004), even though the short-medium run impact on resource depletion and the environment, which depends on farmers' adoption of soil-conserving technologies, is less clear (Shively 1999; Lapar and Pandey 1999).

Globalization

As noted above, Asian economies began to turn away from the most highly inward-oriented development policies after about 1980.[18] During the peak years of growth from 1986-96, the more export-oriented Asian NIEs experienced booms in labor-intensive manufacturing production. These in turn produced very rapid growth of non-agricultural labor demand, and the effects of this spilled over, through internal migration, to labor markets in all sectors. In Thailand and Malaysia, the fastest-growing resource-rich economies of tropical Asia, labor productivity growth in manufacturing caused rural wages to rise sharply, and the agricultural

[17] Such gains must be offset against the long-term costs of intensified production in lowland areas—especially soil quality degradation and the water pollution effects of increased use of inorganic inputs. In addition, the human health effects of intensive pesticide use under common rice-farming practices have been shown to be very high, even exceeding the agricultural benefits of their use (Rola and Pingali 1993; Resosudarmo 2001; for additional coverage see Pingali 2001).

[18] The use of 1980 is merely an approximation. For many purposes it is convenient to date the 'globalization' of developing Asia from the opening of China in 1978. However, this ignores the much earlier opening of economies such as Malaysia (not to mention Singapore and Hong Kong), and does not take account of reforms begun much later, for example in Indochina and India, or not at all, as in Myanmar.

labor force to decline in absolute as well as in relative terms (Coxhead and Plangpraphan 1999; Athukorala 2001). Since the 1980s, Southeast Asian developing economies have experienced average *rural* population growth rates of under 0.6% per year—well below replacement rates.[19]

Within the region, countries that moved fastest to create a more level policy playing field enjoyed faster overall growth and poverty reduction (Herrin 1999). The move away from ISI toward more labor-intensive industrialization is a factor associated with more rapid poverty decline. A recent econometric analysis shows that in Taiwan, which pursued a highly labor-intensive industrialization strategy, industrial growth between the 1950s and 1990s made a statistically significant contribution to poverty reduction, whereas in India its contribution was significantly negative; in Southeast Asia, there is no statistically measurable effect. By contrast, agricultural and services sector growth contribute to poverty declines in every case (Warr 2005a).[20]

The same factor market forces that hasten the decline of poverty in the course of labor-intensive industrialization have contributed to reduced pressure on natural resources at the frontier—with one important exception (see below). Economies moving to EOI depend much less, in a relative sense, on the exploitation of environmental and natural resources to generate employment and foreign exchange. In Thailand, for example, the manufacturing sector boom of 1986-96 increased industry's share of the labor force from 12% to 21%. In a country where well over half the labor force had been engaged in agriculture, the investment inflow that led to the manufacturing boom substantially reduced farm employment and raised rural wages. In the same decade, about 17% of the farm labor force migrated to factory jobs. Their migration reduced farmed area, as seen in Table 2: by 2000, temporary crop land was 31.1% of total area, 1.2 percentage points below its 1980 value, and well down from the 1990 value (34.2%). Available evidence indicates that the decline in land area was disproportionately fast in the more remote and environmentally fragile regions (Coxhead and Plangpraphan 1999). Needless to say, the industrial boom was also associated with a huge reduction in poverty (Warr 2005b).

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[19] Source of basic data: World Bank, *World Development Indicators 2001*.

[20] Warr's analysis shows that India's post-1991 trade policy relaxation (which saw the decline of the most capital-intensive sectors and a rise of labor-intensive industries) is associated with a shift in the statistical association of industrial growth with poverty, from significantly positive to not significantly different from zero in the post-reform period.

The exceptions to this generally positive story are countries with comparative advantage not only in labor-intensive production, but also in plantation crops and aquaculture. As property rights at the frontier are weak, export-driven expansion of these sectors has been strong. Thus in rapidly growing countries with open land frontiers—such as Malaysia and Vietnam—agriculture continues to expand in area. In Vietnam, there has been a large increase in land devoted to lowland rice (and more recently, to aquaculture). Elsewhere in the region, however, the expansion in total area is heavily biased toward the use of land for perennial crops. In Table 2, total agricultural area in a given year is found by summing 'arable land' plus 'permanent crops'. In most cases (Vietnam is the exception; see table 1) the net change in total area is driven by permanent crops, with the area of temporary crops stable (or in the Thai case, declining).

[Table 2 about here]

Plantation crop area continues to expand in the new millenium. In Southeast Asia as a whole, the area planted to coffee has risen by more than 300% since 1980, while for oil palm the increase is more than 500% (Figures 5 and 6), while areas devoted to traditional plantation crops such as coconut and rubber have not declined (Coxhead 2003). New land for expanding crops has been obtained mainly through forest conversion (Gérard and Ruf 2001; Vincent, Rozali and Associates 1997; Ha 2001). In Peninsular Malaysia, for example, agricultural area increased by 46 per cent from 1970-90; more than 100% of this was accounted for by a greater than sevenfold expansion of oil palm plantations. Coincidentally, the increased oil palm area (1.4 m.ha.) almost exactly matches the reduction in forest area (1.3 m.ha.) over the same period.[21] In Indonesia, widespread forest burning, primarily for the purpose of establishing oil palm and other industrial crops, has in recent years produced catastrophic environmental side-effects, including the well-publicized 'haze' that envelops large areas of Southeast Asia during dry seasons and droughts.[22] In Vietnam, although they assert that "data [on the role of the coffee boom on forest cover removal] are scarce and

[21] These calculations are based on data in Vincent, Rozali and Associates 1997, Tables 5.1 and 5.2. Vincent *et al.* note, however, that the rate of deforestation has diminished sharply in recent years.

[22] "The 1990s has seen the rise of tree plantations as the most powerful force behind the conversion of forest lands in [the Indonesian islands of] Sumatra and Kalimantan. The government supported the development of pulp wood and palm oil plantations, using incentives such as free land, subsidized capital, and free use of standing timber. Rising domestic and international demand for palm oil, pulp, and paper…has given additional impetus to the growth of these industries" (Schweithelm and Glover 1999, p.6).

anecdotal", Sunderlin and Huynh (2005:16) cite four studies asserting such a link in the country's main coffee-growing province.

[Figures 5 and 6 about here]

In other Asian countries, mainly net food importers, expansion of overall agricultural area has been more tightly constrained. Moreover, in those countries—especially the Philippines and Sri Lanka—agricultural land expansion has been mainly for food crops. These countries exhibit agricultural development patterns traditionally associated with inward-looking development policies. Deforestation, to an even greater extent than elsewhere in the region, has been mainly to increase the area for short-term food crops and to replace land abandoned due to degradation.

Imbalances in the rate of trade liberalization, as already mentioned, are also important. Historically, the net price-increasing effects of food import restrictions and related interventions were insufficient to offset the prevailing anti-agriculture bias of industrial promotion policies (Siamwalla and Setboonsarng 1990; Intal and Power 1990). In a very significant shift, however, this policy bias was inverted in the 1990s. WTO trade policy rules bind import tariffs for manufactures, but are considerably more lenient where developing country agricultural imports are concerned. As a result, very high levels of protection for cereals persist in Asia even after major trade reforms in other sectors, and rice, corn, and other staples are now among the region's most heavily protected commodities (WTO 1998-2001). Thus in the Philippines, for example, the effective rate of protection for manufacturing declined from 32% to 15% between 1990 and 2000, whereas that for agriculture fell only from 32% to 24% (Aldaba and Cororaton 2001). In 2000, the Philippines' implicit tariff on rice and corn was 43% while the median value for manufactures other than food processing was under 10% (ibid.). Indonesia, another net food importer, liberalized trade in a very wide range of commodities in the 1990s but excluded rice, imports of which remain under the control of Bulog, a State trading agency.

For Southeast Asian economies, then, globalization promises substantial reductions in poverty but mixed achievements on the environment. The shift from ISI to EOI industries generally means reduced intensity of industrial emissions, but with weak property rights over land and natural resources, rising global demand for plantation crops, and relative increases

in domestic protection for cereal crops, have both retarded progress toward more environmentally sustainable forms of development in rural areas.

V Conclusions

As this review suggests, globalization in developing Asia has undercut some 'old' threats to the environment and introduced some new mechanisms for addressing the poverty-environment link, but it also raises new challenges to environmental management when property rights are poorly established or enforced. Job growth in export-oriented manufacturing reduces pressure on agriculture to serve as 'employer of last resort' to the poor. Trade policy relaxation, if extended to staple foods, reduces growth in demand for new land (other things equal) and may reduce food prices. Both trends undercut the rationale for discriminatory policies favoring agriculture as means to poverty alleviation and economic growth (as argued, for example, by Timmer 1995). But uncontrolled exploitation of natural resources and land conversion for commercial agriculture raise serious environmental concerns—especially in an region whose economic future is increasingly dominated by its large, low-wage, resource-hungry, rapidly-growing neighbors, China and India (Coxhead 2005).

First-best approaches to the poverty-environment tradeoff mainly involve non-agricultural policies. These include protecting the natural environment through strengthening of property rights; ensuring steady growth of productive employment opportunities in non-agricultural sectors; and developing mechanisms to protect the consumption and savings plans of poor populations from the ill effects of major economic or environmental shocks. At the same time, however, governments that have begun (like the OECD economies before them) to use agricultural protectionism and subsidies as instruments to raise rural incomes must begin to count the true economic and environmental costs of such strategies and where feasible, design social policies having fewer unwanted side-effects.

Appendix: Calculating poverty changes in the HT model

Assume that the poor earn income only from labor. Define a poverty line z, and assume that initially, $w_a < z < w_m$. Then the headcount measure of poverty is just the numbers of farm workers plus urban unemployed, or (Fields, 2005):

$$H = \frac{L - L_m}{L}. \tag{A.1}$$

Population growth raises this measure of poverty:

$$\frac{dH}{dL} = \frac{L_m}{L^2} > 0.$$

Population growth also increases a measure of the aggregate poverty gap, defined as:

$$G = L_a(w_a - z) + Uz. \tag{A.2}$$

Differentiating, using $L_a + U = L - L_m$,

$$dG = zdU + (z - w_a)dL_a - L_a dw_a > 0\ .$$

The severity of poverty increases along with aggregate poverty, because in HT, labor force growth raises urban unemployment and farm employment and reduces farm wages.

The green revolution (a rise in lowland labor productivity) raises w_a, but leaves $L–L_m$ unchanged. Therefore, even though U declines, there is no effect on the headcount poverty measure unless the wage rise is such that $w_a' > z$, at which point poverty occurs only among the remaining urban unemployed. Even if the wage rise is less, however, the aggregate poverty gap must diminish. Differentiating (A.2), and noting that $dL_a = –dU$ when the total size of the labor force is held constant:

$$\begin{aligned} dG &= zdU + (z - w_a)dL_a - L_a dw_a \\ &= w_a dU - L_a dw_a < 0 \end{aligned}.$$

Industrial labor demand growth at constant w_m reduces the headcount measure of poverty (see (A.1)). The change in the aggregate poverty gap, using $dU = –(dL_m+dL_a)$, is:

$$\begin{aligned} dG &= -zdL_m - (L_a dw_a - w_a dL_a) \\ &= -zdL_m + w_a(1 - \varepsilon)wdL_a, \end{aligned}$$

where $\varepsilon = \frac{\partial w_a}{\partial L_a}\frac{L_a}{w_a}$ is the elasticity of the agricultural labor demand curve in the region of initial equilibrium. Since $dL_m > 0$ and $dL_a < 0$ in this experiment, a sufficient (but not necessary) condition for the severity of poverty to decline is that $\varepsilon < 1$, in which case the rise in the farm wage outweighs job losses. Conversely, in the paradoxical case in which industry policy actually *reduces* L_m, the headcount poverty measure will unambiguously rise. Since in this case $dL_m < 0$ and $dL_a > 0$, $\varepsilon < 1$ will meet a sufficient condition for the severity of poverty also to rise.

Globalization (as we have defined it) involves some combination of labor-intensive expansion in industry plus job growth in export agriculture. From the foregoing analyses this is seen unambiguously to reduce both poverty measures. Finally, *enforcing property rights at the frontier* will reduce labor demand in that subsector, which will leave the headcount measure unchanged but increase the severity of poverty. Achieving environmental protection simultaneously with poverty reduction requires additional measures such as industry job growth or a 'boom' in non-frontier agriculture.

References

Aldaba, R.A.M., and C. B. Cororaton., 2001. "Trade liberalization and pollution: evidence from the Philippines". Unpublished manuscript, Philippine Institute for Development Studies, Manila.

Angelsen, A., 1995. Shifting cultivation and 'deforestation': a study from Indonesia." *World Development* 23(10), October, pp.1713-29.

Antweiler, W.; B. R. Copeland and M. S. Taylor, 2001. "Is free trade good for the environment?" *American Economic Review*, 91(4):877-908

ADB (Asian Development Bank), 1997. *Emerging Asia: Changes and Challenges*. Manila: ADB.

ADB (Asian Development Bank), 2000. *State of the Environment in Asia and the Pacific*. Manila: ADB.

Athukorala, P., 2001. *Crises and Recovery in Malaysia: The Role of Capital Controls.* Cheltenham, UK; Northampton, MA.: Edward Elgar.

Baland, J-M, and Platteau, J-P, 2000. *Halting Degradation of Natural Resources: Is There a Role for Rural Communities*? Oxford, UK: Oxford University Press.

Barbier, E. B., 1990. "The farm-level economics of soil conservation: the uplands of Java". *Land Economics* 66(2), May:199-211.

Barker R., and R. W. Herdt, with Beth Rose. 1985. *The Rice Economy of Asia*. Washington, D.C.: Resources for the Future.

Braga, C.A.P., 1992. "Tropical forests and trade policy: the cases of Indonesia and Brazil". In Patrick Low (ed), *International Trade and the Environment*. World Bank Discussion Papers, no. 159. Washington, D.C.: World Bank, 1992, pages 173-190.

Corden, W.M., and R. Findlay, 1975. "Urban unemployment, intersectoral capital mobility and development policy" *Economica* 42 (165): 59-78

Coxhead, I., 2000. "The consequences of Philippine food self-sufficiency policies for economic welfare and agricultural land degradation." *World Development* 28(1), January: pp. 111-128.

Coxhead, I., 2003. "Development and the environment in Asia: a survey of recent literature", *Asian-Pacific Economic Literature* 17 (1), May:22-54.

Coxhead, I., 2005. "International trade and the natural resource 'curse' in Southeast Asia: does China's growth threaten regional development?" Madison: University of Wisconsin Department of Agricultural and Applied Economics Staff Papers No. 480.

Coxhead, I., and B. Demeke, 2004. "Panel data evidence on upland agricultural land use in the Philippines: can economic policy reforms reduce environmental damage?" *American Journal of Agricultural Economics* 86(5), December: 1354-1360.

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

Coxhead, I., and S. Jayasuriya (2003). *The Open Economy and the Environment: Development, Trade and Resources in Asia* (Chelthenham, UK, and Northampton, MA, USA: Edward Elgar).

Coxhead, I., and S. Jayasuriya, 2005. "Trade liberalization, resource degradation and industrial pollution in developing countries." In S. Jayasuriya, (ed.): *Trade Theory and Analytical Models: Essays in Honour of Professor Peter Lloyd, Vol. 1*. Chelthenham, UK, and Northampton, MA, USA: Edward Elgar: 257-281.

Coxhead, I., and J. Plangpraphan, 1999. "Economic boom, financial bust, and the decline of Thai agriculture: Was growth in the 1990s too fast?", *Chulalongkorn Journal of Economics* 11(1), January: pp. 76-96.

Cruz, W., and H. Francisco, 1993. "Poverty, population pressure and deforestation in the Philippines". Paper presented at a workshop on "Economy-wide Policies and the Environment," World Bank, Washington, D.C., 14–15 December.

David, C. C., and K. Otsuka, eds., 1993. *Modern Rice Technology and Income Distribution in Asia*. Boulder and London: Lynne Reinner; Los Baños, Philippines: IRRI.

David, C. C; and J. Huang, 1996. "Political economy of rice price protection in Asia", *Economic Development and Cultural Change* 44(3), April, pp. 463-483.

Deacon, R., 1995, "Assessing the relationship between government policy and deforestation", *Journal of Environmental Economics and Management* 28(1), January: pp. 1-18.

Dinda, S., 2004. "Environmental Kuznets Curve hypothesis: a survey", *Ecological Economics* 49(4): 431-455

ESCAP and ADB, 2000. *State of the Environment in Asia and the Pacific*. New York: United Nations.

Fields, G.S. 2005. "A welfare economic analysis of labor market policies in the Harris-Todaro model", *Journal of Development Economics* 76(1), February,:127-146.

Gérard, F., and F. Ruf, 2001. *Agriculture in Crisis: People, Commodities and Natural Resources in Indonesia, 1996-2000.* Montpellier, France: CIRAD; and Richmond, UK: Curzon.

Gordon, H., 1954. "The economic theory of a common property resource: the fishery". *Journal of Political Economy* 62: 124-142.

Ha, D. T., 2001. "Balancing Economic Development and Environmental Protection: Challenges for the Uplands of Vietnam". Paper presented at the SANREM Research Synthesis conference, Athens, GA, USA, November 28-30.

Harris, J.R., and M.P. Todaro, 1970. "Migration, unemployment and development: a two-sector analysis", *American Economic Review* 60:126-142.

Hayami, Y., and M. Kikuchi, 2000. *A Rice Village Saga: Three Decades of Green Revolution in a Philippine Village.* Lanham: Barnes and Noble; Los Baños, Philippines: International Rice Research Institute.

Herrin, A. N., 1999. "The impact of globalization on population change and poverty in rural areas". Bangkok: ESCAP Asian Population Studies Series No. 154.

Intal, P. S., and J. H. Power, 1990. *Trade, Exchange Rate, and Agricultural Pricing Policies: the Philippines*. Washington, DC: The World Bank.

International Rice Research Institute, 2006. *World Rice Statistics.* http://www.irri.org/science/ricestat/, accessed June 3, 2006.

Kikuchi, M., and Y. Hayami, 1983. "New rice technology, intrarural migration, and institutional innovation in the Philippines", *Population and Development Review,* 9 (2), pp. 247-257.

Lapar, M. L. A., and S. Pandey, 1999. "Adoption of soil conservation: the case of the Philippine uplands". *Agricultural Economics* 21, 241-256.

Larson, D., and Y. Mundlak, 1997. "On the intersectoral migration of agricultural labor," *Economic Development and Cultural Change* 45(2): 295-319.

Lopez, R., 1994. "The environment as a factor of production: the effects of economic growth and trade liberalization." *Journal of Environmental Economics and Management* 27(2): 163-84

Marjit, S., and H. Beladi, 2003. "An analysis of rural-urban migration and protection" *Canadian Journal of Economics* 29(4): 930-940

Marjit, S., and H. Beladi, 2003. "Possibility or impossibility of paradoxes in the small country Harris-Todaro framework: a unifying analysis" *Journal of Development Economics* 72(1): 379-85

Mundlak, Y., D. Larson, and R. Butzer, 2004. "Agricultural dynamics in Thailand, Indonesia, and the Philippines", *Australian Journal of Agricultural and Resource Economics* 48(1): 95-126.

Myint, H., 1959. "The 'classical theory' of international trade and the underdeveloped countries", *Economic Journal* 68: 317-37.

Neary, J.P., 1981. "On the Harris-Todaro model with intersectoral capital mobility", *Economica* 48 (191): 219-34

Otsuka, K., 2006. "Land tenure and forest resource management in Asia", this volume.

Panayotou, T., 1995. "Environmental degradation at different stages of economic development", in I. Ahmed and J. Doelman (eds), *Beyond Rio: The Environmental Crisis and Sustainable Livelihoods in the Third World*. London: MacMillan.

Panayotou, T., and S. Sungsuwan, 1994. An econometric study of the causes of tropical deforestation: the case of Northeast Thailand. Katrina Brown and David W. Pearce, eds: *Causes of Tropical Deforestation*. London: University College London Press.

Perrings, C., 1989. "An optimal path to extinction: poverty and resource degradation in the open agrarian economy, *Journal of Development Economics* 30(1): 1-24

Pingali, P. L., 2001. "Environmental consequences of agricultural commercialization in Asia". *Environment and Development Economics* 6: 483-502.

Resosudarmo, B. P., 2001. "The economy-wide impact of integrated pest management in Indonesia". EEPSEA Research Report No. 2001-RR11. Singapore: Environment and Economy Program for Southeast Asia.

Roche, F., 1988. "Java's critical uplands: is sustainable development possible?", *Food Research Institute Studies* XXI (1), pp.1-43.

Rola, A. C., and P. L. Pingali. 1993. *Pesticides, rice productivity and farmers' health: an economic assessment*. Los Baños, Philippines and Washington, D.C.: International Rice Research Institute and World Resources Institute.

Schweithelm, J., and D. Glover, (1999). "Causes and impacts of the fires", in D. Glover and T. Jessup (eds): *Indonesia's Fires and Haze: The Cost of Catastrophe.* Singapore: Institute for Southeast Asian Studies, and Canada: International Development Research Center, pp.1-13.

Shively, G. E. 1999. "Risks and returns from soil conservation: evidence from low-income farms in the Philippines". *Agricultural Economics* 21(1), August, pp. 53-67.

Siamwalla, A., and S. Setboonsarng. 1989. *Trade, exchange rates and agricultural pricing policies in Thailand.* Washington, D.C.: The World Bank

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

SUnderlin, W., and T.B. Huynh, 2005. *Poverty Alleviation and Forests in Vietnam*. Bogor, Indonesia: Center for International Forestry Research.

Timmer, C.P., 1995. "Getting agriculture moving: do markets provide the right signals?", *Food Policy* 20(5): 455-472.

Tongpan, S., and T. Panayotou, 1990. *Deforestation and Poverty: Can Commercial and Social Forestry Break the Vicious Circle*. Bangkok: Thailand Development Research Institute.

Vincent, J. R.; Rozali Md Ali, and Associates. 1997. *Environment and Development in a Resource-Rich Economy: Malaysia Under the New Economic Policy* (Cambridge, MA: Harvard Institute for International Development, and Kuala Lumpur: Institute of Strategic and International Studies).

Warr, P.G., 2005a. "Industrialization, trade policy and poverty reduction: evidence from Asia", in S. K. Jayasuriya (ed), *Trade Policy Reforms and Development: Essays in Honour of Peter Lloyd, Volume II*. Cheltenham, UK and Northampton, MA, USA: Eldward Elgar, pp. 239-260.

Warr, P.G., 2005b. "Boom, bust and beyond", in P.G. Warr, ed.: *Thailand Beyond the Crisis* (London and New York: RoutledgeCurzon).

World Bank, 1989. *Philippines Natural Resource Management Study*. Washington, DC: The World Bank.

World Bank, 1990. *Indonesia: Sustainable Development of Forests, Land, and Water*. Washington, DC: The World Bank.

WRI (World Resources Institute). 1989. *Wasting Assets: Natural Resources in the National*

Income Accounts. Washington, DC: World Resources Institute.

WTO (World Trade Organization), 1998-2001. *Trade Policy Review* (various countries).(Geneva: WTO). Accessed December 2001 at www.wto.org.

Table 1: Growth indices of rice production, area and yield (1970 = 100)

	Production			Yield			Harvested Area		
	1980	1990	2000	1980	1990	2000	1980	1990	2000
Cambodia	39	63	106	68	84	133	57	75	79
Indonesia	153	227	268	139	185	185	111	123	145
Laos	117	177	244	106	193	224	110	92	109
Malaysia	122	107	127	153	120	128	80	89	99
Myanmar	163	167	260	163	172	199	100	97	131
Philippines	138	172	222	128	156	175	108	110	126
Thailand	125	147	186	93	99	129	134	149	144
Vietnam	115	188	320	97	151	197	119	125	162

Source: International Rice Research Institute, 2006.

Table 2: Agricultural land use trends in Southeast Asian economies (% of land area)

	Arable land[a]				Permanent cropland[b]			
	1970	1980	1990	2000	1970	1980	1990	2000
Cambodia	15.3	11.3	20.9	21.0	0.8	0.4	0.6	0.6
Indonesia	9.9	9.9	11.2	11.3	4.4	4.4	6.5	7.2
Lao PDR	2.9	3.4	3.5	3.8	0.1	0.1	0.3	0.4
Malaysia	2.8	3.0	5.2	5.5	10.7	11.6	16.0	17.6
Myanmar	15.2	14.6	14.5	15.1	0.7	0.7	0.8	0.9
Philippines	15.7	17.5	18.4	18.9	9.4	14.8	14.8	16.8
Thailand	24.1	32.3	34.2	31.1	3.0	3.5	6.1	6.6
Vietnam	17.3	18.2	16.4	19.0	1.6	1.9	3.2	6.0

Source: World Bank, *World Development Indicators.*

[a] Arable area is defined as land under temporary crops, temporary pastures, and short-term fallow. Excludes land abandoned as the result of shifting cultivation.

[b] Permanent crops area is defined as land cultivated with crops that occupy the land for long periods and need not be replanted after each harvest (flowering shrubs, fruit trees, nuts trees, vines, etc). Excludes areas of trees grown for wood or timber.

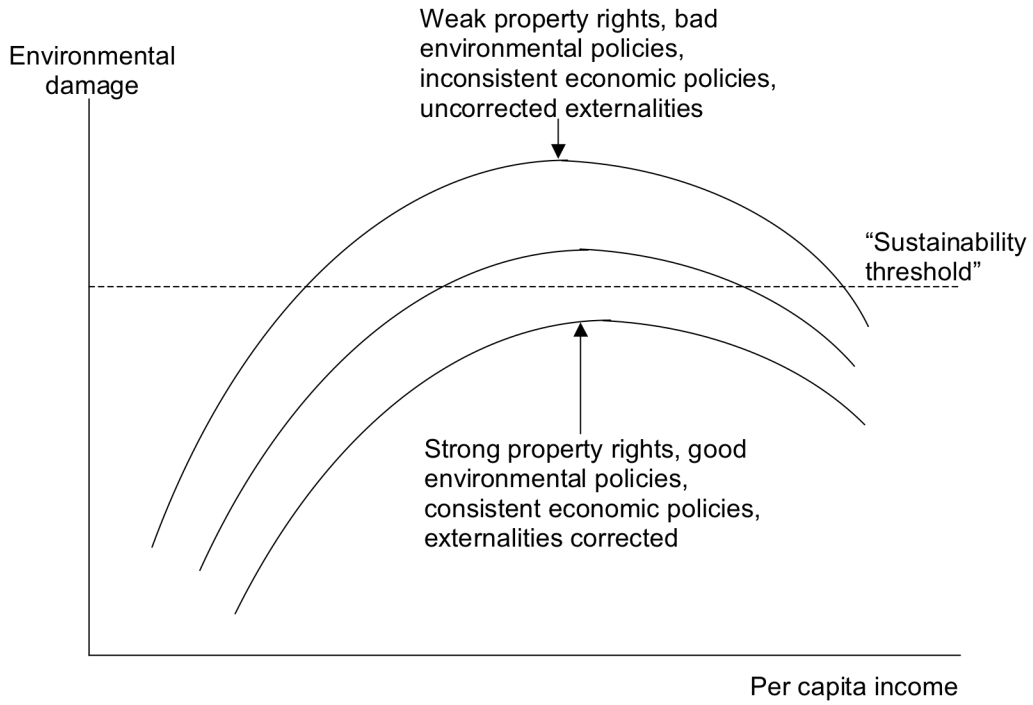

Figure 1 The Environmental Kuznets Curve: relationships between per capita income, policies, institutions and environmental damage (Source: Panayotou 1995)

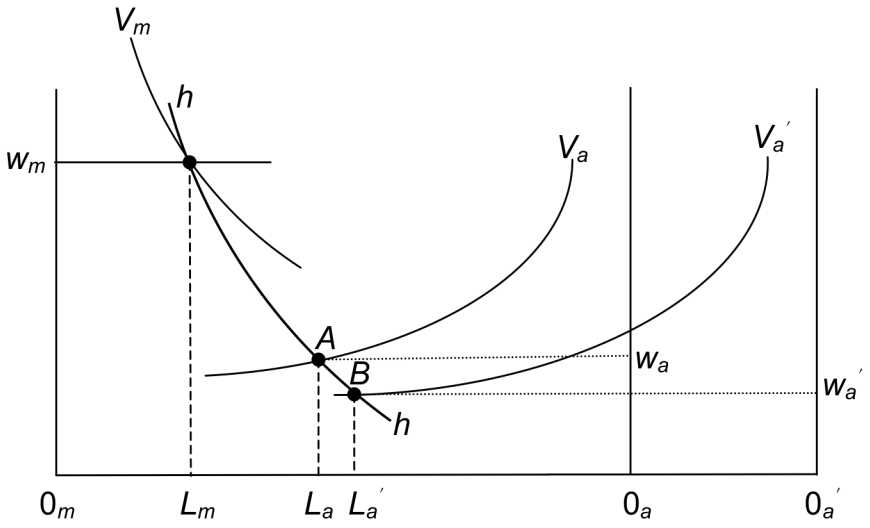

Figure 2 The Harris-Todaro model, and effects of population growth

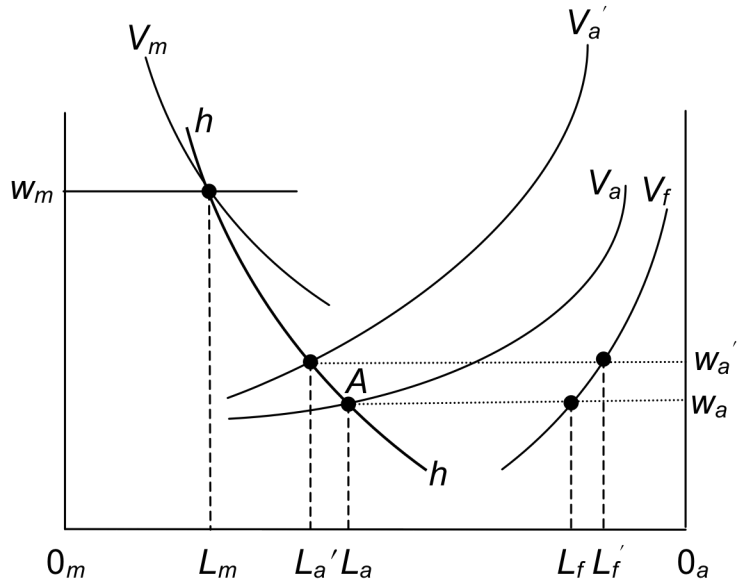

Figure 3 Effects of the green revolution in lowland agriculture

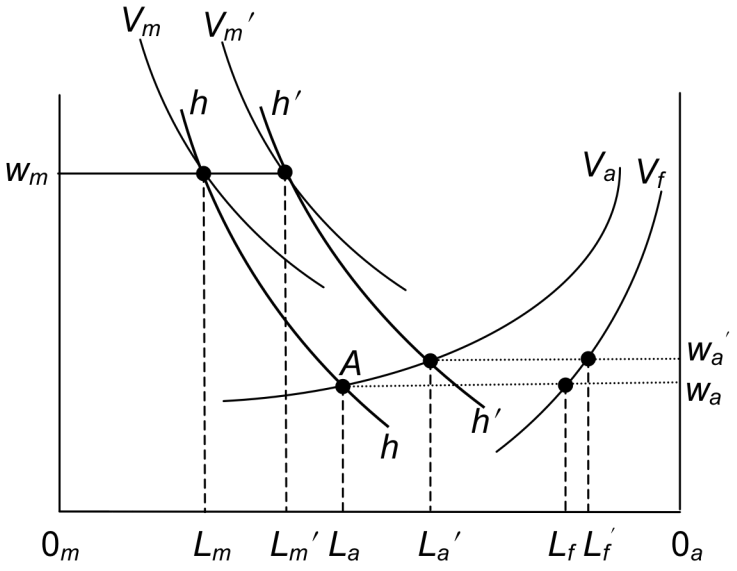

Figure 4 Effects of industrial job growth

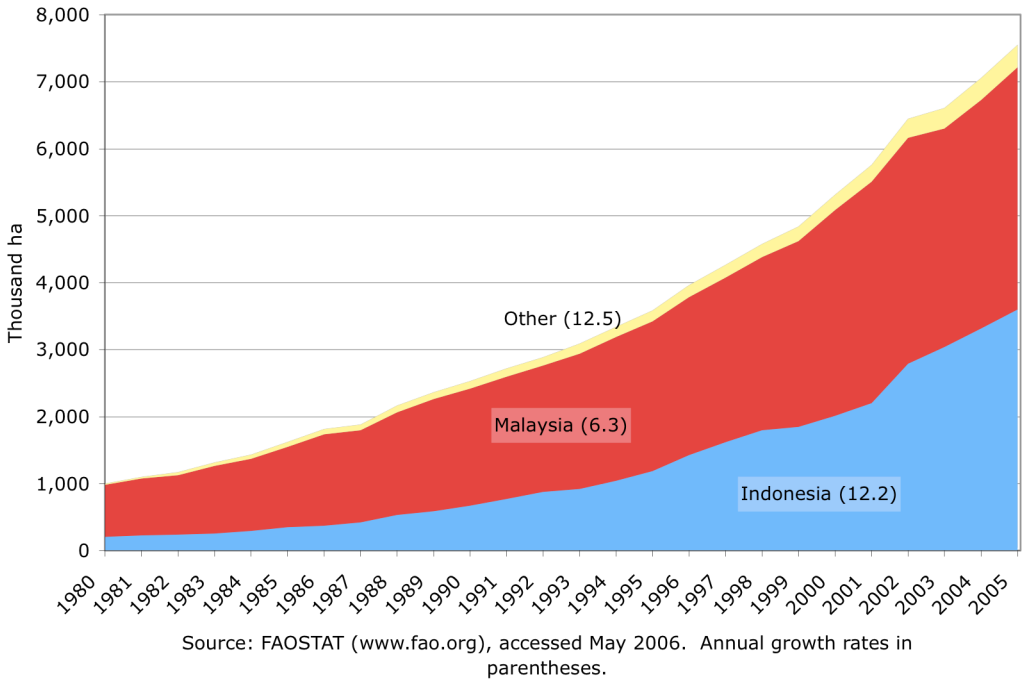

Figure 5: Southeast Asia: Area of Oil Palm Harvested, 1980-2005

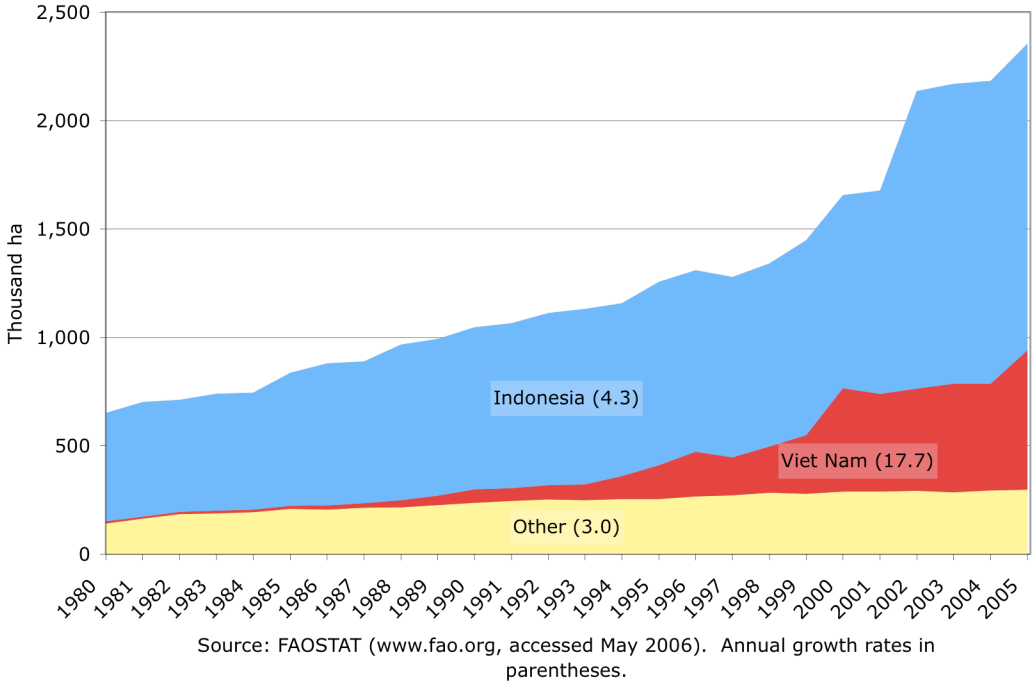

Figure 6: Southeast Asia: Area of Coffee Harvested, 1990-2005