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Structural Variations of Agriculture in the Pacific

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Abstract

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Agricultural shares of output and employment in thirteen Pacific basin countries are analyzed with reference to a global baseline for 1980. Per-capita output parity ratios are lower in the ASEAN, ANICs, and Japan as compared to their trading partners in North America and Oceania. Wide differences in land–labor ratios influence the directions of technological change, economies of scale, and dynamic comparative advantage. Differential changes in the partial productivities of land and labor between the high and middle income economies suggest that there has been a narrowing of the gap in land productivities and a widening of the gap in labor productivities across the Pacific. The implication is that there has been a regressive international impact on wages for farm labor. Further, since agriculture's share of land resources does not tend to fall as fast as its share of output and labor, increasing structural imbalance in terms of differential land rents to agriculture vis-à-vis non-agriculture results in greater adjustment pressures on the property and derived institutional systems that control natural resource allocation decisions. The results are consistent with the heavy adjustment burdens that agriculture and developing economies have been bearing as a result of expanding trade and capital flows, and the need to focus more attention on the structure, functioning, and performance of the different institutional systems that control resource allocation decisions in these countries.

Introduction

The overall structure of agriculture in an economy is typically characterized by its percentage shares of total output (gross domestic product) and total

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employment. In the process of economic development, the tendency is for both shares to steadily decline, with the larger employment shares declining faster after a certain point than the smaller output shares. This is generally held to be a reflection of agriculture's contribution of "surplus" resources to the non-agricultural sectors, in conjunction with technological changes which increase productivity and also with shifts in consumption patterns within the limits of Engel's Law.

In this paper I will present an empirical description and analysis of the patterns of such macro-structural variations for thirteen Pacific basin economies which make up the major trading countries in the region. These countries are tentatively grouped in Table 1 according to their stages in economic development. Singapore, a member of the Association of Southeast Asian Nations (ASEAN), is included among the Asian newly industrializing countries (ANICs). The relative resource endowments of these countries are difficult to measure, but it is generally regarded that the resource-rich economies include those of North America and Oceania (U.S., Canada, Australia, and New Zealand and the ASEAN-4—Malaysia, Philippines, Thailand, and Indonesia); whereas the resource-poor economies include Japan and the ANICs (Singapore, Hong Kong, Taiwan, and Korea).

For my purpose, it will be useful to consider these Pacific basin economies in a global perspective. To establish an initial global norm, I will rely primarily on the 1980 data presented in the World Bank's World Development Report (1982). This will serve as an empirical baseline to compare our thirteen Pacific basin economies. However, this is only for a particular point in time; although we may draw some inferences for change over time from such a cross-sectional analysis, we will want to gain further insight on the directions of technological change by considering the historical patterns of productivity changes for land as well as for labor. At this point we must rely on the induced technology approach of Hayami and Ruttan (1985) with some modifications in the data base and interpretation of results.

Global pattern of agriculture in 1980

The role of agriculture in economic development is the special focus of the World Bank's 1982 Report. The Report covers 125 countries which are categorized in terms of per-capita income classes ranging in 1980 from around $80 up to as high as $26 850. A cross-country summary of the data on agriculture's share of total output and total labor is given in Table 2.

A plot of the individual countries' data, excluding the four high-income oil exporters, reveals a clear pattern. Economic growth is invariably accompanied by declining shares of total output and employment in agriculture; and, although not evident here, at advanced stages of growth the labor force in agriculture starts to decline absolutely. A substantial literature has accumulated over the

TABLE 1

Pacific basin economies: agricultural shares of output and labor in 1980

	Per-capita GNP (X)		Agriculture's share		Parity ratio $\left(\frac{(Y_1/Y_2)}{(1-Y_1)/(1-Y_2)}\right)$
	Code	($)	GDP (Y_1) (%)	Labor (Y_2) (%)	
ASEAN-4					
Indonesia	IN	430	26	58	0.25
Thailand	TH	670	25	76	0.11
Philippines	PI	690	23	46	0.35
Malaysia	MA	1620	24	50	0.32
ANICs					
Korea	KO	1520	16	24	0.37
Taiwan	TW	2101	9	20	0.40
Hong Kong	HK	4240	1	3	0.33
Singapore	SP	4430	1	2	0.49
INDUSTRIAL					
New Zealand	NZ	7090	13	9	1.51
Australia	AU	9820	5	6	0.82
Japan	JP	9890	4	12	0.31
Canada	CA	10130	4	5	0.79
United States	US	11360	3	2	1.52

Data sources: World Development Report, 1982 (World Bank, 1982); Taiwan Statistical Data Book, 1982 (Anon., 1982); Taiwan Agricultural Yearbook (Anon., 1984).

Notes: The Gross Domestic Product (GDP) measures are mostly at factor cost, except for those countries without complete national accounts series at factor cost, in which cases market prices less indirect taxes net of subsidies were used.

The labor force comprises economically active persons, including the armed forces and the unemployed, but excluding housewives, students, and other economically inactive groups. The estimates of the sectoral distribution of the labor force for 1980 are mostly geometric extrapolations of the International Labor Office estimates for 1960 and 1970 in the ILO's Labour Force Estimates and Projections, 1950–2000.

The agricultural sector comprises agriculture, forestry, hunting and fishing.

past several years to rationalize how, in the course of economic development, the agricultural sector is an important source of food, labor, capital, foreign exchange, and market demand. (See the recent textbook "Economics of Development" by Gillis et al. (1983), which cites most of the major works in the field.)

To establish a reasonable statistical baseline, it is useful to first refine the data set before attempting to find good fitting curves. The data for the four high-income oil exporters and the six non-market industrial economies are excluded, since the World Bank Report cautions against their use for comparison purposes. Also, only countries with complete data sets for our three prin-

TABLE 2

Summary of cross-country shares of output and labor in agriculture in 1980

Country category (No. of countries)	Per-capita GNP range ($)	Agriculture's shares of	
		GDP (%)	Labour (%)
Low-income economies (33)	80–410	36	71
Middle-income economies (63)	420–4500	25	44
Non-market industrial economies (6)	3900–7180	15	16
Industrial market economies (19)	4880–16 440	4	6
High-income oil exporters (4)	8640–26 850	1	46

Source: World Development Report 1982 (World Bank, 1982).

cipal variables — per-capita GNP, agriculture's percentage share of output (GDPa) and of the total labor force (LBRa) — were selected. This reduced our sample size to 96 observations distributed as noted at the bottom of Table 3.

The widest range of variations is reflected in the total sample, but some preliminary diagnostic testing of the country category subsamples revealed some interesting results in terms of their relative degrees of participation in the economic development process. Variations in agricultural shares of the middle income economies are more strongly correlated with changing income than that of the industrialized market economies; and, as to be expected, there is little significant correlation for the countries in the low-income group that have not yet entered the process of economic development.

Both practical and theoretical considerations suggest that the choice of functional forms to fit the data should be flexible and not restricting. The top of Table 3 shows the results of fitting two possible equations in transformed semi-log and trans-log quadratic forms. Various other combinations of transformed power, exponential, and higher-order polynomial forms did not help to improve the fit. The difference between the semi-log and trans-log fits is slight, and, in Fig. 1A, I have chosen to show the graph of the semi-log results. With this estimated initial baseline we can proceed to focus more closely on our Pacific basin economies.

Pacific basin countries in the 1980 global pattern

Of our thirteen Pacific basin countries in 1980, eight fell into the middle-income category and five into the higher-income industrial market economies

TABLE 3

Statistical results of curve fitting

Dependent variable	Independent variables (X=per-capita GNP)				
	Intercept	Log X	$(\text{Log } X)^2$	F	R^2
Output shares					
Y_1	217.5	−44.88	2.357	151	0.76
		(6.133)	(4.688)		
Log Y_1	6.488	−0.414	−0.0162	162	0.77
		(1.004)	(−0.572)		
Labor shares					
Y_2	208.1	−26.94	0.5315	198	0.81
		(−2.437)	(0.700)		
Log Y_2	1.772	1.168	−0.1272	214	0.82
		(3.043)	(−4.825)		
	Intercept	X	X^2	F	R^2
Ratios					
Log (PR)	−1.689	2.970E−04	−1.599E−08	27	0.34
		(4.741)	(−3.046)		

Data Source: World Development Report, 1982 (World Bank, 1982).
Sample includes 96 economies as follows: 26 low-income economies, 54 middle-income economies, and 16 industrial market economies. Figures in parentheses are t statistics.

category. None were left in the low-income category. Thus, by 1980 all were actively involved in the process of economic development and growth.

Figure 1A shows their relative positions in the global pattern. All are well within the 95% confidence intervals of the statistical baselines. Of particular interest is the fact that the relative positions of the labor and output shares are consistent with the global patterns for most of our Pacific basin countries except New Zealand and the U.S., which are reversed. We will return to the results of these two cases later.

Further insights can be obtained by examining the pattern of per capita output ratios of agriculture to non-agriculture ("parity" ratios) computed from the output share and labor share series as follows.

$$PR=\frac{(Y_1/Y_2)}{(1-Y_1)/(1-Y_2)}$$

where PR=parity ratio, agriculture vis-à-vis non-agriculture; Y_1=GDPa agriculture's share of GDP, ratio; Y_2=LBRa, agriculture's share of labor force, ratio. What is the expected pattern of this parity ratio as economies grow and

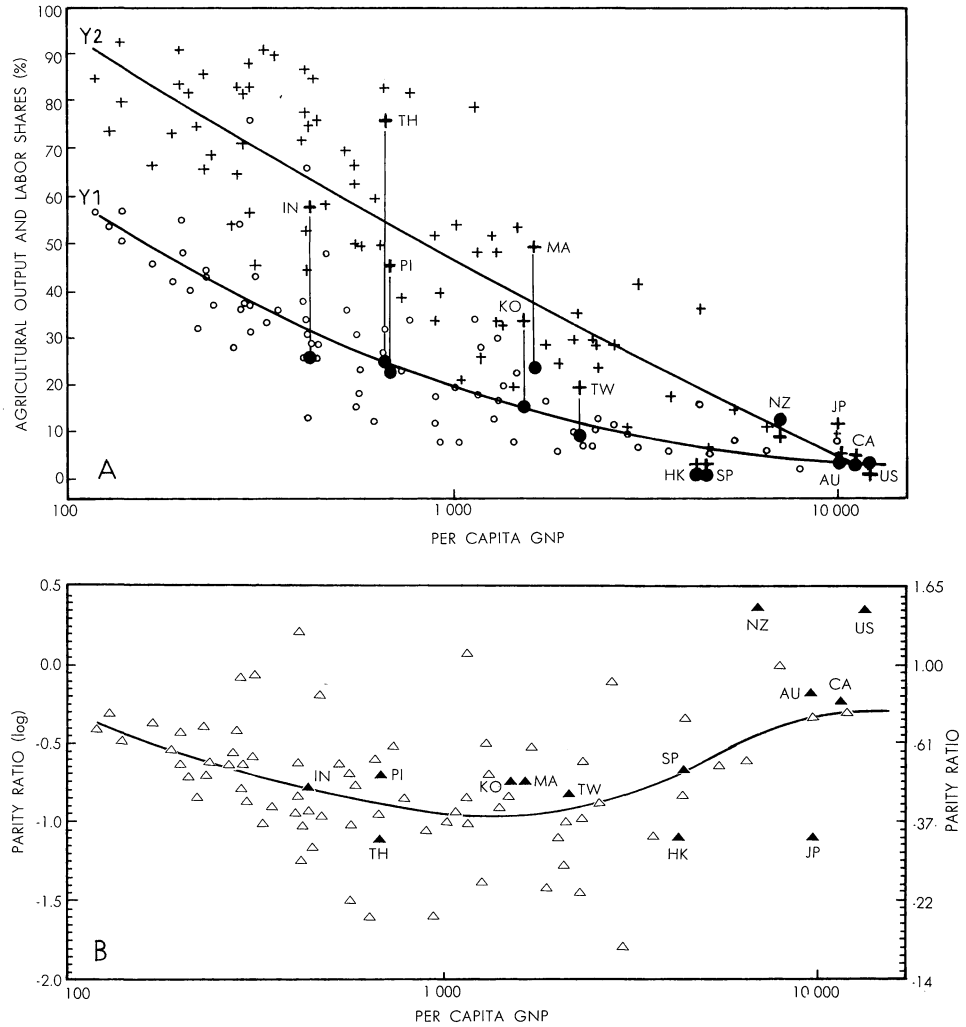

Fig. 1. Cross-country comparison of agricultural output and labor shares, 1980 (World Bank, 1982).

pass through different stages of economic development? As long as the output shares (Y_1) are less than the labor shares (Y_2), the resulting ratios will be less than one. As "surplus" labor from the agricultural sector is reallocated to the rest of the growing economy and technological changes increase agricultural productivity, we should expect a gradual narrowing of the gap between agriculture and the rest of the economy. In other words, there should be a tendency toward parity as the ratio increases and approaches unity.

The resulting ratios are widely scattered, as shown in Fig. 1B. Nevertheless,

changes in per-capita income explain about one-third of the total variations with a second degree exponential function. The results, shown at the bottom of Table 3, are highly significant and generally support our expectations.

Although factors other than income have important influences on the variability of these ratios, it is still useful to examine the relative positions of our Pacific basin economies, again with reference to Table 1 and Fig. 1B. Among the high-income industrial market economies, New Zealand and the U.S. exceed the parity level with ratios around 1.5 since, in their agricultural sectors, the output shares are higher than the labor shares. Australia and Canada are just around the 0.8 level. But Japan is far below that, at about 0.3 and joins the ANICs and ASEAN economies, all with less than 0.5.

These results apply to the 1980 baseline year but tends to hold true for more recent years as well. We must now explore further into the dynamic changes in labor productivities, taking into account other structural differences of agricultural production in the Pacific basin. An obvious difference among countries is in their relative factor endowments of labor and natural resources.

Relative factor endowments of land and labor

Conceptually the same algebraic approach can be used to derive the comparable production ratios for natural resources in agriculture versus non-agriculture, as we did for labor in the previous section. If, in the course of economic development, the uses of natural resources are reallocated among competing purposes, the gaps in average productivities between agriculture and the rest of the economy should tend to decrease. Theory suggests that economic rents to resources in alternative uses should tend toward parity just as in the case of labor.

Unfortunately, the lack of standardized data on an intercountry basis precludes such an analysis. Natural resource bases of economies consist of complex mixes of stock (non-renewable) and flow (renewable) resources which present difficulties for macro-level measurements.

We must, therefore, fall back on another approach in comparing partial productivities of land and labor among countries. The methodological procedure has had a long history of development, and its application has been updated by Kawagoe and Hayami (1983) in their paper on the production structure of world agriculture. Their aim is to explain the large differences in factor productivities experienced among developed and less-developed countries and to draw inferences on the different types of technological changes that are induced by relative factor endowments and their prices. They compare changes in partial productivity ratios of land and labor from 1960 to 1980 in conjunction with changes in inputs of fertilizer and farm machinery.

The relevance of their results to our purpose is as follows. In the densely-populated, less-developed countries of Asia, high population growth and insuf-

ficient labor absorption by the non-agricultural sectors have increased the agricultural labor force absolutely. This has resulted in a deterioration of the land–labor ratios in agriculture, so that changes in agricultural productivities have depended more on biotechnological than mechanical innovations. In essence, the adoption by relatively small farm units in Asia of high-yielding grain varieties that respond readily to fertilizer and related inputs is interpreted in terms of land-substituting biotechnology to overcome the constraints of limited land.

By contrast, in the relatively sparsely populated industrial economies of the "new continents," including North American and Oceanian countries, low population growth and high labor absorption (compared to the densely populated Asian countries) have tended to reduce the agricultural labor force absolutely. This has resulted in marked improvements in the land–labor ratios in agriculture, and the changes in productivities have resulted more from large-scale mechanization and economies on expanded farm sizes rather than through biotechnological intensification of smaller sized farms.

Unfortunately, only seven of our thirteen Pacific basin countries (i.e. Australia, Canada, Japan, New Zealand, Philippines, Taiwan, U.S.A.) are included in Kawagoe and Hayami's worldwide sample of 44 countries. We could let the Philippines represent the three excluded resource-rich ASEAN economies (Indonesia, Thailand, Malaysia) and let Taiwan represent the three ANICs (Hong Kong, Singapore, Korea). But, to avoid possible misrepresentations and also to expand on their very interesting findings, it would be better to include the six excluded Asian economies.

A problem of data availability immediately arises. Kawagoe and Hayami utilize data processed to be consistent with their definitions of variables established in earlier studies and to be comparable over time and among countries. In particular, their output measure is in terms of standard wheat units rather than share of gross domestic product, and labor is measured only in terms of adult male workers in agriculture, excluding fisheries and forestry.

For the present purpose, I will stay with the World Bank's measures of gross domestic product and labor force (see Table 1 notes). For agricultural lands, I have included both arable lands and permanent pasture from the United Nations FAO Production Yearbook.

The resulting 1980 partial productivities for land and labor are plotted on a log-log scale graph similar to that used by Kawagoe and Hayami; see Fig. 2. The dashed 45° lines represent constant land–labor ratios. At any point, this ratio can be computed by dividing the land productivity value on the X-axis by the corresponding labor productivity value on the Y-axis, since the common GDPa value cancels out. The arrows signify the direction only and not the extent of recent (1970–80) changes in the land–labor ratios. In principle, it is possible to also show the extent of productivity changes by plotting the lengths of the arrows from the initial (1970) and terminal (1980) points. However,

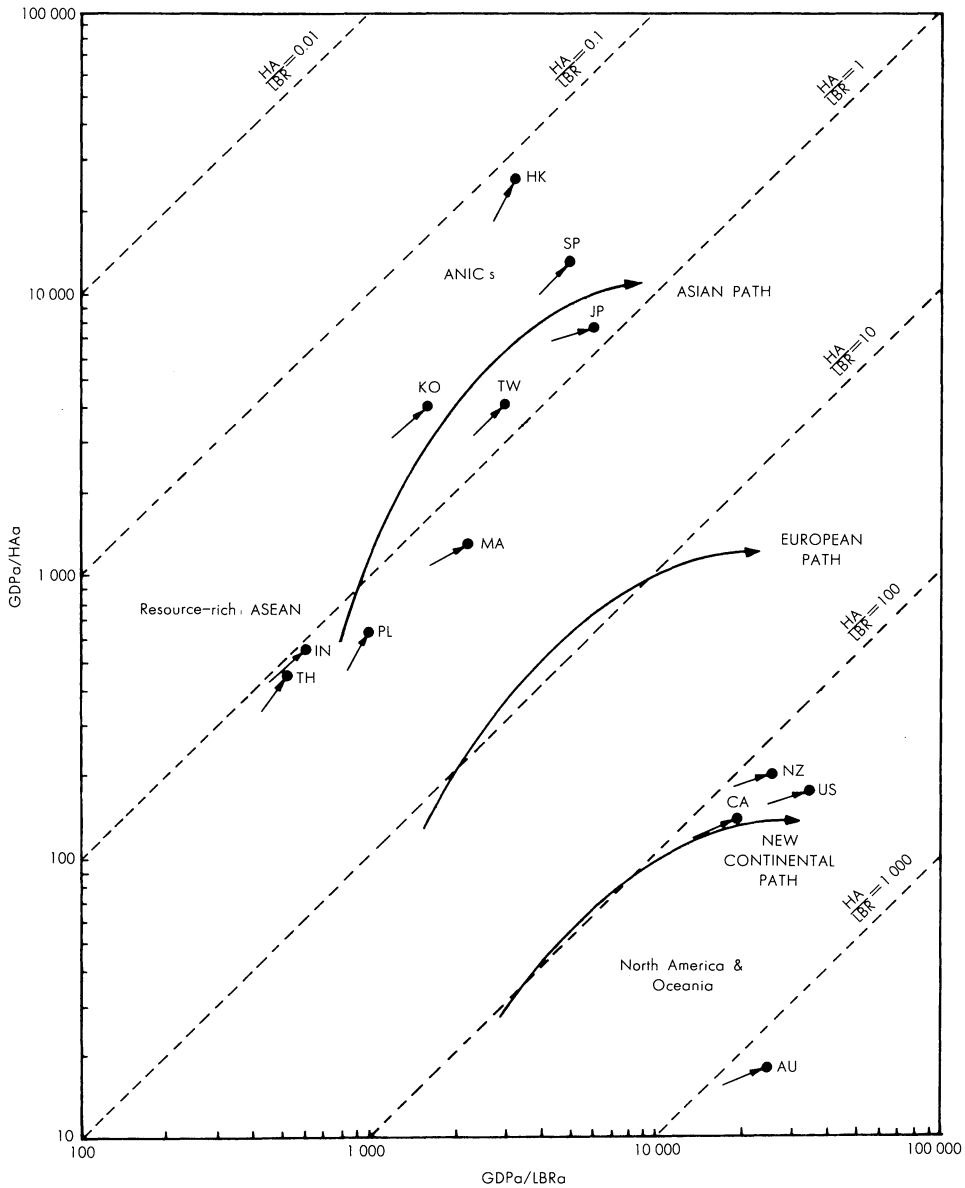

Fig. 2. Partial productivities of land and labor of Pacific basin countries (adapted from Kawagoe and Hayami, 1983).

because of the inherent crudeness of the available macro data, I have elected not to attempt such measurements which would require not only refinement of data, but analytical techniques as well. With the data at hand, it is sufficient to show only the slopes of the arrows, which are indicative of the directions of

change and the relative positions or stages of growth on the respective stylized paths.

The implications for productivity changes are as follows. Over time, changes in the land–labor ratios (HA/LBR) of agriculture are essentially the results of technolocical innovations complementary to the relative endowments of these two factors. Where land is relatively abundant and labor limiting, technological innovations to increase agricultural productivity tend to favor large-scale economies, resulting in higher land–labor ratios. Where labor is relatively abundant and land limiting, technology is adapted to smaller-scale intensive agriculture. Labor and other land substituting inputs tend to increase, thereby resulting in lower land–labor ratios. Finally, when productivity changes are distributed equally to land and labor, the land–labor ratio remains constant.

In other words, slopes parallel to the dashed 45° lines indicate constant land–labor ratios and equal changes in the land and labor productivities. Slopes greater than 45° indicate movements to lower land–labor ratios and relatively greater increases in land productivity than labor productivity, and vice versa.

The 1980 pattern for the seven overlapping countries is essentially similar to that found by Kawagoe and Hayami, and the six additional Asian economies fall within reasonable proximities of their respective groups. Also, our thirteen Pacific basin economies span their three stylized Asian, European, and New Continental paths characterized by different orders of magnitude in land–labor ratios.

The New Continental path is characterized by the industrialized North American and Oceanian economies. Productivity changes here led to higher land–labor ratios (ranging between 100 and 1000), as a result of technological changes favoring large-scale economies and release of farm labor.

A clearer picture emerges for the economies in the Asian path. The ANICs join industrial Japan in leading the way with land–labor ratios all below 1.0. Japan's relatively advanced stage is clearly reflected in its slope, which is closer to that of the larger industrial countries than that of the ANICs. Agricultural support programs tend to increase with industrialization and, in the case of Japan, government programs have supported increasing numbers of part-time farmers who have kept their lands in agriculture, and technological changes have tended to substitute more for labor than land inputs, thereby increasing the land–labor ratio. In the cases of both Taiwan and Korea, their productivity gains were evenly distributed to land and labor, resulting in little, if any, change in their land–labor ratios. Singapore and Hong Kong are essentially entrepot economies with minor agricultural sectors.

The ANICs are followed by the four resource-rich ASEAN economies with slightly higher land–labor ratios, all above 1.0. Malaysia leads in this group with the highest per-capita income. Technological changes in its agricultural sector have tended to expand farm scale through government-sponsored land development and resettlement projects. This is clearly reflected in the rela-

tively flat slope for Malaysia compared to those of the other ASEAN-4 economies, although Indonesia, at a much lower income level, also moved to a slightly higher land–labor ratio.

In general, productivity changes in Asia, except for Japan, are more evenly distributed to land and labor than in North America and Oceania, where technological changes have favored large-scale expansions. The result has been, on the one hand, a narrowing of the gap in land productivities between the high- and middle-income economies of the Pacific and, on the other hand, a widening of the gap in labor productivities between these same economies.

Summary conclusions and implications

Simple algebraic formulas have been used to analyze the macro-level structural variations of agriculture in the Pacific basin. With respect to the shares of output (Y_1) and labor (Y_2) in the general economy, the Asian economies including the ASEAN-4 the ANICs, and Japan tend to have lower parity ratios than the resource-rich industrial economies of North America and Oceania. The ratio exceeds 1.0 when agriculture's share of total output is greater than that of labor. This is the case only for the U.S.A. and New Zealand.

Land–labor ratios (HA/LBR) for agriculture vary widely, from around 0.1 to over 1000, according to relative resource endowments. Asian agricultural economies are characterized by the lower ratios, near 0.1 and 1.0. In contrast, the ratios for North America and Oceania range from around 100 to over 1000.

Technological innovations are adopted to capture economies of scale wherever possible, and this is most evident in the very large-scale agricultural operations of North America and Oceania. In Asia, the opportunities for economies of scale have been constrained to much smaller sized farms, and productivity increases have had to rely more heavily on high-yielding varieties and intensification of complementary labor- and land-substituting capital inputs.

This has led to differential changes in the partial productivities of land and labor between the high- and middle-income economies of the Pacific. To the extent that changes in land productivities are functionally related to changes in rent, and changes in labor productivities functionally related to changes in wages, the implications are that rents to owners of agricultural lands have tended to converge, whereas wages to farm workers have tended to diverge across the Pacific.

The actual extent of such movements has not been precisely measured to assess their relative impacts, but the directions of change are clearly related to income and can be interpreted in the context of the dynamic structural changes that have been occurring in the Pacific basin.

With respect to reallocation of labor, the recent trends in the Pacific basin have been towards more horizontal division of labor in the secondary and tertiary sectors among the industrial economies (Kakazu, 1985). If this horizon-

tal division of labor means a convergence of wages to manufacturing and service sector workers among the industrial countries, the implication of divergence in farm wages between the high- and middle-income economies means that there has been a regressive international impact on farm labor. This is consistent with the heavy adjustment burdens that agriculture and developing economies have been bearing as a result of the expanding international capital markets and changing trade patterns.

With respect to reallocation of land resources, if land rents for agricultural uses have been converging, they have been doing so at relatively lower levels vis-à-vis land rents for urban–industrial uses. Furthermore, in the fringes of metropolitan complexes this convergence would be overshadowed by the increasing competition for agricultural lands from non-agricultural demands. In the agricultural hinterlands, land consolidation for economies of scale is more constrained in the resource-poor Asian economies (with land–labor ratios less than 1.0) than in the resource-rich economies. Since agriculture's share of total land resources in an economy does not tend to fall as dramatically as its shares of GDP and labor, the comparable parity ratios for land (i.e. in terms of GDP or rent per unit land in agriculture vis-à-vis non-agriculture), would tend to diverge from rather than converge toward unity as in the case of the parity ratios for labor. The structural imbalance, in terms of land rents between agriculture and the rest of the economy, would tend to increase, thereby generating greater adjustment pressures on the property and derived institutional systems, such as tenancy, taxation, and credit, that control natural resource reallocation decisions.

The convergence of agricultural land rents across middle-income and high-income countries, and the divergence of land rent parity ratios from unity, suggest that the economic nature of agricultural adjustments problems concerning reallocation of natural resource use are common across the Pacific basin countries, and there is a greater need to focus attention on structure, functioning, and performance of different institutional control systems governing resource use in these countries.

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