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**Agricultural Performance During Structural Transformation**

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Agricultural Performance During Structural Transformation

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As a society changes from being almost entirely agrarian to being minimally agrarian a structural transformation takes place over an extended period of time, with a continuous lessening of the proportion of labor and income in the agricultural sector. Determining factors during structural transformation include higher levels of productivity of factors of production in agriculture--labor and land--derived from inputs that come from beyond the sector and provision of an agricultural surplus in the form of food and raw materials (Mellor, 1966a). Agricultural resource endowment--land/labor ratio--determines and is determined by these elements.

The objective of this paper is to investigate the relationship between the performance of the agricultural sectors, resource endowments, and structural transformation in the Philippines and Thailand during a period in which the economies of both countries underwent significant change. The sources of increased agricultural production are examined in terms of changes in the use and productivity of on-farm inputs (land and labor) and the use of inputs from beyond the sector (fertilizer, machinery and irrigation). The generation of an agricultural surplus above the needs of the agricultural population and the shift of labor out of agriculture is analyzed.

A review is made of the relevant theoretical framework from the field of development economics. Multiple and simple regression analysis is used in a series of recursive equations to make a comparison of differences and similarities in the

process of structural transformation in the two countries, with respect to performance of the agricultural sector.

### **Structural Transformation in Economic Development Theory**

A major endeavor of the discipline of development economics has been to explain the process of structural transformation. The dual model of development was introduced by Lewis (1954) to analyze an economy in transition and Ranis and Fei (1961) extended the dual model. Lewis' "dual structure" is based on subsistence and capitalist sectors. Minami (1973) specified the two sectors as agricultural and nonagricultural for "rough approximations." In the dual model, agricultural sector employment is determined as a residual (Minami 1973; Johnston and Kilby 1975).

Central to Lewis' dual-economy model is the classical surplus labor theory. The premise of this theory is that there exists in the rural sector an excess quantity of labor such that the marginal product of labor in that sector is zero or negative, hindering the transfer of an agricultural surplus out of the rural sector for capital accumulation in other sectors. According to the surplus labor theory, significant amounts of rural labor could be removed from current use without lowering rural product, to accomplish a simultaneous transfer of labor and agricultural surplus to the nonagricultural sector. Lewis and Ranis and Fei included the agricultural surplus in their specification as a result of the transfer of surplus labor, not as the cause of the transfer of labor. Neither Lewis nor Ranis and Fei address the issue of the capacity of the nonagricultural sector to absorb

transferred labor.

Schultz (1964) and Mellor (1966b) see the marginal product of labor in the agricultural sector as being low, but positive, and contend that the use of complementary technical and institutional resources in the agricultural sector can increase productivity of land and labor. Nicholls (1963) criticizes the "excessive preoccupation" with surplus labor, because generation and mobilization of an agricultural surplus through increased productivity of land and labor is more important. According to Johnston and Kilby (1975) a "structural transformation turning point" is identifiable when the agricultural labor force declines absolutely.

Work by Kuznets (1971), Timmer (1984), Rothschild (1986), and Wells (1989) is all based on pooling short time-series data and a cross-section of developing countries. Notably missing from most empirical research on structural transformation has been the use of longer term time-series data for country-specific analysis. An exception is Yamaguchi et al (1974, 1975, 1982, 1984) where a two-sector model is used to analyze the "push" and "pull" of resources between the agricultural and non-agricultural sectors in Japan.

### **Regression Analysis**

Characteristics of structural transformation discussed previously include: increased productivity of agricultural labor and land due to the increased availability and use of augmenting inputs from beyond the agricultural sector; the generation of an agricultural surplus above the consumption needs of the agricultural population; and a relative decline

in the proportion of labor employed in the agricultural sector. These characteristics constitute the basis for the following analysis of agricultural performance during structural transformation in the Philippines and Thailand.

The analysis begins with a determination of the sources of agricultural land and labor productivity. Productivity of agricultural land and labor is explained through employment of technology embodied in or directly associated with irrigation, fertilization, and mechanization. This productivity and its direct relationship with resource endowment--agricultural land per agricultural laborer--determines the generation of an agricultural surplus. The generation of an agricultural surplus is expressed as an increased share of agricultural output above the consumption needs of the agricultural population. Finally, the mobilization of labor from the agricultural to the nonagricultural sector is explained in the context of the generation of an agricultural surplus, a divergence of labor productivity between the agricultural and nonagricultural sectors, and the export orientation of the agricultural sector.

Figure 1. illustrates the general relationships modeled in five recursive equations to explain the relationship between agricultural factor productivity, agricultural surplus generation, and intersectoral labor mobilization.<sup>1</sup>

Apart from the generality of the relationship between

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<sup>1</sup> Data used is from: World Bank (1988), USDA (1990), and FAO (1965-1989). The broad categorizations of agricultural and nonagricultural are in accordance with the definitions used in the data sources. Limitations and merits of the data sources used here are addressed in Wells (1989).

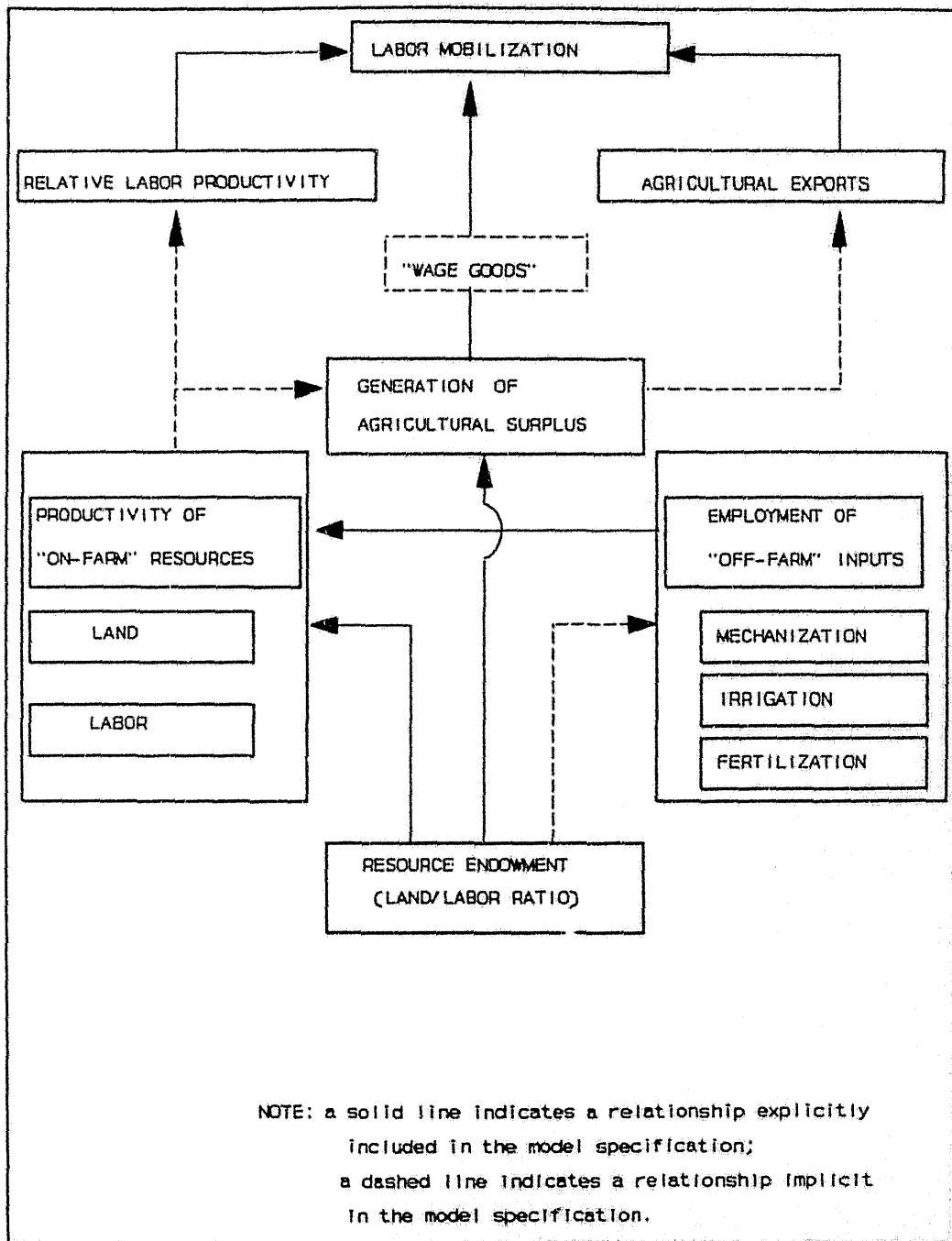


Figure 1 The Performance of the Agricultural Sector in Structural Transformation



agricultural productivity, agricultural surplus, and the mobilization of labor between sectors it would be expected that there is a difference between countries in the direction of influence and the relative importance of the variables used to explain the components of structural transformation process. This difference is based on variation in resource endowment. For the period analyzed (1961-1987), in the Philippines labor was the relatively abundant resource, as the land/labor ratio declined; and in Thailand land was the relatively abundant resource as arable land was rapidly expanded (FAO 1965-1989; USDA 1990). The change in productivity and resource employment in each country emphasized an increase in the productivity of the relatively scarce resource and increased employment of the relatively abundant resource (FAO 1965-1989; USDA 1990).

With the Philippines being a relatively land-constrained economy and Thailand a relatively land-abundant economy, it would be expected that the incremental impact of mechanization --a labor-saving technology--on labor productivity in the Philippines would be greater than in Thailand. Likewise, it would be expected that the incremental impact of fertilization --a land-saving technology--on land productivity in Thailand would be greater than in the Philippines. These impacts occur as respective off-farm inputs associated with the induced innovation choice are utilized in conjunction with a relatively larger endowment of on-farm resources--more tractors with more land in Thailand and more fertilizer with more labor in the Philippines (Hayami and Ruttan 1985).

The productivity of the relatively scarce resource in each country would be expected to be positively associated with the generation of an agricultural surplus. This means that that the two countries analyzed here would differ in terms of the basis of the generation of agricultural surplus. In the Philippines, a land-constrained economy, technology-induced land productivity would be the main source of agricultural output growth and there should be an inverse relationship between resource endowment and agricultural surplus generation. For Thailand, a land-abundant economy, there would be a direct relationship between resource endowment and the generation of an agricultural surplus.

The resource endowment should be positively related to intersectoral labor mobilization (the rate of growth of the nonagricultural labor force as a share of total labor) in both the land-constrained and the land-abundant situation. Just as the relative endowment of on-farm resources induces the emphasis in productivity to be directed toward the resource that is relatively scarce, so is the relationship between the generation of an agricultural surplus and intersectoral labor mobilization expected to vary depending on the relative productivity of the on-farm resources.

Under conditions of a land constraint, increases in labor productivity are a result of land productivity more than a result of resource endowment, while resource endowment predominates over land productivity in explaining labor productivity in a land-abundant situation. Thus, in the land-constrained Philippine economy, prior to the "structural

transformation turning point" where agricultural labor begins an absolute decline and the land/labor ratio increases. The generation of an agricultural surplus would be negatively associated with intersectoral labor mobilization. This is due to the increase in land productivity relative to labor productivity in the land-constrained situation, which means that there is an inverse relationship between land productivity and the transfer of labor out of agriculture in both the land-constrained situation and in the land-abundant situation. In the land-abundant Thai economy the generation of an agricultural surplus would be expected to be positively associated with the intersectoral mobilization of labor.

The generation of an agricultural surplus, alone, does not explain intersectoral labor mobilization. The relative labor productivity is expected to be negatively associated with the movement of labor out of agriculture, as the divergence in factor rewards between sectors "pulls" the labor resource out of the sector where it is less productive, and into the sector offering more productive employment. Export orientation in the agricultural sector is expected to be negatively associated with intersectoral labor mobilization, as agricultural exports offer the agricultural sector the ability to generate income beyond the realm of domestic intersectoral interactions (Johnston and Kilby 1975).

#### **Productivity of On-farm Resources**

Equations (1) and (2) are, respectively, agricultural labor (LA) productivity and land (D) productivity functions, specified as being explained by the introduction of inputs

from beyond the agricultural sector, through irrigation (W), fertilization (F), and mechanization (T). These off-farm inputs are expected to have augmented on-farm resources and thus the coefficients are expected to have positive signs. Equation (3) is an identity relating the association between on-farm resource productivity and resource endowment.

$$(1) \quad (YA/LA)_t = \lambda_0 + \lambda_1(W/LA)_t + \lambda_2(W/LA)_t^2 + \lambda_3(F/LA)_t + \lambda_4(F/LA)_t^2 + \lambda_5(T/LA)_t + \epsilon_{1t}$$

$$(2) \quad (YA/D)_t = \delta_0 + \delta_1(W/D)_t + \delta_2(W/D)_t^2 + \delta_3(F/D)_t + \delta_4(F/D)_t^2 + \delta_5(T/D)_t + \epsilon_{2t}$$

$$(3) \quad (D/LA) = [(YA/LA)_t / (YA/D)_t]$$

$$t = 1, 2, \dots, 27 \text{ years (1961-1987)}$$

Where (YA/LA) and (YA/D) are, respectively, the domestic agricultural product, in constant 1980 US dollars, per agricultural laborer and per hectare of arable land; (W/LA), (F/LA), and (T/LA) are, respectively, irrigated hectares, metric tons of fertilizer, and tractors per 1,000 agricultural laborers; (W/D), (F/D), and (T/D) are, respectively, irrigated hectares, metric tons of fertilizer, and tractors per 1,000 hectares of arable land; (D/LA) is the number of hectares per agricultural laborer.

Results from the estimation of equations (1) and (2) are in Table 4. For both countries the results reflect the positive influence of technology, embodied in off-farm inputs, in increasing the productivity of on-farm resources. Increased productivity and the intersectoral linkages implied by employment of the off-farm inputs are part of the set of characteristics of structural transformation in Figure 1.

Table 1. Regression results for test of the productivity of on-farm resources being explained by "off-farm" inputs during economic development, Philippines and Thailand, 1961-1987. <sup>a</sup>

variable	Philippines	Thailand
agricultural land productivity		
intercept	-416.13 *	-896.44
	(-2.06)	(-1.65)
(W/D)	11.06 **	16.75 **
	(3.40)	(2.25)
(W/D) <sup>2</sup>	-0.03 **	-0.06 **
	(-3.44)	(-2.21)
(F/D)	4.98 **	7.34 **
	(2.16)	(2.17)
(F/D) <sup>2</sup>	-0.04	-0.22 *
	(-1.41)	(1.79)
(T/D)	106.34 **	44.40 **
	(6.55)	(2.85)
F-value	435.64 **	50.60 **
R <sup>2</sup>	.99	.92
agricultural labor productivity		
intercept	-848.52 *	-1316.86 **
	(-2.27)	(-2.74)
(W/LA)	19.55 **	21.79 **
	(3.12)	(3.31)
(W/LA) <sup>2</sup>	-0.08 **	-0.07 **
	(-3.37)	(-3.14)
(F/LA)	7.13 **	8.44 **
	(3.14)	(2.73)
(F/LA) <sup>2</sup>	-0.09 **	-0.23 **
	(-2.66)	(2.38)
(T/LA)	115.33 **	67.56 **
	(7.80)	(3.28)
F-value	215.60 **	68.93 **
R <sup>2</sup>	.98	.94

<sup>a</sup> t-ratios are in parenthesis

\* significant at least at the .10 level

\*\* significant at least at the .05 level

A comparison of the coefficients for mechanization and for fertilization indicate that these technologies resulted in an incremental increase in on-farm resource productivity with respect to specific off-farm inputs in inverse proportions to the same on-farm resources and the off-farm inputs. That is:  $\partial(YA/LA)/\partial(F/LA)$  and  $\partial(YA/D)/\partial(F/D)$  for Thailand (with less fertilization) are greater than for the Philippines, and  $\partial(YA/LA)/\partial(T/LA)$  and  $\partial(YA/D)/\partial(T/D)$  for the Philippines (with less mechanization) are greater than for Thailand.

#### Generation of an Agricultural Surplus

Equation (4) specifies the generation of agricultural surplus as explained by the estimated dependent variables in equation (1) and equation (2)--productivity of agricultural labor and land. This association between the generation of an agricultural surplus and the productivity of on-farm resources is specified in terms of the relationship between labor productivity and land productivity in the identity in equation (3).

$$(4) \quad (AS/YA) = \sigma_0 + \sigma_1(D/LA)_t + \epsilon_4t$$

$$t = 1, 2, \dots, 27 \text{ years (1961-1987)}.$$

Where YA is domestic agricultural product; EA is expenditure for agricultural product; MA is agricultural population; MT is total population; and AS/YA is agricultural surplus as a share of domestic agricultural product. Agricultural surplus (AS) is defined, in constant 1980 US dollars, as the agricultural gross domestic product minus the expenditure for agricultural product weighted by the share of total population in agriculture:

$$AS = YA - (EA * MT).$$

Expenditure for agricultural product (EA) is defined as agricultural gross domestic product (YA) plus agricultural imports (RA) minus agricultural exports (XA):

$$EA = YA + RA - XA.$$

The results from estimation of equation (4) are in Table 2.<sup>2</sup> These results support the relationship, shown in Figure 1, between generation of agricultural surplus and resource endowment.

Just as there is a difference in the relative resource endowment for the Philippines and Thailand, the relationship between agricultural surplus and resource endowment is also different for the two countries. The divergence in the agricultural surplus generation paths can be observed by the opposite signs of the slope coefficients in Table 2. for each of the two countries. The relationship between agricultural surplus generation and resource endowment is:

$$\partial(AS/YA)/\partial(D/LA) < 0 \text{ for the Philippines; and}$$

$$\partial(AS/YA)/\partial(D/LA) > 0 \text{ for Thailand.}^3$$

For the land-abundant Thai economy, agricultural surplus was generated on the basis of a favorable resource endowment. This situation was due to a land expansion in the face of a

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<sup>2</sup> F-values are not calculated for these tests since the models contain only one independent variable and the t-ratios therefore constitute a test of the ability of the entire model to explain the variance in the dependent variable.

<sup>3</sup> This comparative statics analysis should be interpreted as the change in the dependent variable occurring due to changes in one underlying parameter with other parameters held constant.

growing agricultural labor force. A land constraint and rapidly growing agricultural population in the Philippines precluded generation of an agricultural surplus via a resource endowment path.

Given that in all cases:

$$\partial(D/LA)/\partial(YA/LA) > 0 \text{ and}$$

$$\partial(D/LA)/\partial(YA/D) < 0,$$

then the relationship between generation of an agricultural surplus and the productivity of the on-farm resources is:

$$\partial(AS/YA)/\partial(YA/LA) = \partial(AS/YA)/\partial(D/LA) * \partial(D/LA)/\partial(YA/LA)$$

< 0 for the Philippines and > 0 for Thailand; and

$$\partial(AS/YA)/\partial(YA/D) = \partial(AS/YA)/\partial(D/LA) * \partial(D/LA)/\partial(YA/D)$$

> 0 for the Philippines and < 0 for Thailand.

The Philippines generated an agricultural surplus on the basis of increased productivity of land derived from the use of factors of production originating from beyond the sector. The increased labor productivity in Thailand is primarily accountable to the increased resource endowment, and less so to the use of off-farm inputs. Therefore, the basis of Thailand's agricultural surplus generation was primarily resource endowment. Furthermore, this surplus generation is largely attributable to labor productivity associated with that resource endowment.

#### **Intersectoral Labor Mobilization**

Equation (5) specifies intersectoral labor mobilization --the growth rate of nonagricultural labor as a share of total labor--as explained by the estimated dependent variable in (4), by the exogenously given export orientation of the



agricultural sector, and by relative sectoral labor productivity.

(5)  $CDG =$

$$\Delta_0 + \Delta_1(AS/YA)_t + \Delta_2(AS/YA)_t^2 + \Delta_3(XA/YA)_t + \Delta_4[(YA/LA)/(YN/LN)]_t + \epsilon_5$$

$t = 1, 2, \dots, 27$  years (1961-1987).

Where CDG is the coefficient of differential growth or intersectoral labor mobilization, calculated as the difference between the growth rate of nonagricultural labor and the growth rate of the total labor force (Dovring 1959); (XA/YA) is agricultural exports as a share of domestic agricultural product; LA is agricultural labor; LN is nonagricultural labor; and [(YA/LA)/(YN/LN)] is domestic agricultural product per agricultural laborer as a share of domestic nonagricultural product per nonagricultural laborer.

The estimated coefficients and significance tests for equation (5) are in Table 3. The divergence in development paths due to differences in resource endowment is evident. The signs on the coefficients for the agricultural surplus variables are opposite for the two countries:

$\partial CDG / \partial (AS/YA) < 0$  for the Philippines and

$\partial CDG / \partial (AS/YA) > 0$  for Thailand.

As a result of the differences in resource endowment and the associated agricultural surplus generation path, the relationship between the resource endowment and intersectoral labor mobilization is the same for the two countries:

$\partial CDG / \partial (D/LA) = [\partial CDG / \partial (AS/YA)] * [\partial (AS/YA) / \partial (D/LA)] > 0$

for the Philippines and for Thailand.

The relationship between on-farm resource productivity and intersectoral labor mobilization is also the same for the two countries:

$$\begin{aligned} & \partial \text{CDG} / \partial (\text{YA} / \text{LA}) \\ & = [\partial \text{CDG} / \partial (\text{AS} / \text{YA})] * [\partial (\text{AS} / \text{YA}) / \partial (\text{D} / \text{LA})] * [\partial (\text{D} / \text{LA}) / \partial (\text{YA} / \text{LA})] \\ & > 0 \text{ for the Philippines and Thailand; and} \\ & \partial \text{CDG} / \partial (\text{YA} / \text{D}) \\ & = [\partial \text{CDG} / \partial (\text{AS} / \text{YA})] * [\partial (\text{AS} / \text{YA}) / \partial (\text{D} / \text{LA})] * [\partial (\text{D} / \text{LA}) / \partial (\text{YA} / \text{D})] \\ & < 0 \text{ for the Philippines and Thailand.} \end{aligned}$$

The result that increased agricultural labor productivity is positively associated with the mobilization of labor out of agriculture is not consistent with the classical labor surplus theory, where the productivity of labor is assumed to be unaltered by either technology or land expansion, but by outmigration from the agricultural sector. In the two economies analyzed here, the equilibrating effect that brings the land-constrained and the land-abundant situations to have intersectoral labor mobilization responses of the same nature is the determinant effect that resource endowment has on the relative productivity of land and labor.

While agricultural surplus was generated via different paths and intersectoral labor mobilization responded differently in the different resource endowment situations, the force that "pushed" labor out of agriculture was the ability to produce an incremental increase in agricultural surplus with the same amount of labor due to a change in technology or a land-supply-induced change in resource endowment, not due to outmigration of agricultural labor.

Again, the direction of association here is contrary to the

Table 2. Regression results for test of the generation of agricultural surplus being explained by "resource endowment" Philippines and Thailand, 1961-1987.<sup>a</sup>

variable	Philippines	Thailand
intercept	0.94 ** (41.05)	-0.87 * (-2.04)
(D/LA)	-0.50 ** (-19.82)	1.21 ** (3.01)
R <sup>2</sup>	.94	.27

<sup>a</sup> t-ratios are in parenthesis

\* significant at least at the .10 level

\*\* significant at least at the .05 level

Table 3. Regression results for test of intersectoral labor mobilization being explained by agricultural surplus, agricultural export orientation, and relative labor productivity, the Philippines and Thailand, 1961-1987.<sup>a</sup>

variable	Philippines	Thailand
intercept	51.79 ** (3.42)	-34.38 ** (-5.69)
(AS/YA)	-1999.47 ** (-3.21)	188.33 ** (5.74)
(AS/YA) <sup>2</sup>	200.40 ** (3.23)	-211.57 ** (-5.82)
(XA/YA)	-0.75 (-0.91)	-6.22 ** (-2.65)
[(YA/LA) /(YN/LN)]	-3.75 ** (-2.83)	-15.58 (-1.20)
F-value	34.48 **	14.79 **
R <sup>2</sup>	.87	.72

<sup>a</sup> t-ratios are in parenthesis

\*\* significant at least at the .05 level

classical surplus labor theory where agricultural surplus is generated as a result of a reduction in the agricultural laborforce. The inverse relationship between land productivity and intersectoral labor mobilization derives from the ability of the land, being either more available or more productive, to employ more labor at higher productivity levels.

The signs of the coefficients for export orientation and for relative labor productivity were as expected for both countries, indicating a negative relationship between these variables and intersectoral labor mobilization.

### Summary

Structural transformation involves a sectoral reallocation of the employment of resources. Economic development theory suggests structural transformation is related to the productivity of agricultural labor, the productivity of agricultural land, and the generation of an agricultural surplus beyond the needs of the agricultural population. These factors, in various combinations, have been given different roles and priorities in the theory.

This paper sought to identify and explain the characteristics and patterns of structural transformation in the Philippines and Thailand for the period 1961-1987. The Philippines is identified as a land-constrained economy and Thailand is identified as a land-abundant economy.

First, a test was conducted on the relationship between the productivity of on-farm resources and the employment of technology embodied in off-farm inputs. This change in productivity was directly associated with the resource

endowment as outlined in the induced innovation hypothesis. Using this direct association, a test was made of the relationship between resource endowment and the path for generation of an agricultural surplus. Finally, mobilization of labor out of agriculture was modeled as explained by the generation of an agricultural surplus, a divergence of labor productivity between sectors, and agricultural sector export orientation.

Support was given to the general hypothesis of increasing the productivity of on-farm resources with technology that is embodied in off-farm inputs. Irrigation, fertilization, and mechanization were all positively and significantly related to labor and to land productivity.

Generation of an agricultural surplus was significantly associated with the resource endowment. There was a divergence between the two countries in the agricultural surplus generation paths, with the resource endowment being positively related to agricultural surplus generation in Thailand and negatively related to it in the Philippines.

The relationship between the productivity of on-farm resources and agricultural surplus was also opposite for the Philippines and Thailand. The Philippines generated agricultural surplus on the basis of increased productivity of land derived from the use of factors of production originating from beyond the sector. Due to the inverse relationship between resource endowment and land productivity, Thailand's land productivity was negatively associated with agricultural surplus generation.

The relationship between intersectoral labor mobilization and resource endowment was consistent between countries with resource endowment positively associated with the labor mobilization. The determinant effect that resource endowment has on labor productivity and on land productivity results in a common explanation for intersectoral labor mobilization in the land-constrained and the land-abundant situations.

There was also cross-country consistency between on-farm resource productivity and intersectoral labor mobilization. Agricultural labor productivity was positively associated with intersectoral labor mobilization based on the ability to produce an incremental increase in agricultural surplus with the same amount of labor due to a change in technology or a land-induced change in resource endowment. This is in contradiction to the classical surplus labor theory. Land productivity was negatively correlated with intersectoral labor mobilization due to the land, whether more available or more productive, being able to employ more labor at higher productivity levels. Export orientation and relative labor productivity were negatively related to intersectoral labor mobilization.

Implications are in terms of emphasis to be placed on alternative agricultural development paths, given resource endowments. The resource endowment determines the relative advantage of different technologies embodied in factors of production that come from beyond the sector, as well as having an effect on the forces that transfer labor out of agriculture. The appropriate emphasis will change as the

resource endowment changes due to exhaustion of the land frontier, population growth, and/or mobilization of labor out of agriculture. A rapidly declining resource endowment implores action to increase the productivity of existing on-farm resources. Only when nonagricultural employment can absorb all of the labor growth arising from the natural increase in population in both the agricultural and the nonagricultural sectors can technical innovation turn to production processes that emphasize factors of production that substitute for labor.



## Bibliography

- Dovring, F. 1959. "The Share of Agriculture in a Growing Population." Monthly Bulletin of Agricultural Economics and Statistics 8(8/9):1-11.
- FAO. 1965-1989. Production Yearbook. Rome, Italy: United Nations Food and Agricultural Organization.
- Hayami, Y., and V. Ruttan. 1985. Agricultural Development: An International Perspective. Baltimore, Maryland: Johns Hopkins University.
- Johnston, B. F. 1984. "Agriculture and Structural Transformation in Developing Countries: A Survey of Research." Journal of Economic Literature 8:369-404.
- Johnston, B. F., and P. Kilby. 1975. Agriculture and Structural Transformation. New York, New York. Oxford University Press.
- Kuznets, S. 1971. Economic Growth of Nations. Cambridge, Massachusetts: Harvard University Press.
- Lewis, W. A. 1954. "Economic Development with Unlimited Supplies of Labor." Manchester School of Economics and Social Studies 22: 139-191.
- Mellor, J. W. 1966a. "Toward a Theory of Agricultural Development," in Agricultural Development and Economic Growth, edited by Herman M. Southworth and Bruce F. Johnston. Ithaca, New York: Cornell University Press.
- Mellor, J. W. 1966b. The Economics of Agricultural Development. Ithaca, New York: Cornell University Press.
- Minami, R. 1973. The Turning Point in Economic Development: Japan's Experience. Tokyo, Japan: Kinokuniya Bookstore.
- Nicholls, W. H. 1963. "An 'Agricultural Surplus' as a Factor in Economic Development." The Journal of Political Economy 61(1): 1-29.
- Ranis, G., and J.C.H. Fei. 1961. "A Theory of Economic Development." American Economic Review 51: 533-546.
- Rothschild, E. 1986. "A Divergence Hypothesis." Journal of Development Economics 23:205-226.
- Schultz, T. W. 1964. Transforming Traditional Agriculture. New Haven, Connecticut: Yale University Press.
- Syrquin, M. 1988. "Patterns of Structural Change," in Handbook of Development Economics, vol. 1, edited by Hollis Chenery and T.N. Srinivasan, New York: Elsevier Science Publishing Co., Inc.

Timmer, C. P. 1984. "Energy and Structural Change in the Asia-Pacific Region: The Agricultural Sector," in Energy and Structural Change in the Asia-Pacific Region: Papers and Proceedings of the Thirteenth Pacific Trade and Development Conference. Manila, Philippines: Institute of Development Studies and the Asian Development Bank.

USDA/ERS. 1990. "World Agricultural Trends and Indicators." Washington, D.C.: USDA.

Wells, J. C. 1989. "On the Agricultural Performance of Developing Countries, 1950-1985." Food Research Institute Studies 21(3):165-186.

World Bank. 1988. World Table . Washington, D.C.: World Bank.

Yamaguchi, M. 1974. "Population Effects on the Economic Development of Japan." Staff Paper P74-11, Department of Agricultural and Applied Economics, University of Minnesota.

Yamaguchi, M. and H. P. Binswanger. 1975. "The Role of Sectoral Technical Change in Development: Japan, 1880-1965." American Journal of Agricultural Economics 57(2):269-279.

Yamaguchi, M. 1982. "The Sources of Japanese Economic Development: 1880-1970." Economic Quarterly 33:112-146.

Yamaguchi, M. and G. Kennedy. 1984. "A Graphic Model of the Effects of Sectoral Technical Change: The Case of Japan, 1880-1970." Canadian Journal of Agricultural Economics 32:71-88.