Labor Market Structure, New Export Crops, and Inequality: The Case of Mariculture in Honduras*

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I. Introduction

With the halting of agrarian reforms in most developing countries, policy makers are increasingly relying on the labor market to reduce rural poverty and improve income distribution. Outward-looking growth strategies and nontraditional exports in particular should provide large increases in employment and income for the landless poor. Crop adoption rates, changing land access, labor absorption trends, and the working of the labor market ultimately will determine the impact of new exports on the rural resource-poor.

This study analyzes the condition of the local labor market in a nontraditional mariculture (shrimp farming) export zone in southern Honduras. The site is particularly relevant, as promoters argue that the industry's employment generation offsets changes in coastal land access that reduced the livelihood options of the poor.[1] A similar pattern is emerging in coastal mariculture expansions throughout the developing world. In each case, whether the labor market operates in a segmented or clearing fashion can determine whether the new exports contribute to a broadly based development process.

A "segmented" labor market is characterized by persistent divergent wage trends across low-paying and high-paying jobs, wage inflexibility, and restricted mobility into the upper tier. Nonegalitarian rationing of upper-tier entry along race or class lines perpetuates and may worsen preexisting income distribution problems. Employers do the sorting, and they may segment the labor force for one or more of the following reasons: to reduce quitting rates of trained workers and turnover costs, to enhance worker self-supervision through efficiency wages, to follow government minimum wage requirements, or to respond to unionization.[2] A more radical variant of segmentation revolves around employers' need for social control of rebellious rural workers in highly conflictive settings.[3]

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Some argue that the appearance of wage differentials reflects a temporary disequilibrium in a clearing (often called "competitive") labor market. Generally two groups of workers self-select their place of employment according to differences in sectoral nonpecuniary benefits, costs of entry, personal human capital, or ability. In the popular Roy model, supply-side factors dominate job sorting.[4] Wages are flexible, and earnings gaps of workers operating under different contracts reflect productivity differences or compensating differentials. Market equilibration and ability-based income differentials occur over time.

This case study uses data from a household survey to determine which type of labor market is emerging in the Honduran nontraditional export region. The article contributes to the literature by linking explanations of hypothesized segmentation to its empirical verification under a variety of statistical and econometric techniques. For compatibility with other studies, the article uses a tier division of informal- and formal-sector jobs and contracts. In addition, the article highlights the often ignored influence of family ties and social capital in second-best labor markets.

Section II deals with the employment potential of nontraditional exports such as farm-raised shrimp. It reviews selected contractual arrangements to provide theoretical predictions about how the labor market will behave. In Section III the understanding of clearing and nonclearing labor markets in the rural setting is formalized by introducing an endogenous simultaneous switching system. In Section IV I use a cross-sectional data set on earnings and employment to test the econometric model. The results support the notion of a weakly segmented labor market equilibrium, yet they suggest that the source of segmentation along family lines differs from that discussed in the standard literature. Also, the implications for rural income distribution are discussed. Section V concludes.

II. Research Setting and Industry Employment Trends

Farm-raised shrimp production, like other aquaculture enterprises, is one of the fastest-growing industries worldwide. Mariculture involves the transformation of raw larva seed into edible shrimp through stocking and feeding in pond grow-out systems. Industrial production of shrimp began in the southern zone of Honduras in 1985. The southern zone has traditionally been one of the country's poorest areas, with high population densities and declining environmental resources. The previous expansion of cotton, sugar, and cattle farms in the zone resulted in extensive deforestation and population displacement.[5] Poor soils and cycles of drought and flooding have resulted in particularly bad harvests of basic grains and out-migration.

It is hoped that the new nontraditional agricultural exports, such as

shrimp and melon, will solve the twin goals of foreign-exchange generation and regional development. Under Decree 968 of 1980 and Agreement 229 of 1991, the Ministry of Tourism (SECTUR) and the General Directorate of Fishing (DIGPESCA) were mandated to transfer coastal land-use rights to exporters. By 1993 more than 31,000 hectares in southern Honduras had passed from communal gathering use to export development, and some 80 farms operated 11,500 hectares of ponds.[6] These enclosure and land access changes may have negative employment effects, since they reduce the opportunities for self-employment by coastal households and increase the market supply of labor, resulting in downward pressure on existing wage rates. However, new jobs created by the mariculture industry and associated firms increase the market demand for labor, so the final effect on village wage levels remains unclear. The type of mariculture technology implemented (extensive or semi-intensive) and farm size also affect the final labor demands.

Most mariculture studies have focused on one aspect of the labor market—the number of jobs created—and present wide discrepancies. The most commonly cited figure is 12,000 families employed by the Honduran shrimp industry.[7] Casual labor contracts dominate the local market, and to date about 30% of the shrimp jobs are permanent, and 50% of the positions are direct hire. In general, the industry exhibits a decreasing intensity of labor use with size, so that the big farms create fewer jobs per land unit than the smaller ones.[8]

Specific labor contracts for different tasks in mariculture reflect the technology and social setting in which production occurs. The agency problem around effort extraction represents the largest worker management problem in many natural resource industries, such as mariculture. The unsupervisable task of larva gathering for shrimp seed to stock the ponds (the task requiring the largest number of people in the region) is a case in point. Firms acquire synthetic seed from international hatcheries or wild seed from local contractors who manage the gatherers' labor. A gatherer's product is influenced by his or her effort and by the total larvae available, which is a function of stochastic variables such as water temperature, salinity, and the lunar cycle. In effect, the fruits of the gatherer's work or shirking cannot clearly be separated from the impact of the stochastic natural environment, so a classic moral hazard problem emerges.

Labor contractors use two types of incentive-compatible contracts—tournaments and piece rates—to solve the moral hazard problem. In some areas the contracts exist side by side, which suggests that workers could be compensated under either arrangement. The use of these two types of contracts also makes it possible to control for concerns about occupational-specific compensating differentials across jobs in the lower and upper tiers as an alternative explanation to segmentation.

Piece-rate contracts are common in gathering and fishing settings.[9] These daily contracts may be viewed as a form of egalitarian rationing in which all who desire can work. The slice of the total possible employment is "rationed" into smaller pieces in a nondiscriminatory manner. But returns (the average piece rate) may be scaled down as the number of entrants increases or the natural environment changes, so that wage rates are flexible. Piece-rate gathering arrangements resemble other temporary rural labor contracts in cattle tending, sugarcane cutting, and land clearing, and these occupations are grouped along with other temporary work into a "lower tier" of the labor market.

Access to the more unusual tournament contracts, however, represents the type of nonegalitarian rationing common in the efficiency wage and labor market segmentation literature. Contractors choose their permanent gatherers very carefully, and job retention is a function of both player effort and luck. In the tournament payment system, shrimp farm technicians and labor contractors rank gatherers on the basis of performance; winners are retained for the next period and paid a salary with bonus, and losers are not invited back to work and thus are fired. Tournament players remaining with a labor contractor for several months enter into an interlinked labor-consumption contract with additional benefits not unlike those offered to full-time formal-sector workers covered by national labor laws. These occupations may be grouped together into an "upper tier" of the labor market.

These institutional features of the labor market suggest that a distinct schism is emerging between the formal and informal sectors and that efficiency wage concerns may offer a plausible explanation for earnings differentials and segmentation. Higher wages should be associated with upper-tier workers undertaking unsupervisable tasks, and both fixed payments and returns to human capital may be higher in this tier of the labor market. However, other hiring and signaling mechanisms may reduce the need to pay efficiency wages. Reliance on kin networks is increasingly cited in the literature as an alternative mechanism for ensuring worker productivity.[10] Hiring along family lines is a fishing industry tradition.

Other demand-side explanations for segmentation, as suggested by Funkhouser, might be relevant in the Honduran case.[11] Mariculture firms could be paying the most experienced, trained farm employees higher wages to reduce turnover costs. Likewise, larva seed contractors may want to reduce the turnover of experienced gatherers who have acquired significant fishing knowledge. A minimum-wage explanation of segmentation is less compelling, as the Honduran labor code pertains only to direct-hire permanent shrimp farm employees who have worked more than 3 months. In 1993 shrimp farms were legally required to pay (permanent) laborers L 17.50–L 21.00 (L = lempiras; $2.50–$3.00) daily.

Yet this minimum is not a relevant price floor, since the observed sample mean and employer offer are higher.

As yet no unions exist in the nontraditional agricultural export sector. Substitute management-sponsored solidarity associations operate on the large shrimp farms. These organizations provide economic benefits, such as discount shops and savings clubs, to permanent workers to enhance their loyalty and, indirectly, their effort for the firm in a "pseudo-efficiency-wage" arrangement. Indeed, the use of solidarity associations could lend support to a more radical interpretation of segmentation as a means to divide an angry rural population affected by enclosure. Under this scenario, higher earnings differentials between the upper and lower tier in the most enclosed village are expected. Additional supply-side causes of segmentation are explored below, and the relevance of each of these segmentation variants is sorted out by analyzing the results of an endogenous simultaneous switching model.

III. An Econometric Model to Explore Segmentation

Several statistical techniques commonly are used to verify the segmentation suggested by theory. The econometric challenge is to provide consistent estimates of sectoral earnings equations and, if possible, to control for relevant economic factors such as human capital, latent ability, and costs of entry. In this article I undertake these estimates and then test for labor market segmentation through the use of methods developed in extensions of the Roy model.[12]

In statistical terms, the first criterion for segmentation is the existence of distinct wage payment equations across tiers, with higher rewards to human capital in the upper tier. Two separate earnings functions should fit the data better than a pooled function. Selectivity corrections of the earnings functions often are necessary, since self-selection may be based on a worker's latent and visible characteristics.

In the simplest model, tier groups are mutually exclusive so that a dichotomous, univariate probit selection function is appropriate.[13] Total sample observations on earnings are split into an "s" and an "n" subgroup by whether a worker is ever observed in the upper tier ($M = 1$). The latent choice rule is

$$M^* \begin{cases} 1 \text{ enter the upper tier if } M^* > 0, & \text{group s,} \\ 0 \text{ remain in the lower tier if } M^* \leq 0, & \text{group n.} \end{cases} \tag{1}$$

Tier placement is an endogenous choice rule based on both earnings differentials and other factors, as driven by self-selection or employer

sorting. Let the daily earnings of the two tiers be Y_{is} and Y_{in}, with C as the costs of entry into the upper tier.

The reduced-form tier placement rule measures the relative gains to upper-tier work less the cost of entry:

$$M^* = Y_{is} - Y_{in} - C. \tag{2}$$

The binary tier outcome M^* is a function of the "m" exogenous variables in Z_i and the X_i variables in the earnings regressions, since income is a determinant of participation.[14] Equations (3)–(5) describe the full endogenous switching system of earnings for a single agent:

$$M = M^* = b_1'Z_i + b_2X_i + w_i, \quad M = 0, 1, \tag{3}$$

$$E(Y_i|M) = \begin{cases} Y_{is} = \alpha_s + B_s'X_i + E[\varepsilon_{is} & \text{if } M = 1], \quad (4) \\ Y_{in} = \alpha_n + B_n'X_i + [\varepsilon_{in} & \text{if } M = 0], \quad (5) \end{cases}$$

where

Z_i = an $m \times 1$ vector of regressors unique to selection;
X_i = a $k \times 1$ vector of regressors on earnings;
B_s, B_n = a $k \times 1$ vector of coefficients of parameter returns for those in the upper tier and lower tier;
b_1, b_2 = the $m \times 1$ and $k \times 1$ vector of coefficients measuring the contribution of factors in upper-tier selection;
α = intercept terms to capture fixed differentials across tiers; ε and ω are random error terms (ρ as the cross-correlation of ε and ω).

The coefficients α_s and α_n measure the fixed benefit of entering the upper or lower tier. It can be verified empirically if earnings are higher in the upper tier for factors unrelated to a worker's endowments by examining if $\alpha_s > \alpha_n$. B_s and B_n vary across regimes to measure the differential contribution of observable endowments to earnings.

The common second criterion for segmentation is that access to the better tier of work is rationed, so the majority remains in a lower tier. Recall that in a clearing market supply-side factors dominate job allocation. A person decides whether to self-select into a tier by evaluating the compensating differences across tiers for his or her human capital. Thus, a formal definition of segmentation is one in which any worker, *i,* with given observable attributes, *x,* and latent factors, *L,* would earn more in the upper tier, but some workers remain in the lower tier, since upper-tier placements are rationed:

$$E(y_s|x_{is}, L_{is}) > E(y_n|x_{in}, L_{in}) \text{ and } \exists \text{ some } i \in n. \quad (6)$$

If such differentials exist, earnings-maximization behavior suggests that a worker should be found in the high-paying sector, but barriers prevent him or her from getting there.[15] The most direct test of this inequality is to evaluate a person with the mean characteristics of the tier group across both payment structures.[16] Using the coefficients from equations (4) and (5), it can be determined whether the following terms are greater than zero:

$$\bar{X}_s(B_s - B_n) > 0 \quad \text{and} \quad \bar{X}_n(B_s - B_n) > 0. \quad (7)$$

In addition, following Heckman and Hotz, Magnac, and Assaad, this rationing of entry into the upper tier can be established by rejecting or accepting "competitive" (clearing) market cross-equation restrictions, taking into account upper-tier costs of entry.[17] In these variations of the Roy model of occupational choice and earnings, rationing creates high costs of entry into the upper tier, and these costs vary by the individual's background characteristics. The implicit price of entry into the upper tier should be identical to the differences in the earnings across tiers in a competitive market.

This means that if the coefficient variables in the tier-sorting equation are proportional to the difference between the coefficients of the same variable in the two wage equations, the conditions of entry into the upper tier match the perceived earnings differences so that the market is operating in a competitive fashion. In equations (3)–(5),

$$B^* = -(B_s - B_n)\alpha^* = -(\alpha_s - \alpha_n)\varepsilon^* = -(\varepsilon_{is} - \varepsilon_{in}).$$

The sorting regime of equation (1) in fact reduces to include the terms B^*, α^*, and ε^*. The cross-equation restriction of a competitive, clearing market is operationalized as $B_{2k} = B^* = B_{sk} - B_{nk}$ (for each of the variables common to all equations)

$$b_{2k} = B^* = B_{sk} - B_{nk} \quad (8)$$

(for each of the variables common to all equations). Rejection of this equality implies some form of segmentation in the labor market. It can then be determined whether the mechanisms of rationing across tiers are related to economic or noneconomic background characteristics of the workers.

Ordinary least squares (OLS) estimates of earnings are followed by full-information maximum likelihood (FIML) estimates with endogenous switching of the system in equations (3)–(5). The OLS results are useful when addressing the first criterion for segmentation and the earnings

inequalities implied in equations (6)–(7). The cross-equation correlation coefficients ρ_s and ρ_n as well as the standard error terms σ_s and σ_n and variances are provided by the maximum likelihood estimates, and, following standard practice, it is assumed $[\varepsilon_{is}, \varepsilon_{in}, w_i] \sim N(0, \Sigma)$. The likelihood-ratio test statistics are derived from the FIML results to test the cross-equation restrictions of competition implied in equation (8). The likelihood-ratio test requires the separate estimation of both the unconstrained and constrained likelihood functions.[18] Interpretation of the likelihood-ratio test results will depend on the common variables restricted in subgroups.

IV. The Operational Model and Econometric Results

A. Data and Descriptive Statistics

The data come from a firsthand random survey of coastal households in southern Honduras conducted in 1993. Repeated-visit record keeping and formal interviews of 150 coastal households were undertaken in three midsized villages affected by shrimp farming.[19] Enumerators collected data biweekly over 10 months, gathering information on households' monthly and total yearly income, days worked in different activities, as well as fixed household human capital and asset variables.[20]

Table 1 defines the relevant survey variables used in both the selec-

TABLE 1

VARIABLE DEFINITIONS

Variable	
Earnings equations:	
Income	Natural log of daily income
Kin	Dummy variable = 1 if worker is a relative of a labor contractor
Land	Manzanas (=0.7 hectares) of owned land
Experience	Dummy variable = 1 if worker has fishing experience, experience in shellfish collection, or a skilled trade
Age	Age of main worker
Literacy	Dummy variable = 1 if worker is literate
Village B	Dummy variable = 1 if household resides in middle zone
Village C	Dummy variable = 1 if household is in eastern village
Tier selection equation:	
Work	Dummy variable = 1 if worker entered the upper tier
Adult equivalent	Number of household members
Preference	Dummy variable = 1 if stated preference for fixed-wage contract payment
Kin	Dummy variable = 1 if relative of contractor
Land	Manzanas (=0.7 hectares) of owned land
Experience	Dummy variable = 1 if previous work in fishing, shellfish collection, or a skilled trade
Age	Age of main worker
Literacy	Dummy variable = 1 if worker is literate
Village B	Dummy variable = 1 if household resides in middle zone
Village C	Dummy variable = 1 if household is in eastern zone

tion and earnings equations. Imputed daily log earnings is the regression dependent variable as the total annual household income per day. This variable represents sources of income reported by all working-age members of the family. Different seasonal marginal products of labor exist for wage and self-employment, and calculating total yearly income allows temporal differences in expenses and incomes to round out. Data on the standard continuous variables determining earnings (age, education, landholdings) were collected, as well as index variables measuring family affiliation, literacy, the type of previous job experience, and worker's contractual preference.

An initial division into work tiers of the village households engaged in shrimp farming was made by classifying into the upper tier those who worked at least 1 month full-time on a shrimp farm or in larva-gathering contracts for a fixed wage payment.[21] The sample includes 81 households in the upper tier and 45 in the lower tier. The operational model includes the variables of family kinship ties, landholdings, work experience, literacy, age, and village residency as determining earnings. These variables are incorporated into the selection equation, together with the background characteristics of the worker, contractual preference, and household size to allow identification of the system.

The variable descriptive statistics in table 2 show a wide variation of income across tiers and villages. Across all villages, the upper-tier worker earns 40% more during the year, or 0.22 log points in daily wages, than the lower-tier worker. Even controlling for upper-tier workers who show more days of employment across the year, the sample daily wage for upper-tier work on the shrimp farms is L 24.47 ($4.45), while that for off-farm temporary agricultural labor is L 19.69 ($3.58).

Workers in both tiers earn more in village A than in the other two sites, and village A has multiple farm types and labor contracts. In village C nearly 94% of the public wetlands have been enclosed and converted to large-scale mariculture ponds. Two areas of impact on the labor market are particularly relevant in village C: (1) the high enclosure rates of public wetlands, increasing the labor supply and putting downward pressure on wage rates; and (2) the subsequent implementation of semi-intensive techniques, creating greater demands for labor. At the other extreme, in village B small-scale artisanal shrimp farms are more common, and only 30% of the public wetland area have been converted to private lease households.

B. Empirical Results

In both table 2 and the probit selection results of table 3, village effects are strong determinants of tier placement. Workers residing in village C are 55% more likely to enter the upper tier, while those in village B are 39% less likely. Kinship with a labor contractor—as a form of social capital—also is strongly associated with upper-tier permanent larva-

TABLE 2

DESCRIPTIVE STATISTICS

Variable	Total Sample (N = 145)	Upper Tier (N = 81)	Lower Tier (N = 64)
Income: Log daily earnings*	$3.10 = L 22.20	$3.20 = L 24.47	$2.98 = L 19.69
	(.60)	(.57)	(.58)
Work*	.56	1.00	.00
Adult equivalents	4.41	4.40	4.42
	(1.81)	(1.76)	(1.86)
Preference*	.62	.67	.56
	(.49)	(.47)	(.50)
Kin*	.24	.36	.09
	(.43)	(.48)	(.29)
Land (manzanas)	1.60	1.56	1.66
	(2.48)	(2.77)	(2.07)
Age (years)*	33.52	30.07	37.89
	(14.17)	(11.46)	(16.05)
Literacy*	.56	.64	.45
	(.49)	(.48)	(.50)
Experience	.19	.16	.23
	(.40)	(.37)	(.43)
Place of residence:			
Village A	.29	.28	.30
	(.46)	(.45)	(.46)
Village B*	.29	.09	.55
	(.46)	(.28)	(.50)
Village C*	.42	.63	.16
	(.50)	(.49)	(.37)

NOTE.—Values are means, with standard deviations in parentheses.

* Indicates a significant difference in means of the upper and lower tier at the 95% level.

gathering or on-farm positions. A person with a relative already on a shrimp farm is 23% more likely to enter the upper tier. It is surprising that in specification 1 workers who prefer fixed wage payments do not end up in the upper tier, yet this changes in specification 2 when the village effects are omitted. As expected under self-selection, more educated workers (in terms of literacy) are more likely to participate in the upper tier.[22] Landholdings appear inversely related to upper-tier work, possibly because well-endowed individuals would choose self-employment and select out of permanent labor contracts. The model of tier placement correctly predicts 81% of the observations.

The results of the OLS regressions on the semi-log-linear earnings functions without controlling for selectivity are presented in table 4. The first specification includes village residency as a determinant of earnings, while specification 2 excludes residency. There is a 25% divergence in base pay levels, as might be expected in the efficiency wage variant of segmentation. The variables of literacy, work experience, landholdings, and village effects are the significant determinants of earnings. Of the

TABLE 3

PROBIT MAXIMUM LIKELIHOOD ESTIMATES OF REDUCED-FORM TIER PLACEMENT RULE
(Reference Is Lower-Tier Work)

	SPECIFICATION 1		SPECIFICATION 2	
	Coefficient	Slope	Coefficient	Slope
Constant	.22	.17	.64	.25
Kin	.59*	.23*	.91***	.36***
Land	−.05	−.02	−.003	−.001
Preference	−.45	−.18	.47*	.18*
Adult equivalents	.07	.03	.04	.015
Experience	.08	.005	−.30	−.12
Literacy	.21	.06	.17	.07
Age	−.005	.0007	−.04	−.02
Age squared	−.0003	−.0001	.0002	.0001
Village B	−1.02***	−.39***		
Village C	1.44***	.55***		
Log-likelihood	−62.16		−84.97	
Chi-squared	74.69***		29.07***	

NOTE.—Number of observations for both specifications is 145.
* Significant at the 10% level.
*** Significant at the 1% level.

TABLE 4

OLS REGRESSIONS ON INCOME

	SPECIFICATION 1			SPECIFICATION 2		
	Upper (1)	Lower (2)	All (3)	Upper (4)	Lower (5)	All (6)
Constant	3.07*	2.78***	2.63**	2.61	2.40***	2.63**
Experience	.31*	.23*	.30	.32*	.32*	.32*
Kin	.09	.04	.13	.16	.27	.24
Literacy	.25**	.35**	.23***	.27**	.28**	.23***
Age	.06	.023	.014	.02	.03	.015
Age squared	−.0003	−.0003	−.0002	−.0002	−.0003	−.0002
Land	.04	−.10*	.006	.04	−.07	.004
Village B	−.36*	−.38*	−.38*			
Village C	−.37*	−.06	−.26*			
R^2	.24	.28	.23	.15	.24	.17
SE	.52	.75	.54	.54	.57	.56
F-Statistics	2.77**	2.99*	5.10***	2.25*	3.08*	4.87***
Number of observations	81	64	145	81	64	145

* Significant at the 10% level.
** Significant at the 5% level.
*** Significant at the 1% level.

upper-tier workers, those in village C do 37% worse than those in the omitted village A. Lower-tier workers in village B earn 38% less. But the largest gap between the upper- and lower-tier workers is still observed in village C, where public lands enclosure has been most extensive.

Recall that the first criterion of the dual labor market theory is the existence of two separate earnings equations with significantly higher returns to human capital in the upper tier. Although returns to literacy are higher in the lower tier, the other human capital variables of fishing experience and age have larger upper-tier coefficients, and the differential on the fishing experience dummy is highly significant. In addition, the returns to landholdings are quite different across the tiers. Use of each additional land unit reduced lower-tier earnings by 9.4%, yet increased upper-tier earnings. Thus, differential access to technology and other inputs also contributes to the earnings differentials across tiers.

Despite the significant difference in several of the individual earnings coefficients, results of a Chow test suggest that one equation fits the data better than two separate earnings trends.[23] The null hypothesis of at least a weakly competitive market cannot be rejected; however, this does not necessarily mean the segmentation hypothesis is rejected.[24]

Following equation (7), it appears that workers would choose to work in the upper tier if they could. Using the average value of the explanatory variables under the different payment structures, I found that upper-tier workers earn about 1% more than they would have in the lower tier, but the differential for lower-tier-type workers was 18%. Using the actual background characteristics of the 145 observations in the data set, 55% would receive higher expected earnings in the upper tier. Although these percentages are not as high as those reported in other studies,[25] they provide some support for the second criterion of segmentation.

Tables 5 and 6 report results from the joint FIML estimation of selection and earnings. The signs of the coefficients on most of the variables in table 5 match those under the earlier results. Including the village regressors provides a better fit in specification 1, yet sharper trends in the other selection variables are observed in specification 2.

The significant cross-equation correlation for the upper tier suggests a positive sorting of workers. A significantly positive relationship exists between the latent factors affecting the probability of entering the upper tier and the earnings return to those factors. Thus, those who work in the upper tier earned more there, ceteris paribus, than an average person would have. The insignificant sign of the correction term in the lower-tier equation implies that there is no relationship between the worker's propensity to be in the lower tier and unexplained earnings there.

A Chow test on the probit two-stage least squares results (which

TABLE 5

MAXIMUM LIKELIHOOD ESTIMATES OF BASE MODEL SPECIFICATION 1

	SINGLE EQUATION MODEL		SWITCHING REGRESSION MODEL		
	Select (1)	General Earnings (2)	Select (3)	Upper Earnings (4)	Lower Earnings (5)
Constant	.20	2.88***	.24	2.96	2.73*
Kin	.60*	.13	.67*	.15	.05
Land	−.08	.004	−.06	.03	−.10*
Literacy	.23	.25***	.20	.28	.35*
Age	−.0005	.01	−.005	.003	.02
Age squared	−.0003	−.0002	−.0003	−.0001	−.0003
Preference	−.479		−.40		
Adult equivalents	.05		.06		
Experience	.10	.28*	.12	.30	.23
Village B	−.96**	−.350*	−.98**	−.57	−.35
Village C	1.52***	−.21	1.52***	−.23	−.10
SE		.53***		.53***	.52***
Correlation switching error(ρ_{ie})		.27		.60***	−.11
Log-likelihood		−174.24		−167.63	
Specification 2 with villages excluded: Log-likelihood		−203.09		−197.09	
Number of observations	145	145	145	81	64

* Significant at the 10% level.
** Significant at the 5% level.
*** Significant at the 1% level.

TABLE 6

LIKELIHOOD RATIO TESTS OF RESTRICTIONS

Restrictions of $B_{2k} = B_{ks} - B_{kn}$	Log-Likelihood Restricted MLE Model*	Likelihood Ratio Statistic	df†	Critical $\chi^2_{0.05}$ (df) ($N = 145$)
Specification 1 including all variables (log-likelihood = −167.63):				
All common variables = 0	−185.86	36.46	7	14.07
Endowment subset = 0	−183.25	31.24	3	7.81
Village variables = 0	−181.71	28.16	1	3.84
Kin, land variables = 0	−174.13	13.00	1	3.84
Human capital subset = 0	−182.36	29.46	3	7.81
Specification 2 with villages excluded (log-likelihood = −197.09):				
All common variables = 0	−219.75	45.31	5	11.07
Kin, land variables = 0	−216.34	38.50	1	3.84
Literacy, experience = 0	−205.43	6.68	1	3.84

* MLE = maximum likelihood estimate.

† df = number of restrictions less 1 in the case of the cross-equation restrictions; the number of single selection restrictions = k.

provide the starting values for likelihood maximization) demonstrates that two equations fit the data better than one.[26] But the likelihood-ratio test cannot reject the restrictions of the single equation model.[27] To sum up, there is mixed evidence concerning the first criterion of segmentation of two distinct earnings patterns and higher returns to human capital in the upper tier. This may be because formal education is not widespread in the study zone, and the survey data include both agricultural income and employment wages in the earnings calculations.

The existence of rationing in the labor market is the second criterion to be tested. Table 5 shows that the key factors that affect entry into the upper tier—kinship ties and village residency—do not enhance earnings. This supports a rationing hypothesis in that the higher probability of tier entry for workers possessing these traits is not due to higher anticipated relative earnings. Rationing appears to be occurring due to noneconomic background characteristics.

The FIML estimates of table 5 also allow the imposition of the cross-equation restrictions of equation (8) implied by the nonrationing hypothesis. Table 6 reports the likelihood-ratio test statistics calculated from the two regression specifications.[28] Turning to the first specification, the likelihood-ratio test easily rejects the competitive market restriction when all variables common to the sorting and earnings equations are considered.[29] Thus, the labor market appears segmented in that factors

rationing entry into the better tier are not matched by an adequate compensating differential across tiers.

A first subgroup of endowment variables appears slightly more important in explaining this trend. In particular, place of residence affects rationing of entry into the better jobs (the test statistic is 28.16, compared with the critical level of 3.84). But rather than support a segmentation argument, this type of cross-village differentiation is consistent with other problems in the labor market. The few high-paying positions are located in village A and village C mariculture operations, and residents of village B face effective barriers to entry to these jobs. Because of distance, transportation limitations, and farm managers' preferences for hiring near the farm, little employment mobility across villages was observed during the study period. The other important endowment variables—kin relations and landholdings—are highly significant in contributing to segmentation.

The second specification with the village variables excluded shows even stronger evidence of segmentation. The likelihood-ratio test statistic strongly rejects equation (8) when all the remaining dependent variables are constrained. The paired variables of worker kinship ties and land, rather than literacy and experience, appear to be significant sources of job rationing and segmentation. Much of this derives from the highly significant role of kinship in tier sorting and its insignificant effect on earnings.[30]

Sorting by experience, preference, or landholdings is consistent with a weakly competitive market associated with self-selection, but sorting by kinship is not. As noted above, employers may use family ties to achieve efficiency gains in unsupervisable settings or as a substitute signaling device of worker quality. Yet, since the kin variable is insignificant at the earnings stage, these family ties do not provide productivity gains and earnings benefits to the workers.

This suggests that segmentation along kinship lines could be serving another purpose—that of securing worker loyalty in a conflictive production setting or even safeguarding an employer's production assets. But, since kinship ties are endowed rather than invested in by workers, kinship is not a perfect substitute for human capital, and workers who lack kinship ties simply may be excluded from new opportunities arising in the export sector.

V. Concluding Remarks

In this article I suggest that to assess the development potential of new export products it is first necessary to understand how rural labor markets operate. Despite projected increases in labor demands, whether the labor market clears or not in equilibrium remains a primary concern. The article draws on various strands of the literature which suggest that in a setting of conflictive land-use changes and a second-best economic envi-

ronment, a nonclearing, segmented labor market may be expected because of efficiency wage, worker recruitment, or social control concerns. One of the objectives of the article is to assess whether the labor market operates as described above or in a more competitive manner characterized by worker self-selection.

The econometric tests from the Honduran case study demonstrate weak labor market segmentation, most likely for reasons associated with employers' needs to pay efficiency wages and to acquire some loyalty from residents in the areas most affected by land enclosures. The descriptive statistics show a sorting of fishermen into more flexible positions and of educated workers into the upper tier, providing some evidence of worker self-selection. But other factors important in selection—including kinship and village residency—bring few earnings benefits.

The regression results of two specifications do not change greatly across the OLS and FIML techniques. There are higher returns to some of the human capital variables in the upper tier, which demonstrates an important part of the segmentation theory. I also determined that in many cases a worker whose observed characteristics are identical to those of another earns more merely by being in the upper tier. There were conflicting results across the estimates as to whether two-tier earnings equations represent the data better than equation (1). But extensions of the likelihood-ratio tests demonstrate some job rationing of the upper-tier positions, most likely along kinship and geographical lines. Also, definitive submarkets across villages were observed, most likely due to travel mobility barriers. However, the segmentation of the labor market by kinship ties remains problematic, since this form of social capital is not easily acquired.

The findings point to the emerging effects of mariculture and other natural-resource-based export expansions in developing countries. Areas with conflictive land-use changes, large-scale production operations, and worker-monitoring concerns may be more prone to subsequent income distribution problems. Finally, the econometric results, and the importance of kinship in particular, contrast much of the standard representation of developing country labor markets differentiated by education, race, class, and minimum-wage coverage.

Further research is needed into the nature of institutional innovations to deal with labor market imperfections in monitoring, recruitment, and loyalty. In addition, extension of the analysis to settings with widespread formal education coverage may more accurately reveal the differential returns and importance of social and human capital in rural economies.

Notes

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American States. Helpful comments by Ragui Assaad, Brad Barham, Michael Carter, Matt Murray, and an anonymous referee are also appreciated.

1. For an overview of the regional process, see Billie DeWalt, P. Vergne, and M. Hardin, "Shrimp Aquaculture Development and the Environment: People, Mangroves, and Fisheries on the Gulf of Fonseca, Honduras," *World Development* 24 (1996): 1193–1208.

2. Edward Funkhouser, "Demand-Side and Supply-Side Explanations for Barriers to Labor Market Mobility in Developing Countries: The Case of Guatemala," *Economic Development and Cultural Change* 45 (1997): 341–66.

3. In this scenario, workers should be offered different arrangements by ethnicity or class to keep them divided and prevent sabotage of the production process. See, e.g., Gillian Hart, "Interlocking Transactions: Obstacles, Precursors or Instruments of Agrarian Capitalism," *Journal of Development Economics* 23 (1986): 177–203; Philippe Bourgeois, *Ethnicity at Work: Divided Labor on a Central American Banana Plantation* (Baltimore: Johns Hopkins University Press, 1989).

4. See Albert Roy, "Some Thoughts on the Distribution of Earnings," *Oxford Economic Papers* 3 (1951): 135–46.

5. Robert Williams, *Export Agriculture and the Crisis in Central America* (Chapel Hill: University of North Carolina Press, 1986).

6. DeWalt et al. Current estimates suggest that there are nearly 14,000 hectares in production and a greater concession area; however, the labor contracts and production arrangements remain the same.

7. Federation of Honduran Non-Traditional Export Producers (FPX), *Informe Annual* (Annual report) 1992 and 1993 (San Pedro Sula, Honduras: FPX, 1993).

8. Yang C. Shang, *Aquaculture Economics: Basic Concepts and Methods of Analysis* (Boulder, Colo.: Westview, 1990).

9. Jean Philippe Platteau and J. Nugent, "Share Contracts and Their Rationale: Lessons from Marine Fishing," *Journal of Development Studies* 28 (1992): 386–422.

10. On kinship ties and greater worker incentives and productivity, see Elizabeth Sadoulet, A. de Janvry, and S. Fukui, "The Meaning of Kinship in Sharecropping Contracts," *American Journal of Agricultural Economics* 79 (1997): 394–406; Peter Doeringer, P. Moss, and D. Terkla, "Capitalism and Kinship: Do Institutions Matter in the Labor Market?" *Industrial Labor Relations Review* 40 (1986): 48–60; Platteau and Nugent; and Ragui Assaad, "Kinship Ties, Social Networks, and Segmented Labor Markets: Evidence from the Construction Sector in Egypt," *Journal of Development Economics* 52 (1997): 1–30.

11. Funkhouser.

12. See, e.g., James Heckman and V. Hotz, "An Investigation of Labor Market Earnings of Panamanian Males: Evaluating Sources of Inequality," *Journal of Human Resources* 21 (1986): 507–42; Ted Magnac, "Segmented or Competitive Labor Markets?" *Econometrica* 59 (1991): 165–87; and Assaad.

13. A second option is to consider how the extent of upper-tier incorporation affects earnings (as in the models of credit use or years of schooling in Lawrence Kenny, L. Lee, G. Maddala, and R. Trost, "Returns to College Education: An Investigation of Self-Selection Bias Based on the Project Talent Data," *International Economic Review* 20 [1979]: 775–89; Maqbool Sial and M. Carter, "Financial Market Efficiency in an Agrarian Economy: Microeconomic Analysis of the Pakistani Punjab," *Journal of Development Studies* 32 [1996]: 771–98). This approach could determine how the length of tenure increases the earnings differential across tiers and whether recruitment cost explanations for seg-

mentation are relevant. However, as a reviewer noted, there is a subtle difference between these previous Tobit models and the current data set in which monthly participation in the upper tier is affected by earnings received so that the sector choice decision is made continuously. Thus, the estimation strategy focuses on the probit selection model, with a binary choice based on initial entry; see, e.g., Lung-Fei Lee, "Unionism and Wage Rates," *International Economic Review* 19 (1978): 415–33.

14. Important background characteristics, which could affect both selection and earnings, are included in both equations. All the earnings variables are included in the selection equation. For simplicity, the regressors common to both equations are subscripted with the letter k.

15. In most of the segmentation literature, the individual choice model reduces to comparing the earnings obtained across the relevant sectors or tiers. Nonpecuniary differences of occupations in the different tiers are assumed to be zero or minimal. In the Honduran data, there are few nonpecuniary differences across occupations; e.g., larva gatherers with tournament contracts in the upper tier work in muddy swamps at early dawn hours, a disutility probably comparable to "working in salt ovens" or other alternative employment. The possible nonpecuniary occupational differences are controlled for in two tests addressing just the larva-gathering work.

16. This draws on the technique suggested in Ronald Oaxaca, "Male-Female Wage Differentials in Urban Labor Markets," *International Economic Review* 14 (1973): 693–709; and T. H. Gindling, "Labor Market Segmentation and Determination of Wages in the Public, Private and Informal Sectors in San José, Costa Rica," *Economic Development and Cultural Change* 39 (1991): 585–605.

17. See Magnac; Heckman and Hotz; and Assaad. The test was originally presented in William Dickens and K. Lang, "A Test of the Dual Labor Market Theory," *American Economic Review* 75 (1985): 792–805.

18. Equation (8a) describes the unconstrained likelihood function, while equation (8b) describes the likelihood function constrained with restriction variables k:

$$\begin{aligned}\ln L = (P)^*[&-.5 \ln 2\pi - \ln \sigma_s - .5((y - B_s'X_i)/\sigma_s)^2 \\ &+ \ln \phi\{(b'Z_i + (\rho_s/\sigma_s)(y - B_s'x_i))/(1 - \rho_s^2)^{.5}\}] \\ + (1 - P)^*[&-.5 \ln 2\pi - \ln \sigma_n - .5((y - B_n'X_i)/\sigma_n)^2 \\ &+ \ln \phi\{b'Z_i + (\rho_n/\sigma_n)(y - B_n'x_i))/(1 - \rho_n^2)^{.5}\}];\end{aligned} \tag{8a}$$

$$\begin{aligned}\ln L = (P)^*[&-.5 \ln 2\pi - \ln \sigma_s - .5((y - B_s'X_i)/\sigma_s)^2 \\ &+ \ln \phi\{((b'Z_i - b_k'Z_{ik}) + (B_{sk}'X_k - B_{nk}'X_k)/\sigma_s \\ &+ (\sigma_w\rho_s/\sigma_s)(y - B_s'X_i))/(1 - \sigma_w\rho_s^2)^{.5}\}] \\ + (1 - P)^*[&-.5 \ln 2\pi - \ln \sigma_n - .5((y - B_n'X_i)/\sigma_n)^2 \\ &+ \ln \phi\{((b'Z_i - b_k'Z_k) + (B_{sk}'X_k - B_{nk}')/\sigma_s \\ &+ (\sigma_w\rho_n/\sigma_n)(y - B_n'X_i))/(1 - \sigma_w\rho_n^2)^{.5}\}].\end{aligned} \tag{8b}$$

19. The random stratified sample included households that rely primarily on labor incomes, rather than households that are heavily endowed with boats, land, cattle assets, and other forms of wealth. Village informants suggested a classification of wealth levels such that households owning more than five manzanas (0.7 hectares) of land, one boat, and five cattle were considered the wealth-

iest but not primarily "labor-based" households relevant to the sample. Five households were ultimately dropped from the original sample of 150 because of their early migration from the study zone or because of conflicting information revealed later about their asset levels.

20. In multiworker households, the human capital endowment of the household's primary worker is used for the regression analysis; usually, this primary worker had the highest human capital endowment. The value of this human capital most likely affects not only that worker's earnings but also those of other family members given the reported crossover effects in family enterprises. See Wim Vijverberg, "Returns to Schooling in Non-Farm Self Employment: An Econometric Case Study of Ghana," *World Development* 23 (1995): 1215–27.

21. Consideration of more time in the formal sector as the criterion for being in the upper tier did not significantly improve the fit of the model. With a stricter specification of additional months, and a smaller sample size, the significance of each of the selection variables and the value of the test statistic declined in the probit model. Differences in the earnings equations did not appear.

22. Literacy appears to be the key categorical human capital variable differentiating lower- and upper-tier workers, as years of formal education were quite low (a mean of 3 years) and only 15% of the sample had a primary education certificate.

23. The *F*-test statistic was 1.255, compared with a critical level of 1.88 for a 95% significance level and 9 and 127 degrees of freedom.

24. See Magnac (n. 12 above).

25. See Gindling.

26. The *F*-test statistic was 2.45, compared with a critical level of 2.32 for a 95% significance level and 10 numerator and 125 denominator degrees of freedom.

27. The likelihood-ratio test statistic is 13.22, compared with the Chi-squared statistic of 15.98 for 10 degrees of freedom at the 90% significance level.

28. I am grateful to Ragui Assaad for LIMDEP programming assistance of the competitive market tests using unconstrained and constrained likelihood functions.

29. The actual number of degrees of freedom to be used is the number of restrictions, k, less 1 for not normalizing the standard error term σ_w to 1 in the cross-equation restrictions. Thus, restricting all nine common variables implies 8 degrees of freedom, with a critical value of 36.46 for a 99% confidence level.

30. In results not reported here, separate restrictions on the individual variables were taken by excluding them from the wage equations. Comparing these unconstrained models with key selection variables set to zero again showed the importance of kinship in segmentation. An unconstrained variant excluding kinship and land from earnings produced a likelihood statistic of -200.53; constraining the function to set kin to zero produced a likelihood statistic of -207.53. The likelihood-ratio statistic is 14, which is much greater than the critical level of 3.84 for 1 degree of freedom at the 95% confidence level. No such pattern was observed in excluding land, experience, or literacy in a similar fashion.