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AN INTERCOUNTRY ANALYSIS OF EMPLOYMENT AND RETURNS TO LABOR IN AGRICULTURE

(An Interim Report)

by

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ABSTRACT

The inter-country analysis reported in this paper focuses on the following features. In growing economies, labor shifts from agriculture in a gradual process of reallocation. With growth, relative income gaps between agriculture and the rest of the economy narrow but absolute income differences increase. Despite the smaller relative gaps, occupational migration is comparatively more intensive in the higher income countries. Exit from agriculture explains most of the increase in the returns to the farm labor of the developed countries, it explains only a relatively small part of the increase in the developing countries. In a preliminary simulation analysis it was found that in the developing countries the long term effect of an increase in non-farm income on returns to labor in agriculture is only 15 percent of the corresponding magnitude in the developed economies. Intensification of irrigation will have, on the other hand, a comparatively stronger effect on the returns to farm labor in the developing countries.

Introduction and Summary

Many of the lower income countries are agrarian economies and others have large agricultural sectors. The welfare of a great number of people in the developing countries depends, therefore, on the returns to labor in agriculture. This is particularly so in the densely populated countries, where many of the workers in the farm sector are landless.

In this paper we report some preliminary findings in a study of employment and returns to labor in agriculture. Two major topics are covered in the report. Basically, the study is an exploration of the process of labor shift from agriculture and an explanation of several of its characteristics. At the same time, the paper is also an elaboration of a conceptual approach to labor market analysis in the agricultural sector in growing economies: Labor supply is a time consuming process; the conventional supply function and the associated analysis of comparative statics of markets in equilibrium are inappropriate tools of study in a dynamic context. A growing economy is characterized by income disparities between the sectors and by occupational migration out of agriculture. These income gaps gradually narrow as labor is reallocated.

The approach is not new. The theoretical background is based on Mundlak's earlier work on growth paths and on agricultural supply (Mundlak 1979, 1985, Cavallo and Mundlak 1982). Partly we even duplicate Mundlak's work. The study of migration has a long history (Harris and Todaro, 1970, Greenwood 1981, Kuznets 1982); and Kirzner (1973), for example, argues for the analysis of competitive markets in terms of processes, not equilibria.

Our study is an intercountry analysis, covering 43 developing and developed economies (listed in the Appendix), with observations for three points in time, 1960, 70, 80. We are using the Hayami and Ruttan (1985) sample which was taken because of its comprehensive coverage of agricultural data. The sample was expanded to include labor market information and prices. The sample and the data will be explained in a review now in preparation. Separate papers will report in detail on the analysis of demand and on other aspects of the study.

The framework of the analysis is partial equilibrium--prices of products and inputs are considered as exogenous variables even in the long run. A general equilibrium analysis is impossible at this stage. Moreover, partial equilibrium is the appropriate framework for the investigation of the effects of price distortion and market intervention in which we are interested. In the short run, we are taking factor quantities to be constant; the economic rational behind this approach is explained in detail for the case of labor; similar reasoning applies also to other factors, particularly production assets and land. We plan to elaborate on these issues in future reports.

The basic features of the process of labor shift from agriculture are presented in the next section. The noteworthy characteristics are that, with growth and development, migration intensifies, relative income gaps between agriculture and the other sectors narrow, but absolute income differences increase. That section is followed by a discussion of the operation of the labor market, by a presentation of the logistic migration equation, and an estimation of its parameters. These sections lead to an analysis of the effect of labor reallocation on wage equalization. The paradoxical finding of narrowing relative gaps and widening absolute income differences is explained with reference to human capital theory. Between 1960 and 1980 wages in agriculture increased by 32 percent in the developing countries; they doubled in the developed countries. By the calculations presented, labor shift explains almost all of the wage increases in the developed countries; while in the developing countries--in which labor force in agriculture actually grew despite migration--wages increased mostly due to production intensification. The paper closes with an example of a simulation analysis of the operation of the labor market in agriculture and a discussion of the distribution of income gaps in the sample countries, pointing to the need for further research.

Basic features

The world labor force grew between 1950 and 1980 from 1.2 to 2.0 billion workers and it is expected to reach 2.7 billion by the end of the century (Table 1 and see similar information in Figure 1). The share of agriculture is declining both in the developed and the developing groups of countries. But in absolute numbers, the size of farm labor is decreasing only in the developed countries; it is increasing in the developing ones (again, taken as a group). As a result, while the farm labor force of the developing countries was in 1950 four times larger than that of the developed ones, it will, by our estimate, be more that thirty times larger in the year 2000.

In the sample, the share of farm labor decreased between 1960 and 1980 from 63 to 48 percent in the developing countries and from 23 to 10 percent in the developed ones (Table 2). In fact, all countries in the sample

Table 1

World Labor Force Distribution
(millions)

	1950	1980	2000
Total	1200	2000	2700
Agriculture	800	1000	1190
Share in Agr. (ratio)	0.67	0.50	0.44
Agriculture in Developing Countries	650	925	1153
Share in Agr. (ratio)	0.81	0.65	0.55
Agriculture in Developed Countries	150	68	37
Share in Agr. (ratio)	0.38	0.13	0.06

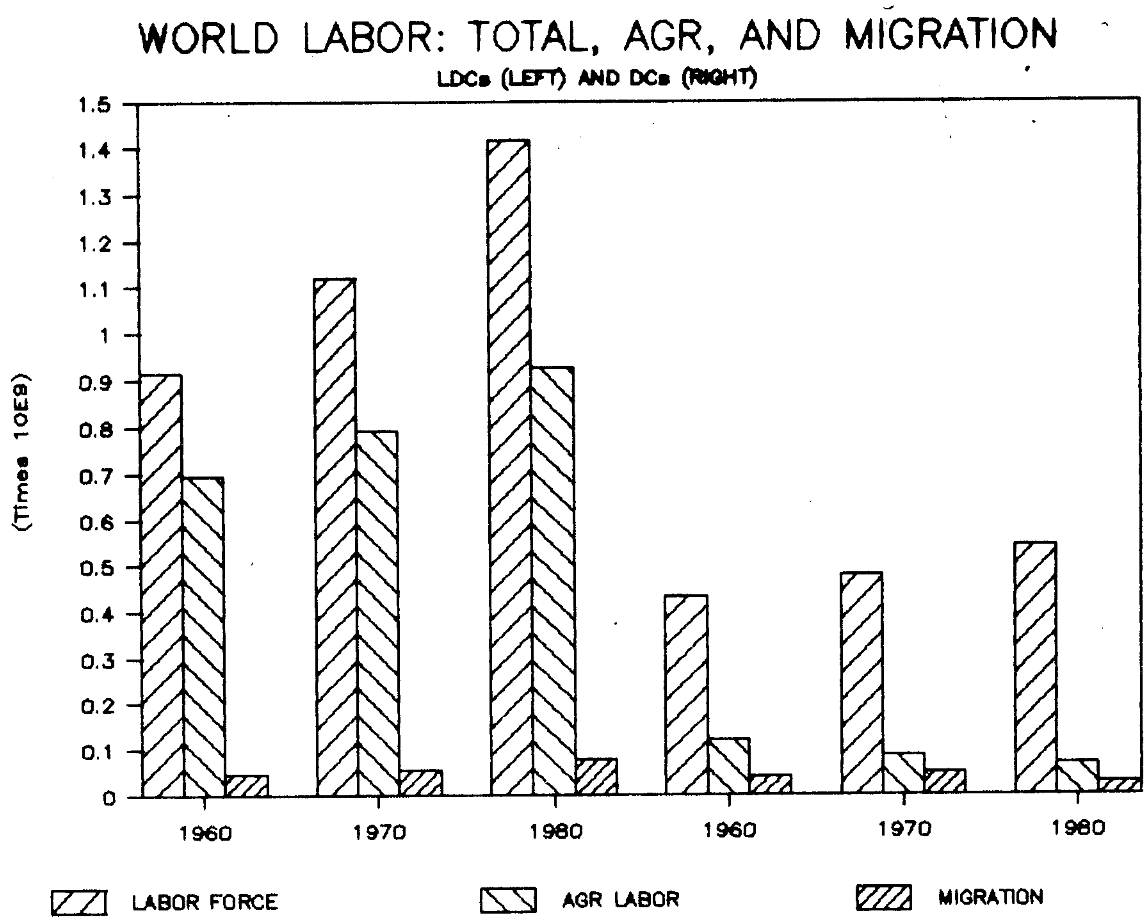
Notes:

Developed countries are in Europe, North America, Australia, New Zealand and Japan. Numbers are rounded.

Source: World Bank World Development Report, 1986.

Agricultural labor force for 2000 is our estimate arrived by extropolating past trends.

Figure 1:


WORLD LABOR: TOTAL, AGR, AND MIGRATION
LDCs (LEFT) AND DCs (RIGHT)
(Times 10E9)
1.5
1.4
1.3
1.2
1.1
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
1960
1970
1980
1960
1970
1980
LABOR FORCE
AGR LABOR
MIGRATION

experienced positive migration from agriculture for the three decades of the 1950s, 60s, and 70s.[1/]

The choice of a measure of the income gap between agriculture and the other sectors raises both conceptual and empirical questions. Two alternative measures are used in the study: the differences in wages and the differences in the average products. Wages measure the returns to labor and are, in general, the appropriate variable to use in the study of labor allocation; but the change from agricultural to non-agricultural occupation is often also a geographic migration, and the migrants may be self employed, in the rural as well as in the urban sector, not only wage earners.[2/] The average product may therefore be a more appropriate measure of the alternative to agricultural income. Also, wherever the marginal product is proportional to the average, the latter is an appropriate measure of the return to labor in an exponential specification, such as in the commonly used double log regression.

In addition, wage data are often incomplete. In agriculture the wages are only for a relatively small share of the farm labor force, are often paid partly in kind, are hard to observe, and measurement methods vary between countries. In the non-agricultural sector, comparable comprehensive wage statistics are not available. We are using, therefore, two measures of the income gap: the difference between wages in agriculture and in manufacturing and the difference between the average product, per laborer, in agriculture

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1/ An exception is Paraguay that registered a negligible occupational shift to agriculture in the 1950s. This decade is not included in the empirical analysis and, as explained below, migration may be underestimated due to the assumption of identical natural growth rates in the rural and in the urban sectors; the real shift might have been out of agriculture in this case too.

2/ At this stage of the study labor is treated as uniform. A distinction between self employed and hired laborers will be attempted in the future.

Table 2

Labor Allocation and the Income Gap

	Developing Countries 1960	1970	1980	Developed Countries 1960	1970	1980
1. Share of labor force in Agriculture, s_a	.63	.57	.48	.23	.15	.10
2. Wage Gap						
farm wage, w_a	1.43	1.90	1.69	5.19	8.09	11.17
relative, w_a/w_u	.32	.37	.31	.44	.47	.49
absolute, w_u-w_a ($ per day)	3.07	3.22	3.83	6.69	9.26	11.79
3. Product Gap						
product in agr., p_a	487	507	605	2,203	3,505	5,978
relative, p_a/p_u	.27	.25	.26	.43	.44	.66
absolute, p_u-p_a ($ per year)	1,311	1,540	1,764	2,862	4,412	3,102
4. Rate of growth of total labor force, n	.020	.024	.028	.011	.012	.012
5. Rate of migration, m	.011	.014	.022	.042	.056	.062
6. Kuznets' measure of change						
$s_a(t-1) - s_a(t)$	.059	.067	.075	.083	.071	.042
ms_a	.072	.082	.107	.095	.087	.064

Notes:

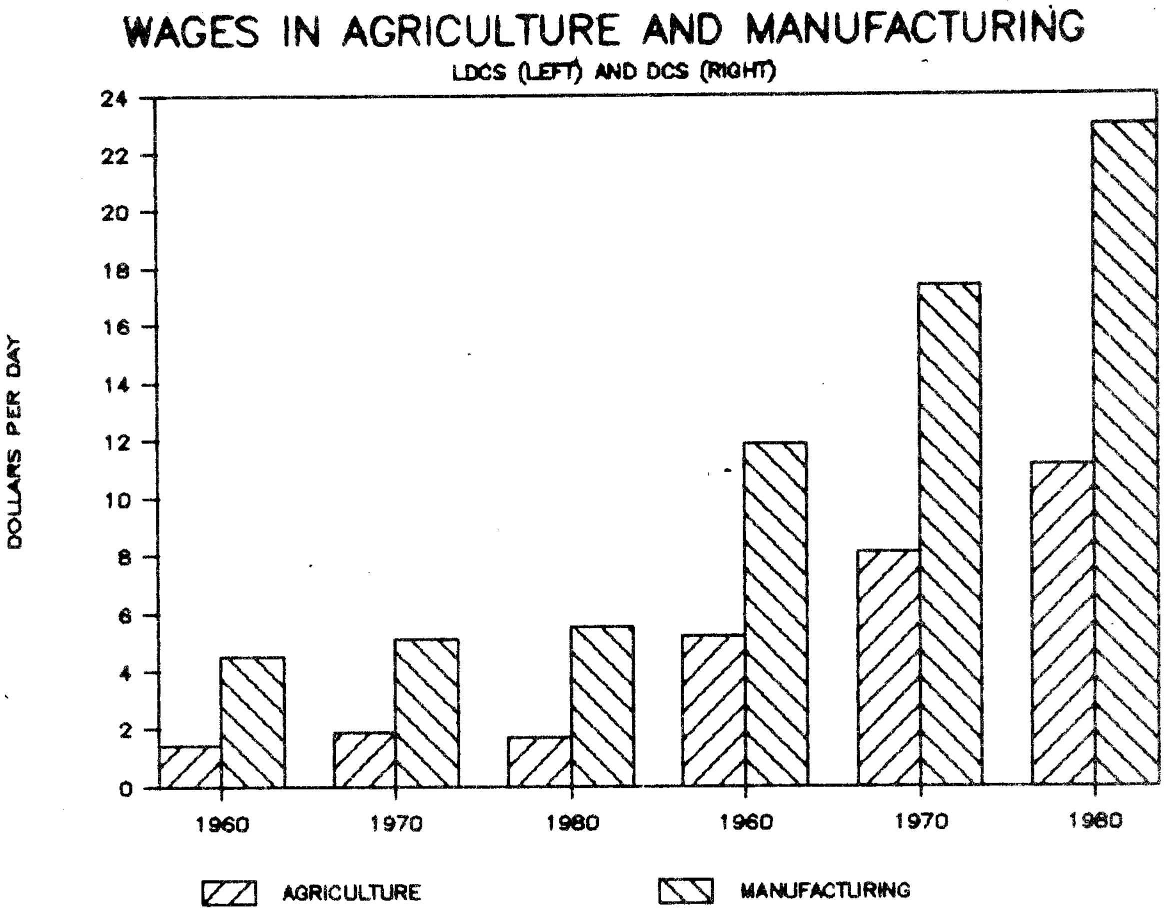
s_a share of labor force in agriculture;
w_a, w_u wage rate in agriculture and in manufacturing, 1970 dollars per day;
p_a, p_u product per laborer, agriculture and non-agricultural, 1970 dollars per year.

Wages and values of products were deflated by local Consumer Price Index and converted to dollars using Kravis et al., 1978, Purchasing Power Parity exchange rates.

Lines 4, 5--average rate of change per year over the decade prior to the year in the column.
Line 5--the rate of migration is the number migrated divided by the labor force in agriculture at the end of the decade, calculated according to eq.(7).
Line 6, see text.

Averages are arithemetic and non-weighted.

Figure 2:


WAGES IN AGRICULTURE AND MANUFACTURING
LDCS (LEFT) AND DCS (RIGHT)
DOLLARS PER DAY
0
2
4
6
8
10
12
14
16
18
20
22
24
1960
1970
1980
1960
1970
1980
AGRICULTURE
MANUFACTURING

and in the rest of the economy. Whether measured in wages or in average product, the returns to labor in agriculture in developed countries were in 1960 more than 3 times larger than in the developing ones (Table 2 and Figure 2). These differences were even larger in 1980.

The two intersectoral income gaps are measured, in Table 2, as absolute differences and as ratios, and these two measures move in opposite directions. The absolute differences, both in wages and in products, are larger in the developed countries than in the developing ones, and they are growing in time within each group (an exception is the decline in the product gap in the developed countries in the 70s when the industrial economies stagnated but their agriculture continued to expand). In terms of ratios, the gaps are smaller in the developed countries than in the developing ones (the ratio w_a/w_u is higher) and they were narrowed with time; again, with one exception: the wage gap in the developing countries widened in the 1970s.

We turn now to migration. Labor reallocation need not take the form of shift of workers from one occupation to another. Gradual redistribution can be achieved when all the new entrants into the labor force are employed by the growing sector and the labor force in the declining sector is reduced at the natural attrition rate. Indeed, as the economy develops and the share of agriculture in product and employment decreases, a significant part of the reallocation process is achieved by the young, new entrants taking non-agricultural employment. Geographic migration is also not a necessary component of labor reallocation even if involving agriculture--many farmers take part-time non-farm employment in the rural areas. But since a great share of the farm to non-farm labor redistribution involves exit from agriculture and involves geographic movement and these kinds of exit and movement determine the marginal cost of adjustment, we follow other students of the subject and term the general reallocation process "migration."

Two factors combine to make the process of labor supply time consuming: occupational migration is costly, and the rate of shift is constrained by the supply of younger people with long planning horizons. Labor reallocation is therefore a gradual process.

The rate of migration, the ratio of the number of those who migrated over the decades of the 1950s, '60s, and '70s to the labor force in agriculture, is calculated in the study as the difference between the natural rate of growth of labor and the actual change in its size. Migration may in this way be underestimated if the natural rate is higher in rural than in urban areas. The natural growth rate is, in Table 2, twice as fast in the developing countries as in the developed ones. The rate of migration is higher in the developed countries--despite narrower relative income gaps--and it has been increasing in both groups of countries through time.

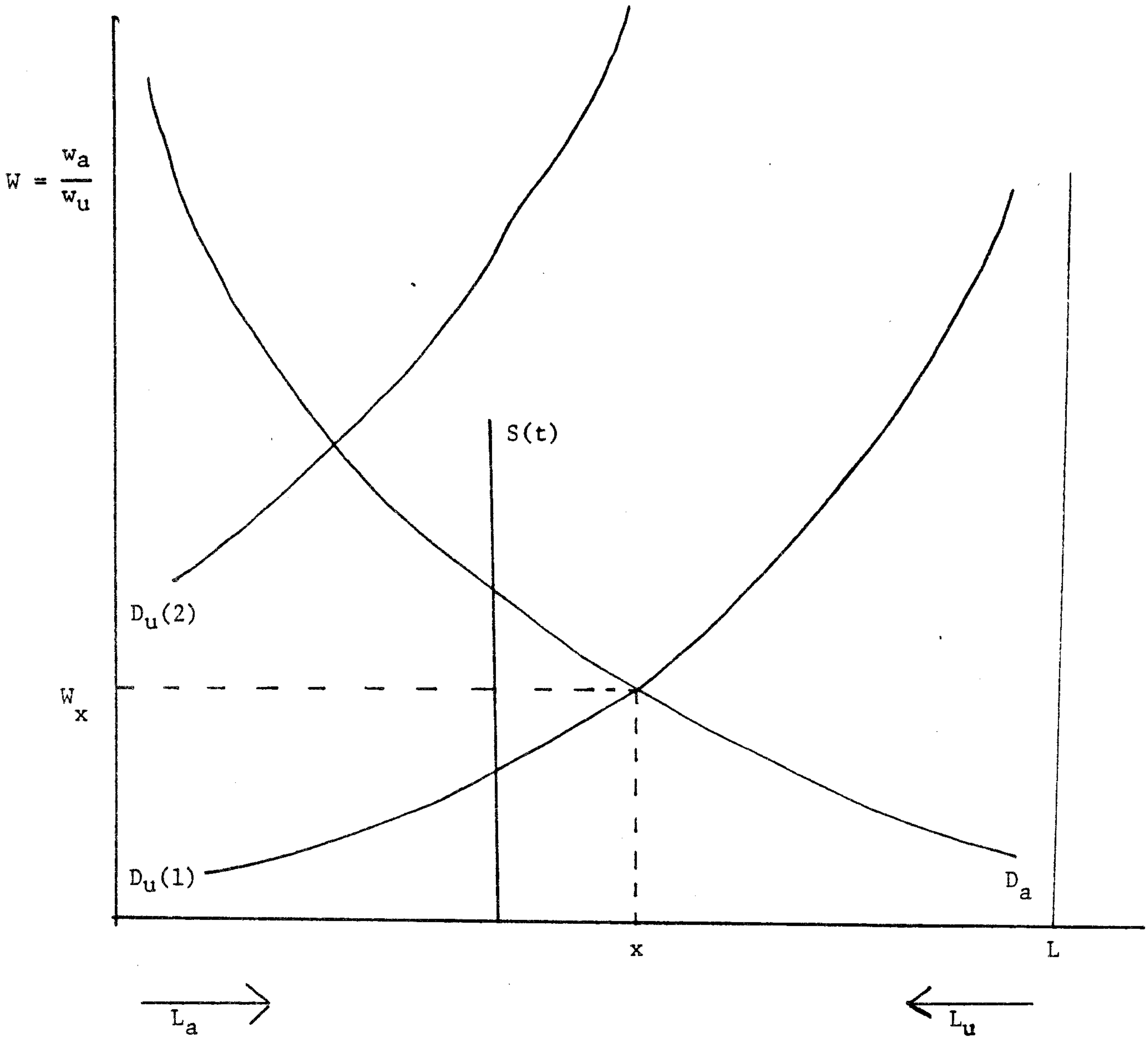
The labor market

It was already indicated that all countries in the sample registered positive migration from agriculture in the period of the analysis. This means that all the observations in the study are for labor markets in the process of adjustment, not in long run equilibrium. In this section we describe the operation of a labor market in adjustment and draw econometric implications from this description. We start by considering the market in a single country and then broaden the analysis.

The labor market of a country allocates workers between agriculture and the rest of the economy. In Figure 3, D_a is the long run demand for labor in agriculture and the curves D_u are the long run demand in the u sector; in both sectors, the demand is a function of the wage ratio. The diagram is drawn for a given labor force, L. The function D_u is the long run supply of labor to agriculture. In the stagnant initial equilibrium, the allocation was x and the wage ratio was W_x. Assume that the demand for labor in the u sector increased from $D_u(1)$ to $D_u(2)$. If this was the only change in the economy, then eventually a new allocation will be reached with wage ratio at the intersection of $D_u(2)$ with D_a. Introduce now the assumption that the process of reallocation is time consuming; say it takes 10 years. Over this period labor migrates from agriculture. Then at each point in time during the migration period, the short run labor supply is an inelastic function such as S(t) in Figure 3. The process of labor shift gradually traces the demand function.

In the real world it is not a once and for all shift in the demand for labor that affects the labor market, but rather continuous shifts in demand in the sectors and a continuous growth of the national labor force. Permanently, therefore, the market is in an intermediate, non-static-equilibrium position as in Figure 3.

Figure 3: The Labor Market



The operation of the market can be described by the following system of equations[3/]

demand:

(1) $$w_{at} = c_o + c_1 L_{at} + c_2 K_{at} + c_3 S_t + v_{1t}$$

short run supply:

(2) $$L_{at} = (1 + n) L_{a,t-1} - M_{t-1}$$

migration

(3) $$M_t = M (w_{ut}/w_{at}, n, L_a, L_u) + v_{2t}$$

In the equations w, K and S, are wages, capital, and other factors in agriculture, L_a, L_u labor force in agriculture and in the other sectors, M the number of migrants, and the error terms in the regressions are v_1 and v_2. The migration equation will be formulated explicitly in the next section. During the period of adjustment, the flow of labor from agriculture is determined at each point of time, t, by the migration equation (3) in which it is affected by the wage ratio and by the relative size of the labor forces in the sectors a and u. The short run labor supply, eq. (2), is determined by $L_{a,t-1}$, by the rate of growth, n, and by migration. Given the inelastic short run

3/ At this stage we present short run estimates of the demand equation (1) in which wages in agriculture are a function of the quantities of labor and other inputs. A long run formulation with prices of fertilizers, energy, and capital assets will be attempted in the future.

supply, market clearing wages are determined by (1), and they, in turn, affect next period's migration and short run supply.

The market operates in a recursive fashion--note that migration in the short run supply equation (2) is for t-1--allocation and wages are not determined simultaneously. This view of the market leads to two empirical implications.

The first implication is that in a single country, the migration equation and the demand function can be estimated separately by Ordinary Least Squares. In an intercountry analysis, on the other hand, we are observing not one single market, but a set of markets. And while each may operate recursively, simultaneity may exist in an intercountry sample. This possibility is tested in the estimates (details in the next version of the report).

The second implication stemming from the view of the labor market presented above is that the long run supply function is not traced by the market experiment in a process of adjustment and cannot be estimated from observations accumulated during such processes. To see why, recall that in a regular market setting the supply function can be identified if there were exogenous changes in the demand. In the market depicted by Figure 1 and during the adjustment period, changes in demand do not trace the supply function. Assume that the demand in agriculture shifted and, consistently with the observation of continuous migration, the shift was relatively small so that it did not stop migration or reverse its direction. Such a shift, if it occurred, affected the rate of the flow of labor from agriculture, but it did not trace the supply curve, because the market never reached points on the long run supply function.

Distributed lags models were proposed to estimate long run behavioral functions; they can be applied in this setting. Workers considering migration, compare expected future incomes in the alternative sectors, a simple assumption can be that expectations are weighted averages of past experience. This leads to a distributed lags formulation of the migration equation. This is a legitimate formulation which was not adopted here due to the paucity of data. But such a formulation will also not trace the long run supply function; again, because none of the observations in the sample is a point on that function.

We turn now to an explicit formulation of the migration equation.

Migration as A Modified Logistic

Consider a country with a constant labor force of size L divided into s_a (= L_a/L) percent in agriculture and $s_u = 1-s_a$. Opportunities are better in the u-sector and labor moves gradually. The occupational migration is affected by the relative size of the source, by s_a, and by that of the absorbing sector, by s_u. A simple formulation is that the share of labor force in agriculture changes according to the differential equation

$$(4) \qquad \frac{ds_a}{dt} = -\rho s_a(1-s_a)$$

where ρ is a positive constant. This is a conventional formulation of the mathematic representation of constrained population growth (Davis, 1962, p. 96). Note that

$$\frac{ds_u}{dt} = - \frac{ds_a}{dt}$$

and the process of growth of s_u is the same as that of the decline of s_a.

The solution of (4) is the logistic function

(5) $$s_a = \frac{1}{1+ae^{\rho t}}$$

See Figure 4.

In application, the elementary logistic function of eq. (5) is modified in several ways. The rate of migration is affected by income differentials, by population pressure and by other factors. The parameter ρ is therefore not treated as constant, rather

(6) $$\rho = \rho(w_u/w_a, n)$$

where w_u and w_a are income or wages in the u and the a sectors, respectively, and n is the natural rate of growth of the labor force.

Equation (4) is also slightly modified and takes a more flexible formulation:

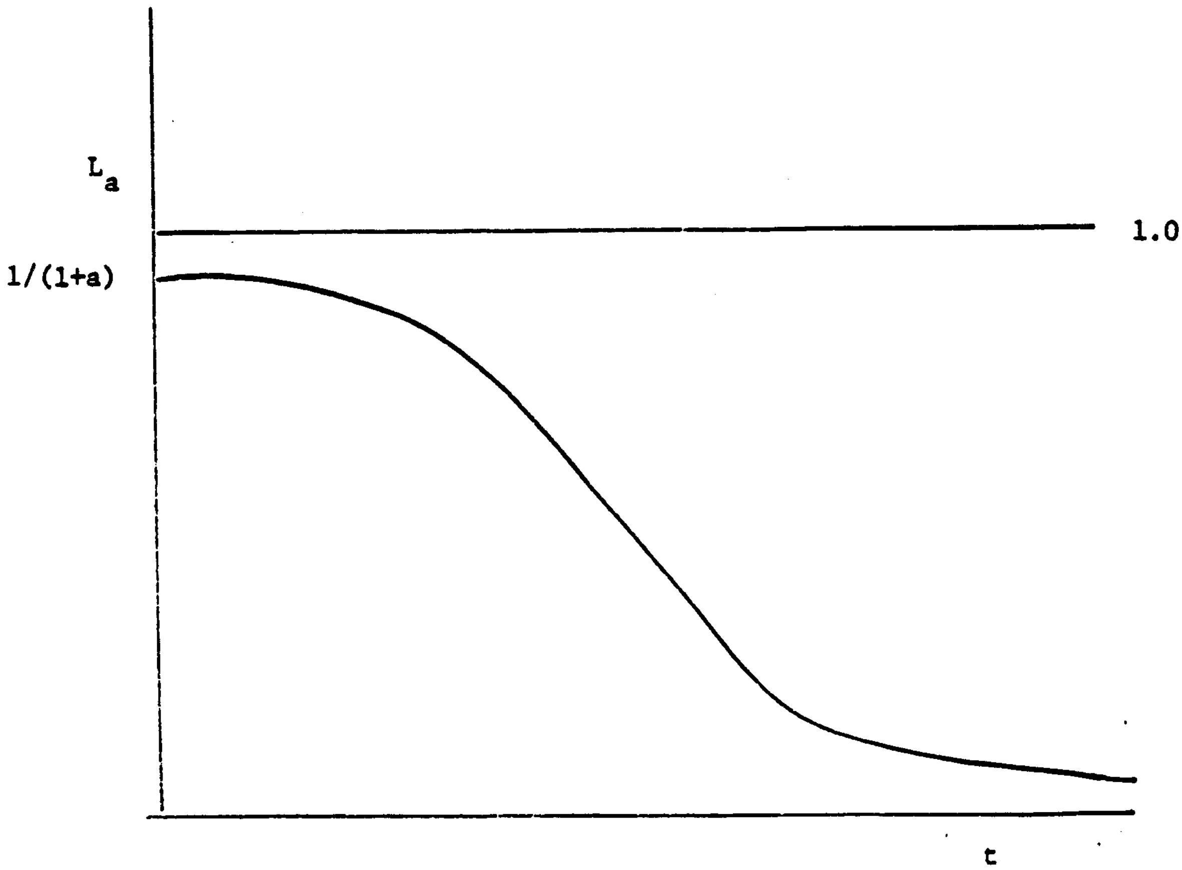
(4') $$\frac{ds_a}{dt} = -\rho s_a^{1-\beta}(1-s_a)^{\beta}$$

with β to be estimated empirically.

Migration, m, is defined as an annual rate, relative to the size of the labor force in agriculture. For a non-constant labor force, the change in L_a is

$$\frac{dL_a}{dt} = (n - m)L_a$$

Figure 4: The Logistic Curve



Not having separate information on the natural rate of growth the agricultural sector, n is measured for the total labor force: $n = (dL/dt)/L$. The rate of migration is measured in the study as the discrete equivalence of eq. (7).

$$(7) \qquad m = n - \frac{dL_a}{dt}\frac{1}{L_a}$$

Note that

$$(8) \qquad m = -\left(\frac{ds_a}{dt}\frac{1}{s_a}\right)$$

Dividing (4') through by s_a, combining with (8) and with an explicit formulation of (6), we get

$$(9) \qquad m = B(w_u/w_a)^{\beta_1}(1+n)^{\beta_2}[(1-s_a)/s_a]^{\beta_3}$$

Estimates of the parameters of eq. (9) are reported in the next section.

The logistic process converges to $s_a = 0$, while long run equilibrium will be established at a positive s_a. We will have to eat even in the long run. This possibility of a convergence to a constant s_a is outside the sample space of this study and is therefore disregarded here. 4/

4/ For an attempt to incorporte long run cessation or reversal of migration in empirical estimates, see Mundlak (1979).

Empirical Evidence

The data in Table 2 confirm the general logistic nature of the migration process. As we have seen, combining eqs. (4) and (8) in this process in its elementary formulation

$$m = \rho(1-s_a)$$

and for a constant ρ, m grows as the share of labor in agriculture (the denominator in m) decreases and the relative size of the absorbing sector increases. Indeed, in Table 2, m grows as s_a decreases both within the groups of countries and between the groups.

It will be useful to consider here the pattern of labor shift found by Kuznets (1982). He worked with 131 countries, ordered them by the share of labor in agriculture, and calculated the percentage point reduction in this share over the decades of the 1950s and 1960s. Moving from the most agrarian to the most industrialized country, the magnitude of the change Kuznets calculated first increased and then decreased. Expressed in the symbols of this paper, Kuznets calculated the difference

$$s_a(t-1) - s_a(t)$$

where t is 1960 and 1970 and t-1 is 1950 and 1960, respectively. This measure of the change is approximately ms_a (see eq. (8)). The measure is calculated for the data of the this study in line 6, Table 2 and it shows the same general pattern that Kuznets reported (he worked with 9 groups of countries and in single periods; the pattern of growth and decline was therefore more pronounced in his data than in Table 2). The growth and reduction that

Kuznets observed are due to the opposite effects of the components of the product ms_a.

With time, and as development proceeds, returns to labor move toward equalization; again, both within and between the groups of the countries in Table 2. We shall take up the equalization process in more detail below.

Income equalization can be expected to modify the logistic nature of the migration process. When wages are completely equalized (allowing for skill differences and other specific factors) migration will stop. In terms of the parameters, ρ will be zero. This has not happened yet in the groups of countries for which data are summarized in Table 2, and, as noted earlier, the possibility of the cessation of migration was, therefore, not incorporated in the empirical specification.

The estimated migration equation is, in logarithms

$$\text{(9')} \qquad \log m = \beta_o + \beta_1 \log(w_u/w_a) + \beta_2 \log\,(1+n) + \beta_3 \log[(1-s_a)/s_a] + \varepsilon$$

The first three terms on the right of (9'), as in eq. (9), are the components of the parameter ρ. The equation will also be estimated with a time variable and a dummy distinguishing developed and developing countries.

Eq. (9') is estimated in a sample of countries with data for two decades. Since countries differ in their position on the migration logistic, we get variability in the observations. This variability facilitates the empirical estimates, even if the variability over time within each country for the relatively short history of the analysis is small.

Table 3: Regression Estimates

Regression	Migration (1)		Labor Demand: Wages (2)	Labor Demand: Average Product (3)
R^2 (adj)	.572	R^2 (adj)	.544	.943
Intercept	-5.326 (12.698)	Intercept	2.9135 (.753)	.887 (4.549)
Ratio of average product, non agr to agr (p_u/p_a)	.789 (2.922)	Labor (male)	-1.373 (2.530)	-.552 (12.20)
Labor allocation (s_u)/s_a	.555 (3.645)	Land	-.201 (.202)	-.109 (3.55)
Natural Growth (1+n)	-4.034 (.423)	Livestock	.680 (2.944)	.486 (9.57)
Developed countries	.990 (2.928)	Fertilizers	-.122 (1.209)	-.031 (.87)
Decade, 1960s	-.123 (.611)	Machinery	.143 (2.044)	.114 (3.84)
		Schooling	1.195 (3.283)	.312 (2.75)
		Irrigation	.031 (.728)	.087 (4.44)
		Year, 1960	.182 (.720)	-.082 (1.23)
		Year, 1980	-.149 (-.817	.139 (2.39)
		DCs	-.213 (1.633)	.451 (4.35)

Notes to Table 3:

Dependent variables

Regression 1: annual rate of migration, m, in the decades 1960-70, 1970-80;

Regression 2: wage rate in agriculture;

Regression 3: average product per worker in agriculture;

s_a, s_u = share of labor in agriculture and in the rest of the economy.

n = rate of growth of total labor force;

Product ratio and labor allocation in the migration equation are for the beginning of the decade, natural growth is over the decade;

Country, decade and year variables are dummies;

In parentheses, t statistics;

Number of observations: 65, 78, 105 in Regressions 1, 2, 3, respectively.

The estimates are reported in Regression 1 under the heading "migration" in Table 3 (the other regressions in the table will be discussed below). The significant factors in the migration regression in the table are the coefficients of the ratio of returns to labor, of labor force in the sector, and the DCs variable. The effect of "population pressure"--growth of labor force--is negative and not significant in this regression.

The migration equation for the two groups of countries and for the decades of the 1960s and the 1970s is reconstructed in Table 4. This is done in stages. In line group 1 the components of log ρ [the first three terms in (9')] are reconstructed. Then the geometric average s_u/s_a ratio, reported in line 4, is raised to the power of β_3 and multiplied by the calculated ρ to yield the "predicted" m value in line 5. These calculated migration rates are compared to the actual rates (reported in line 6, in accordance with the procedure in the regression, as geometric means).

Despite the fact that in Table 3 the coefficient of the average product ratio (p_u/p_a) is substantial in size and significant, the quantitative effect of this variable on the migration coefficient is relatively small [the magnitude of .789 times $\log(p_u/p_a)$ is between 15 and 25 percent of log ρ]. Quantitatively, the most important component of ρ is the intercept in the regression equation. This may imply that, contrary to the theoretical hypothesis that migration is mainly driven by income differentials, the data show that other factors--not specified in the estimated model--affect migration to a much larger extent than income differentials do. But there may also be another explanation for this statistical finding: It will be seen below that countries with similar labor allocation differ substantially in product and wage ratios. This may indicate that the equilibrium income ratio

Table 4

The Migration Equation: $m = \rho\ (s_a/s_u)^{\beta_3}$

(Annual Rates)

	Developing Countries		Developed Countries	
	1960s	1970s	1960s	1970s
1. The components of ρ (in logs)				
Intercept	-5.326	-5.326	-5.326	-5.326
DC Dummy			.990	.990
1960 Dummy	-.123		-.123	
.789 log (p_u/p_a)	1.055	1.037	.607	.586
- 4.034 log (1+n)	-.080	-.096	-.044	-.044
2. Log ρ	-4.474	-4.385	-3.896	-3.794
3. The value of ρ	.011	.013	.020	.023
4. Labor ratio, s_u/s_a	.802	1.055	4.651	8.065
5. Calculated migration rate, m	.010	.012	.047	.072
6. Actual migration, m (geometric average)	.009	.015	.056	.061

Notes:

Calculated with the parameters of the migration regression in Table 3.

Line 5: $m = \rho\ (s_u/s_a)^{\beta_3}$, $\beta_3 = 0.555$

(the post migration ratio--if the process is ever to cease) differs between the countries; for different countries a different ratio will cause migration to stop (will bring the value of ρ to zero). Estimating the migration equation in cross-sectional data, the income ratio is a "variable with an error," the coefficient of which is under-estimated and the "explanation" is taken over by the intercept of the regression.

Absolute and Relative Measures of the Income Gap

Two countervailing forces operate on the income and the wage gap in a growing economy. On the one hand, migration eliminates wage differentials, it closes the income gap. On the other hand, the process of development, capital intensification and the rise in the general level of wages and income--increase the absolute wage and income differences. The explanation of the second phenomenon is based on the observation that the demand for skills is lower in agricultural employment than in the non-farm sector and on the theory of human capital. The presentation is based on Mincer (1974).

Start with schooling. The major cost of schooling is time spent--income foregone; assume this to be the only investment of the student. Let the income of a person with s years of schooling be y_s, and let the rate of returns to schooling be r. We are interested in the effect of additional schooling on income differentials.[5/] When a person with income y_o per year stays in school for another year, the investment is y_o and income next year, if this person quits schooling then, is y_1

$$y_1 = y_o + ry_o$$

5/ To simplify the presentation, we assume infinite life and accordingly compare income levels and not human capital stocks.

$$= y_o(1+r)$$

Similarly

$$y_2 = y_o(1+r)^2$$

and

$$y_s = y_o(1+r)^s$$

The schooling of the labor force in agriculture is generally lower than that of the non-farm labor force. This is true not only for hired workers, but also for the average of hired and self employed. Assume, as an example, that the schooling level of the farm labor force is 6 years, that of the non-farm is 10 years and the rate of return is 10 percent, then

$$y_{10} = y_6 1.1^4$$

$$= 1.46y_6$$

Hence the ratio between income in the sectors in constant; if y_6 increases, the absolute difference will grow.

Just as most of the investment in schooling is in the form of income foregone, so also a great part of the investment in training is in this form. Therefore, if in the non-farm sector the demand for trained personnel is relatively higher than in the farm sector, wages in the non-farm sector will be higher than those in the farm sector. Formally, let a worker in the urban sector with s years of schooling be trained on the job for n years and at this period the income of the trainee is k percent lower than what it would otherwise have been. Then, income in the training period is $y_s(1-k)$ and income after training is $y_s(1+k(1+r)^n)$.

With development, growth and capital accumulation--all wages in the economy grow, including y_o of the previous equations. Then y_s grows, on account of schooling, by $(1+r)^s>1$; training adds another muliplying factor (mitigated somewhat by the relative reduction of the earnings of the trainees). Hence, growth and development increase the absolute wage differentials due to schooling and experience. However, so long as the structure of demand for skills does not change, economic growth will not affect the relative income gap.

The foregoing was an analysis of earning differentials in equilibrium. Two questions are raised when this analysis is incorporated into a dynamic context with occupational migration: is migration driven by absolute or by relative income differences? and, will migration close the absolute income differences or only the relative gaps?

Migration is costly, it takes time and income is foregone, it is therefore a form of investment in human capital subject to the same eonomic considerations as schooling. If this is so, then it should be expected that similar relative income gaps will induce similar migration rates, even if the absolute income differences are not the same. With this explanation, when the relative gap increases, migration intensifies because workers with higher comparative advantages in agriculture will also migrate. On the other hand, if the cost of migration is constant, then workers will migrate when the absolute income differences (their capitalized value) will be higher than that cost. It is harder to explain however the positive correlation between the rate of migration and the income gap in such a constant cost formulation.

Turn now to the second question. By the human capital theory, if the demand for skills is comparatively lower in agricuture, there will be earning differences between agriculture and the other sectors even in the long run, and these differences will be higher in absolute value but unchanged in relative terms the higher the average level of the income of the country (actually, the relevant magnitude is not the average income but the base income of the unskilled: y_0 of the preceding analysis). Hence, in a county without capital accumulation in which the returns to skill levels do not change, migration will reduce both the relative and the absolute income gap. In an economy in which capital is accumulating, technology improves, and earnings increase, absolute income gaps will widen, and the effect of migration will be realized in the reduction of the relative gap.

Reallocation and Equalization

The effect of labor reallocation on the wages and the income gap depends on the demand for labor in agriculture. We present in Table 3 two estimates of the demand equation: in Regression 2 the dependent variable is the wage rate, in Regression 3 it is average product in agriculture. The equation was also estimated in a covariance analysis of a "within" country regression with similar results, but those are not reported here. The estimated demand functions are used in the following in two kinds of simulation analysis. First Regression 2 is used in this section to explain changes in wages. In the next section we use the estimates of Regression 3 to simulate time paths of employment and returns to labor in agriculture and to assess the reaction elasticities to exogenous changes.

The observed changes in wages in agriculture between 1960 and 1980, reported in Table 5, were an increase of 32.2 percent in the developing countries and of 91.4 percent in the developed countries. In part A of the table this change is divided into its components: In the developing economies labor increased over the period by 5.9 percent and the net effect of this change was to reduce wages by 8 percent; in the developed countries, labor supply in agriculture was decreased by 75.9 percent causing an increase of 104 percent in wages. By the same calculation, the accumulation of the non-labor factors had a much larger positive effect on the farm wages in the developing than in the developed countries--39.9 and 4.9 percent, respectively (the effect of prices, of terms of trade, will be studied in future work). Accordingly, the "prediction" of the regression of Table 3 is that wages in agriculture increased by 31.9 and 108.9 percent for the two groups of countries, respectively; close to the observed changes.

Two alternative hypothetical developments are simulated in Part B of Table 5. If labor force in agriculture had not changed at all, farm wages in the developing countries would have been higher by 8 percentage points than what they actually were (an increase of 39.9 instead of 32.2 percent); in the developed countries, under the same assumption, wages would have increased only by 4.9 percent (instead of a calculated increase of 108.9 percent). Similarly, without migration, the farm labor force would have increased--by 51.4 percent in the developing countries and by 22.2 percent in the developed ones--wages would have decreased by 30.7 percent in the developing countries, and by 25.6 percent in the developed economies.

Changes in the relative income gap--in wages or product ratio--affect the rate of migration. The elasticity of migration with respect to the ratio p_u/p_a is .789 (Table 3). Between 1960 and 1970 the product ratio changes only slightly both in the developing and the developed countries (Table 2). The

Table 5: The Effect of Labor and of Other Variables on the Changes in Wages, 1960- 1980 (Percent)

A. Explanation	Developing Countries	Developed Countries
Observed change of wages in agriculture	32.2	91.4
Calculated		
Labor (-1.373 times .059 for LDCs, times -.759 for DCs)	-8.0	104.0
Other factors	39.9	4.9
Change in wages	31.9	108.9
B. Simulated change in wages		
No change in agricultural labor force	39.9	4.9
No migration (Growth of labor force over the period LDCs .514, DCs .222)	-30.7	-25.6

Note:

Part A was calculated using the estimated coefficients of the demand equation in Table 3 and the geometric averages of the changes, over the period, of the explanatory variables in the regression.

effect of these changes on the rate of migration was evidently small. The product ratio changed markedly between 1970 and 1980, and when the data on the decade of the 1980s are available it will be interesting to see whether this narrowing of the gap actually reduced migration.[6/]

Short and Long Run Effects

The implication of the gradual nature of labor reallocation is that the effect of exogenous and policy changes on employment and returns to labor in agriculture is also only gradually realized. The impact and the short run effects of such changes are in general different from their long run effects.

In Table 6 we report simulation exercises designed to assess the effects of two exogenous changes: an increase in non-farm income and an increase in the intensity of irrigation. (In some cases irrigation is an endogenous variable in the economy of agriculture, in many others it is part of the infrastructure provided exogenously.)

The first column in the table is the actual geometric mean per country of labor, product and migration, for the sample years. The second column reports the replay of history with the model: we start in 1960 with the historically given labor force, calculate wages in agriculture according to demand regression 2 in Table 3 and calculate labor shift according to the migration equation. Subsequently, labor force for 1970 is determined by eq. (2) and the process continues.

6/ A single year may be an outlier, particularly after 1970 when farm prices were volatile. The average ratio for a period is a more appropriate measure of the gap.

Table 6: Preliminary Simulation Exercises (Geometric Averages)

	Developing Countries				Developed Countries			
	Actual	History Repl'd	Double Non-ag Income	Double Irrigation	Actual	History Repl'd	Double Non-ag Income	Double Irrigation
1960								
Labor ('000)	5548	5548	5548	5548	1168	1168	1168	1168
Avg. product ($)	760	698	698	741	2244	2430	2430	2580
Rate Of Mig (%)	0.009	0.011	0.019	0.0105	0.056	0.045	0.077	0.043
1970								
Labor ('000) ($)	5920	6044	5581	6073	802	825	585	843
Avg. Product ($)	974	928	970	983	3822	3796	4590	3983
Rate Of Mig (%)	0.0146	0.0128	0.022	0.012	0.061	0.072	0.124	0.069
1980								
Labor ('000)	6073	6628	5631	6689	564	470	199	492
Avg. Product ($)	1306	1212	1326	1.281	6464	6753	10853	6992
Elasticities								
Migration								
Impact (1960s)			0.73	-0.045			0.71	-0.044
Intermediate (1970s)			0.72	-0.063			0.72	-0.042
Employment								
Impact (1960)			0	0			0	0
Intermediate (1970)			-0.077	0.005			-0.29	0.022
Long Run (1980)			-0.15	0.009			-0.58	0.047
Average Product								
Impact (1960)			0	0.062			0	0.062
Intermediate (1970)			0.045	0.059			0.21	0.049
Long Run (1980)			0.094	0.057			0.61	0.035

Note: based on regressions 1 and 3 in Table 3. See text for explanations.

The simulation is done for each country separately and the figures reported in the first part of Table 6 are geometric averages per group of countries. The correlation between the country level actual observations and the "history replayed" simulation were higher than .90 for labor allocation and for average product, and .75, .65 for the migration flows in the two decades.

The third and fourth columns are simulations with non-agricultural income (average product) doubled in each of the years 1960, 70, 80 or with irrigation intensity doubled similarly. These changes have no impact effect on employment in 1960. Doubling irrigation increases the demand for farm labor and the average product rises in the first year and subsequently; doubling non-farm income affects returns to labor in agriculture only to the extent that it affects labor supply. This change is realized for the first time in the simulation exercise in 1970.

The second part of Table 6 reports elasticities calculated from the simulation exercises. It is striking how slow exogenous changes are realized in the farm sector. In the very long run, a rise in non-farm income will cause a proportional increase in returns to labor--the very long run elasticity of this effect is one--but by our simulation doubling non-farm income will result, after 20 years, in an increase of only 61 percent in agriculture in the developed countries. In the developing countries the reaction is much slower: after 20 years income in the farm sector will rise by less that 10 percent. The effect of irrigation, on the other hand, is comparatively stronger in the developing countries.

The differences between the developed and the developing countries reaction time is due to differential effects of migration on the labor force in the two groups. A proportional change in migration has a much larger effect on labor supply in the developed countries. As a result, improved non-farm opportunities has a comparatively large effect on labor supply in the agriculture of the rich countries; its effect on labor supply in the poorer countries is smaller. It is not the elastic long run supply of labor (surplus labor in the sense of Lewis, 1954, and Ranis and Fei, 1961) but the slow reaction of a large mass of workers that keeps returns to labor constant in agrarian economies. Similarly with irrigation, increased demand for labor is met by increased supply that dampens the beneficial effect of irrigation of the returns to labor in agriculture. This dampening effect is comparatively stronger in the developed countries.

General Pattern and Dispersion

The general patterns of wage and product gaps and labor allocation follow the logistic outline, but countries deviate markedly from this pattern. It will be useful to examine the relations between the income gaps and labor allocation diagramatically.

Figures 5 and 6 are scatter diagrams of the wage ratio and of the product ratio in the sample. Several features are noteworthy in these diagrams: We have less information, and therefore fewer points in the diagram, on wage ratio than on the product ratio. Wage data are not only scarce, they are also less reliable--there are several outliers in Figure 5, all of them for developing countries: Argentina, Yugoslavia and Turkey. The outliers probably reflect differences in the definition of agricultural workers or their wages between the countries. There is evidently more uniformity in measurement of the product--in agriculture and elsewhere in the economy.

Both Figures 5 and 6 reveal the general negative correlation between the share of labor in agriculture and the product ratio. But, both diagrams also reveal the fact that behind this negative correlation there exists a marked dispersion of the country data. This is manifested more clearly in Figure 6: Most of the developing countries are grouped at the lower range of the product ratio, but they differ substantially in the share of labor in agriculture. The developed countries are characterized mostly by comparatively lower shares of labor in agriculture but exhibit a large dispersion in the product ratio. These dispersions--both for the developing and for the developed countries--will have to be studied separately.

Figure 5: Wage Ratio and Labor Allocation

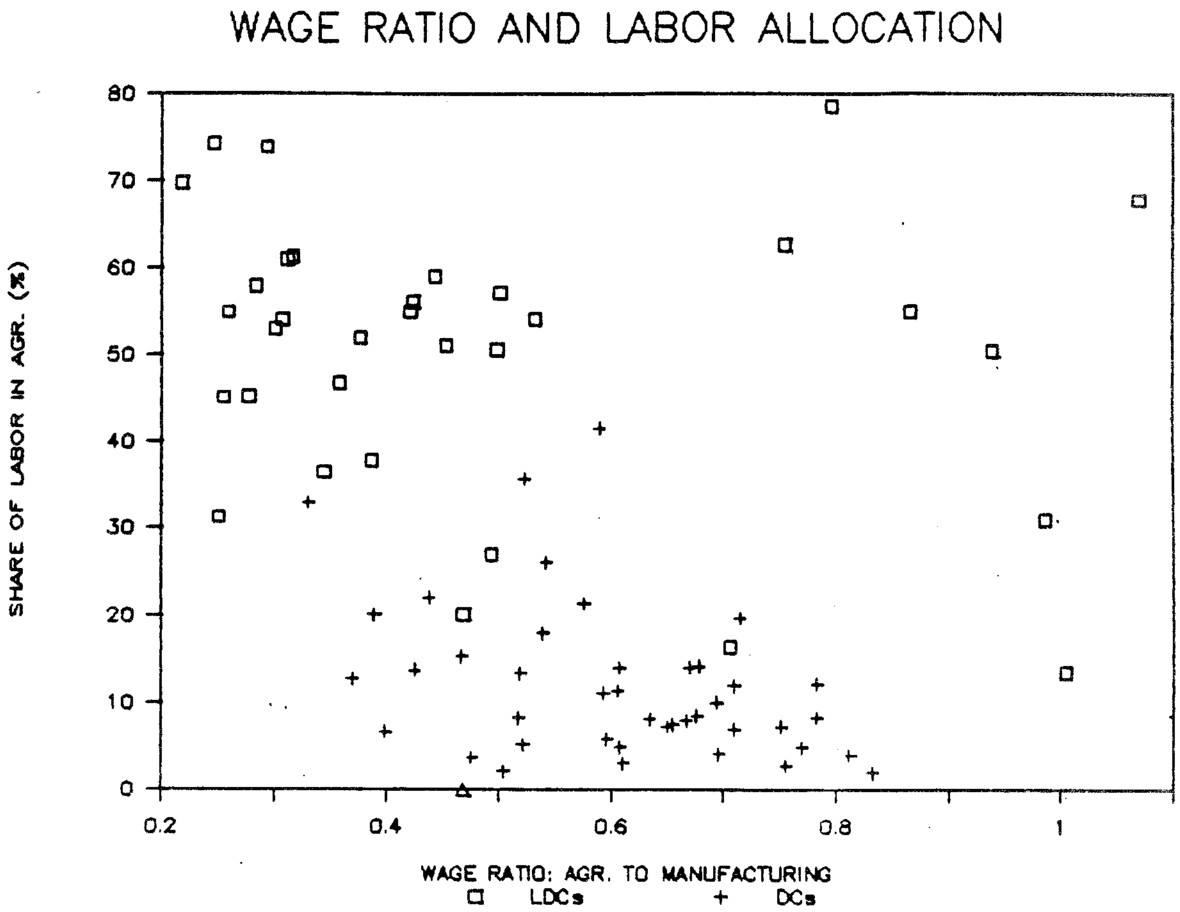
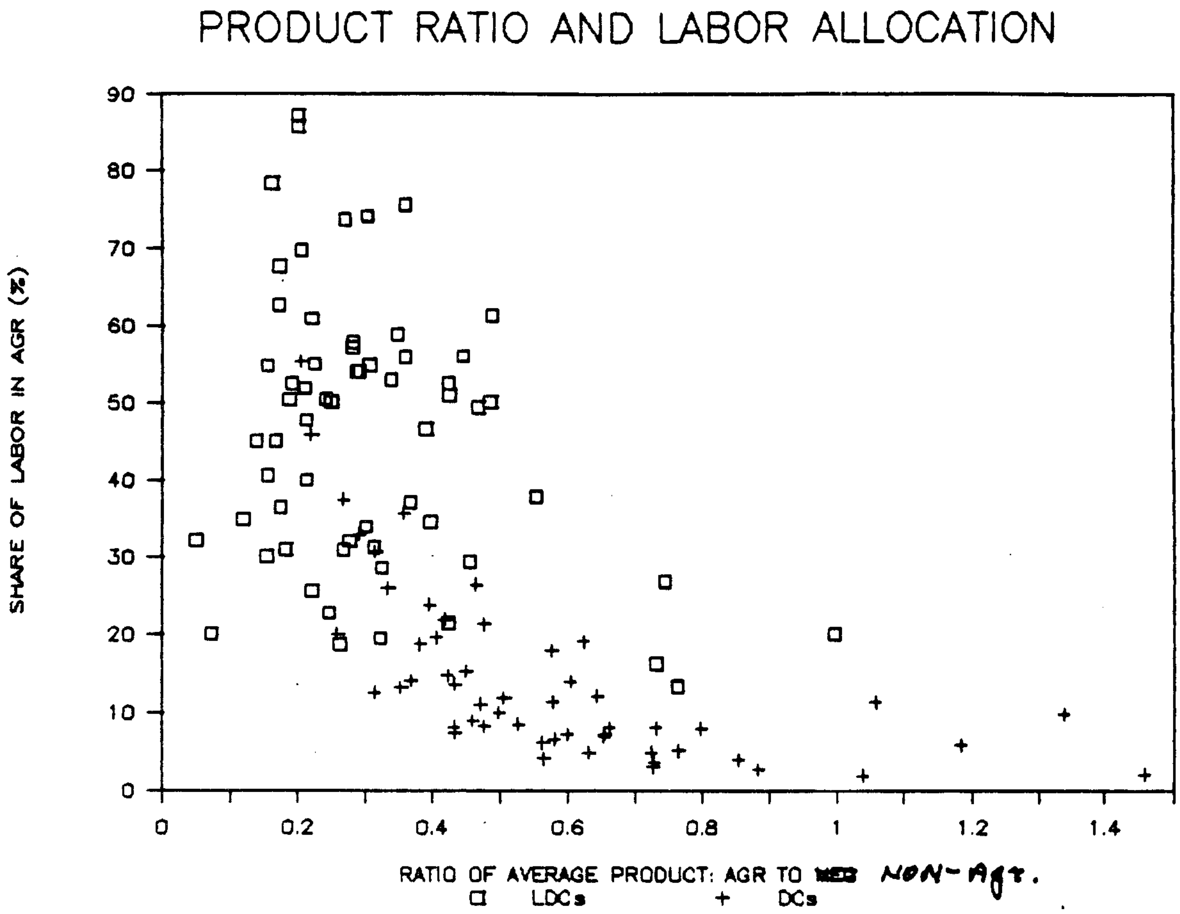


Figure 6: Product Ratio and Labor Allocation



Appendix

Sample Countries

Argentina	Australia
Bangladesh	Austria
Brazil	Belgium
Chile	Canada
Colombia	Denmark
Egypt	Finland
India	France
Libya	Germany, Fed Rep
Mauritius	Greece
Mexico	Ireland
Pakistan	Israel
Paraguay	Italy
Peru	Japan
Philippines	Netherlands
Portugal	New Zealand
South Africa	Norway
Sri Lanka	Spain
Syria	Sweden
Taiwan	Switzerland
Turkey	United Kingdom
Venezuela	United States
Yugoslavia	

References

Binswanger, Hans, Yair Mundlak, Maw-Cheng Yang, and Alan Bowers, 1985, "Estimation of Aggregate Agricultural Supply Response," The World Bank, Discussion Paper, Report No.: ARU 48.

Cavallo, Domingo and Yair Mundlak, 1982, Agriculture and Economic Growth in an Open Economy: The Case of Argentina, International Food Policy Research Institute, Research Report 36, Washington, D. C.

Davis, Harold T., 1962. Introduction to Nonlinear Differential and Integral Equations. Dover, New York.

Greenwood, M. J., 1981, Migration and Economic Growth in the United States, Academic Press, New York.

Harris, J. R. and M. P. Todaro, 1970, "Migration, Unemployment and Development: A Two-Sector Analysis," American Economic Review, 60:126-42.

Hayami, Yujiro, and Vernon W. Ruttan, 1985, Agricultural Development, An International Perspective, Johns Hopkins, Baltimore and London.

Kirzner, Israel M., 1973, Competition and Entrepreneurship, University of Chicago.

Kravis, Irving B., Alan W. Heston and Robert Summers, 1978, "Real GDP Per Capita for More Than One Hundred Countries." Economic Journal, 88:215-42.

Kuznets, Simon, 1982, "The Pattern of Shift of Labor Force from Agriculture, 1950-70," in: The Theory and Experience of Economic Development, ed: Mark Gersovitz, Carlos Diaz-Alexandro, Gustav Ranis and Mark R. Rosenzweig, Allen and Unwin, London.

Lewis, W., 1954, "Economic Development with Unlimited Supply of Labor," Manchester School of Economic and Social Studies, 22:139-91.

Mincer, Jacob, 1974, Schooling, Experience, and Earnings, National Bureau of Economic Research, New York.

Mundlak, Yair, 1979, Intersectoral Factor Mobility and Agricultural Growth, International Food Policy Research Institute, Research Report 6, Washington, D. C.

Mundlak, Yair, 1985, The Aggregate Agricultural Supply Function, mimeo.

Ranis, G. and J. C. H. Fei, 1961, "A Theory of Economic Development," American Economic Review, 51(4):534-65.