TECHNOLOGY, WAGES, AND FACTOR SHARES

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The objective of this paper is an inquiry into the variation in factor shares associated with technological differences and wage differentials between countries and within countries. Variation within countries is discussed with reference to "regional development projects" in a developing country. These projects bring about a radical change in the production patterns of a section of the country in question while the country as a whole retains its traditional characteristics, including an abundance of unskilled labor and a scarcity of managerial power.

The first section of this paper presents an attempt to hypothesize about potential variation in factor shares. The second section includes some empirical observations related to the proposition contemplated in the first section.

POTENTIAL VARIATION IN FACTOR SHARES

A Uniform Labor Input and Neutral Technical Change

Consider the case of two countries, each of which is characterized by a distinct set of real wage rates. Agrotechnological differences between the two countries are limited to total factor productivity, and the input-output relationships in farming in both countries can be summarized by a single CES production function.[1] The function contemplated is homogeneous of the first degree:

$$(1) \qquad Y_j = \gamma_j[(1-\delta)\bar{L}_j^{\rho} + \delta X_j^{\rho}]^{1/\rho}$$

where

Y_j = the value of the farm gross product of a characteristic farm in the country j measured in international prices

$\bar{L}_j$ = the services rendered by farm labor in a characteristic farm in country j

X_j = the value of the services of the production agents (other than labor) employed by a characteristic farm in country j measured in term of Y

γ_j = a constant term signifying the total factor productivity in country j

$0 < \delta < 1$ the coefficient of labor intensity

and

j = 1,2 countries.

Assuming that farm labor is a uniform entity, $\bar{L}_j = L_{\cdot j}$ where $L_{\cdot j}$ is the number of man-days employed by the characteristic farm in country j. The coefficient ρ is interpreted as

$$\rho = \frac{\sigma_{L/X} - 1}{\sigma_{L/X}}$$

where $\sigma_{L/X}$ is the elasticity of substitution of X for $\bar{L}$ and of X for L. as well.

Let $\bar{W}_j$ stand for the jth country wage rate measured in terms of units Y per man-day. Assuming optimal allocation, the ratio of labor's share in the gross product in country j, denoted as $\bar{S}_j$, over the share of X, $1 - \bar{S}_j$, will be:

$$(2) \qquad \frac{\bar{S}_j}{1-\bar{S}_j} = \left(\frac{\delta}{1-\delta}\right)^{\sigma_{L/X}} \left(\frac{\bar{W}_j}{R_j}\right)^{1-\sigma_{L/X}}$$

where R_j is the rate of remuneration of X in country j.

Let country 1 be technologically more advanced than country 2 and characterized by a higher relative wage rate: $\bar{W}_1/R_1 > \bar{W}_2/R_2$.

Insofar as the elasticity of substitution, $\sigma_{L/X}$, is greater than one, the country characterized by a relatively low wage rate is also characterized by a relatively high labor share as $\bar{S}_1/(1-\bar{S}_1) < \bar{S}_2/(1-\bar{S}_2)$.

Nonuniform Labor and Nonneutral Technical Change

The two countries contemplated above differed in total factor productivity only. A slight departure from this assumption of neutral technical change and from the assumption of labor uniformity follows a reconsideration of variable $\bar{L}_j$ in the basic equation (1). Let $\bar{L}_j$ be defined as follows:

$$(3) \qquad \bar{L}_j = [\lambda_j L_{1j}^{\eta} + (1-\lambda_j) L_{2j}^{\eta}]^{1/\eta}$$

where

L_{1j} = man-days of management employed by a characteristic farm in country j

L_{2j} = man-days of labor proper employed by the characteristic farm in country j

$0 < \lambda_j < 1$ the management intensity associated with the state of technology in country j

$\eta = (\sigma_{1/2}-1)/\sigma_{1/2}$

and

$\sigma_{1/2}$ = the elasticity of substitution of L_2 for L_1.

Where the farm firm in question selects the least-cost input combinations, the ratio of L_1/L_2 is given by

$$(4) \qquad q_j = \frac{L_{1j}}{L_{2j}} = \frac{\lambda_j}{1-\lambda_j} \left[\frac{W_{2j}}{W_{1j}}\right]^{\sigma_{1/2}}$$

where W_{1j} is farm management's wage rate in country j and W_{2j} is the wage rate of farm labor proper in country j.

The simple aggregate $L_{\cdot j}$ is redefined as $L_{\cdot j} = L_{1j} + L_{2j}$. It could be shown that $\bar{L}_j = Q_j L_{\cdot j}$ where Q_j is a constant term as long as the ratio W_{2j}/W_{1j} is constant.[2] Hence, as before, $\sigma_{L/X}$, pertaining to the basic equation (1), signifies the elasticity of substitution of X for $\bar{L}$ and of X for $L_{\cdot}$ as well.

The "average" wage rate $\bar{W}_j$ is redefined in accord with q_j:

$$(5) \qquad \bar{W}_j = \frac{q_j}{1+q_j} W_{1j} + \frac{1}{1+q_j} W_{2j}.$$

Insofar as $\bar{W}_j$ in equation (2) has been properly determined (according to equation 5), the proposition stated at the end of the previous section holds true: The aggregate labor's share in the gross product of country 1 is expected to be smaller than the corresponding share in country 2 —that is, $\bar{S}_1 < \bar{S}_2$.[3]

A Transformed Region in a Developing Country

Assume now that advanced technology is introduced to a region of country 2 which is small enough not to affect the given wage rates. Unlike the rest of the country, production in the transformed region is characterized by the management intensity λ_1 rather than λ_2. As management intensity of the advanced technology is larger than that of the "traditional" technology ($\lambda_1 > \lambda_2$), the management ratio in the transformed region (denotes q_2^*) will be higher than that of the rest of country 2 —that is, $q_2^* > q_2$. Consequently, the average wage rate of the developing section (denoted $\bar{W}_2^*$) will be higher than the one pertaining to traditional production patterns in the rest of the country, $\bar{W}_2^* > \bar{W}_2$, assuming that management is more expensive than labor proper, $W_{1j} > W_{2j}$. As a result, the aggregate share of labor in the developing section (denoted S_2^*) will be smaller than the corresponding share in the rest of the country—that is, $\bar{S}_2^* < \bar{S}_2$.

As management's relative wage rate is presumably higher in a developing country, $W_{12}/W_{22} > W_{11}/W_{21}$, q_2^* is bound to be smaller than q_1. It seems reasonable to suggest that management and labor proper are poor substitutes so that $\sigma_{1/2}$ is smaller than unity. Given the relative wage rates, as $\sigma_{1/2}$ approaches zero, q_2^* falls closer to q_1, and the drop in labor share associated with the adoption of the advanced technology becomes sharper. A paradoxical situation may occur if management's absolute wage rate in the developing country is higher than the one prevailing in the developed country: $W_{12} > W_{11}$. Under this condition, the aggregate share of labor in the transformed region of country 2 may be **smaller** than the one characterizing country 1—that is, $\bar{S}_2^* < \bar{S}_1$.

SOME EMPIRICAL OBSERVATIONS

Development and Variation in Aggregate Labor Share

Does the aggregate labor share decline as the wage rate tends to rise in the course of development? Considering this question with reference to the United States longterm experience, Ruttan and Stout suggest that, when that share is computed on the basis of the recorded gross farm income, labor loads, and wage rates, the answer is affirmative as labor's share has changed as follows (13, Table 3A):

Period	Labor's Share (percent)
1925-1928	39.4
1938-1940	32.3
1954-1957	25.7

Adopting Ruttan's imputation procedure, a similar phenomenon could be detected in the international (farm level) cross-section data compiled by Heady and Dillon (6) (Table 1), an international cross-section prepared by Hayami and Inagi (5) (Table 2),[4] and the statistics for two of Iran's major farming provinces, Ghazvin and Khuzestan, compared with Israel's Negev district where climatic conditions and the output mix are approximately similar. The outcome in the latter comparison is consistent with the proposition suggesting that labor's share tends to decline as farm wage rate rises in the course of development:

	Labor's share in the gross product (percent)
Traditional agriculture, Ghazvin and Khuzestan, Iran (3,14,15)	61.5
Modern agriculture, Negev family farms, Israel (8,9,10)	33.0

Table 1. The share of labor in the gross farm product, selected countries.

Year	State and/or country	Labor's share in the gross farm product[a]	Labor's opportunity costs
		percent	dollars per month
1953-54	Iowa and Illinois, United States	18[b]	160
1954	Alberta, Canada	16	148
1954	Norway	23[c]	73
1951-52	England	27	64
1954-55	Austria	48	36
1955-1958	Hokkaido, Japan	36[d]	35-40
1954-1956	Uttar Pradesh, India	62[d]	23

[a] Imputed as the ratio of the sample's mean labor-load times the respective opportunity cost over the sample's mean output value.

[b] A simple average of three samples.

[c] A simple average of two samples.

[d] A simple average of four samples.

Source: Heady and Dillon (6).

Table 2. Wage rates, production per man-day, and labor's share in agriculture's gross product, selected countries.[a]

	Country	Wage rates (i)[b]	Production per man-day (ii)[c]	Labor's share 100 ((i)/(ii))
		kilogram per man-day[d]		percent
I.	Australia	115.7	502.6	23
	United States	113.3	439.5	26
	Canada	93.9	355.6	26
	New Zealand	72.0	670.4	10
	United Kingdom	66.1	188.9	34
	Denmark	60.8	178.7	34
	Israel	36.0	137.9	26
	Ireland	31.0	76.4	40
II.	Mexico	10.6	25.1	42
	Japan	9.9	35.4	28
	Portugal	8.8	26.5	32
	Chile	8.4	39.6	21
III.	India	3.2	6.5	49

[a] Based on Hayami and Inagi's series using a kilogram of wheat as numeraire. The original series included 43 countries. Excluded from the above table are developed countries where the domestic price of wheat (expressed in U.S. dollars) deviated by more than 20 percent from the United States price or countries in group II with similar deviation with reference to Japan's price.

[b] Imputed as the ratio of the wage rate, quoted in local currency over the producer price of wheat expressed in local currency.

[c] Based on Hayami and Inagi's production series with (physical) weights pertaining to relative prices in the United States (group I), Japan (group II), and India (group III).

[d] Wheat equivalent.

Sources: Food and Agriculture Organization of the United Nations (4), Hayami and Inagi (5), and International Labour Office (7).

A Transformed Region in a Developing Economy

Two regional development projects take place in the two Iranian provinces referred to in the previous section—one is the Khuzestan "DEZ Irrigation Project" and the other is the Ghazvin "Agriculture Development Project."[5] An interesting phenomenon manifested in these two provinces in question is a sharp decline in labor's share in the gross product associated with the agrotechnological transformation (2,3,12,14,15):

	Labor's share in the gross product	
	Traditional agriculture (percent)	Transformed agriculture (percent)
Ghazvin area	53.0	31.8
Province of Khuzestan	70.0	13.7

The labor share variation thus indicated differs from the one reflected in Ruttan and Stout's statistics, the international cross-sections (Tables 1 and 2), and the Ghazvin-Khuzestan/Negev comparison of the previous section. The labor share variation within the provinces of Ghazvin and Khuzestan is **not** associated with a distinct variation in the wage rates of labor proper. Yet, even in this case one cannot rule out the possibility that factor share variation is a reflection of wage variation. Assuming that production in the transformed region tended to rely on least-cost combinations and that labor and management are very poor substitutes, the observed phenomenon may be interpreted in term of our second proposition relating a low labor share to a high rate of management remuneration (and a high $\bar{W}$). Indeed, management rates of remuneration in the transformed region were exorbitant as wage rates (in U.S. dollars) for "imported" management were virtually twice as high as the ones prevailing in the countries of origin (United States and Israel). This was more evident in the case of Khuzestan; and it might even be suggested that, in accord with our second proposition, a relatively higher labor share in Ghazvin, as compared with Khuzestan, is associated with a relatively lower management wage rate in that region.[6]

FOOTNOTES

1. For a discussion of this function, see Brown (1) and Nerlove (11).

2. $Q_j = [\lambda_j + (1-\lambda_j)q_j^{-\eta}]^{1/\eta}(1+q^{-1})$.

3. As $\lambda_2 \cong 0$, the average wage rate in country 2 ($\bar{W}_2$) is, in essence, the reflection of W_{22}; thus, $\bar{W}_2$ is bound to be smaller than $\bar{W}_1$.

4. These comparisons are subject to some reservations; for one, differences in the composition of X and Y and variation in R are overlooked.

5. The first project, aiming at large-scale farming, involves an area of 300,000 out of 2,400,000 acres of arable land in the Khuzestan province. The second project is directed at mixed family farms as well as large farms; it involves 128,000 acres in the Ghazvin region.

6. Ghazvin's project enjoys a relatively lower rate of management remuneration for two reasons. First, it "imported" managers from Israel while the Khuzestan project relied on United States experts. Secondly, an apparently higher rate of Iranian experts are employed in Ghazvin as compared to Khuzestan.

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