Differential Returns to Labor in Indian Agriculture

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This article explores the speed of adjustment in Indian agricultural labor markets to changing economic circumstances. Agricultural wages in sixteen states during 1970–86 are analyzed. Results indicate that agricultural wages adjust quickly toward their long-run values, completing about one-fifth to one-fourth of the adjustment per year. Results also suggest strong linkages between the agricultural and nonagricultural labor markets. Interstate agricultural productivity differences have risen substantially in the last twenty-five years, and many feel this has led to a disintegration of the agricultural labor market. The findings suggest an indirect integration may be occurring through migration to nonagriculture.

It is commonly accepted that, given time, spatial differences in factor returns are eliminated as people reallocate their resources to take advantage of the resulting opportunities. In today's international financial markets, the equilibriating process takes only minutes. In cases where markets are less developed or the costs of resource adjustments are large, attaining equilibrium can take much longer. For labor in lower-income countries, the required time is generally presumed to be measured in years or perhaps decades. Confounding the process is the fact that the equilibrium is usually a moving target. Technical change, changes in factor supplies, and other forces alter the long-run equilibrium.

The objective of this article is to explore the rate of adjustment in agricultural labor markets in India and to quantify the speed with which wages adjust to changing economic circumstances. Much of Indian agriculture has undergone significant changes in the last twenty-five years. Modern crop varieties have had major impacts on production and yield in north-central and northwestern India. In the rest of the country, however, output and yield growth have been small or negligible. Many feel that interstate disparities in returns to labor have increased as disparities in yield have increased (e.g., Bhalla and Tyagi). To what extent has migration moderated these trends?

There is some seasonal migration of hired farm workers between states (Oberai and Singh). At harvest time, many workers travel from poorer states in the east to the northwestern states of Punjab and Haryana. However, India is a very diverse country. Linguistic, cultural, and racial forces place strong constraints on long-term movements of farm families from one region of the country to another. National Sample Survey data indicate that the vast majority (85%–90%) of migration in India takes place within the home state. Very little (less than 5%) consists of rural-rural interstate migration. If integration of the agricultural labor market between states is occurring, the driving force cannot be rural-rural interstate migration. It must be migration to various urban areas that compete with each other in product markets. Product-market competition would tend to equalize wages across urban areas as places with high wages found themselves priced out of product markets. This process is known to economists as the factor price equalization theorem.

Competition in agricultural product markets would not necessarily equalize wages across states in the same manner as in nonagriculture. Technology levels differed across states to a far greater extent in agriculture than in nonagriculture even in the 1960s (Verma). In addition, differences within agriculture have risen substantially over the last twenty-five years. Only if these differences were small would agricultural product market competition be sufficient to equalize wages. There is no definite evidence on whether differences within nonagriculture have grown or narrowed since the 1960s.

The Model

Consider a simple model of the agricultural labor market within a state i at time t. Labor demand, N_{it}, is assumed to be a function of the wage, w_{it}:

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$$(1) \qquad \hat{N}_{it} = \hat{a}_{it} - \alpha\hat{w}_{it},$$

where ˆ denotes the percentage change in a variable, a_{it} is an exogenous demand shifter, and $\alpha > 0$ is the demand elasticity.

Agricultural laborers can either work in their own state or migrate to nonagriculture. Nonagriculture is not differentiated by state on the simplifying assumption that wages in this sector are equal across states. Laborers cannot move to agriculture in another state. Labor demand in nonagriculture, N_t^*, is assumed to be a function of the nonagricultural wage, w_t^*:

$$(2) \qquad \hat{N}_t^* = \hat{a}_t^* - \alpha^*\hat{w}_t^*,$$

where a_t^* is an exogenous demand shifter and $\alpha^* > 0$ is the demand elasticity.

Let $M_{it} > 0$ be net migration from agriculture to nonagriculture and let Γ_{it} be the "original" agricultural labor force (prior to any migration). Labor supply to agriculture is $\Gamma_{it} - M_{it}$, so that labor market equilibrium requires $\Gamma_{it} = N_{it} + M_{it}$. This can be written as

$$(3) \qquad \hat{\Gamma}_{it} = (1 - \theta_{it})\hat{N}_{it} + \theta_{it}\hat{M}_{it},$$

where $0 < \theta_{it} = M_{it}/\Gamma_{it} < 1$. Let Γ_t^* be the original labor force in nonagriculture. Labor market equilibrium in nonagriculture requires $N_t^* = \Gamma_t^* + \Sigma_i M_{it}$, or

$$(4) \qquad \hat{N}_t^* = \omega_t^*\hat{\Gamma}_t^* + (1 - \omega_t^*)\Sigma_i\omega_{it}\hat{M}_{it},$$

where $0 < \omega_t^* = \Gamma_t/N_t < 1$ and $0 < \omega_{it} = M_{it}/\Sigma_i M_{it} < 1$, with $\Sigma_i\omega_{it} = 1$.

The original labor force is by definition the actual labor force in the previous period plus some natural labor-force growth factor:

$$(5) \qquad \hat{\Gamma}_{it} = \hat{r}_{it} + \hat{N}_{it-1},$$

$$(6) \qquad \hat{\Gamma}_t^* = \hat{r}_t^* + \hat{N}_{t-1}^*,$$

where r_{it} and r_t^* are the growth factors, assumed exogenous for simplicity. Since the labor force in the previous period depends on that period's wage, the labor market equilibrium conditions imply that the current-period wage will also depend on the previous period's wage.

Migration as a fraction of the original labor force, $\theta_{it} = M_{it}/\Gamma_{it}$, is assumed to be a function of the nonagricultural-agricultural wage ratio, w_t^*/w_{it}:

$$(7) \qquad \hat{M}_{it} - \hat{\Gamma}_{it} = \hat{b}_{it} + \beta(\hat{w}_t^* - \hat{w}_{it}),$$

where b_{it} is an exogenous migration shifter and $\beta > 0$ is the migration-wage elasticity.

The equilibrium solution for each agricultural wage is of the Nerlovian partial-adjustment form:

$$(8) \qquad \hat{w}_{it} = (1 - \lambda_{it})\hat{w}_{it-1} + \lambda_{it}\hat{w}_t^* + \hat{d}_{it},$$

where

$$(9) \qquad \lambda_{it} = \theta_{it}\beta/[(1 - \theta_{it})\alpha + \theta_{it}\beta]$$

$$(10) \qquad \hat{d}_{it} = [(1 - \theta_{it})(\hat{a}_{it} - \hat{a}_{it-1} - \hat{r}_{it}) + \theta_{it}\hat{b}_{it}]/[(1 - \theta_{it})\alpha + \theta_{it}\beta].$$

To obtain this solution, put the demand equation (1) and the migration equation (7) into the agricultural labor market equilibrium equation (3). This yields a solution for w_{it} in terms of w_t^*, Γ_{it}, and exogenous variables. Then lag equation (1) by one period and insert it in the original labor force equation (5). This yields a solution for Γ_{it} in terms of w_{it-1} and exogenous variables. When combined, these two solutions give us equation (8).

The exogenous variable d_{it} represents the combined effect of changes in labor demand from $t - 1$ to t, labor-force growth, and migration shifts. $0 < \lambda_{it} < 1$ measures the speed with which agricultural wages respond to nonagricultural wages. The closer λ_{it} is to one, the less sluggish the response and the more quickly agricultural wages adjust toward their long-run values.

To obtain the solution for the nonagricultural wage, take a weighted average of equation (8) across states. This yields

$$(11) \qquad \hat{w}_t = (1 - \lambda_t)\hat{w}_{t-1} + \lambda_t\hat{w}_t^* + \hat{d}_t,$$

where $\hat{w}_t = \Sigma_i\omega_{it}w_{it}$ is a weighted average of the state wages, $\lambda_t = \Sigma_i\omega_{it}\lambda_{it}$ is a weighted average of the adjustment coefficients, and

$$(12) \qquad \hat{d}_t = \Sigma_i\omega_{it}\hat{d}_{it} - [(1 - \lambda_t)\hat{w}_{t-1} - \Sigma_i\omega_{it}(1 - \lambda_{it})\hat{w}_{it-1}].$$

As an approximation, $\hat{d}_t \approx \Sigma_i\omega_{it}\hat{d}_{it}$. Next, utilize the nonagricultural labor market equilibrium condition (4), drawing on other equations to eliminate all endogenous variables except the wage rates. This yields

$$(13) \qquad \hat{w}_t^* = \omega_t^*(1 - \lambda_t^*)\hat{w}_{t-1}^* + \lambda_t^*\hat{w}_t + (\alpha/\beta)\lambda_t^*\hat{w}_{t-1} + \hat{d}_t^*,$$

where

$$(14) \qquad \lambda_t^* = (1 - \omega_t^*)\beta/[\alpha^* + (1 - \omega_t^*)\beta],$$

$$(15)\quad \hat{d}_t^* = [\hat{a}_t^* - \omega_t^*\hat{a}_{t-1}^* - \omega_t^*\hat{r}_t^* - (1 - \omega_t^*)\Sigma_i\omega_{it}(\hat{a}_{it-1} + \hat{b}_{it} + \hat{r}_{it}) + \alpha(1 - \omega_t^*)(\Sigma_i\omega_{it}\hat{w}_{it-1} - \hat{w}_{t-1})]/[\alpha^* + (1 - \omega_t^*)\beta].$$

As an approximation, the last term in the numerator of (15) can be dropped and $\hat{d}_t^*$ consists solely of exogenous variables.

Equations (11) and (13) constitute a system of two equations in two unknowns, $\hat{w}_t^*$ and $\hat{w}_t$. The solution for the nonagricultural wage can be written as

$$(16)\quad \hat{w}_t^* = \mu_t^*\hat{w}_{t-1}^* + \mu_t\hat{w}_{t-1} + \hat{h}_t,$$

where $\hat{h}_t$ captures all exogenous variables. The reader can verify that $0 < \mu_t^* < 1$ and $\mu_t > 0$. A similar solution for the average agricultural wage can be derived.

Fitting the Model to the Data

In the Indian context, data limitations restrict the equations of the model that can be estimated. State-level data on migration and labor-force composition are available only at ten-year intervals in the *Census of India* and periodically in the National Sample Surveys. The determinants of migration have been estimated from census data by Dhar and others. However, limiting oneself to this data prevents exploiting the annual state-level data on agricultural wages that can be constructed from *Agricultural Wages in India* (AWI).

AWI data have often been criticized because the state governments, which collect the data, do not document their sampling techniques. This can cause wide variations in sampling methods and makes interstate comparisons of wage levels tenuous. Rao compared AWI data with more-reliable wage rates collected for specific locations and particular time periods. He found the wages in AWI to be systematically higher than wages obtained from other samples but accurate in showing changes over time. This suggests that AWI is reliable for time series analysis, but that the wage in some initial period should be included for cross-sectional analysis to control for the independent sampling techniques and other persistent interstate differences.

Equation (8) suggests an equation that can be fitted to the data of the form

$$(17)\quad \log w_{it} = \delta_{it} + (1 - \lambda_{it}) \log w_{it-1} + \lambda_{it}^* \log w_t^* + e_{it},$$

where δ_{it} incorporates all exogenous variables and e_{it} is a normally distributed, AR(1) random error with autocorrelation coefficient ρ:

$$(18)\quad e_{it} = \rho e_{it-1} + v_{it}.$$

An AR(1) process is used to keep the model parsimonious in parameters. As will be indicated below, however, the data do not lend much support to more-complicated alternatives.

The wage-responsiveness parameter λ_{it} is an increasing function of θ_{it}, migration as a fraction of the original labor force. From equation (7), θ_{it} is an increasing function of the nonagricultural-agricultural wage differential. This suggests

$$(19)\quad \lambda_{it} = \eta_0 + \eta_w (\log w_t^* - \log w_{it}),$$

with $\eta_w > 0$ presumed. Equation (8) implies

$$(20)\quad \lambda_{it}^* = \lambda_{it}.$$

This system of equations is estimated via maximum likelihood. We should find $0 < \lambda_{it} < 1$. A plausible alternative to (20) that does not impose too many demands on the data is

$$(20')\quad \lambda_{it}^* = \eta_0^* + \eta_w^* (\log w_t^* - \log w_{it}),$$

where $\eta_0^* \neq \eta_0$ and $\eta_w^* \neq \eta_w$ are possible. A likelihood ratio test can be applied to see if (20) is acceptable relative to (20′).

For the sake of simplicity, the nonagricultural wage is treated as exogenous. The model indicates that the nonagricultural wage will be contemporaneously correlated with the national average agricultural wage. Since even the largest state in India makes a small contribution to the national average, however, simultaneity should not be too serious a problem.

The agricultural wage is the state average daily real wage received by male hired farm workers. Data for sixteen states are analyzed. National average real annual earnings of factory workers are used for the nonagricultural wage. Like hired farm work, the bulk of factory work in India is relatively unskilled. Over 90% of factory workers are males. Female agricultural wages are not analyzed because of the absence of yearly data on female nonagricultural wages. However, wages for male and female hired farm workers are highly correlated (the correlation coefficient is at least .9 in nine of sixteen states). The period of analysis is 1970–86, where 19*ij* refers to the July 19*ij*–June 19*ij* + 1 crop year. Complete definitions and data sources for all variables are provided in the appendix.

The exogenous wage shifters in (17) are

$$(21)\quad \delta_{it} = \gamma_0 + \gamma_w \log w_{i0} + \gamma_\tau t + \gamma_y \Delta \log y_{it},$$

where w_{i0} is the initial (1960) state agricultural wage and $\Delta\log y_{it}$ is the change in the log of state agricultural output from year $t - 1$ to year t. Time captures any systematic trends in labor force growth rates, migration, and labor demand (apart from output). Agricultural output is a demand shifter and is exogenous for simplicity. The change in output, rather than the level, is used because we are controlling in (17) for the wage at $t - 1$. Given w_{it-1}, a change in w_{it} requires a change between $t - 1$ and t in demand. Other wage shifters (such as unemployment or the natural rate of labor-force growth) are not included for lack of yearly state-level data.

Bearing in mind the caveat on interstate comparisons, a weighted average of the state male agricultural wages is shown in Figure 1. Also shown is the nonagricultural wage. The two series are closely associated, suggesting strong labor-market linkages between agriculture and nonagriculture. The variation in agricultural wages across states is shown in Figure 2. Leaving aside the peaks in 1974 and 1986, there is a clear downward trend in variability. This is suggestive regarding the strength of equilibriating forces in the labor market. It implies that the agricultural labor market is becoming more, not less, integrated across states. The year 1986 was one of severe drought in several states, while 1974 was a bad year in general for the Indian economy.

Results

The maximum-likelihood results are

$$(22)\quad \log w_{it} = \underset{(4.4)}{-0.35} + \underset{(4.3)}{0.19} \log w_{i0} + \underset{(1.3)}{0.02}t + \underset{(3.0)}{0.14}\, \Delta \log y_{it} + (1 - \underset{(6.3)}{0.22}) \log w_{it-1} + \underset{(6.3)}{0.22} \log w_t^* + \underset{(1.2)}{0.02}e_{it-1} + v_{it},$$

$$(23)\quad \lambda_{it} = \underset{(6.0)}{0.22} + \underset{(0.5)}{0.03} (\log w_t^* - \log w_{it}),$$

where absolute values of the asymptotic t-ratios are in parentheses. The coefficient on $\log w_{it-1}$ and $\log w_t^*$ in equation (17) is the estimate of λ_{it} at the sample means of these two variables.

Notwithstanding the simplicity of the model and the tenuous nature of the wage-rate data, the fit is quite good ($R^2 = .89$). There is a tendency in the literature to treat each state as a special case in terms of its agricultural wages (see the references in Jose). These results suggest that a more general explanation may do just as well (although the model begs the question of where the initial wages come from).

The χ^2 statistic for (20) as an alternative to (20′) is 0.007 (2 degrees of freedom), so that the parameter restrictions in (20) cannot be rejected at virtually any significance level. Four regional dummies (North Central, South Central, East, and South) were also tried. The χ^2 statistic is 0.04 (4 degrees of freedom), indicating that they are not even close to being significant.

Evidence for first-order autocorrelation in the errors is not strong. As a check on the appropriateness of an AR(1) specification, the model was estimated assuming no serial correlation. The resulting estimate (t-ratio) for λ_{it} at the sample mean of $\log w_t^* - \log w_{it}$ was 0.21 (6.3), virtually identical to the result in equation (22). None of the sample autocorrelation coefficients of lag greater than one (up to a lag of five) from this regression were significantly different from zero.

The results are generally in line with expectations. At the sample means, the agricultural wage completes about one-fifth to one-fourth of its long-run adjustment toward the nonagricultural wage in a single year. This is a fairly rapid rate of adjustment, although it is by no means implausible. Given low wages and no assurance of employment, hired farm workers have to be flexible (possibly more flexible than others in rural areas). Estimates (t-ratios) for λ range from 0.20 (3.8) at the sample minimum of $\log w_t^* - \log w_{it}$ to 0.24 (4.3) at the sample maximum.

To see the importance of nonagriculture to the integration of the agricultural labor market, suppose this integrating force had been absent ($\lambda_{it} = 0$). Alternatively, suppose that it had been about twice as strong as estimated ($\lambda_{it} = 0.5$). Starting with 1970 agricultural wages and the other parameter estimates, one can recursively estimate what wages during 1971–86 would have been. (Equations (9) and (10) indicate that other parameter values must change as λ_{it} changes, but it is hard to say by how much. Thus the estimates in

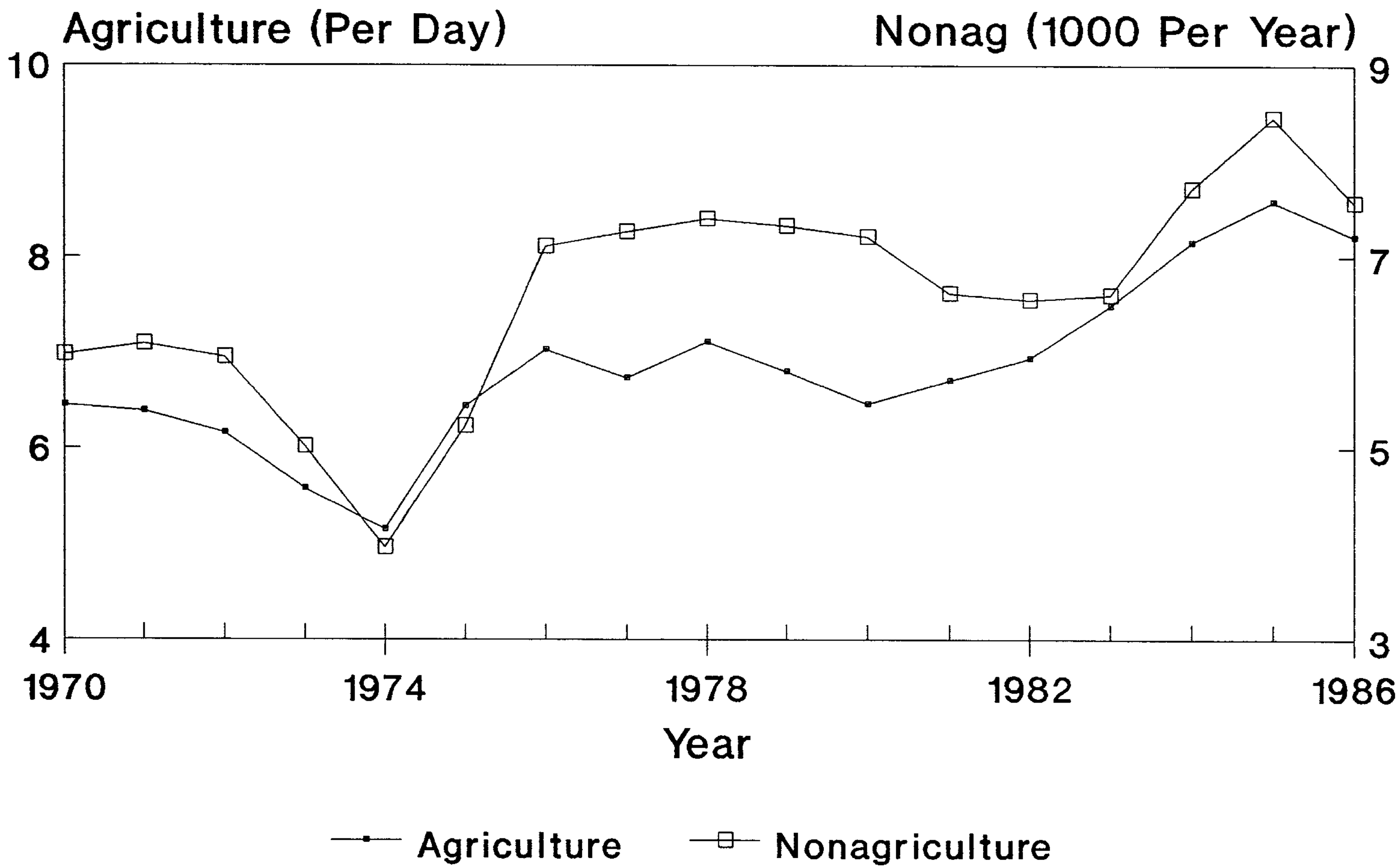

Figure 1. **Real Wages in India (1980 Rupees)**

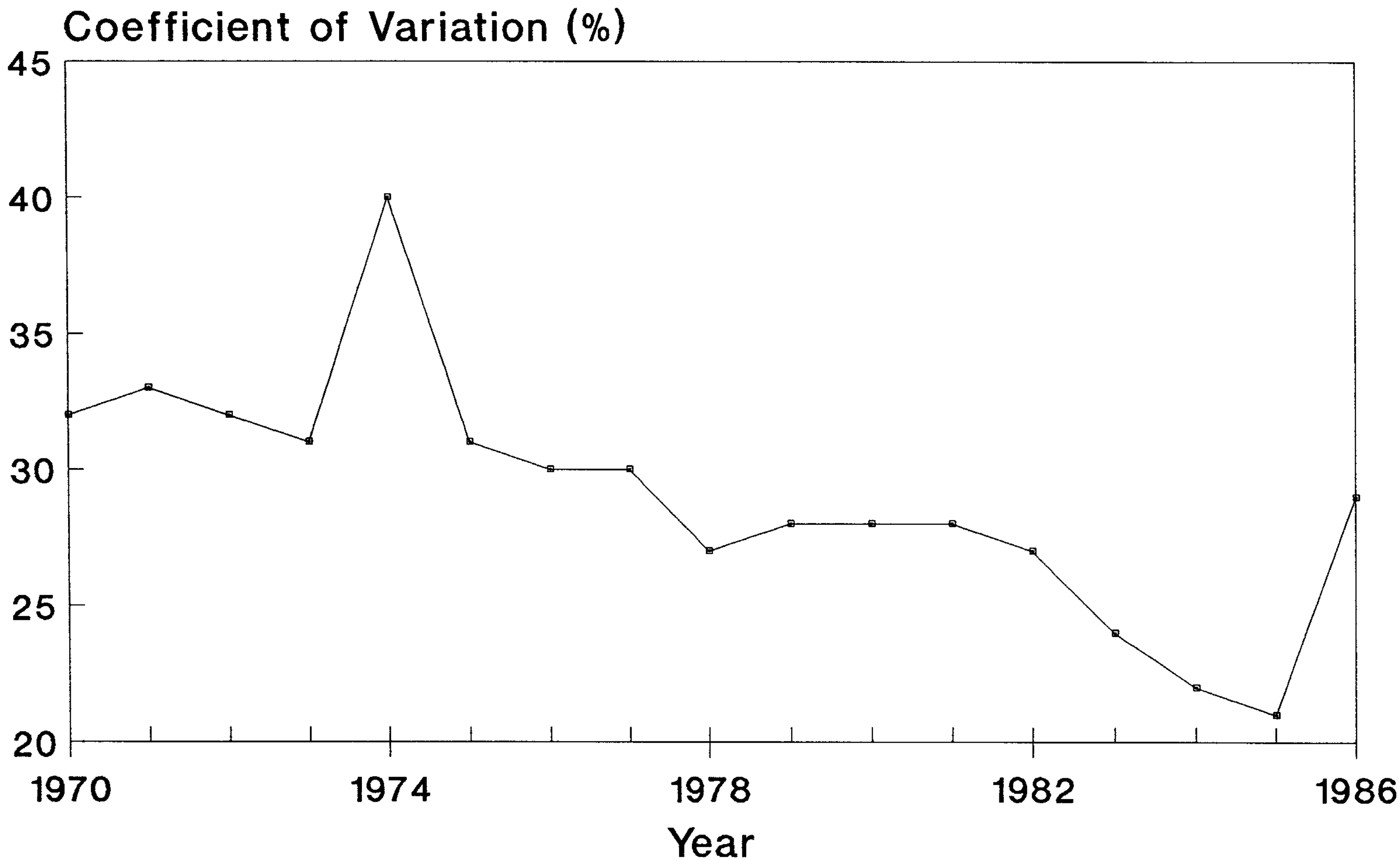

Figure 2. Interstate Variation in Agricultural Wages

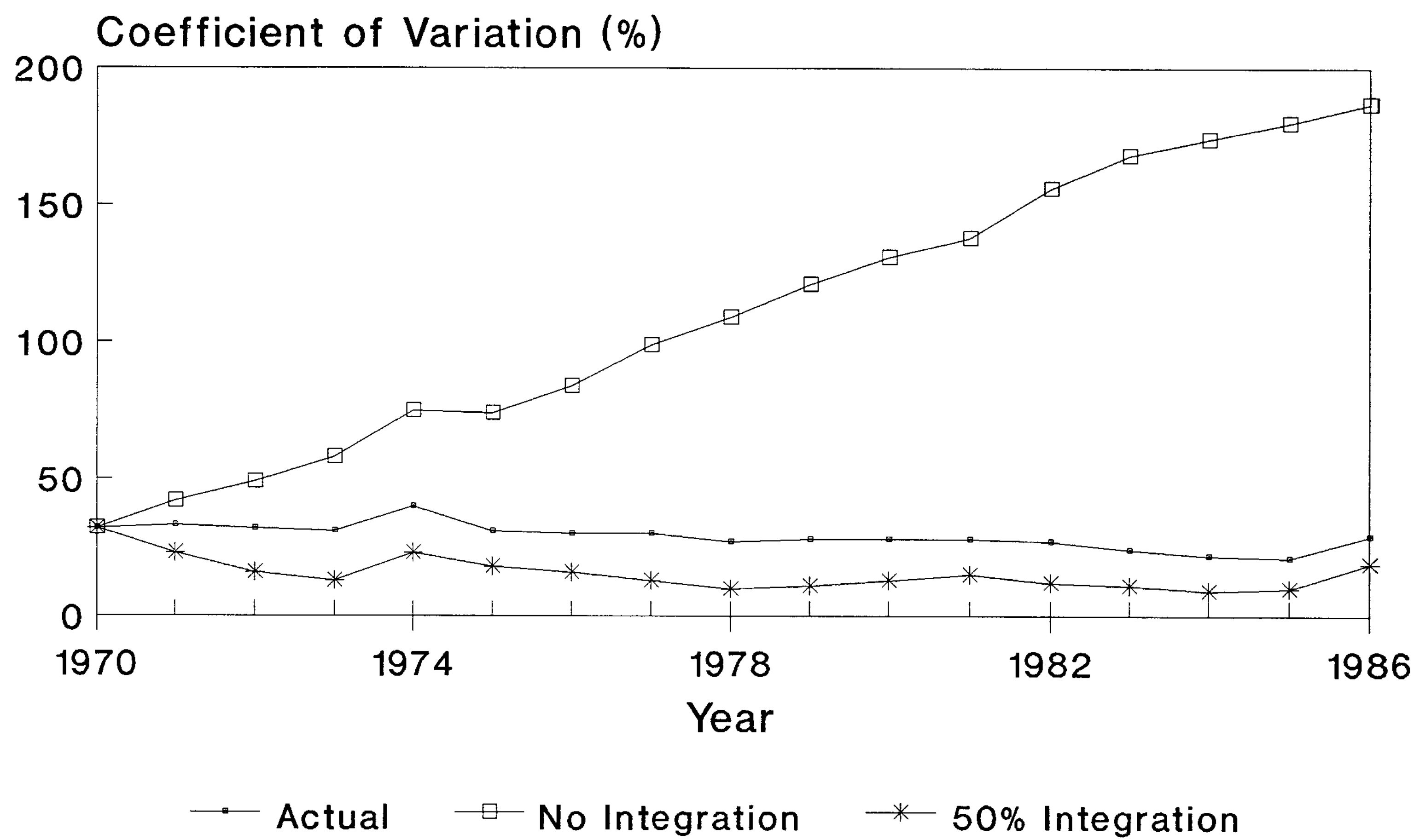

Figure 3. Simulated Variation in Agricultural Wages

equation (22) are retained for these two simulations.) Figure 3 shows the variation in wages across states under these two scenarios. Huge interstate differences appear under the no-integration scenario. Variability under the 50% integration scenario is about half of what it actually was. The conclusion is that nonagriculture is probably the driving force behind the decreasing interstate variability in agricultural wages.

The solution for the migration-wage elasticity, β, in terms of λ_{it} and other parameters is (dropping subscripts) $\beta = \alpha[\lambda/(1-\lambda)](1-\theta)/\theta$. Assume an annual outmigration among hired male farm workers of about 2%, a value broadly in agreement with census and National Sample Survey data. Also assume a demand elasticity for labor of -0.4 (values in the -0.2 to -0.7 range were obtained by Evenson and Binswanger). Then the results here imply $\beta \approx 6$, a fairly large number. Migration-wage elasticities in the 1.0 to 4.0 range for male rural-urban migrants as a whole were obtained by Dhar.

Most of the prior work on Indian agricultural wages at an aggregate level consists of simple time-trend analyses. More sophisticated work has been done at the district and household levels (e.g., Rosenzweig 1978, 1980; Schwarz). Results indicate that wages are highly responsive to supply and demand shifters, and that rural labor markets are geographically isolated from each other to a great extent. The findings here do not contradict these results, although they indicate that the effects of limited geographic mobility between rural areas may be moderated to a large degree by rural-urban migration.

Conclusions

The objective of this article was to explore the speed of adjustment in Indian agricultural labor markets to changing economic circumstances. Agricultural wages in sixteen states during the 1970–86 period were analyzed. The results indicate that agricultural wages adjust fairly quickly toward their long-run values, completing about one-fifth to one-fourth of the adjustment in a single year. The results also suggest strong linkages between the agricultural and nonagricultural labor markets. These results must be tempered, however, by the weaknesses of the agricultural wage rate data and the many simplifying assumptions implicit in the theoretical and empirical models.

Many feel that there has been a disintegration of the agricultural labor market in India during the last twenty-five years based on differential rates of technical change across states and the limited amount of rural-rural interstate migration. The findings here, however, indicate that an indirect integration may be occurring via migration to nonagriculture.

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Appendix

The period of analysis is 1970–86, where 19*ij* refers to the July 19*ij*–June 19*ij* + 1 crop year. The sixteen states in the study are Andhra Pradesh, Assam, Bihar, Gujarat, Haryana, Himachal Pradesh, Karnataka, Kerala, Madhya Pradesh, Maharashtra, Orissa, Punjab, Rajasthan, Tamil Nadu, Uttar Pradesh, and West Bengal.

Agricultural wages. Except for 1972, 1981, 1985, and 1986, data on nominal daily wages for male hired farm workers are from Jose. To obtain district-level wages, Jose took a simple average of wages in *Agricultural Wages in India* (AWI) over months and reporting centers in each district. He then took a weighted average of the district wages to obtain state-level figures. Weights were based on male-hired-farm-work-force data in the *Census of India 1981*. In Assam, a simple average of the district wages was used. When wages were differentiated by occupation, Jose used the following (in order of preference): ploughing, sowing, weeding, harvesting, and other farm labor. When wages were not specified by occupation, Jose used the wages reported for all hired farm work. For 1981, 1985, and 1986, data constructed from AWI by the author following Jose's methodology were used. AWI data could not be obtained for 1972, and so figures for that year were constructed from 1971 and 1973 data. AWI data include in-kind payments of food, housing, etc.

To obtain real wages (1980 rupees), each state's nominal wage was deflated by that state's consumer price index (CPI) for agricultural laborers. (Source: *Agricultural Situation in India.*)

Initial (1960) agricultural wages. An average of real wages for 1958, 1959, 1961, and 1962 (data for 1960 itself were unavailable) was used. It is based on real-wage indices in Jose and the real wages as derived above. Punjab, Haryana, and Himachal Pradesh were all assumed to have the same rate of growth in real wages during 1960–70. Rajasthan was assumed to have a growth rate in real wages during 1960–70 equal to an average of the Punjab and Gujarat growth rates.

Nonagricultural wages. Average annual earnings of factory workers (excluding those in higher-paying managerial jobs), deflated by the CPI for industrial workers (to obtain real wages in thousands of 1980 rupees), were used. Data for 1984–86 were unavailable. Wages were imputed from a 1970–83 OLS regression of the log of the real nonagricultural wage on the log of the national average real agricultural wage, the log of a manufacturing price index, and a dummy variable equal to one for years after 1982 and zero otherwise. The manufacturing price index is the ratio of the wholesale price index for manufactured goods to the CPI for industrial workers. (The source for all variables was the *Statistical Outline of India.*)

Agricultural output. The state's net domestic product in agriculture (in 1980 rupees) was used. (Source: *Estimates of State Domestic Product.*)