Changes in the Structure of Wages in the U.S. Pork Industry*

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By

Terrance M. Hurley, Assistant Professor,
Department of Applied Economics
Room 249c Classroom-Office Building
1994 Buford Avenue
University of Minnesota
St. Paul, MN 55108-6040
Telephone: (612)-625-0216
Fax: (612)-625-6245
E-Mail: thurley@dept.agecon.umn.edu

Peter F. Orazem, Professor of Economics,
Department of Economics, Iowa State University

And

James B. Kliebenstein, Professor of Economics,
Department of Economics, Iowa State University

Abstract

Consolidation in the U.S. pork industry continues to reduce the number of operations, while increasing the demand for hired labor. This paper explores how wages have evolved over time by decomposing the increase in wages into a change in the level of wages, human capital, and returns to human capital.

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The US pork industry has experienced turbulent change over the last several decades. Relatively small operations that rely almost exclusively on family labor continue to be replaced by larger operations with a greater demand for hired labor. In addition to demanding more labor, these large operations require more skilled labor in order to take advantage of new productivity enhancing technologies (Rhodes). The result is an emerging labor market with the potential to provide new opportunities for skilled workers in rural communities.

Understanding the structure of wages and wage growth in this rapidly emerging labor market is useful for employers and employees in the pork industry, as well as rural communities that are interested in economic development. Pork producers can use the information on industry wages and wage growth to determine if they pay enough to attract and retain quality employees or if their wages are too high to maintain a competitive unit cost of production. Employees will find this information useful for evaluating their current wages and determining if it is in their interest to seek employment elsewhere. Rural communities can use the information to determine if attracting hog production facilities represents a good opportunity for economic development as suggested by Hayes, Otto, and Lawrence. If wages in the pork industry are atypically low and wage growth poor, communities might find it in their interests to look toward other industries to promote economic development. Alternatively, if wages are high and wage growth strong, attracting pork production facilities may indeed be a good economic development strategy.

The purpose of this paper is to use survey data collected by the National Pork Producers Council (NPPC) and National Hog Farmer (NHF) magazine during the 1990s to evaluate wages and wage growth in the US pork industry. First, the impact of factors such as gender, education, experience, tenure, operation size, technology use, and region on industry wages is estimated along with the changes in these impacts over time. Predicted wages and wage growth in the pork industry are then compared to the wages of the average civilian worker in the US to provide evidence on wage competitiveness. Finally, the change in wages in the US pork industry is decomposed into three distinct effects. The first effect measures a general increase in the level of wages for all employees. The second captures changes in wages due to changes in human capital, technology use, and operation size. The third effect measures the change in wages due to changes in the market returns paid to human capital, technology use, and operation size.

The results indicate that there has been strong wage growth in the US pork industry, substantially stronger than in the economy as a whole. As a result of this strong wage growth, pork industry employees now enjoy a wage that is comparable to the average civilian employee, where as in the early 1990s wages in the industry were about 20 percent lower. Between 1991 and 1995, the majority of this increase in wages was attributable to a general increase in the level of wages for all pork industry employees. More recently, wage growth in the industry has been driven by an increase in the educational attainment of employees and operation size and an increase in the rates of return to education and the use of some technologies.

Earnings Functions

Economic theory argues that wages are determined by an employee's value of marginal product. The theory of human capital developed by Mincer and reviewed in Willis extends this theory by recognizing that an employee's value of marginal product increases with the accumulation of knowledge and skill. This accumulation of knowledge and skill is referred to as human capital. Human capital can be general to all jobs, such as the ability to read and write proficiently, or firm specific, such as the knowledge of work rules or standard operating procedures. Typical measures of general human capital include years of formal education and experience in the work force. Firm-specific human capital is traditionally associated with the number of years that an individual has worked for a particular employer.

In addition to education, experience, and tenure, other personal and employer characteristics consistently influence wages. Women earn less than men do even when human capital differences are held constant (Gunderson). Larger firms pay more than smaller ones although the reason for the wage premium remains unclear (Brown and Medoff). Firms adopting more advanced technological innovations tend to pay more, presumably for the added skills needed by employees to implement these innovations (Hurley, Kliebenstein, and Orazem). Wages can also differ across regions due to differences in the cost of living and other amenities.

A standard earnings function incorporating these factors can be written as

$$(1) \qquad \ln W_{it} = \alpha_{0t} + \alpha_{5t}F_{it} + K_{it}\alpha_{Kt} + \alpha_{1t}E_{it} + \alpha_{2t}E_{it}^2 + \alpha_{3t}T_{it} + \alpha_{4t}T_{it}^2 + N_{it}\alpha_{Nt} + I_{it}\alpha_{It} + R_{it}\alpha_{Rt} + \varepsilon_{it} = \alpha_{0t} + \alpha_t' X_{it} + \varepsilon_{it}$$

where i indicates an individual respondent, t indicates the survey year, $\ln W_{it}$ is the natural log of annual wages, F_{it} indicates gender, K_{it} is a vector indicating the level of education, E_{it} is years of work experience, T_{it} is years of firm tenure, N_{it} is a vector indicating operation size, I_{it} is a vector indicating technological innovation, R_{it} is a vector indicating geographic region, and ε_{it} is a random disturbance. The quadratic terms for job experience and firm tenure will mimic commonly observed concave earnings profiles over time if $\alpha_{1t} > 0$, $\alpha_{2t} < 0$, $\alpha_{3t} > 0$ and $\alpha_{4t} < 0$.

The earnings function in equation (1) can be estimated using data from three nationwide surveys of pork industry employees conducted by National Pork Producers Council (NPPC) and National Hog Farmer (NHF) magazine during the 1990s. The NPPC-NHF surveys were sent to between 8,000 and 9,000 individuals designated as employees on the NHF's qualified mailing list in first quarter of 1991 and 1995 and fourth quarter of 1999. In 1991, 1995, and 1999, 1,622, 1482, and 907 surveys were returned resulting in an initial response rate of about 18.5, 16.5, and 11.0 percent. All three surveys collected information on a respondent's annual salary, education, tenure, and gender. The surveys also collected information on the level of employment, annual hog production, and location of the operation where a respondent worked. The 1995 and 1999 surveys included information on the different technologies used by the operation where an individual worked.

Table 1 summarizes survey responses with complete information. There are a number of interesting features to note about these responses. Annual salaries have drifted upward over time and became more spread out in 1999. The percentage of female respondents doubled between 1991 and 1999. Educational attainment has steadily increased. Experience also increased, while job tenure declined. The number of full-time employees and annual hog production has expanded dramatically. The use of most technologies has increased as have the number of respondents from the West.

Empirical Strategies

Earnings functions are typically estimated using ordinary least squares because annual salary information is usually continuous. The categorical nature of the salary information collected by the NPPC/NHF surveys requires an alternative approach. Hurley, Kliebenstein, and Orazem use a conventional order probit model to estimate earnings functions for the 1995 NPPC/NHF survey. The approach however artificially transforms the scale of the earnings function, which makes it harder to interpret the results. This artificial scale can easily be transformed back to a more recognizable measure when there is a single year of data. When there are multiple years of data, estimation with a standard ordered probit can still be done, but testing hypotheses across years becomes problematic because the earnings function for each year must be estimated separately. Estimating each equation separately does not allow for cross equation restrictions to be imposed and the convenient use of the likelihood ratio test for the statistical inferences based on those restrictions.

In order to obtain joint estimates of the earnings functions that allow for cross equation restrictions and the use of the likelihood ratio test for statistical inference, we use a generalized ordered probit model. Let J_t be the number of categories a respondent can choose from in year t. Let μ_{jt} for $j = 1,..,J_t - 1$ be the dollar denominated cutoffs for the salary ranges j and $j + 1$ in year t. The probability that the ith respondent chose category y_{it} in year t can be written as

$$
\begin{aligned}
&\Pr(y_{it} = 1) = \Pr(W_{it} \le \mu_{1t}), \\
(2)\qquad &\Pr(y_{it} = j) = \Pr(W_{it} \le \mu_{jt}) - \Pr(W_{it} \le \mu_{j-1t}) \text{ for } j = 2,..,J_t - 1. \\
&\Pr(y_{it} = J_t) = 1 - \Pr(W_{it} \le \mu_{J_t t})
\end{aligned}
$$

Substituting equation (1), equation (2) becomes

$$
\begin{aligned}
&\Pr(y_{it}=1)=\Pr(\varepsilon_{it}\le \ln\mu_{1t}-\alpha_t' X_{it}),\\
(3)\qquad &\Pr(y_{it}=j)=\Pr(\varepsilon_{it}\le \ln\mu_{jt}-\alpha_t' X_{it})-\Pr(\varepsilon_{it}\le \ln\mu_{j-1t}-\alpha_t' X_{it}) \text{ for } j=2,..,J_t-1.\\
&\Pr(y_{it}=J_t)=1-\Pr(\varepsilon_{it}\le \ln\mu_{J_t t}-\alpha_t' X_{it})
\end{aligned}
$$

By specifying the distribution of ε_{it} equation (3) can be estimated using standard maximum likelihood techniques. Since the data were collected at different points in time, heteroscedasticity is a potential concern. Therefore, we assume that ε_{it} is independently and identically normally distributed with mean 0.0 and variance σ_t^2, such that equation (3) can be rewritten as

$$
\begin{aligned}
&\Pr(y_{it}=1)=F\left(\frac{\ln\mu_{1t}-\alpha_t' X_{it}}{\sigma_t}\right),\\
(4)\qquad &\Pr(y_{it}=j)=F\left(\frac{\ln\mu_{jt}-\alpha_t' X_{it}}{\sigma_t}\right)-F\left(\frac{\ln\mu_{j-1t}-\alpha_t' X_{it}}{\sigma_t}\right) \text{ for } j=2,..,J_t-1.\\
&\Pr(y_{it}=J_t)=1-F\left(\frac{\ln\mu_{Jt}-\alpha_t' X_{it}}{\sigma_t}\right)
\end{aligned}
$$

where $F(\cdot)$ is the cumulative normal distribution.

The coefficient estimates for α_t reflect the rates of returns to various factors influencing wages. These rates of return reflect the percentage increase in earnings for an increase in the factor of interest. Of interest is whether these rates of return have changed over time. To facilitate hypothesis testing, let $\alpha_{2000} = \beta$, $\alpha_{1995} = \beta + \beta_{1995}$, and $\alpha_{1991} = \beta + \beta_{1995} + \beta_{1990}$. Therefore, $\beta_{1995} = \alpha_{1995} - \alpha_{1999}$ and $\beta_{1990} = \alpha_{1991} - \alpha_{1995}$. β captures the rates of return for the 1999 survey, while β_{1995} and β_{1990} capture the changes in the rates of return between 1995 and 1999 and 1991 and 1995. If the elements of β_{1995} or β_{1990} are not statistically different from zero, then there is no statistical evidence of a difference in the rate of return between survey years.

The constant terms combined with the estimated variances (due to the log-normal specification of the earnings function) capture changes in level of wages between survey years. Here we let $\alpha_{02000} = \beta_0$, $\alpha_{01995} = \beta_0 + \beta_{01995}$, and $\alpha_{01991} = \beta_0 + \beta_{01995} + \beta_{01990}$ to facilitate hypothesis testing. Part of this change will simply represent a nominal increase in wages, while part may represent real wage growth. To determine how much of the growth in wages is due to a nominal increase and how much is due to a real increase, the growth in predicted wages can be compared to various measures of the cost of living or wage growth in the US economy. Let $\overline{X}_t$ be the vector of averages for the explanatory variables in year *t*. Predicted wages in year *t* will be

$$(5) \qquad \overline{W_t} = e^{\alpha_{0t} + \alpha_t ' \overline{X}_t + 0.5\sigma_t^2} .$$

The percentage change in the predicted wage between year *t* and *t* + 1 will is

$$(6) \qquad \Delta_t = 100 \cdot \frac{\overline{W_{t+1}} - \overline{W_t}}{\overline{W_t}} .$$

To determine what factors are driving wage growth in the industry, we decompose this growth into three distinct effects. The first effect measures a general increase in the level of wages for all employees. The second captures changes in wages due to changes in human capital, technology use, and operation size. The third effect measures the change in wages due to changes in the rates of return paid to human capital, technology use, and operation size. The percentage change in wages due to a general increase in the level of all wages between *t* and *t* +1 is measured as

$$(7) \qquad \Delta_{tLevel} = 100 \cdot \frac{e^{\alpha_{0t+1} + \alpha_t ' \overline{X}_t + 0.5\sigma_{t+1}^2} - \overline{W_t}}{\overline{W_t}} .$$

The percentage change in wages due to an increase in human capital, technology use, and operation size between t and $t+1$ is measured as

(8) $$\Delta_{tHC} = 100 \cdot \frac{e^{\alpha_{0t} + \alpha_t ' \overline{X}_{t+1} + 0.5\sigma_t^2} - \overline{W_t}}{\overline{W_t}}.$$

The percentage change in wages due to an increase in the rates of return to human capital, technology use, and operation size between t and $t+1$ is measured as

(9) $$\Delta_{tRR} = 100 \cdot \frac{e^{\alpha_{0t} + \alpha_{t+1} ' \overline{X}_t + 0.5\sigma_t^2} - \overline{W_t}}{\overline{W_t}}.$$

The explanatory variables used for the analysis include measures for gender, general and specific human capital, operation size, technology use, and region:

- A dummy variable for women is used for gender differences.
- For general human capital, we have measures of education and experience. A series of three dummy variables are used for the marginal increase in earnings from obtaining a high school diploma, 2-year college degree, and 4-year college degree. The respondent's age minus years of formal education completed minus six reflects experience.
- Job tenure is used to capture firm specific human capital.
- Two measures of operation size are used: the number of full-time employees and a series of five dummy variables for the marginal increase in earnings from working on an operation that produces more than 1,000, 2,000, 3,000, 5,000, and 10,000 hogs annually.
- For technology use, we construct dummy variables for when a computer and formal management practices such employee handbooks, written job descriptions and work plans, and formal evaluations are used to help manage the operation. We also

construct dummy variables for when the respondent's operation uses artificial insemination, split-sex feeding, phase feeding, multi-site production, early weaning, and all-in/all-out production.

- For location, a series of three dummy variables are used for differences in earnings relative to the Midwest. Those dummy variables include the Northeast, Southeast and West.

Since technology information was not collected on the 1991 survey, we estimate two different models. The first uses data from all three surveys and does not include technology information. The second model focuses on the 1995 and 1999 surveys and includes technology information. Comparing the results for 1999 and 1995 across the two models provides insight into the potential effect of missing variable bias due to the neglect of differences in technology use that reflect industry specific human capital.

Results

Table 2 reports the coefficient estimates for the two models, the maximized value of the log-likelihood function, and the number of observations. Table 3 reports the maximized log-likelihood function and the likelihood ratio tests for the joint restrictions that set coefficients for education, experience, tenure, annual hog production, and region to 0.0. The coefficient estimates in the first column under Model 1 are the estimated rates of return for 1999. In the second and fourth columns are the estimated rates of return for 1995 and 1991. The third and fifth columns are the estimated differences between the 1995 and 1999 and the 1991 and 1995 estimates of the rates of return. The coefficient estimates in the first and second columns under Model 2 are the estimated rates of return for 1999 and 1995 including technology use, while the coefficient estimates in the third column are for the difference in the rates of return between 1995 and 1999.

The coefficient estimates for Model 1 are consistent with earnings function estimates from other industries. Women earned significantly less than otherwise identical men did: 22.2 percent less in 1999. Earnings were significantly higher for more educated workers: 31 percent more for high school graduates as compared to high school drop outs and 16 percent more for 4-year college graduates as compared to a 2-year college graduates in 1999. Experience increased earnings at a decreasing rate: one percent more for each additional year an employee with average experience worked in 1999. Tenure increased earnings at a decreasing rate, though the effect was significant only in 1991. Larger operations paid significantly higher wages: 3.6 percent more for each additional full-time employee and 20 percent more for operations producing more than 10,000 as compared to more than 5,000 hogs annually in 1999. There were also some significant regional differences observed in earnings. For instance, employees in the West earned 10 percent less then those in the Midwest in 1999.

The estimates for Model 2 are consistent with those for Model 1. In 1995, the rates of return for all technologies are positive and significant for computer use, formal management practices, artificial insemination, phase feeding, and all-in/all-out production. In 1999, formal management practices, artificial insemination, phase feeding, and all-in/all-out production were all significantly positive. Split-sex feeding was negative, though not significantly so. Early weaning was negative and significant.

It is interesting to note that we tended to over estimate the returns to education and operation size and under estimate regional differences in returns when we did not include technology use in the earnings functions. The reason for these results is that larger operations are more likely to adopt new technologies and hire more educated workers to implement these new technologies. While technology use tends to be higher on average in the Southeast and West, this is due to the fact that operations in these regions tend to be larger on average. All else equal, operations in the Midwest have been found to be more likely to adopt new technologies.

Comparing changes in the rates of return over time, we see that the earnings differential between men and women was significantly lower in 1995 as compared to 1991. A high school diploma was worth more in 1999 and 1991 than in 1995, while a 4-year college degree was worth more in 1991 than in 1995. Returns to experience diminished more rapidly in 1995 than in 1999. Initial returns to tenure were higher in 1991 than in 1995 and also diminished faster. Returns to working for an operation producing over 1,000 hogs annually were significantly higher in 1991 than in 1995. The returns for employees working for operations that used artificial insemination were significantly higher, while those for operations using early weaning fell. The earnings for employees in the Southeast also declined significantly between 1995 and 1999.

Using the estimates for Model 1, the predicted annual wage in the pork industry increased from $18,514 in 1991 to $24,069 in 1995 and $29,785 in 1999. This represents an increase of 30 percent between 1991 and 1995 and 23.7 percent between 1995 and 1999. Overall the increase was 60.9 percent. For Model 2, the predicted wage increased from $23,938 to $29,599 or by 23.6 percent. During this same period of time, the average civilian wage, as measured by the Bureau of Labor Statistic's Employment Cost Index, increased by only 32.7 percent: 14.7 percent between 1991 and 1995 and 15.7

percent between 1995 and 1999. However, in 1991, the average civilian worker in the US earned about $23,074, which is 20 percent higher than our predicted wage for the US pork industry at that time. In 1999, the average civilian worker earned about $30,617, which is only 3 percent higher than our predicted wage for the US pork industry at that time. Therefore, the rapid wage growth in the US pork industry has served mostly to increase wage parity with the average US worker. This is good news for the pork industry, but we would now expect less dramatic growth in the future.

The rapid growth of wages in the pork industry can be attributed to three possible factors. The low predicted wages in 1991 as compared to the US average suggests there may have been a general increase in the wages of all employees in order for the industry to compete more effectively for labor with other industries. Table 1 also shows some substantial changes in the human capital of individual workers and in the characteristics of the operations they work for. Table 2 shows some rather substantial differences in the rates of return paid to human capital and by operations that are larger and use more technology. Table 4 shows the percentage increase in wages if only the level of all wages in the industry had increased, if only human capital and operation size, technology use, and location had changed, and if only the rates of returns to human capital and operation size, technology use, and location had changed.

Between 1991 and 1995, the dramatic wage growth was primarily attributable to a general increase the wages of all employees. Indeed, if only the general level of wages had increased, wage growth would have been even more astonishing. Increases in education, experience, and operation size also helped to spur wage growth, but not by nearly as much. Changes in the rate of return to human capital and operation size and location actually served to stifle wage growth during this time.

Between 1995 and 1999, the situation was quite different. Improvements in the rates of return were the primary factor driving wage growth followed by increases in education, operation size, and technology use. For the estimates from Model 1, a general increase in the level of wages only had a small positive impact. Model 2 suggests that there was actually a fairly substantial decrease in the general level of wages, which stifled wage growth. These results suggest that the industry responded to generally low wage levels in 1991 by rapidly increasing the wages of all workers. Once the level of wages became more equal to other industries in 1995, further growth was attributable to labor market conditions and the individual characteristic of employees and the operations they worked for.

Conclusions

The pork industry continues to experience dramatic structural change. Operations are getting larger, more specialized, and more technologically advanced. With increased size comes an increase in the demand for hired labor. With greater specialization and the application of more technology comes the need for highly educated and skilled labor.

Three national surveys of pork industry employees conducted by the National Pork Producers Council and National Hog Farmer magazine in the 1990s offer new insight into this rapidly emerging rural labor market. Analysis of the survey results shows that employees in the pork industry have become more educated and experienced, but are also more mobile. It also shows that wages in the pork industry were low in the early 1990s when compared to the average US civilian worker. Substantial growth in pork industry wages during the 1990s has resulted in greater wage parity with civilian workers. The most important factor driving wage growth in the industry in the early 1990s was a general increase in the wage of all workers. A result that was necessary for the industry to compete effectively in labor markets and sustain rapid growth. In the mid to late 1990s, the primary factors driving wage growth were an increase in the average level of education and operation size and an increase in the premiums paid by employers to more educated workers and workers that could use more advanced technologies. Now that the level of wages in the industry are more comparable to other industries, wage growth is being driven more by market factors and the individual characteristics of employees and the operations they work for.

Employers in the pork industry are now offering a more competitive wage and should be able to attract quality employees for continued growth. Employees in the industry need not look elsewhere to find better opportunities. Rural communities can also now count on pork production facilities to offer good paying jobs for skilled rural labor, but should not expect wage growth to continue to outpace the economy as a whole.

One interesting result that remains to be explained is the strong negative impact on earnings of an employer’s use of early weaning technologies. Even if early weaning did not require any special skills on the part of workers, one would expect no impact on earnings. While controlling for an operations use of technology helped to explain some of the wage premium paid by larger operations, this explanation is certainly not complete and remains for further exploration.

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Table 1: Descriptive statistics.

	1999	1995	1991
Annual Salary			
Under $10,000	4.9%	5.7%	12.6%
$10,000-$15,000	3.7%	6.5%	17.8%
$15,000-$20,000	7.6%	17.9%	24.8%
$20,000-$25,000	18.3%	27.4%	23.2%
$25,000-$30,000	21.7%	20.3%	10.7%
$30,000-$35,000	15.1%	10.5%	5.7%
$35,000-$40,000	13.2%	5.2%	2.0%
Over $40,000	15.5%	6.4%	3.1%
$40,000-$50,000	9.1%	5.1%	-
$50,000-$60,000	2.5%	1.3%	-
Over $60,000	3.9%	0.0%	-
Gender			
Female	12.0%	9.4%	6.0%
Human Capital			
High School Drop Out	5.6%	5.1%	6.2%
HighSchool Graduate	36.3%	35.4%	42.6%
2-Year College Degree	20.2%	24.7%	22.4%
4-Year College Degree	37.9%	34.7%	28.8%
Experience	15.3	14.3	13.6
	(9.2)	(9.8)	(9.1)
Tenure	6.3	6.5	7.7
	(6.3)	(6.5)	(7.3)
Operation Size			
Number of Full-Time Employees	13.8	12.2	4.5
	(23.6)	(24.3)	(10.7)
Annual Hog Production			
Under 1,000	3.1%	5.8%	16.0%
1,000-2,000	2.5%	9.3%	17.2%
2,000-3,000	6.0%	9.4%	11.8%
3,000-4,000	5.6%	10.9%	12.9%
5,000-10,000	9.5%	15.8%	19.8%
Over 10,000	73.2%	48.9%	22.3%
Technology Use			
Personal Computer	73.6%	69.9%	-
Formal Management	74.4%	64.7%	-
Artificial Insemination	79.6%	59.1%	-
Split-Sex Feeding	45.8%	48.9%	-
Phase Feeding	53.4%	57.2%	-
Multi-Site Production	45.6%	38.8%	-
Early Weaning	4.9%	10.2%	-
All-in/All-out Production	67.6%	69.5%	-
Region			
Midwest	69.3%	68.3%	72.8%
Northeast	5.2%	4.4%	5.4%
Southeast	10.3%	15.2%	11.8%
West	15.1%	12.1%	9.9%
Observations	515	994	1377

Notes: Standard deviations are reported in parentheses. Midwest includes IA, IL, IN, MN, MO, ND, NE, OH, SD and WI. Northeast includes CT, MD, ME, MI, NJ, NY and PA. Southeast includes AL, FL, GA, KY, LA, MS, NC, SC, TN, VA and WV. West includes: AK, AR, AZ, CA, CO, HI, ID, KS, MT, OK, OR, TX, UT, WA and WY.

Table 2:Ordered probit estimates.

	Model 1					Model 2		
	1999	1995	1995-1999	1991	1991-1995	1999	1995	1995-1999
Constant	2.47[a]	2.47[a]	0.0066	1.96[a]	-0.51[a]	2.23[a]	2.34[a]	0.11
	(23.34)	(44.83)	(0.06)	(37.39)	(6.68)	(18.12)	(42.83)	(0.84)
Gender								
Female	-0.22[a]	-0.19[a]	0.030	-0.31[a]	-0.12[b]	-0.19[a]	-0.18[a]	0.0028
	(3.67)	(5.45)	(0.44)	(6.34)	(2.01)	(3.20)	(5.46)	(0.04)
Human Capital								
High School Graduate	0.31[a]	0.12[a]	-0.18[b]	0.26[a]	0.13[b]	0.31[a]	0.076[c]	-0.23[a]
	(5.29)	(2.92)	(2.57)	(6.23)	(2.27)	(5.06)	(1.82)	(3.16)
2-Year College Degree	0.083	0.10[a]	0.013	0.086[a]	-0.010	0.043	0.089[a]	0.046
	(1.51)	(3.07)	(0.21)	(2.96)	(0.22)	(0.77)	(3.00)	(0.74)
4-Year College Degree	0.16[a]	0.11[a]	-0.043	0.21[a]	0.10[b]	0.14[a]	0.075[b]	-0.069
	(3.00)	(3.64)	(0.71)	(6.99)	(2.31)	(2.79)	(2.50)	(1.15)
Experience	0.010	0.024[a]	0.014[c]	0.024[a]	-0.00016	0.013[b]	0.023[a]	0.010
	(1.64)	(7.04)	(1.93)	(8.47)	(0.04)	(2.12)	(7.03)	(1.44)
Experience^2	-0.00010	-0.00048[a]	-0.00038[b]	-0.00036[a]	0.00012	-0.00015	-0.00044[a]	-0.00029[c]
	(0.70)	(5.67)	(2.26)	(6.17)	(1.18)	(1.07)	(5.30)	(1.76)
Tenure	0.0055	0.00097	-0.0045	0.0096[a]	0.0087[c]	0.0047	0.0051	0.00044
	(0.80)	(0.26)	(0.58)	(2.70)	(1.68)	(0.67)	(1.38)	(0.06)
Tenure^2	-0.00009	0.000065	0.00016	-0.000198[c]	-0.0003[c]	-0.000052	-0.000047	0.0000050
	(0.43)	(0.59)	(0.65)	(1.92)	(1.74)	(0.25)	(0.42)	(0.02)
Operation Size								
Number of Full-Time Employees	0.36[a]	0.028[a]	-0.074	0.042[a]	0.13	0.28[a]	0.018[a]	-0.10
	(4.14)	(4.53)	(0.70)	(3.55)	(1.00)	(3.28)	(2.80)	(0.96)
Annual Hog Production								
Over 1,000	-0.045	-0.015	0.030	0.159[a]	0.17[a]	-0.026	-0.029	-0.0028
	(0.46)	(0.37)	(0.28)	(5.16)	(3.41)	(0.26)	(0.70)	(0.03)
Over 2,000	0.11	0.084[b]	-0.028	0.110[a]	0.026	0.084	0.064	-0.020
	(1.22)	(2.02)	(0.28)	(3.13)	(0.48)	(0.87)	(1.58)	(0.19)
Over 3,000	0.064	0.053	-0.011	0.027	-0.026	0.041	0.045	0.0043
	(0.61)	(1.10)	(0.10)	(0.64)	(0.41)	(0.38)	(0.99)	(0.04)
Over 5,000	0.040	0.090	0.050	0.095	0.0048	0.085	0.060	-0.025
	(0.39)	(1.88)[c]	(0.45)	(2.29)[b]	(0.08)	(0.84)	(1.35)	(0.23)
Over 10,000	0.20[a]	0.087[b]	-0.12c	0.107[b]	0.019	0.078	0.030	-0.048
	(3.71)	(2.29)	(1.73)	(2.56)	(0.34)	(1.30)	(0.80)	(0.68)

Table 2:Ordered probit estimates (continued).

	Model 1					Model 2		
	1999	1995	1995-1999	1991	1991-1995	1999	1995	1995-1999
Technology Use								
Personal Computer						0.031	0.045[c]	0.013
						(0.74)	(1.76)	(0.27)
Formal Management						0.11[b]	0.16[a]	0.045
						(2.23)	(6.41)	(0.81)
Artificial Insemination						0.18[a]	0.085[a]	-0.094[c]
						(4.18)	(3.61)	(1.93)
Split-Sex Feeding						-0.035	0.016	0.051
						(0.86)	(0.63)	(1.07)
Phase Feeding						0.080[c]	0.068[a]	-0.013
						(1.86)	(2.85)	(0.25)
Multi-Site Production						0.045	0.013	-0.032
						(1.05)	(0.51)	(0.65)
Early Weaning						-0.16[b]	0.04	0.21[a]
						(2.36)	(1.11)	(2.60)
All-in/All-out Production						0.070[c]	0.061[a]	-0.0093
						(1.80)	(2.60)	(0.20)
Region								
Northeast	-0.030	0.013	0.043	0.117[b]	0.10	-0.020	-0.016	0.0041
	(0.49)	(0.26)	(0.54)	(2.54)	(1.54)	(0.30)	(0.34)	(0.05)
Southeast	-0.033	0.066[c]	0.10	0.03	-0.036	-0.051	0.069[c]	0.12[c]
	(0.58)	(1.79)	(1.46)	(0.87)	(0.70)	(0.90)	(1.95)	(1.79)
West	-0.10[c]	-0.0070	0.10	0.00	0.0093	-0.11[b]	-0.0079	0.100
	(1.88)	(0.21)	(1.50)	(0.07)	(0.20)	(2.02)	(0.23)	(1.58)
Sigma	0.38[a]	0.33[a]		0.36[a]		0.37[a]	0.32[a]	
	(38.71)	(46.14)		(48.33)		(37.41)	(45.05)	
Maximized Log-Likelihood			-5177.24				-2810.96	
Observations			2886				1509	

[a] Significant at one-percent level of confidence.
[b] Significant at five-percent level of confidence.
[c] Significant at ten-percent level of confidence.

Table 3: Joint hypothesis tests.

	Model 1 1999	Model 1 1995	Model 1 1995-1999	Model 1 1991	Model 1 1991-1995	Model 2 1999	Model 2 1995	Model 2 1995-1999
Education								
Maximized Log-Likelihood	-5203.88[a]	-5212.83[a]	-5179.51	-5274.13[a]	-5183.91[a]	-2831.71[a]	-2833.3[a]	-2814.76[c]
$\chi^2(3)$	(53.28)	(71.18)	(4.54)	(193.78)	(13.34)	(41.50)	(44.68)	(7.60)
Experience								
Maximized Log-Likelihood	-5181.79[b]	-5203.54[a]	-5179.47	-5215.95[a]	-5180.55[b]	-2817.34[a]	-2838.19[a]	-2812.39
$\chi^2(2)$	(9.10)	(52.60)	(4.46)	(77.42)	(6.62)	(12.76)	(54.46)	(2.86)
Tenure								
Maximized Log-Likelihood	-5177.78	-5178.24	-5177.42	-5181.6[b]	-5178.4	-2811.56	-2813.23	-2810.98
$\chi^2(2)$	(1.08)	(2.00)	(0.36)	(8.72)	(2.32)	(1.20)	(4.54)	(0.04)
Annual Hog Production								
Maximized Log-Likelihood	-5179.1	-5223.64[a]	-5199.21[a]	-5282.86[a]	-5182.91[b]	-2819.86[a]	-2827.09[a]	-2811.87
$\chi^2(5)$	(3.72)	(92.80)	(43.94)	(211.24)	(11.34)	(17.80)	(32.26)	(1.82)
Region								
Maximized Log-Likelihood	-5179.17	-5179.63	-5179.16	-5180.68[c]	-5178.78	-2813.21	-2813.82	-2813.46
$\chi^2(3)$	(3.86)	(4.78)	(3.84)	(6.88)	(3.08)	(4.50)	(5.72)	(5.00)

Note: The absolute value of the t-statistic is reported in parentheses.
[a] Significant at one-percent level of confidence.
[b] Significant at five-percent level of confidence.
[c] Significant at ten-percent level of confidence.

Table 4: Decomposition of wage growth.

	Model 1		Model 2
	1995-1999	1991-1995	1995-1999
Total Change	23.8%	30.0%	23.6%
Change in the General Level of Wages	1.2%	64.6%	-9.0%
Change Due to Changes in Human Capital and Operation Size, Technology Use and Location	6.6%	13.4%	6.8%
Change Due to Changes in the Rates of Return to Human Capital and Operation Size, Technology Use and Location	12.7%	-28.6%	21.3%