Structure of Wages and Benefits in the U.S. Pork Industry

Terrance M. Hurley*, James Kliebenstein**, and Peter F. Orazem**

Staff Paper No. 283
December 1996

*Visiting Scientist, CARD; **Professor, Department of Economics.

This research benefited from helpful conversations with Marvin Hayenga and John Lawrence. Richard Hugdahl, Mark Imerman, Garry Pshonik, and the staff at NPPC helped us obtain the data used in the analysis. Partial support from the National Pork Producers Council is gratefully acknowledged.

Abstract

Structure of Wages and Benefits in the U.S. Pork Industry

Pork production has been evolving from relatively small, family-run operations toward large-scale operations with several employees. This study uses a national survey of pork producers and their employees to answer several questions about the structure of wages and benefits in this rapidly changing labor market. The findings include: 1) wages do not differ across regions of the country but, instead, reflect differences in worker skills and firm size consistent with a nationally competitive labor market; 2) there is no evidence that large producers have market power in local labor markets that enable them to pay lower wages than competitors; 3) rather, large firms pay higher wages, offer better benefits, and safer working environments than smaller firms; 4) the wage premiums in larger firms seem to be partly explained by the greater use of skill-intensive technologies in large firms; 5) the remaining wage premium in large firms seems to be consistent with returns to scale that are partly shared with labor; 6) salary, benefits, and a safe working environment all contribute to worker job satisfaction so that firms offering better working conditions and benefits can pay lower salaries than competitors with fewer benefits or inferior working environments.

Pork production in the United States has shifted from relatively small, family-run operations to large-scale farms with several employees. This trend is illustrated dramatically by a Stigler-type (1958) survival analysis in Figure 1. Production shares in 1990 relative to 1995 are traced out by production size. Ratios above one imply lost market share, whereas those below one imply rising market share. The pattern shows gains in production shares for farms with production levels above 3000 hogs per year, with progressively larger gains in market share as production size increases. Production shares for the smallest farms fell 26 percent, whereas market shares for the largest farms rose 43 percent. The gains in market share for the largest operations mimic the findings of declining long-run average cost in pork production (Good, Hurt, Foster, Kadlec, and Zering, 1995).

Increased scale of hog production eventually necessitates additional labor services beyond those provided by family members. Increased scale of operation seems to be complementary with the adoption of new technologies. Some of these new technologies require little if any additional labor while others such as artificial insemination are much more labor intensive. Additionally, many of these new technologies require more skilled labor. Thus, changes in the structure of the pork industry have been accompanied by large changes in the demand for labor numbers and skills.

The National Pork Producers Council - *National Hog Farmer* Magazine (NPPC-NHF) survey of pork producers and their employees was conducted to shed light on this rapidly changing rural labor market. Several issues were of particular interest. One issue was whether differences in the concentration of large-scale pork production across regions were creating local labor markets with idiosyncratic wages or if wages seemed to be set consistently across regions. Related to the issue of local labor market segmentation is whether factors affecting wages in the pork industry are consistent with those in more-established labor markets outside agriculture. A third issue is how technology and size of farm affect wages; if new technologies and larger farms are associated with lower unit costs, are these rents shared with labor, or do all benefits accrue to management. Alternatively, do large plants have local monopsony power that enables them to pay wages below those of their smaller competitors? Finally, are hazards associated with the pork production priced in the labor market through compensating wage differentials, and are benefits also priced? The rapid changes in the structure of the pork industry make it an ideal candidate for this analysis— there are large differences across farms in technology, size, and location, yet all factors produce a homogeneous product priced competitively in a national market. Hence, if the labor market in the industry behaves competitively as well, wages should reflect differences in marginal products across workers and their farms in a manner consistent with the labor market at large.

We analyze the NPPC- NHF data within the framework of the standard human capital model of wage determination developed by Mincer (1974) and reviewed in Willis (1986). We extend the standard model by analyzing how technology and plant size influence wages. We also evaluate the information on compensation and job attributes in the context of a hedonic framework to calculate trade-offs between alternative benefit packages and salary. Our results support three main conclusions. First, we do not find substantial evidence of regional or local labor market segmentation. Differences in wages are explained by traditional measures of human capital, as well as by differences in gender and firm size consistent with patterns in the labor market as a whole. There is no evidence that larger firms pay lower wages, and in fact, the opposite pattern holds. Part of the wage premium paid by larger firms is related to a production complementarity between skilled labor and technology use and some to apparent rent sharing of returns to scale in production. Finally, we find significant and consistent trade-offs between salary, insurance benefits, an employee's working conditions, and an employer's provision of safety equipment. Hurley, Kliebenstein, and Orazem (1996) found that employees in the hog industry are significantly more likely than other farmers to complain about nagging health problems. Together, the results suggest that employers compensate, insure, protect, or provide the means to protect their employees' against work-related health risks.

The paper is organized as follows: Section II estimates a standard human capital earnings function with the addition of gender, firm size, regional and local regressors, and tests for the significance of regional and local labor market segmentation. Section III re-estimates the earnings functions controlling for technology use among different firms. Section IV estimates the trade-off between salary, fringe benefits, and working conditions. Section V offers a summary and conclusions.

II. Earnings Functions

Differences in marginal products across workers are typically associated with differences in 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. General human capital is usually associated with an individual's years of formal education and years of experience in the work force regardless of current or past occupation. Firm-specific human capital is traditionally associated with the number of years that an individual has worked for an employer. In addition to human capital, other personal and employer characteristics have been found important determinants of wages. Women are traditionally found to earn less than men (Gunderson, 1989) even when human capital differences are held fixed. Larger firms pay more than smaller firms (Brown and Medoff, 1989), although the reason for the wage premium is unclear. If labor markets are segmented so that labor cannot flow freely between local markets, systematic wage differentials may exist between regions. A standard earnings function that incorporates these factors can be written as

(1) $$\ln W = \alpha_0 + \alpha_1 K + \alpha_2 E + \alpha_3 E^2 + \alpha_4 T + \alpha_5 T^2 + \alpha_6 F + \alpha_7 P + \alpha_7 N + R\alpha_R + L\alpha_L + \varepsilon$$

where $\ln W$ is the natural log of annual wages, K is years of formal education, E is years of work experience, T is years of firm tenure, F is a dummy variable that takes the value of one if the incumbent is female, P is firm's level of annual pork production, N is size of firm's labor force, R is a vector of regional dummy variables, L is a vector of local labor market variables, and ε is a random disturbance. The quadratic terms in job experience and firm tenure mimic commonly observed concave earnings profiles over time if $\alpha_2 > 0$, $\alpha_3 < 0$, $\alpha_4 > 0$ and $\alpha_5 < 0$.

The NPPC-NHF survey was sent to 9000 individuals designated as employees on the NHF's qualified mailing list. Of the 9000 surveys, 1538 were returned for an initial response rate of just over 17 percent. Of these, 967 or 11 percent of the original sample had complete information needed for the analysis. The survey provided direct information on employee education, tenure, and gender and on firm employment and location. Experience was measured as the respondent's age minus years of formal education minus six. Annual hog production was reported by size categories, so production was approximated by using midpoints. The largest category (25,000 or more) was given a value of 40,000.

Local labor market characteristics were constructed by using 1990 census data and 1993 Bureau of Economic Analysis data by county. These regressors included a Herfindahl index of employment concentration[1], the proportion of the county population over 25 with a high school diploma, the county employment rate, the county average annual income, and proportion of county employment in agriculture. Table 1 (a) reports the means and standard deviations for the dependent and independent variables used in the analysis.

Due to the ordered, categorical nature of annual wage information, the parameters in equation (1) cannot be estimated directly by using ordinary least squares. Instead, we use an ordered probit specification (Greene, 1990, pp. 703-706). Table 2 reports the estimated coefficients for four alternative models. Model 1 is the full model, including all ***Regional*** and ***Local*** labor market characteristics. Model 2 eliminates the ***Regional*** regressors, Model 3 eliminates the ***Local*** regressors, and Model 4 eliminates both the ***Regional*** and ***Local*** regressors. At the bottom of Table 2 is the maximized value of the log-likelihood function and the log-likelihood ratio tests for Models 2, 3, and 4 against Model 1.

First, notice that, at a five-percent level of significance, we cannot reject the hypothesis that the regional and local labor market characteristics do not significantly improve the explanatory power of the model. In addition, the estimated coefficients for ***Human Capital***, ***Gender***, and ***Firm Size*** are consistent with the results of other more-established labor markets and are robust to the inclusion or exclusion of the local and regional variables. These results suggest a national market for workers in the pork industry instead of locally segregated markets.

Ordered probit estimates are based on an artificial index that does not have a direct correspondence to annual rates of return. This makes it difficult to interpret the coefficients. To obtain an estimated annual rate of return, we regressed the estimated thresholds from the ordered probit on the NPPC-NHF survey's dollar-denominated thresholds by using ordinary least squares:

(2) $$Y = \gamma_0 + \gamma_1 \mu + \varepsilon$$

where Y is a vector of the survey's dollar-denominated thresholds, μ is a vector of the corresponding estimated thresholds, γ_0 and γ_1 are the intercept and slope coefficients, and ε is a standard normal random error term.[2] By

---

[1] This is taken to be $\Sigma_{i=1}^{n} e_i^2$ where e_i is the employment share of the ith two-digit SIC industry in the county. Index values close to one represent more concentrated labor markets, and values close to zero reflect broadly distributed employment across industries.

[2] These regressions explained more than 98 percent of the variation for all four models.

using the estimated coefficients from equation (2), the implied annual rates of return are estimated by dividing the calibrated marginal effects by the calibrated estimated average salary:

(3) $$r_i = \frac{\gamma_1 \frac{\partial lnW}{\partial X_i}}{\gamma_0 + \gamma_1 \overline{X}\alpha}$$

where r_i is the implied annual rate of return for the ith variable, $\frac{\partial lnW}{\partial X_i}$ is the derivative of equation (1) with respect to the ith variable, $\overline{X}$ is the row vector of means for the independent variables, and α is the column vector of estimated coefficients for equation (1). The results, reported in Table 3 (a), are consistent with earnings functions in other labor markets. Women earn about 18 percent less than men with comparable human capital attributes. An additional year of education generates an annual return of about 5 percent of annual earnings. An additional year of experience and tenure is worth about 1 percent and 0.5 percent, respectively. In addition, marginal returns to experience increase at a decreasing rate so that lifetime wages peak at about 25 years of experience. Workers on farms earn an 8 percent premium for every additional 10,000 hogs produced and a 1.5 percent premium for every 10 additional full-time employees. These last two results indicate that larger firms do not pay substandard wages, nor do they locate atypically in low wage markets.

The premium for working in larger operations has been observed in other labor markets. Some hypotheses advanced are that larger firms pay higher wages to obtain higher-quality labor, larger firms pay more to forestall unionization, larger firms pay more because they can afford to, and larger firms pay more to avoid monitoring cost. When Brown and Medoff (1989) considered these alternative hypotheses, they found little support for all but the first. Although Brown and Medoff did find that larger firms paid more to obtain higher-quality labor, the support was not strong enough to completely explain the positive relationship between firm size and wages. Technology information collected by the NPPC-NHF gives us the opportunity to explore an additional hypothesis— that the wage premium reflects specialized skills required by newer technologies, which have been atypically adopted by larger firms.

III. Technology and Earnings

Pork production is a biologically constrained process. Stock must be bred, followed by a fixed gestation period, birthing, weaning, growing, and finishing. That is not to say that technology cannot help speed or improve the process. Artificial insemination can help improve gene pools (Singleton and Schinckel, 1995). Early weaning may reduce the time between breeding cycles for a sow and reduce disease. Split-sex and phase feeding can improve nutrition and feed efficiency. All in / all out production can reduce the days to market, and multiple-site production can help curb the spread of disease and reduce death loss. Each of these technologies improves efficiency by either speeding up the production cycle, lowering input cost, or reducing output loss. Alone or in combination, these technologies have been estimated to reduce the cost of production or increase revenues anywhere from $1.79 to $11.59 per hog (Hurt, 1995).

In addition to improvements in production technologies, improvements in organizational structure can help firms allocate resources more efficiently. Computers can reduce the time required and improve the accuracy of maintaining both production and financial records. Formal management practices such as the provision of employee handbooks, written job descriptions, work plans, and formal evaluation procedures can help efficiently organize and direct labor resources. As firm size increases, these practices support the division of labor into specializations. Improving labor productivity translates into a lower marginal production cost.

Some technological advances require few if any special skills to implement. Others require skilled, quality labor. Some technologies may be feasible only in large operations, whereas others are equally effective regardless of firm size. For example, multiple-site production requires little if any additional skill on the part of labor, but may require greater annual hog production and more full-time employees to support . Alternatively, it requires special training to implement a program of artificial insemination or to operate a computer. Artificial insemination may be equally effective regardless of annual hog production, but also may require additional labor resources. Computer use may be equally effective regardless of annual hog production while reducing the labor requirements for record keeping. In general, however, if skill-intensive technology adoption is more viable in larger firms, then larger firms will have to pay higher wages to compensate workers for their ability to implement these technologies.

The NPPC-NHF survey data afford us the opportunity to determine whether higher wages in larger firms are explainable through more advanced technology adoption. The survey asked employees if they are currently using artificial insemination, split-sex feeding, phase feeding, multiple site production, segregated early weaning, medicated early weaning, modified medicated early weaning, and/or all in/all out production methods. Respondents were also asked if a computer is used to help manage the operation, if employee handbooks, written job descriptions or work plans are provided, and if they are formally evaluated. For tractability, we combine segregated early weaning, medicated early weaning, and modified medicated early weaning into a single measure of early weaning technologies. Provision of either employee handbooks, written job descriptions, work plans, or formal evaluations were assumed to indicate the use of formal management practices. Summary statistics for these technologies and management variables are reported in Table 1 (a).

Table 4 (a) reports the conditional means for *Human Capital* and *Technology* based on annual hog production. Larger firms have less experience and tenure partly because these firms have recently been expanding their employment. Newer hires will have less tenure by definition. Average education also does not differ by size of operation. However, use of all the technologies in Table 4 (a) increases with annual hog production. It is possible that larger firms may pay more to compensate employees for the skills required to implement more advanced technologies.

We test this hypothesis by re-estimating Models 1-4, controlling for ***Technology***. Table 5 reports the ordered probit estimates for ***Human Capital***, ***Gender***, ***Firm Size***, and ***Technology***. As before, inclusion of ***Regional*** and ***Local*** regressors, the maximized value of the log-likelihood function, and log-likelihood ratio test for Models 6, 7, and 8 against Model 5 are also reported. Again, note that there are no significant regional or local effects. Comparing Models 1-4 with Models 5-8, the results are consistent, with two notable differences. The number of full-time employees is no longer significant, and tenure is now significant at the five percent level. Formal management practices, artificial insemination, phase feeding, and all in/all out production technologies are all positive and significant at the one percent level. All other technology parameters are positive but not statistically significant.

Table 3 (b) reports the technology controlled implied annual rates of return. Relative to the estimates in Table 3 (a), inclusion of ***Technology*** reduces the rate of return to education by about 20 percent and, to annual hog production and number of full-time employees, by about 37 percent. The rate of return to tenure for an average employee increases by about 50 percent. Firms that are better organized in the sense that they use employee handbooks, written job descriptions, work plans, and/or formal evaluations pay their workers about 15 percent more annually. The use of artificial insemination, phase feeding, or all in/all out production technologies increases worker compensation by about 6 to 7 percent annually.

To gain additional insights into the role of technology in wage determination, we can characterize the technologies as education-intensive, experience-intensive, labor-intensive and/or scale-intensive through the use of auxiliary regressions which predict the probability of technology use as a function of operation attributes. These regressions (available from the authors on request) suggest that all the technologies are scale intensive, as suggested by the cross-tabulations in Table 4 (a). Artificial insemination, phase feeding, multi-site production and early weaning were labor intensive. Artificial insemination, split-sex feeding, phase feeding, all in/all out and formal management practices are education intensive. However, none of the technologies are experience-using. In fact, the education-intensive technologies were experience-saving, consistent with a pattern of recent expansion of skill-intensive technologies. The technologies which significantly increased wages were the ones associated with education intensity. Early weaning and multi-site production which were labor- but not atypically skill-intensive did not alter wages significantly.

The inclusion of the technology regressors reduces the return to employment size by about one-third, supporting the hypothesis that some of the Brown-Medoff size effect on wages is related to technology choice. In addition, skills needed to implement new education-intensive technologies are hired at a wage premium. Nevertheless, the scale-wage effect is still present, even when technology controls are added, consistent with the hypothesis that large firms share rents with workers. The reduction in the returns to education in the presence of technology controls is consistent with the finding that these technologies are education-intensive. Less experienced, educated workers are being hired to implement these new education-intensive technologies. Once type of technology is controlled, the traditional returns to tenure are once again evident.

IV. Salary, Fringe Benefits, and Working Conditions

Wages are an important part of any compensation package, but total compensation generally consists of more than just wages. Employers offer fringe benefits such as insurance benefits, incentive plans, retirement plans, paid time off, or in-kind goods and services. In addition to alternative goods and services, an employee's working conditions are important. Hurley, et al. (1996) found a greater reported incidence of nagging health problems for hog operations in general and further evidence of an even greater incidence of health problems in confinement operations. Whether these nagging health problems are life threatening or not, employees may require compensation to offset the disamenity of unpleasant working conditions. Therefore, the cost to an employer of hiring an additional worker is not just the salary paid to the worker, but also the cost of any fringe benefits and the cost of providing acceptable working conditions. The cost of providing fringe benefits is likely to be less for larger firms, so the share of benefits in total compensation is likely to increase with the size of the firm. Larger firms may also have a greater incentive to provide safer work environments because the costs are spread over more output, making the unit cost of safety investment smaller.

In a competitive labor market, employees choose among alternative compensation packages and working conditions on the basis of their preferences. Favorable tax laws and group discounts due to risk pooling may cause employees to favor one dollar of health insurance to one dollar in salary. This provides an opportunity for employers to trade off employee salary with fringe benefits and investments in working conditions in ways that raise worker utility without raising overall labor costs.

Results from earnings function estimates suggest a nationally competitive labor market in pork production. This suggests that firms must offer a compensation package that at least matches the opportunities a worker has elsewhere. Let $U_F(W_F, B_F, Z_F, L_i, K_i, E_i, T_i, F_i, P_F, N_F; \tau_i)$ be the workers utility from his current compensation package, where W_F is the salary, B_F is a vector of benefits, Z_F is a vector of job amenities or disamenities, τ_i is unobserved tastes, and the rest of the variables are as already defined. The worker's opportunity utility at other firms depends on the worker's general human capital. This opportunity utility is given by $U_o(K_i, E_i, T_i, F_i, L_i; \tau_i)$, where the first three variables measure worker human capital and L_i represents the strength of the labor market for workers with those skills. Worker satisfaction from the firm's compensation package depends upon the difference in the utility offered by the firm relative to the worker's opportunities elsewhere, so that

$$S = U_F - U_o = g(W_F, B_F, Z_F, L_i, K_i, E_i, T_i, F_i, P_F, N_F; \tau_i) \geq 0 \quad (4)$$

where S is some index of satisfaction. Worker satisfaction is assumed to be positively related to wages, benefits, and firm amenities and negatively related to firm disamenities, holding the worker's opportunities elsewhere fixed. Because there are several ways firms can affect worker utility, it is optimal for firms to adjust their compensation package so as to equalize the marginal utility per dollar expended on wages, benefits, and investments in working conditions. Firms that have cost advantages in providing benefits or favorable working conditions would be expected to offer compensation packages with more benefits, fewer health risks, and lower wages, other things equal. Because human capital should raise opportunities elsewhere as well as compensation within the firm, it should have no systematic effect on worker satisfaction.

In addition to the individual, firm, and regional variables discussed earlier, the NPPC-NHF survey collected detailed information on fringe benefits and working conditions. The vector of fringe benefits was constructed as follows: Insurance premiums is the approximated aggregate insurance premium paid by the employer, constructed by using survey data and information from a local insurance agent. After determining whether or not an employer offered major medical, dental, disability, and/or life insurance to an employee and his family, we calculated the average proportion of the premium paid by employers. A local insurance agent quoted us the standard premiums paid for an individual whose average age was equal to the average age of our respondents. We calculated an aggregate premium by summing the average standard premium paid for each benefit multiplied by the average proportion of the premium paid by the employer. Admittedly, this approximation is a rough estimate, but it does capture the systematic differences between what benefits are offered and what percentage of those benefit premiums are paid by an employer on average. Incentive plan is a dummy variable set equal to one if an employee indicated receiving performance-based compensation such as a profit-sharing plan or a bonus paid for greater feed efficiency, reduced death loss, and/or some other measures of production efficiency influenced by an employee. Paid time off is a dummy variable that was set equal to one if an employee indicated receiving paid vacation days, holidays, or sick leave. In-kind transfers was a dummy variable set equal to one if an employee indicated receiving paid housing, utilities, vehicle, processed meat, and/or continuing education expenses. Finally, retirement plan is a dummy variable that was set equal to one if an employee indicated receiving retirement benefits. Each of these benefits is an alternative form of compensation and is expected to increase satisfaction.

The vector of job amenities and disamenities was constructed as follows: Because dust and gas levels were both highly correlated with the employee's reported working environment within the hog facilities, we used the measure of an employee's working environment to construct a set of dummy variables that capture marginal differences in working conditions. Excellent to good, good to fair, and fair to poor are all dummy variables that were set equal to zero if the employee reported that his working environment was excellent. If an employee reported that his working environment was good, excellent to good was set equal to one, and good to fair and fair to poor were set equal to zero. If an employee reported that his working environment was fair, excellent to good and good to fair were set equal to one, and fair to poor was set equal to zero. If an employee reported that his working environment was poor, excellent to good, good to fair and fair to poor were all set equal to one. Inasmuch as each dummy variable represents successive marginal declines in the employee's working environment, negative impacts on satisfaction are expected. Finally, the dummy variable mask or respirator was set equal to one if an employee indicated that his employer provided a dust mask or respirator. Because an employer's provision of a dust mask or respirator gives an employee the opportunity for protection against work-related health risk, a positive relationship between mask provision and satisfaction is expected.

Table 4 (b) reports the conditional means of our vector of fringe benefits and working conditions. Notice that salary and insurance premiums are increasing in annual hog production. Incentive plans and paid time off are more common in firms with greater annual hog production. In-kind transfers are not as strongly related to a firm's annual hog production, and retirement plans seem more common in firms with low or very high annual hog production. In terms of working conditions, it seems that the largest firm, those producing more than 10,000 hogs annually, do in fact have the most favorable working conditions. Nearly 85 percent of employees working for these large firms reported good or excellent working conditions. Alternatively, just over 71 percent of employees working for the smallest firms, those producing less than 2,000 hog annually, reported good or excellent working conditions. Firms with higher levels of production are also more likely to supply dust masks or respirators.

Although we do not have a direct measure of utility, we do have a suitable proxy. The NPPC-NHF survey asked employees if they agreed or disagreed with the statement, "My salary and benefits are competitive with other job opportunities in this community." This statement, while indirect, measures how an individual rates job prospects within his community. The more likely an employee is to agree with this statement, the happier an employee is with his current compensation package and employment. Therefore, we use the probability that an employee agrees with this statement as a measure of the employee's utility or level of satisfaction with the compensation package and job. Let Y equal one if an employee agrees with the statement above or zero if he disagrees. Assuming that $g(W_F, B_F, Z_F, L_i, K_i, E_i, T_i, F_i, P_F, N_F; \tau_i)$ is linear,

$$(5) \qquad \Pr(Y=1) = \Pr(X\phi + \tau_i \geq 0) = \Pr(-X\phi \leq \tau_i) = 1 - \Gamma(-X\phi),$$
$$X\phi = \phi_0 + \phi_W W_F + B_F\phi_B + Z_F\phi_Z + \phi_1 K_i + \phi_2 E_i + \phi_4 T_i + \phi_6 F_i + \tau\phi_\tau + \tau_i .$$

$\Gamma(\cdot)$ is the cumulative distribution of τ_i.. On average, almost 78 percent of employees agreed with the statement. This agreement generally increased with annual hog production.

The parameters in equation (5) and the likelihood that an employee agrees with the statement are estimated by using the Probit model (see Greene, 1990, pp. 662-686). Table 6 reports the estimated coefficients and standard errors. First, notice that all coefficients are of the expected signs with the exception of the paid time off, which is not statistically different from zero. The coefficients for *Salary*, insurance premiums, excellent to good, good to fair, and mask or respirator are all significant at the five percent level.

The implicit value of firm benefits, amenities, and disamenities is implied by the parameters in equation (5). Suppose a firm is considering changing a benefit level from B_F to B_F', where we assume, for ease of exposition, that the vector B_F has only one variable. The worker's valuation of the benefit change is the change from W_F to W_F' needed to leave the worker's satisfaction unchanged. This compensating wage differential is implicitly defined by

$$\Pr(Y=1) = 1-\Gamma\left(-\left(\phi_W W_F' + B_F'\phi_B + Z_F\phi_Z + \Phi\right)\right)$$

(6)

$$= 1-\Gamma\left(-\left(\phi_W W_F + B_F\phi_B + Z_F\phi_Z + \Phi\right)\right)$$

which implies $\phi_W W_F' + B_F'\phi_B = \phi_W W_F + B_F\phi_B$ where, for ease of exposition, Φ is set equal to the sum of all remaining factors weighted by their respective coefficients in equation (5). The dollar trade off between benefits and wages is $-(W_F'-W_F)/(B_F'-B_F) = \phi_B/\phi_W$. Similarly, the other trade-offs are computed by dividing ϕ_B and ϕ_Z by ϕ_W. This normalization yields marginal trade-offs that are measured in terms of salary dollars. These trade-offs are also reported in Table 6.

The dollar equivalents for insurance premiums, excellent to good, good to fair, and mask or respirator are all significant at the five percent level. The dollar equivalent for insurance premiums implies that an employer can reduce an employee's salary by about $2.60 for every dollar of insurance provided. Given group discounts and favorable tax treatment, we expected this trade off to exceed $1. Employees working in facilities with excellent as opposed to good working conditions are willing to give up more than $10,000 in salary and are still equally satisfied with their compensation package. Similarly, employees working in facilities with good as opposed to fair working conditions are willing to give up just under $8,000 in salary and are still equally satisfied with their compensation packages. Alternatively, by providing a dust mask or respirator, an employer can reduce an employee's salary by just over $6,800 while still maintaining the employee's level of satisfaction with his compensation package.[3]

Hog farmers and their employees are significantly more likely to report nagging health problems relative to the population as a whole. These nagging health problems will drive workers from hog production unless they are appropriately compensated. We find that employees are in fact compensated for poorer working environments that lead to increased health risks. Employees express a willingness to accept lower wages in exchange for protection against the risk of nagging health problems or for insurance that provides treatment should nagging health problems arise. An employer can provide protection by improving the working environment, or by providing protective gear such as a dust mask or respirator. The first strategy guarantees a reduction in an employee's health risk, while the second strategy shifts the burden of protection to the employee. While a dust mask or respirator may be available, an employee must choose to use it so as to reduce any health risk. Therefore, we would expect employees to prefer the first strategy to the second as is indicated by the value of these trade-offs. Interestingly, while over 80 percent of employees indicate the provision of a dust mask or respirator, only about 20 percent report using them. This suggests that the value of the mask is primarily an option value. Employees want the option to use the mask should they choose to do so. Alternatively, health insurance can provide treatment for employees who find themselves afflicted with nagging health problems.

[3] Although these trade-offs are of the correct sign, the magnitudes seem high. The estimated dollar trade-offs proved extremely sensitive to the magnitude of the coefficient on salary in Table 6.

V. Summary and Conclusions

Increases in firm size and the adoption of new labor-intensive technologies have increased the demand for labor numbers and skill in rural labor markets. Although anecdotal evidence of regional differences in wages suggest the possibility of regional or local labor market segmentation, the 1995 survey data do not support this hypothesis. Differences in wages are consistent with other competitive labor markets and can be explained by differences in human capital, gender, and firm size. Larger firms pay more, in part because of a production complementarity between skilled labor and technology. However, even controlling for technology, a strong positive relationship between wages and annual hog production remains. The higher wages offered by larger firms do not support the hypothesis that larger firms locate in labor markets with atypically low wages or that larger firms exercise monopsony power in local labor markets. The more generous compensation packages paid by larger firms suggest that rents accrued as a result of cost savings due to economies of scale are shared with employees.

We find significant trade-offs between salary, insurance premiums, working environment, and an employer's provision of a dust mask or respirator. These trade-offs indicate that employees are willing to accept lower wages if an employer is willing to provide a less risky work environment, supply voluntary protection, or insure an employee against work-related health hazards. Therefore, employees are requiring either compensation, protection, or insurance for work-related health risks, and employers are choosing those options for which they have a comparative advantage in providing. On average, larger firms provide more generous benefit packages and safer working environments, suggesting that larger firms may also enjoy returns to scale in the provision of benefits and investments in workplace safety.

References

Brown, Charles, and James Medoff. "The Employer Size-Wage Effect." *Journal of Political Economy* 97 (October 1989):1027-1059.

Good, Keith, Chris Hurt, Ken Foster, John Kadlec, and Kelly Zering. "Comparative Costs of Hog Production in the Midwest and North Carolina." Presented at the Pork Global Competitiveness Seminar, St. Louis Missouri, January 9, 1995.

Greene, William H. *Econometric Analysis*. New York: MacMillan Publishing Company, 1990.

Gunderson, Morley. "Male-Female Wage Differentials and Policy Responses." *Journal of Economic Literature* 27 (March 1989):46-72.

Hurley, Terrance M., Peter F. Orazem, and James B. Kliebenstein. "An Analysis of Occupational Health in Pork Production." Report for National Pork Producers, July 9, 1996.

Hurt, Chris. "Summary and Conclusions." In Laura Hoelscher, ed., *Positioning Your Pork Operation for the 21st Century*. Purdue Cooperative Extension Service, 1995:183-193.

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

Singleton, Wayne, and Allan Schinckel. "Artificial Insemination and Genetics." In Laura Hoelscher, ed.., *Positioning Your Pork Operation for the 21st Century*. Purdue Cooperative Extension Service, 1995:111-122.

Stigler, George J. "The Economics of Scale." *The Journal of Law and Economics* 65 (October 1958):54-71.

Willis, Robert J. "Wage Determinants: A Survey and Reinterpretation of Human Capital Earnings Functions." In Orley Ashenfelter and Richard Layard, eds., *Handbook of Labor Economics*. Amsterdam: Elsevier Science Publishers B.U., 1986.

Figure 1: Ratio of production shares 1990 / 1995 by annual hog production.

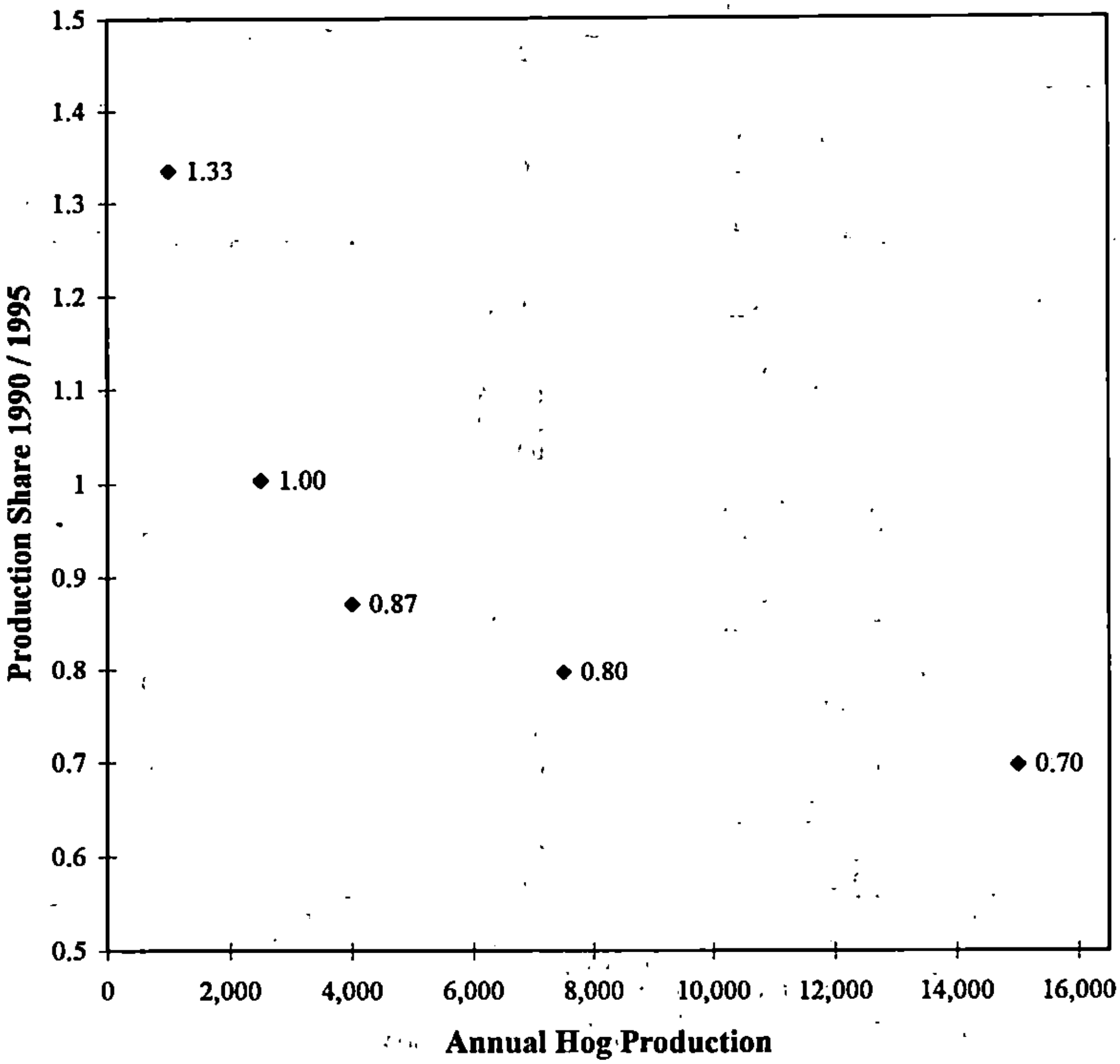

Table 1: (a) Earnings functions descriptive statistics.
(b) Trade-off descriptive statistics.

(a)

Variable		Mean	Standard Deviation
	Salary[a]	3.31	1.74
Human Capital			
	Education	14.04	1.97
	Experience	14.05	9.53
	Tenure	6.43	6.56
Gender			
	Female	0.0941	0.2921
Firm Size			
	Annual Hog Production	1.51	1.47
	Number of Full-Time Employees	1.15	2.35
Regional			
	Midwest[b]	0.6960	0.4602
	Northeast[c]	0.0455	0.2085
	Southeast[d]	0.1510	0.3582
	West[e]	0.1075	0.3100
Local			
	Herfindahl Index	0.1750	0.0560
	Proportion with a High School Education	0.7338	0.0768
	Employment Rate	0.6953	0.1300
	Average Income	$33,845	$7,041
	Proportion in Agriculture	0.0138	0.0129
Technology			
	Formal Management Practices	0.6308	0.4828
	Personal Computer	0.6784	0.4673
	Artificial Insemination	0.5739	0.4948
	Split Sex Feeding	0.4757	0.4997
	Phase Feeding	0.5584	0.4968
	Multiple-Site Production	0.3847	0.4868
	Early Weaning	0.2254	0.4181
	All In/ All Out Production	0.6960	0.4602

[a] Salary codes: 0=Less than $10,000, 1=$10,000 to $15,000, 2=$15,000 to $20,000, 3=$20,000 to $25,000, 4=$25,000 to $30,000, 5=$30,000 to $35,000, 6=$35,000 to $40,000, 7=$40,000 to $50,000 and 8=$50,000 to $60,000.
[b] The midwest region includes: IA, IL, IN, MN, MO, ND, NE, OH, SD, and WI.
[c] The northeast region includes: CT, MD, ME, MI, NJ, NY, and PA.
[d] The southeast region includes: AL, FL, GA, KY, LA, MS, NC, SC, TN, VA, and WV.
[e] The west region includes: AK, AR, AZ, CA, CO, HI, ID, KS, MT, OK, OR, TX, UT, WA, and WY.

(b)

Variable		Mean	Standard Deviation
	Satisfied With Compensation	0.7782	0.4157
	Salary	$24,280	$9,264
Fringe Benefits			
	Incentive Plan	0.6099	0.488
	Paid Time Off	0.8238	0.3812
	Insurance Premiums	$1,459	$1,412
	In-kind Transfers	0.7347	0.4417
	Retirement Plan	0.3683	0.4826
Working Conditions			
	Excellent to Good	0.7554	0.4300
	Good to Fair	0.2020	0.4017
	Fair to Poor	0.0317	0.1752
	Mask or Respirator	0.8139	0.3894

Table 2: Earnings functions.

	Model 1[a]	Model 2	Model 3	Model 4
Human Capital				
Education	0.1521**	0.1585**	0.1598**	0.1650**
	(9.58)	(10.10)	(10.34)	(10.80)
Experience	0.0692**	0.0690**	0.0693**	0.0692**
	(5.92)	(6.00)	(5.98)	(6.01)
Experience^2	-0.0014**	-0.0014**	-0.0014**	-0.0014**
	(4.55)	(4.62)	(4.64)	(4.66)
Tenure	0.0185	0.0170	0.0181	0.0178
	(1.55)	(1.43)	(1.57)	(1.55)
Tenure^2	-0.0003	-0.0003	-0.0002	-0.0002
	(0.76)	(0.68)	(0.62)	(0.63)
Gender				
Female	-0.5969**	-0.5873**	-0.5988**	-0.5885**
	(5.02)	(5.09)	(5.13)	(5.18)
Firm Size				
Annual Hog Production[b]	0.2635**	0.2668**	0.2562**	0.2636**
	(8.41)	(8.63)	(8.20)	(8.66)
Number of Full-Time Employees[c]	0.0513*	0.0554**	0.0473*	0.0506**
	(2.48)	(2.77)	(2.32)	(2.58)
Regional				
Included	Yes	No	Yes	No
Local				
Included	Yes	Yes	No	No
Number of Observations	967	967	967	967
Log-Likelihood	-1689.334	-1691.736	-1694.143	-1696.128
χ^{2b}		4.80	9.62	13.59

[a] The absolute value of the t-statistic is indicated in parentheses.
[b] Likelihood-ratio test of restrictions against Model 1.
*Significant at the 5% level.
**Significant at the 1% level.

Table 3: (a) Implied annual rates of return.[a]
(b) Technology controlled implied annual rates of return.

(a)

	Model 1	Model 2	Model 3	Model 4
Human Capital				
Education	4.83%	5.05%	5.11%	5.29%
Experience	0.94%	0.95%	0.94%	0.94%
Tenure	0.47%	0.44%	0.49%	0.47%
Gender				
Female	-18.97%	-18.73%	-19.14%	-18.85%
Firm Size				
Annual Hog Production[b]	8.37%	8.51%	8.19%	8.45%
Number of Full-Time Employees[c]	1.63%	1.77%	1.51%	1.62%

(b)

	Model 5	Model 6	Model 7	Model 8
Human Capital				
Education	3.75%	3.97%	3.96%	4.20%
Experience	0.97%	0.98%	0.96%	0.97%
Tenure	0.74%	0.71%	0.75%	0.75%
Gender				
Female	-17.93%	-17.72%	-18.11%	-17.86%
Firm Size				
Annual Hog Production[b]	4.86%	5.03%	4.70%	5.15%
Number of Full-Time Employees[c]	0.98%	1.11%	0.85%	0.99%
Technology				
Formal Management Practices	14.62%	14.54%	14.78%	15.08%
Personal Computer	4.56%	4.68%	4.55%	4.23%
Artificial Insemination	7.14%	7.27%	7.35%	7.49%
Split Sex Feeding	2.90%	2.64%	2.62%	2.38%
Phase Feeding	7.09%	6.93%	7.28%	6.84%
Multiple-Site Production	1.06%	0.83%	1.02%	0.56%
Early Weaning	4.44%	4.59%	4.50%	4.27%
All In/ All Out Production	6.33%	6.41%	6.46%	6.04%

[a] All rates of return are evaluated at the sample means.
[b] Per 10,000 hogs.
[c] Per 10 full-time employees.

Table 4: (a) Conditional human capital and technology means based on annual hog production.
(b) Conditional fringe benefit and working condition means based on annual hog production.

(a)

	Annual Hog Production				
	Less Than 2,000	2,000 to 2,999	3,000 to 4,999	5,000 to 9,999	More than 10,000
Salary	2.61	2.58	2.81	3.06	3.91
Human Capital					
Education	14.25	13.89	13.75	13.68	14.19
Experience	16.05	15.32	13.18	14.30	13.23
Tenure	9.21	8.06	7.19	6.25	5.03
Gender					
Female	0.1146	0.0652	0.0094	0.1032	0.1094
Firm Size					
Number of Full-Time Employees	0.2548	0.2185	0.2500	0.3929	2.1201
Technology					
Formal Management Practices	0.4331	0.4239	0.4434	0.5226	0.8206
Personal Computer	0.4841	0.6522	0.6321	0.6581	0.7681
Artificial Insemination	0.3503	0.3261	0.4057	0.5355	0.7527
Split Sex Feeding	0.2229	0.2609	0.4057	0.4774	0.6214
Phase Feeding	0.3758	0.5000	0.6132	0.6065	0.6039
Multiple-Site Production	0.2038	0.1848	0.2075	0.2968	0.5580
Early Weaning	0.0892	0.1630	0.1698	0.2065	0.3042
All In/ All Out Production	0.4522	0.5652	0.6226	0.7677	0.7987
Number of Observations	157	92	106	155	457

(b)

	Annual Hog Production				
	Less Than 2,000	2,000 to 2,999	3,000 to 4,999	5,000 to 9,999	More than 10,000
Satisfied With Compensation	0.6842	0.6979	0.7857	0.7578	0.8282
Salary	$20,444	$20,208	$21,496	$22,748	$27,413
Fringe Benefits					
Incentive Plan	0.3224	0.4583	0.5446	0.5652	0.7587
Paid Time-Off	0.5329	0.6979	0.8214	0.8075	0.9448
Insurance Premiums	$986	$1,333	$1,374	$1,386	$1,674
In-kind Transfers	0.6842	0.7396	0.7321	0.7578	0.7423
Retirement Plan	0.2632	0.2396	0.1607	0.2050	0.5276
Working Conditions					
Excellent to Good	0.8487	0.7813	0.7679	0.7888	0.7076
Good to Fair	0.2829	0.2500	0.1964	0.2484	0.1534
Fair to Poor	0.0263	0.0104	0.0268	0.0435	0.0348
Mask or Respirator	0.6513	0.6667	0.7679	0.8199	0.9018
Number of Observations	152	96	112	161	489

Table 5: Technology Augmented Earnings Functions.

	Model 5[a]	Model 6	Model 7	Model 8
Human Capital				
Education	0.1249**	0.1315**	0.1311**	0.1387**
	(7.61)	(8.11)	(8.20)	(8.78)
Experience	0.0704**	0.0703**	0.0702**	0.0703**
	(5.92)	(6.02)	(5.91)	(5.99)
Experience^2	-0.0014**	-0.0013**	-0.0014**	-0.0014**
	(4.26)	(4.33)	(4.27)	(4.34)
Tenure	0.0306*	0.0291*	0.0304*	0.0303*
	(2.46)	(2.34)	(2.53)	(2.51)
Tenure^2	-0.0005	-0.0004	-0.0004	-0.0004
	(1.16)	(1.08)	(1.09)	(1.12)
Gender				
Female	-0.5967**	-0.5874**	-0.5998**	-0.5893**
	(5.09)	(5.21)	(5.24)	(5.33)
Firm Size				
Annual Hog Production	0.1616**	0.1667**	0.1556**	0.1698**
	(4.65)	(4.87)	(4.50)	(5.10)
Number of Full-Time Employees	0.0326	0.0368	0.0282	0.0328
	(1.55)	(1.82)	(1.36)	(1.64)
Technology				
Formal Management Practices	0.4865**	0.4820**	0.4897**	0.4973**
	(6.13)	(6.12)	(6.29)	(6.41)
Personal Computer	0.1517	0.1550	0.1506	0.1395
	(1.87)	(1.93)	(1.87)	(1.76)
Artificial Insemination	0.2376**	0.2410**	0.2434**	0.2471**
	(2.89)	(2.94)	(3.12)	(3.18)
Split Sex Feeding	0.0964	0.0876	0.0869	0.0784
	(1.21)	(1.10)	(1.10)	(1.00)
Phase Feeding	0.2358**	0.2299**	0.2411**	0.2258**
	(3.15)	(3.07)	(3.24)	(3.03)
Multiple-Site Production	0.0353	0.0277	0.0339	0.0185
	(0.43)	(0.34)	(0.41)	(0.23)
Early Weaning	0.1477	0.1521	0.1491	0.1410
	(1.68)	(1.75)	(1.71)	(1.63)
All In/ All Out Production	0.2105**	0.2124**	0.2138**	0.1993**
	(2.73)	(2.76)	(2.80)	(2.63)
Regional				
Included	Yes	No	Yes	No
Local				
Included	Yes	Yes	No	No
N	967	967	967	967
Log-Likelihood	-1636.167	-1639.142	-1639.852	-1643.846
χ^{2b}		5.95	7.37	15.36

[a] The absolute value of the t-statistic is indicated in parentheses.
[b] Likelihood-ratio test of restrictions against Model 5.
*Significant at the 5% level.
**Significant at the 1% level.

Table 6: Salary, fringe benefit, and working condition trade-offs.

	Probit Estimates[a]	Dollar Equivalent[b]
Salary[c]	0.0383**	
	(5.68)	
Fringe Benefits		
Incentive Plan	0.1482	$3,873
	(1.47)	(1.41)
Paid Time Off	-0.0111	-$290
	(0.08)	(0.08)
Insurance Premiums[c]	0.0992**	$2.59*
	(2.72)	(2.41)
In-kind Transfers	0.0547	$1,429
	(0.52)	(0.51)
Retirement Plan	0.0691	$1,806
	(0.58)	(0.57)
Working Conditions		
Excellent to Good	-0.3960**	-$10,352**
	(3.03)	(2.67)
Good to Fair	-0.3036*	-$7,938*
	(2.53)	(2.28)
Fair to Poor	-0.0618	-$1,615
	(0.24)	(0.24)
Mask or Respirator	0.2604*	$6,807*
	(2.20)	(2.04)
Individual, Firm and Regional Characteristics Included	Yes	
N	1010	
Log-likelihood	-470.77	

[a] The absolute value of the t-statistic is indicated in parentheses.
[b] The dollar equivalent is estimated by dividing each of the *Fringe Benefit* and *Working Condition* coefficients by the *Salary* coefficient.
[c] Per $1,000.
*Significant at the 5% level.
**Significant at the 1% level.