Logging Worker Wage, Performance, and Experience

Yecheng Xu
Mathew Smidt
Yaoqi Zhang

Abstract

Many believe the logging industry faces significant challenges in recruiting and maintaining a qualified workforce. The relationship between wage and productivity is a critical component of attracting quality workers while controlling labor cost. We attempted to examine the relationship between worker performance and wage with results from a mixed (mail, Internet, and interview) national survey targeting logging firm owners, corporate officers, and supervisors. Respondents (162 total) varied regionally (North, South, and West) with respect to harvest systems and firm size. Wage expectations were considerably higher with aerial harvest systems, which were confounded with the respondents from the West, larger firm size, and greater respondent experience. Wages for workers with higher skill levels were more related to firm and respondent attributes than were lower skill levels, and most of the relationships were logical. Respondents indicated that equipment operators perform adequately after 12 months on the job and supervisors after 24 months. For chainsaw operators, results appeared to vary by region from 6 to 36 months of experience. Changes in wage due to increased skill level were similar across regions when expressed as a percentage of the lower skill level. Once the worker was able to perform at an adequate level, it appears that wage changes due to performance were roughly equivalent to the expected increase in productivity.

In logging, the perceived labor shortages in the 1960s and 1970s (Irland 1975) were followed by a rapid pace of mechanization, which decreased labor demand and increased output. Adapting new logging systems contributed to higher productivity and lower average per unit cost (Cubbage and Carter 1994). Logging labor productivity grew substantially from the 1960s (Granskog and Guttenberg 1973) until the mid-1980s (Parry 1999), with no growth into the mid-1990s. Contemporary data on labor productivity are unavailable since logging was dropped from the Economic Census after 1997, when it was reclassified from manufacturing (Standard Industry Classification 2411) to agriculture (North American Industry Classification System [NAICS] 1133). The pace of change in labor productivity for logging may be limited by factors such as changing harvests and business conditions (Rickenbach and Steele 2005, Allen et al. 2008, Baker and Greene 2008, Moldenhauer and Bolding 2009, Bolding et al. 2010) and return-to-scale issues in modern logging (Stuart et al. 2010).

Concerns about recruiting and retaining the next generation of firm owners and workers stem in part from increasing average age of firm owners (Baker and Greene 2008). Expectations for growth in the sector are modest (Abt 2013, Bureau of Labor Statistics [BLS] 2014). However, even in the absence of growth in the sector, the demand for workers and firm owners is sustained by turnover within and among firms. Annually, about 15 to 20 percent of the logging workforce turns over due to firm expansion and creation or firm contraction and closing (US Census Bureau 2014). Almost 13 percent of existing firms closed in 2010. Surveys of firm owners have indicated that recruiting and maintaining workers were significant concerns in business success (Allen et al. 2008, Egan 2011, Ward 2013). Poor perception of logging status, working conditions, pay, and benefits were identified as recruiting challenges (Goldstein et al. 2005, Egan and Taggart 2009).

Given the importance of worker performance and wage rates in the success of logging firms, we explored their relationship for US logging firms. The primary objectives of these analyses were (1) to estimate the expected performance level of experienced hires in logging, (2) to determine how skill levels or experience affect wage rates,

The authors are, respectively, Research Assistant, Associate Professor, and Professor, Auburn Univ., Auburn, Alabama (yzx0013@auburn.edu, smidtmf@auburn.edu [corresponding author], zhangy3@auburn.edu). This paper was received for publication in March 2014. Article no. 14-00035.

Forest Prod. J. 64(5/6):210–216.
doi:10.13073/FPJ-D-14-00035

and (3) to examine the relationship between firm attributes (e.g., logging system, product sorting, region, and firm size) and expected wage rates and performance. The data may provide more specific labor costs in production models and information on the relative costs and benefits of skill and work experience in logging.

Methods

The survey was administered in 2013 to a target population of logging firm employers/owners across the United States. A mixed (mail, Internet, and interview) survey was designed according to Dillman (2011) and included information on firm and respondent demographics as well as worker wage and performance level. The estimated completion time was 10 to 15 minutes. A draft was sent to state logging association directors for their input before dissemination.

The first part (16 items) collected respondent's background concerning personal and firm attributes (e.g., education level, experience in the logging industry, structure of the logging firms, and recent hiring activity). The second part analyzed job performance, which was rated according to three attributes: job quality, safety, and productivity.

Each respondent chose current job positions in the logging firm and then indicated what the minimum acceptable or adequate job performance level was for each of the three attributes. The performance level was measured with a scale ranging from 0 to 100, with 0 indicating no knowledge or skill and 100 indicating an expert operator. Next, the respondent selected the amount of on-the-job experience needed to achieve the minimum performance level indicated in the previous question. Options ranged from less than 1 month to more than 4 years.

Finally, we asked the respondent for the anticipated wage rates for logging employees with different combinations of productivity and safety performance measured in hourly wage (range from $10 to $30 per h).

Completed surveys were obtained through four attempts. The first attempt was distribution of a short description of the study with a link to an online survey. The study description with the survey link was sent to logging associations and industry publications. This method was nonpointed, and there were no assigned potential respondents. This round started on April 17, 2013, and began receiving responses on April 25, 2013. The second attempt was an e-mail distribution to contacts in the Federal Motor Carrier Safety Administration database. We created a randomly selected list of 1,320 carriers with ''logging'' in the firm name. The e-mail contact was followed by mail contact that included both the link and a paper copy of the survey. The mail contact was followed by a postcard reminder 7 days after the survey was mailed. This round started on May 3, 2013. The third distribution was a mail survey to a randomly selected list of 300 participants of state logger training programs. This round, through mail contact and postcard reminder, started on May 27, 2013. The last distribution was completed by presenting the survey at regional logging equipment shows in Michigan (September 6, 2013) and North Carolina (September 20, 2013), where survey forms were completed during face-to-face interviews. The respondents were selected by two screening questions after approaching the display. Data from all distributions were merged for analysis. Although the possibility of repeated responses from the same person is negligible, potential respondent lists generated from these sources interact at some level.

Results and Discussion

The response set was open for about 5.5 months, from April 17 to October 1, 2013. We received 164 responses, but 2 were incomplete or unreadable. All responses received during this period were aggregated, and most were from the northern and southern states. For analysis, we used the categories of all states (A), northern states (N), southern states (S), and western states (W; Fig. 1). The categories follow USDA Forest Service (USFS) regions 8 (South) and 9 (North), with the remaining USFS regions lumped in the West because there were so few responses. We chose not to identify by state in the survey since it might be possible to identify a single respondent in a state. This approach clearly complicated the addition of surveys from regional shows but maintained respondent anonymity.

The response rate was impossible to estimate in general, but the response rate of mail-distributed surveys was about 2 percent. Duplicate responses in IP addresses were not found. None of the survey respondents contacted personally at the shows indicated any previous contact by mail or e-mail. The survey response rate and mixed methods for data collection hinder generalization of survey results to the population. Our perspective is that few national logging surveys are attempted, and we believe those who responded were able to evaluate the relationship between wage and performance. Bias among respondents might be identified by key demographic attributes (e.g., age, firm size, and education)

Most of the respondents were in the North or South (Table 1) because the last distribution targeted areas in those regions. About 50 percent of the respondents were from the interviews. Most respondents were firm owners with considerable experience in logging and logging firm management. The average age was 48 years. Our respondent age is similar to what has been found among other recent surveys: The mode age in a New England survey was 50 to 59 years (Leon and Benjamin 2012), and the mean age was 48 in North Central States (Allred 2009), 50 in Georgia (Baker and Greene 2008), and 51 years in the inland Northwest (Allen et al. 2008). Educational attainment levels showed some difference between the North and the South

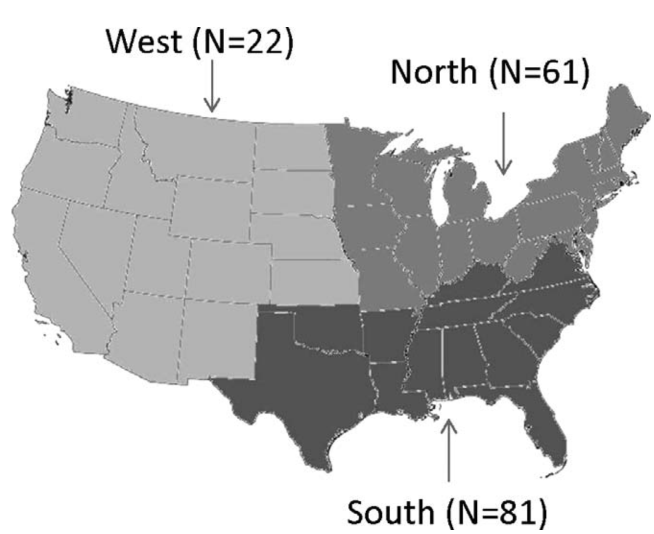

Figure 1.—Regional distribution for survey responses.

Table 1.—Summary statistics for respondents by region.

Survey item	Region		
	North	South	West
No. of respondents	61	81	20
Logging firm owner (%)	77	68	75
Mean (SD) age (y)	47.9 (11.7)	46.2 (13.4)	52.8 (8.8)
Bachelor's degree (%)	7	19	20
Some college (%)	16	16	25
Logging experience (>10 y) (%)	89	80	90
Experience in current position (>10 y) (%)	80	72	85
Experience running firm (>10 y) (%)	89	84	79
Formal training (% yes)	74	60	68

and were similar to or slightly higher than estimates from other surveys. Twenty-three percent of respondents in Virginia had some college or a college degree (Bolding et al. 2010), compared with 14 percent in West Virginia (Milauskas and Wang 2006). In Maine, the average education was 12.8 years (Egan and Taggart 2009).

Regional differences in firms included firm size distribution, with mostly small firms in the North and South (Table 2). At least half of the employees in firms were equipment operators. The regional differences in logging systems were apparent, with nearly equal use of all systems in the North and reliance on feller buncher–skidder systems in the South. Greater diversity in harvesting systems in the West and the North versus the South has been identified by a number of authors (Rickenbach and Steele 2005, Milauskas and Wang 2006, Allen et al. 2008, Baker and Greene 2008, Bolding et al. 2010, Leon and Benjamin 2012).

About two-thirds of most recent hires were experienced, demonstrating the preference for (Reisinger et al. 1994), and perhaps the availability of, experienced workers. About one-third of respondents had hired people with formal training, with slightly more being in the South. We assumed that formal training responses referred to the state logger training programs or other short-duration professional training (e.g., Best Management Practices, safety, and felling).

The survey results for expected performance levels of new hires as equipment operators, chainsaw operators, and supervisors are presented in Figure 2. Minimum safety performance averaged near 90 (100 equals expert) across all jobs and regions. There was more variability in minimum performance level regarding job quality and productivity. Supervisor performance was consistently higher in these attributes (near or above 80) compared with the other jobs. Expected performance levels ranged from the mid-60s to the upper 70s for productivity and job quality for equipment and chainsaw operators. The lowest expectation of overall proficiency was for equipment operators among respondents in the North.

Expected experience referred to the time required for an employee to transition from a new hire (no experience or training) to an employee who can function at adequate performance levels with minimal supervision (Table 3). For equipment operators, the expectation was similar for respondents in the North and the South. Most indicated that less than 24 months of experience was adequate for equipment operators. There were greater regional differences for chainsaw operators. Most respondents from the North indicated that more than 12 months of experience was needed, while respondents from the South and West had lower expectations for experience. Respondents in the North and South expected that supervisors would need more than 2 years of experience, while those in the West indicated 4 years or more would be needed.

Wage data were collected at four performance levels using productivity and safety performance, where high was expert, medium was minimally acceptable, and low was recent hire. Productivity/safety levels were low/low (L/L), low/medium (L/M), medium/high (M/H), and high/high (H/H). Table 4 shows the comparison between survey data (H/H) and data from the 2012 Occupational Employment Survey (OES; BLS 2013b). OES data were from the

Table 2.—Summary statistics for firms by region.[a]

Survey item	% by region		
	North	South	West
Firm employees (no.)			
1–6	70	40	32
7–10	8	23	0
11–20	12	17	16
>20	10	20	47
Firm equipment operators (no.)			
1–3	70	40	32
4–6	8	23	0
7–10	12	17	16
11–20	10	20	47
Logging system used			
Feller buncher–skidder	43	79	78
Chainsaw-skidder	52	40	56
Harvester-forwarder	57	8	39
Products separated (no.)			
1–3	34	45	39
4–6	44	43	33
>7	21	13	28
When was most recent hire (y)			
<1	38	56	56
1–3	25	33	28
Recent hire job			
Equipment operator	49	63	44
Chainsaw operator	16	14	0
Supervisor	2	1	0
Most recent hire had logging experience	66	63	50
Hired workers with formal training	38	48	33

[a] Multiple responses were only allowed for logging systems used.

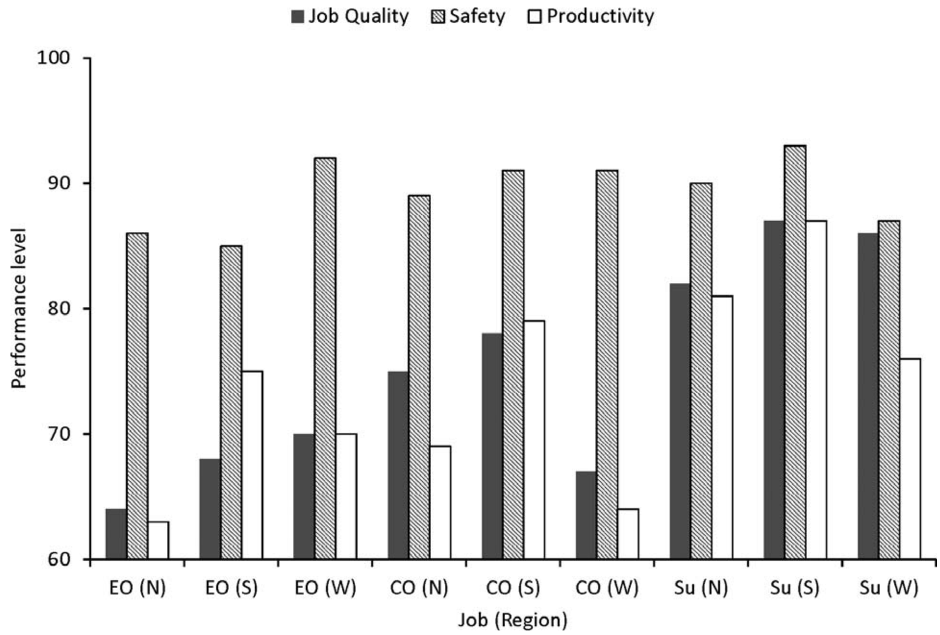

Figure 2.—Average minimum performance levels for job quality, safety, and productivity for equipment operator (EO), chainsaw operator (CO), and supervisor (Su) for North (N), South (S), and West (W) regions. A performance level of 100 refers to an expert operator/supervisor.

occupations equipment operator (45-4022), feller (45-4021), and supervisor (45-1011) within NAICS 1133. Feller was the closest occupation to chainsaw operator. For equipment operators, the OES average was lower than the survey results. The next lower performance level (M/H) had an average for all survey respondents of \$14.55/h, compared with \$16.74/h from the OES. While the survey sample bias may contribute to the difference, other issues in comparability could be related to the occupation description and the average experience or performance level of employees in the OES sample compared with the performance levels given in the survey.

Table 3.—Experience required (by job) for inexperienced workers to reach performance levels expected of experienced workers.[a]

	Equipment operator			Chainsaw operator			Supervisor		
	North	South	West	North	South	West	North	South	West
Experience category									
<1 mo	0.09	0.08	0.00	0.03	0.04	0.00	0.04	0.02	0.00
1–2 mo	0.06	0.04	0.00	0.08	0.07	0.00	0.00	0.00	0.00
3–5 mo	0.13	0.13	0.06	0.05	0.14	0.27	0.00	0.05	0.00
6–11 mo	0.15	0.22	0.25	0.08	0.14	<u>0.27</u>	0.08	0.08	0.00
12–23 mo	<u>0.26</u>	<u>0.32</u>	<u>0.44</u>	0.24	<u>0.30</u>	0.27	0.08	0.18	0.13
2–3 y	0.24	0.12	0.06	<u>0.34</u>	0.18	0.18	<u>0.35</u>	<u>0.24</u>	0.13
≥4 y	0.07	0.09	0.19	0.18	0.13	0.00	0.46	0.44	<u>0.75</u>
No. of responses	54	77	16	38	56	11	26	62	8

[a] Values are the proportion of respondents in each column. Median category for each column is underlined.

Table 4.—Comparison of average wages from high productivity and high safety performance levels compared with Occupational Employment Survey (OES) data for similar occupational codes within logging (North American Industry Classification System 1133) for 2012.

	Avg. wage (\$/h) [a]			
Source	Supervisor (45-1011)	Equipment operator (45-4022)	Chainsaw operator (45-4021)	Avg. (45-4020)
OES	26.23 (2.6)	16.74 (1.1)	19.55 (4.6)	17.20 (1.3)
All	20.34 (2.5)	18.34 (2.0)	17.30 (2.9)	
North	20.51 (4.4)	18.86 (2.9)	18.92 (3.8)	
South	19.74 (3.2)	17.24 (2.9)	15.50 (4.1)	
West	24.90 (9.4)	22.13 (3.7)	21.17 (8.1)	

[a] Percent relative standard errors are in parentheses.

For wage data, respondents may have had to estimate the wage equivalent (dollars per hour) from their own pay system. Firms may use a combination of daily and hourly rates along with an allocation or bonus for production rates (Schuh and Kellogg 1988). Regional differences in wage allocation in straight wage versus bonus could affect the estimate. Indirect labor costs and total compensation costs may also influence wages. Large indirect cost variations may be related to workers' compensation insurance premiums. In 2010, premiums for logging class code 2702 ranged from 10 to more than 40 percent of payroll for most forested states (Oregon Department of Consumer and Business Services 2011). In terms of total compensation, regional surveys indicated some difference in benefit availability (retirement and health insurance). Benefits were available to employees in 24 percent of firms in the South (Munn et al. 1998), less than 20 percent of firms in New England (Egan and Taggart 2004), and 53 percent of firms in Washington (Mason and Lippke 2007). Benefits were accessible to 60 to 80 percent of employees among construction, extraction, farming, fishing, and forestry (BLS 2013a)—two to three times the rate indicated by regional surveys for logging.

Descriptions of variables used in the regression analyses are presented in Table 5. While all the stepwise models (selection P value < 0.15) were highly significant (at either $P < 0.01$ or $P < 0.05$), R^2 values were modest, ranging from 0.04 to 0.21 (Table 6). For equipment operators and chainsaw operators, increased skill levels had models with higher R^2 and more included variables. With higher skill levels, the firm, worker, and employer characteristics may play a larger role in differentiating wage expectation. At lower skill levels, wages may be set mostly by the market, with little differentiation.

The results in Table 6 show that respondents with larger firms and more experience had higher expectations for wages. Respondents with aerial systems had higher expectations for wages for most job and skill combinations. For other variables that were positively related to wage, including sort number and expected experience (for the referenced job), the relationships were logical. Wage expectation was negatively related to respondent age in three supervisor models and one equipment operator model. Wage differences due to respondent age totaled about \$1.00 to \$2.00 per h across most of the ages observed. Reasons for the difference could not be determined by the analysis but

Table 5.—Dependent variable descriptions for regression analyses.

Label[a]	Explanation	Measure
Region	Region of respondent	Dummy variables for North and South
Experience, experience logging (ExpLog), experience job (ExpJob)	Respondent experience in industry, at current job (y)	Value for midpoint of category, >10 = 12
Age	Respondent age (y)	Continuous variable
Harvesting system (Aerial, FB, CS, CTL)	Identified systems	Dummy variable for each system
Employees (Emp#)	No. of employees per firm	Value for midpoint of category, >20 = 24
Equipment operators (EqOps#)	No. of equipment operators per firm	Value for midpoint of category, >10 = 15
Firm age	Age of firm	Value for midpoint of category, >10 = 15
Hiring history (Hexp, Htrain)	Indicated characteristics of last hire	Dummy variables for Experienced and Trained
Sort number (Sort#)	No. of typical product sorts	Ordinal variable from lowest to highest number of sorts
Employee experience (EmpExp)	Expected experience at job for acceptable performance level (mo)	Value of category midpoint, >48 = 60
Productivity, safety, job quality	Work performance level for experienced hire measured by index	Continuous variable (0–100)

[a] FB = feller buncher–grapple skidder; CS = chainsaw-skidder; CTL = cut-to-length.

Table 6.—Results of stepwise regression ($P < 0.15$) of independent variables against wage at given performance levels of productivity/safety as low (L), medium (M), and high (H).[a]

Job	Productivity/safety	n	R^2	Model P value	Model
Equipment operator	L/L	144	0.13	0.0001	9.97^a+3.46(Aerial^a)+0.08(Emp#^{b})
	L/M	144	0.13	0.0001	10.35^a+2.86(Aerial^a)+0.09(Emp#^{b})
	M/H	144	0.12	0.0014	9.52^a+0.75(Sort#^{b})+0.21(ExpLog^b)+0.08(Emp#^{c})+2.17(Aerial^c)
	H/H	144	0.16	0.0002	13.46^a+0.81(Sort#^{c})+0.04(ExpLog^a)+3.82(Aerial^b)+0.47(EmpExp^c)–0.06(Age^c)
Chainsaw operator	L/L	101	0.04	0.0358	11.03^a+2.77(Aerial^b)
	L/M	101	0.10	0.0146	8.89^a+0.12(ExpLog^c)+0.11(Emp#^{b})−1.32(Htrain)
	M/H	101	0.18	0.0007	7.35^a+1.35(Sort#^{a})+0.28(ExpLog^b)+0.11(Emp#)−0.18(EqOps#^{b})
	H/H	101	0.21	0.0003	7.76^b+0.44(ExpLog^a)+4.34(Aerial)+2.07(North^c)+0.05(Safety) −0.20(EqOps#^{b})
Supervisor	L/L	92	0.21	0.0004	14.03^a+0.13(Emp^c)+6.78(Aerial^a) −0.07(Age^b) −2.26(Htrain^c)
	L/M	92	0.18	0.0016	16.59^a+0.13(EqOps^c)+6.84(Aerial^b) −0.08(Age^b) −2.42(Htrain^c)
	M/H	92	0.12	0.0106	17.63^a+0.26(ExpLog)+6.05(Aerial^b) −0.11(Age^a)
	H/H	92	0.13	0.0134	17.65^a+0.06(EmpExp^b)+0.015(EqOps#^{c})+5.23(Aerial) −2.69(Htrain)

[a] $P < 0.01$.
[b] $P < 0.05$.
[c] $P < 0.10$.

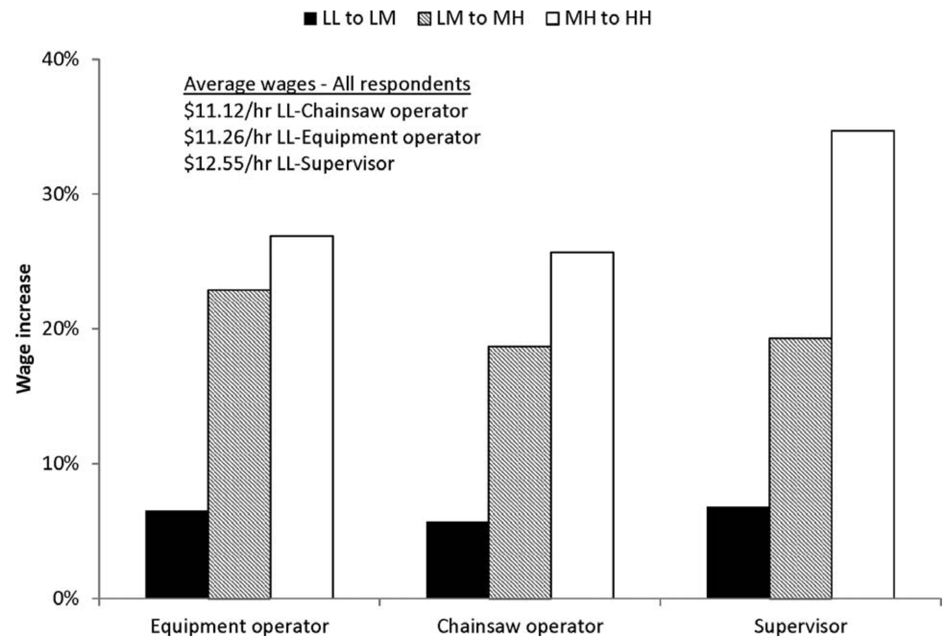

Figure 3.—Average relative wage increases of performance steps for equipment operator, chainsaw operator, and supervisor. Letters indicate performance levels for productivity and safety, respectively (L = low, M = medium, H = high). Average wage for each position for L/L is presented.

could include lower value placed in supervisory functions, lack of recent experience in hiring a supervisor, or closer connection to supervisor tasks by younger respondents. Finally, if the firm had hired trained employees, the wage expectations for supervisors were reduced by about $2.50/h. Again, further analysis led to no specific attribution, but a possible explanation could be that higher skill levels among workers result in lowered expectation of supervisor value.

Because performance steps in wage were relative, wage bias may have less effect on relative wage increases. To determine if wage steps (L/L to L/M, L/M to M/H, and M/H to H/H) differed by region, we applied a general linear model with wage for each job and wage step combination as the dependent variable and used the independent variables in Table 5. None of the models were significant at a P value of 0.10 and are not presented. Figure 3 shows that wage increases were relatively low for the first step in skill level (L/L to L/M) and increased similarly for all jobs for the second step (L/M to H/M). For the third step (M/H to H/H), there was little change for equipment and chainsaw operators, but the wage increase continued to expand for supervisors.

Wage increases for the performance steps seemed logical in the context of employer revenue and expected experience. For operators, the first performance step would result in little revenue change for the employer while reducing some injury risk and cost. Given learning curves for logging workers (Parker et al. 1996, Purfurst 2010), the first step will likely occur a few months after initial hire. Inexperienced workers (L/L and L/M) may be paid more than their contribution to the firm justifies, and the firm performance suffers. Smaller firms would suffer more because each worker has greater production responsibility. That result was indicated by the positive relationship between wage and firm size in the regression analyses (Table 6).

The second step generally results in operators who are at the expected level of performance for experienced hires. From survey data, the second step should be completed by 6 to 24 months after hiring. Individual variability and the complexity of the machine or task could easily justify the wide range. If the wage steps are analogous to the learning curves, the second step is a doubling of productivity (from 30% to between 60% and a maximum of 70%), with a wage increase of nearly 20 percent. The learning curves would indicate that this performance level is reached sooner than our survey respondents expect. The third step, a performance increase from between 60 and 70 percent to between 80 and 90 percent, is similar to the wage increase (25%) for chainsaw and equipment operators. Some workers may not achieve the last step due to motivation, skill level, or departure from the firm. Supervisor performance may be more critical to firm success, and the larger wage increase can be justified by firm income. In addition, supervisors may have more opportunities to change occupations, join other firms, or start their own firm.

Conclusions

Respondents were similar in age and had slightly higher educational attainment than previous regional surveys with higher response rates. Attributes of firm size and harvesting system indicate that the respondents may be representative of logging firms from the North and South. There were too few responses from the West to draw an inference. Because both the North and South samples were dominated by responses from the logging shows, they are most representative of those areas (South: North Carolina, South Carolina, and Virginia; North: Wisconsin and Michigan). Logging system varied by region, as expected. Excluding aerial systems, those variations had relatively modest effects on wage or expected experience. The West region was confounded with aerial systems for the reason that no aerial systems were reported in other regions. Similarities in wage between the North and the South indicate similar conditions for equipment operator and supervisor employment. Additional demand due to harvesting system diversity may be revealed by increased wages for high-performing chainsaw operators among respondents from the North.

Our survey provides what we believe to be the first information about relative skill level and wages among key employees. Wage level increases seem to be relative to productivity increases. This is a logical result because at least a portion of the wages are production based. We interpret wage levels at low productivity to be higher than would be indicated by productivity or piece rate equivalents. Those wages are supported at that level because jobs may not be attractive at the equivalent piece rates for the skill level and/or workers attempting to achieve those piece rates would assume an undesirable level of risk. Because wages exceed the equivalent piece rate, expansion in capacity by the addition of low-skill workers would negatively impact firm profit in the short term by producing higher labor cost per unit. Larger firms may be in a better position to deal with the disparity between wage and productivity of new workers because they may have multiple workers, including the low-productivity workers, in similar functions.

The survey results introduce and reinforce the importance of several questions regarding logging work. Could investment in selection and training of workers improve production capacity of current firms? Is there a career path in logging through increasing wage and responsibility? Are wages at specific skill levels competitive with other employment having similar requirements? How do non-wage employment costs and benefits impact wage rates and the desirability of logging work? The logging industry and the other sectors that rely on logging would all benefit from a more thorough understanding of logging work and workers.

Acknowledgment

This work was supported in part by USDA–National Institute of Food and Agriculture through the Integrated Biomass Supply Systems project.

Literature Cited

Abt, K. L. 2013. Employment and income trends and projections for forest-based sectors in the US South. *In:* Southern Forest Futures Project: Technical Report. General Technical Report SO-178. USDA Forest Service, Southern Region, Asheville, North Carolina. pp. 293–308.

Allen, T. T., H. S. Han, and S. R. Shook. 2008. A structural assessment of the contract logging sector in the Inland Northwest. *Forest Prod. J.* 58(5):27–33.

Allred, S. B. 2009. Logging firm succession and retention. *Forest Prod. J.* 59(6):31–36.

Baker, S. A. and W. D. Greene. 2008. Changes in Georgia's logging workforce, 1987–2007. *South. J. Appl. Forestry* 32(2):60–68.

Bolding, M. C., S. M. Barrett, J. F. Munsell, and M. C. Groover. 2010. Characteristics of Virginia's logging businesses in a changing timber market. *Forest Prod. J.* 60(1):86–93.

Bureau of Labor Statistics (BLS). 2013a. Employee benefits in the United States—March 2013. 19 pp. (News release.)

Bureau of Labor Statistics (BLS). 2013b. Occupation employment statistics. http://www.bls.gov/oes/home.htm. Accessed February 25, 2014.

Bureau of Labor Statistics (BLS). 2014. National employment matrix. http://data.bls.gov/projections/nationalMatrix?queryParams=113300&ioType=i. Accessed February 6, 2014.

Cubbage, F. and D. Carter. 1994. Productivity and cost changes in southern pulpwood harvesting, 1979 to 1987. *South. J. Appl. Forestry* 18(2):83–90.

Dillman, D. A. 2011. Mail and Internet Surveys: The Tailored Design Method—2007 Update with New Internet, Visual, and Mixed-Mode Guide. John Wiley & Sons, New York. 544 pp.

Egan, A. 2011. Characteristics of and challenges faced by logging business owners in southern New England. *North. J. Appl. Forestry* 28(4):180–185.

Egan, A. and D. Taggart. 2004. Who will log? Occupational choice and prestige in New England's north woods. *J. Forestry* 102(1):20–25.

Egan, A. and D. Taggart. 2009. Public perceptions of the logging profession in Maine and implications for logger recruitment. *North. J. Appl. Forestry* 26(3):93–98.

Goldstein, J. P., L. C. Irland, J. A. Senick, and E. W. Bassett. 2005. The intergenerational supply of loggers under conditions of declining economic well-being. *Ind. Relat. A J. Econ. Soc.* 44(2):331–340.

Granskog, J. E. and S. Guttenberg. 1973. Employment trends in southern forest industries. *Forest Prod. J.* 23(6):16–18.

Irland, L. C. 1975. Labor trends in US forest industry: A statistical survey. School of Forestry and Environmental Studies, Yale University. Bulletin 86:192–210.

Leon, B. H. and J. G. Benjamin. 2012. A survey of business attributes, harvest capacity and equipment infrastructure of logging businesses in the northern forest. School of Forest Resources, University of Maine, Orono. 29 pp.

Mason, C. L. and B. R. Lippke. 2007. Jobs, revenues, and taxes from timber harvest: An examination of the forest industry contribution to the Washington State economy. Working Paper. College of Forest Resources, University of Washington, Seattle. 58 pp.

Milauskas, S. J. and J. Wang. 2006. West Virginia logger characteristics. *Forest Prod. J.* 56(2):19–24.

Moldenhauer, M. C. and M. C. Bolding. 2009. Parcelization of South Carolina's private forestland: Loggers' reactions to a growing threat. *Forest Prod. J.* 59(6):37–43.

Munn, I. A., J. B. Cutshall, and D. G. Hodges. 1998. 1993 pulpwood logging contractor survey. *Forest Prod. J.* 48(7/8):47–53.

Oregon Department of Consumer and Business Services (DCBS). 2011. Oregon workers' compensation premium rate ranking: Calendar year 2010. DCBS, Salem. 36 pp.

Parker, R., P. Kirk, and M. Sullman. 1996. Learning curves of mechanized harvester and forwarder operators. New Zealand Logging Industry Research Organization, Rotorua. Report 21(29). 6 pp.

Parry, I. W. H. 1999. Productivity trends in the natural resource industries: A cross-cutting analysis. *In:* Productivity in Natural Resource Industries: Improvement through Innovation. Resources for the Future, Washington, D.C. pp. 175–204.

Purfurst, F. T. 2010. Learning curves of forest operators. *Croat. J. Forest Eng.* 31(2):89–97.

Reisinger, T. W., R. G. Sluss, and R. M. Shaffer. 1994. Managerial and operational characteristics of '''safety successful'' logging contractors. *Forest Prod. J.* 44(4):72–78.

Rickenbach, M. and T. W. Steele. 2005. Comparing mechanized and non-mechanized logging firms in Wisconsin: Implications for a dynamic ownership and policy environment. *Forest Prod. J.* 55(11):21–26.

Schuh, D. D. and L. D. Kellogg. 1988. Timber-harvesting mechanization in the western United States: An industry survey. *West. J. Appl. Forestry* 3(2):33–36.

Stuart, W. B., L. A. Grace, and R. K. Grala. 2010. Returns to scale in the eastern United States logging industry. *Forest Policy Econ.* 12(6):451–456.

US Census Bureau. 2014. Statistics of US businesses. http://www.census.gov/econ/susb/. Accessed February 6, 2014.

Ward, N. 2013. Attracting workers to logging employment: Survey report. Forest Resources Association, Washington, D.C. 8 pp.