# NEW EVIDENCE ON THE RETURNS TO JOB SKILLS

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**SESSION TITLE** The Skill Content of Jobs and the Evolution of the Wage Structure

**SESSION CHAIR** Frank Levy (Massachusetts Institute of Technology)

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The typical Mincerian wage equation examines wages in relation to the education, potential experience and other personal characteristics of job incumbents. The included characteristics serve as proxies for the job holder's skill level, but do not indicate what specific skills are being rewarded. Several recent papers have analyzed wages in relation to measures of the skills required to perform particular jobs (see, for example, David Autor, Frank Levy and Richard Murnane 2003; Beth Ingram and George Neumann 2006; Maarten Goos and Alan Manning 2007). To the extent that the labor market does a good job of matching individuals to jobs for which they are well suited, these analyses shed new light on how workers' job skills are valued in the labor market.

Studies of the returns to job skills generally begin with data from the Current Population Survey (CPS) or another household survey that contains information on the detailed occupation in which people work and the wages they earn. Information on required job skills is attached to the survey records according to reported occupation. There is considerable evidence, however, of significant errors in the coding of occupation in household survey data. Wesley Mellow and Hal Sider (1983) find disagreements between the occupation recorded in CPS data compared to that based on information supplied by individuals' employers for 19 percent of jobs at the major occupation level and 42 percent at the detailed occupation level. Nancy Mathiowetz (1992) reports similar findings for the employees of a large manufacturing firm. Table 1 displays data

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for 2003-2004 on the distribution of jobs by broad occupation in the CPS and similar information from the Occupational Employment Statistics (OES) survey, a large employer survey.[1]

**Table 1: Number and Share of Jobs by Occupation, CPS and OES (2003-2004 Averages)**

| | CPS | | OES | | |
|---|---|---|---|---|---|
| Occupation | Employment | Percent | Employment | Percent | CPS - OES Employment |
| Management | 11,047,302 | 10.0 | 6,470,976 | 5.9 | 4,576,326 |
| Business & Financial Ops | 4,373,443 | 4.0 | 4,437,796 | 4.0 | -64,353 |
| Engineering | 3,009,643 | 2.7 | 2,947,418 | 2.7 | 62,225 |
| Life, Phy, & Soc Science | 885,902 | 0.8 | 795,205 | 0.7 | 90,698 |
| Computer & Mathematical | 1,914,938 | 1.7 | 1,924,134 | 1.7 | -9,196 |
| Healthcare Practitioners | 5,874,971 | 5.3 | 5,474,081 | 5.0 | 400,891 |
| Other Prof & Technical | 7,188,146 | 6.5 | 6,087,255 | 5.5 | 1,100,891 |
| Sales and Related | 14,981,874 | 13.6 | 13,487,712 | 12.2 | 1,494,162 |
| Office & Admin Support | 16,191,229 | 14.7 | 19,042,123 | 17.3 | -2,850,895 |
| Protective Service | 941,474 | 0.9 | 1,055,695 | 1.0 | -114,221 |
| Food Prep & Serving | 6,663,697 | 6.0 | 9,362,297 | 8.5 | -2,698,600 |
| Bldg & Grounds Cleaning | 2,653,444 | 2.4 | 2,715,581 | 2.5 | -62,137 |
| All Other Services | 7,225,054 | 6.6 | 7,509,735 | 6.8 | -284,681 |
| Production Supervisors | 1,957,998 | 1.8 | 1,784,462 | 1.6 | 173,536 |
| Installation & Maintenance | 4,020,842 | 3.6 | 4,406,756 | 4.0 | -385,915 |
| Construction & Extraction | 5,807,282 | 5.3 | 5,133,985 | 4.7 | 673,297 |
| Production | 8,123,199 | 7.4 | 8,756,966 | 8.0 | -633,767 |
| Transportation & Moving | 4,706,703 | 4.3 | 4,555,242 | 4.1 | 151,462 |
| Production Helpers | 2,619,859 | 2.4 | 4,162,137 | 3.8 | -1,542,278 |
| Total | 110,187,008 | 100.0 | 110,109,561 | 100.0 | 77,447 |

Compared to the CPS data, there are fewer professional, sales and, especially, management jobs in the OES data, but more office/administrative, food preparation and production helper jobs. To the extent that occupation is systematically mis-measured in household survey data, estimates of the returns to job skills based on these data also may be distorted. In particular, if lower-skilled jobs are systematically misclassified in occupations that require the performance of highly-compensated skills, estimates of the returns to those skills are likely to be biased downwards.

[1] See Katharine Abraham and James Spletzer (2008) for a more detailed discussion of the CPS and OES data on occupational employment. Changes in OES coding practices beginning in 1999 reduced the number of management jobs. The data reported in Table 1 have been adjusted to reverse the effects of this change.

## I. Data on Occupational Employment, Job Skills and Wages

In this paper, we compare estimates of the returns to job skills based on CPS data for 2003 and 2004 to estimates for the same two years based on OES data. Both surveys provide data on employment and wages for nonagricultural wage and salary workers. For present purposes, we restrict our attention to private sector wage and salary jobs.

The CPS data we use are collected from the one-quarter of the CPS sample each month that is in its 4th or 8th month in sample. Employed respondents are asked to report the occupation of their main job and of any second job; information on wages is collected only for the main job. Following Thomas Lemieux (2006), we focus on the hourly wage, which is reported directly for persons paid by the hour and defined as usual earnings divided by usual hours for those paid on some other basis.[2] In contrast to some previous studies, we retain observations for which the wage is imputed in order to preserve insofar as possible the observed distribution of employment across occupations. Top-coded earnings are multiplied by a factor of 1.4 before proceeding with the analysis. We do not trim wage outliers, but our findings are not sensitive to the exclusion of observations with wages below $1.00 per hour and above $100.00 per hour. Wages are missing for approximately 8.6 percent of CPS jobs, including the 3.9 percent that are second jobs and the 4.4 percent that are classified as self-employed incorporated jobs.

In the 2003 and 2004 OES surveys, employers were asked to report the number of people employed, as of either May or November, by detailed occupation in each of the 12 wage intervals shown in Table 2 below. The present analysis makes use of data for November 2003 and November 2004. The underlying unit of observation in the OES data is jobs at an establishment in a particular occupation paying a wage in a specified wage interval. All of the

[2] Missing hours were imputed using an algorithm developed by Lemieux based on advice from Anne Polivka of the Bureau of Labor Statistics. We thank Lemieux for sharing the SAS code to implement the algorithm with us.

estimates reported here are weighted as described in Abraham and Spletzer (2008) so that the data represent private sector jobs as of the reference dates. Changes in the coding of management occupations were introduced into the OES beginning in 1999. Both because these coding changes are a problem for the historical analysis planned in the next phase of our research and because we believe that the coding changes caused many people who should in fact have been categorized as managers to be coded as something else, we have reclassified about 1.5 million jobs each year as management jobs (see Abraham and Spletzer 2008). We have no way to determine the specific type of management position held by those we reallocate into the management category; when job characteristics are assigned to these jobs, they are set at the management occupation average. Mean wages based on data from the National Compensation Survey (NCS) are assigned to each wage interval and used in the calculation of average wages. Approximately 20 percent of sampled establishments do not respond to any given OES survey panel; data are imputed for these establishments (see Bureau of Labor Statistics 2008 for further details).

The Standard Occupational Classification (SOC) system is used to classify occupations in both the CPS and the OES. Data are available for 486 distinct CPS occupations and 821 distinct OES occupations. Information on the skills required for each of 733 6-digit SOC occupations is taken from Version 13.0 of the Occupational Information Network (O*NET), released in June 2008 (Employment and Training Administration 2008). The first version of O*NET was introduced in 1998 and the database is being filled in over time with information on occupational and worker requirements, largely collected from people working in those occupations. For most occupations, the O*NET worker sample is constructed by first sampling businesses and then sampling workers in the occupation at those businesses. We use O*NET information on the

importance of various generalized activities by occupation. Job incumbents are asked to rate the importance of each of 41 activities to their job performance on a scale from 1 (not important) to 5 (extremely important). Average importance scores on this 1 to 5 scale (X) are converted to scores on a zero to 100 scale (Y = 25*(X-1)) prior to analysis.

Among the 41 generalized activities, there are clusters of related activities that are highly correlated across occupations. For this analysis, we form three job activity measures that, based on an exploratory analysis of the data, seem to represent distinct activity dimensions. The first, intended to capture the importance of analytical skills, averages the responses to two questions about the importance of "making decisions and solving problems" and "updating and using relevant knowledge" on the job; the second, intended to capture the importance of interpersonal skills, averages the responses to two questions about the importance of "establishing and maintaining relationships" and "resolving conflicts and negotiating with others"; and the third, a physical activities variable, is based on the responses to a question about the importance of "handling and moving objects." [3]

Many of the CPS occupations are a direct match for the occupations included in O*NET Version 13.0. In other cases, the O*NET data are more detailed than the CPS data and the activity variable scores for the more detailed O*NET occupations can be aggregated up to the broader CPS occupation using OES employment weights. In a few cases, we could find no match for the CPS occupation in the O*NET data. About 2 percent of CPS employment was excluded from our regressions of wages on job skills for this reason. Our final data set includes data for 467 CPS occupations. For comparability, the OES data were aggregated up to the same

[3] We experimented with other ways of creating the analytical, interpersonal and physical activity variables and obtained qualitatively similar results concerning the relationship between wages and job skills. In future work, we plan to carry out a more formal factor analysis to identify distinct activity dimensions.

467 occupations. About 5 percent of OES employment was in occupations that we could not match to the O*NET data and was excluded from our wage regressions.

## II. Occupational Wages in the CPS and the OES

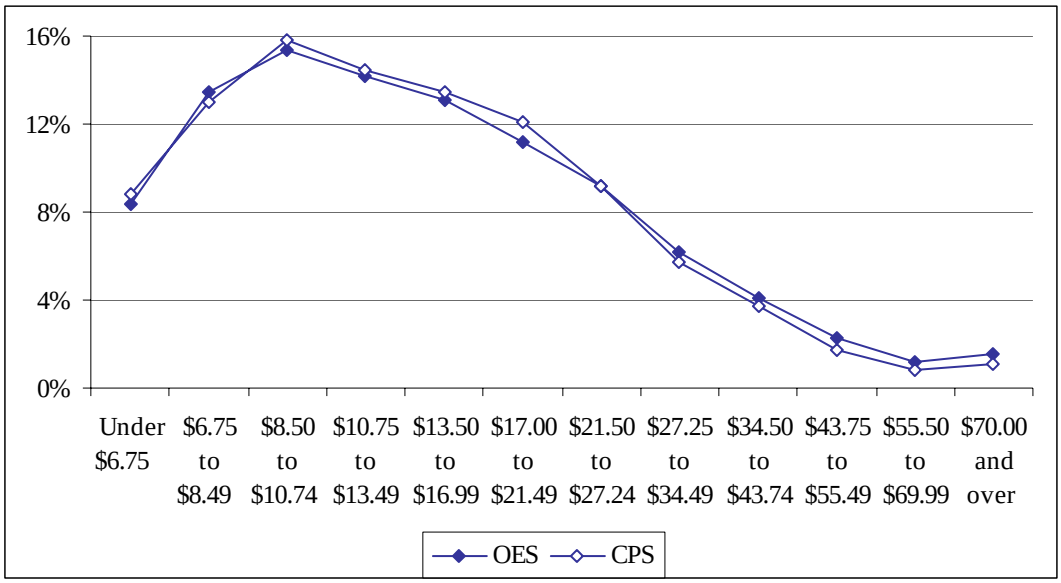
We begin by looking at the distribution of hourly wages in the CPS and the OES. As can be seen in Table 2 and also in Figure 1, based on the CPS jobs for which we have wage information, the overall distribution of wages in the two surveys across wage intervals is fairly similar. The shares of jobs in the higher wage intervals are slightly higher in the OES data, but the differences in the two distributions are not visually striking.

**Table 2: Number and Share of Jobs by Wage Interval, CPS and OES (2003-2004 Averages)**

| | CPS | | OES | |
|---|---|---|---|---|
| | Employment | Percent | Employment | Percent |
| Under $6.75 | 8,917,056 | 8.9 | 9,171,475 | 8.3 |
| $6.75 to $8.49 | 13,108,637 | 13.0 | 14,857,994 | 13.5 |
| $8.50 to $10.74 | 15,892,950 | 15.8 | 16,883,430 | 15.3 |
| $10.75 to $13.49 | 14,593,025 | 14.5 | 15,663,677 | 14.2 |
| $13.50 to $16.99 | 13,518,355 | 13.4 | 14,383,082 | 13.1 |
| $17.00 to $21.49 | 12,148,156 | 12.1 | 12,353,413 | 11.2 |
| $21.50 to $27.24 | 9,281,497 | 9.2 | 10,078,243 | 9.2 |
| $27.25 to $34.49 | 5,738,402 | 5.7 | 6,787,570 | 6.2 |
| $34.50 to $43.74 | 3,782,528 | 3.8 | 4,467,519 | 4.1 |
| $43.75 to $55.49 | 1,780,996 | 1.8 | 2,478,592 | 2.3 |
| $55.50 to $69.99 | 845,399 | 0.8 | 1,281,167 | 1.2 |
| $70.00 and over | 1,077,794 | 1.1 | 1,703,396 | 1.5 |
| Total | 100,684,791 | 100.0 | 110,109,555 | 100.0 |
| Missing Wages | 9,502,211 | | | |
| | 110,187,002 | | 110,109,555 | |

Somewhat surprisingly, given the apparent similarity of the two wage distributions, the overall mean OES wage, calculated based on the mean wage by wage interval, is nearly a dollar higher than the overall mean CPS wage calculated in the same fashion ($17.75 versus $16.82).

**Figure 1: Share of Jobs by Wage Interval, CPS and OES (2003-2004 Averages)**




A simple decomposition shows that more than 90 percent of this difference can be attributed to the larger share of OES jobs in the top three wage intervals.[4]

One possible explanation for the difference in mean hourly wages between the two surveys is that, for salaried workers, the CPS hourly wage is calculated as the ratio of earnings to hours worked and hours worked may exceed hours paid, producing a lower estimated hourly wage. We repeated our CPS calculations with all salaried workers treated as having worked a 40-hour week; this raised the estimated mean CPS wage from $16.82 to $17.40, closing much of the OES-CPS gap. Another contributing factor may be that CPS workers for whom we do not observe a wage are disproportionately highly paid.

[4] More than 120 percent of the difference can be attributed to the larger share of OES jobs in the top five wage intervals, with offsetting effects due to the larger share of CPS jobs in lower wage intervals. Using CPS employment shares and OES wage interval means yields an estimated mean wage of $16.90, very close to the original CPS mean. Similarly, using OES employment shares and CPS wage interval means yields an estimated overall mean wage of $17.68, very close to the original OES mean.

We look next at mean wages by occupation in the two surveys. These data are shown in Table 3 and Figure 2. For comparability between the two surveys, mean wages by occupation in the CPS are computed using "intervalized" data, though this has very little effect on the calculations. In lower-wage occupational groups, CPS and OES wages match fairly closely.

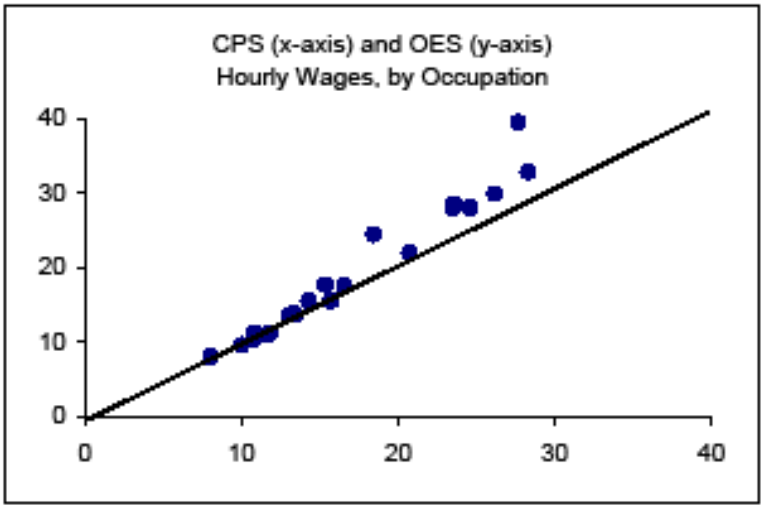
**Table 3: Mean and of Hourly Wage by Occupation, CPS and OES (2003-2004 Averages)**

| | CPS | OES |
|---|---|---|
| Management | 27.68 | 39.39 |
| Business & Financial Ops | 23.53 | 27.94 |
| Engineering | 28.30 | 32.81 |
| Life, Phy, & Soc Science | 24.59 | 27.97 |
| Computer & Mathematical | 26.18 | 29.85 |
| Healthcare Practitioners | 23.58 | 28.43 |
| Other Prof & Technical | 20.73 | 21.91 |
| Sales and Related | 15.73 | 15.47 |
| Office & Admin Support | 13.43 | 13.69 |
| Protective Service | 11.78 | 11.01 |
| Food Prep & Serving | 8.03 | 8.01 |
| Bldg & Grounds Cleaning | 10.00 | 9.56 |
| All Other Services | 10.86 | 11.21 |
| Production Supervisors | 18.47 | 24.39 |
| Installation & Maintenance | 16.56 | 17.46 |
| Construction & Extraction | 15.38 | 17.62 |
| Production | 13.11 | 13.62 |
| Transportation & Moving | 14.29 | 15.48 |
| Production Helpers | 10.82 | 10.35 |
| Total | 16.82 | 17.75 |

In higher-wage occupational groups, however, OES wages often exceed CPS wages, in some cases by a considerable amount. Part of this may be attributable to the use of hours worked in the CPS and hours paid in the OES. Mean CPS wages by occupation calculated with all salaried workers treated as working a 40-hour week tend to be closer to mean OES wages, but substantial gaps remain. For managers, the adjusted CPS mean wage with the 40-hour adjustment is $30.74 rather than $27.68 in the original calculations, still considerably below the OES mean wage of $39.39. A second factor may be that, in some occupations, the earnings of those for whom CPS

wages are missing have higher earnings than those with reported wages. Wages are missing in the CPS for 17 percent of managers, many of whom seem likely to be business owners. Another plausible explanation for mean wages in the OES in higher-paid occupations to exceed those in the CPS for the same occupations is that, in the CPS, there are a significant number of people assigned to higher-paid occupations who in fact work in lower-paid jobs, pulling down the estimated average wage for the higher-paid occupation.

**Figure 2: Mean Hourly Wage by Occupation, CPS versus OES (2003-2004 Averages)**




This last explanation would lead us to expect the within-occupation variation of wages in the CPS to be higher than in the OES, even after the CPS wages have been "intervalized" in the same way as OES wages. The within-occupation standard deviation of the ln(wage) averages 0.4470 across the 467 detailed occupations for which we have data in the CPS and 0.3791 across the same occupations in OES. Further, when the within-occupation standard deviation of the ln(wage) is regressed on the mean of the ln(wage) for the occupation, the coefficient on the mean

ln(wage) is considerably larger in the CPS data than in the OES data. While not definitive, this seems consistent with what one would expect if recorded occupations are less homogeneous in the CPS than in the OES and occupational status commonly is exaggerated in the CPS responses.

## III. Returns to Skill in the CPS and the OES

The major question we seek to answer is how the different job activities for which we have information – analytical activities, interpersonal activities and physical activities – are related to earnings. To answer this question, we fit ln(wage) models in which these job activity measures serve as independent variables. All models shown in Table 4 also include a year dummy.

**Table 4: Relationship of Earnings to Job Activities, CPS and OES (2003-2004)**

| | CPS Mean (std.dev) | OES Mean (std.dev) | CPS β (se) | CPS β (se) | OES β (se) |
|---|---|---|---|---|---|
| Analytic | 62.47 (13.77) | 60.23 (13.70) | .0218 (.0001) | .0212 (.0001) | .0269 (.0000) |
| Interpersonal | 58.07 (13.10) | 56.65 (12.38) | -.0046 (.0001) | -.0041 (.0001) | -.0023 (.0000) |
| Physical | 45.32 (21.32) | 46.92 (20.92) | -.0046 (.0001) | -.0045 (.0001) | -.0036 (.0000) |
| R-Squared | | | .2337 | .2654 | .3963 |
| Mean(Dep.Var) | | | 2.61 (0.65) Continuous | 2.62 (0.60) Interval | 2.64 (0.61) Interval |

For the first model estimated using the CPS data, the ln(wage) dependent variable uses the continuous wage constructed for individual observations; the second uses a wage that has been "intervalized" to correspond to the information available in the OES data. The results of

the two models are virtually identical. In both, jobs that require more analytical activity pay significantly higher wages, while jobs that require more interpersonal activity or more physical activity pay lower wages. The last column of the table reports the corresponding model estimated using the OES data. Although the general pattern of the estimated coefficients is broadly similar, the estimated coefficient on the analytical activities variable is considerably larger in the OES equation. For someone who is one standard deviation above the occupational average with respect to the importance of analytical activities rather than one standard deviation below (based on either the CPS or the OES data), the estimated OES coefficients imply an effect on earnings that is roughly 15 percentage points larger than the effect implied by the estimated CPS coefficients. The estimated returns to analytical skills in the CPS are slightly higher in models estimated with a wage variable calculated with salaried workers constrained to work 40 hours per week, but this does not explain the difference between the CPS and the OES results.

Our findings are consistent with biased reporting of occupation and resulting bias in measures of the job activities performed by CPS respondents. In particular, to the extent that there is a systematic tendency for CPS respondents to be assigned to occupations in which highly-rewarded analytical skills are more important than in the jobs they actually perform, it is not surprising that the estimated returns to analytical skills should be biased downwards.

## IV. Conclusion

This paper describes an exploratory analysis of estimated returns to job skills in data from the OES as compared to those from the CPS. Much of what is known about the determinants of earnings in the U.S. labor market is based on CPS data. There has been growing interest in the rewards to different job skills and other research has discussed the growing return to skills

similar to those captured by our analytical skills measure. We find that estimates of returns to analytical job skills based on CPS data in fact understate the extent to which those skills are rewarded in today's labor market.

In future work, we plan to carry out a more formal factor analysis to identify job skill dimensions and then to examine how the job skill dimensions identified through the factor analysis are rewarded in the labor market. We also plan to extend our cross-sectional analysis to look at the returns to job skills over time as measured using OES versus CPS data.

REFERENCES

**Abraham, Katharine G., and James R. Spletzer.** 2008. "Are the New Jobs Good Jobs?" Unpublished paper.

**Autor, David H., Frank Levy, and Richard J. Murnane.** 2003. "The Skill-Content of Recent Technological Change: An Empirical Investigation," *Quarterly Journal of Economics*, 118(4), 1279-1333.

**Bureau of Labor Statistics, U.S. Department of Labor.** 2008. "Occupational Employment and Wages, 2007," USDL 08-0620. http://www.bls.gov/oes/.

**Employment and Training Adminstration, U.S. Department of Labor.** 2008. "O*Net Data Collection Program, Office of Management and Budget Clearance Package and Data Collection Instruments." http://www.onetcenter.org/dataCollection.html.

**Goos, Maarten, and Alan Manning.** 2007. "Lousy and Lovely Jobs: The Rising Polarization of Work in Britain," *Review of Economics and Statistics*, 89(1), 118-133.

**Ingram, Beth F., and George R. Neumann.** 2006. "The Returns to Skill," *Labour Economics*, 13, 35-59.

**Lemieux, Thomas.** 2006. "Increasing Residual Wage Inequality: Composition Effects, Noisy Data, or Rising Demand for Skill?" *American Economic Review*, 96(3), 461-498.

**Mathiowetz, Nancy.** 1992. "Errors in Reports of Occupation," *Public Opinion Quarterly*, 56, 352-355.

**Mellow, Wesley, and Hal Sider.** 1983. "Accuracy of Response in Labor Market Surveys: Evidence and Implications," *Journal of Labor Economics*, 1(4), 331-344.