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Trends In Direct Measures Of Job Skill Requirements

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INTRODUCTION

It is commonly assumed that jobs in the United States require ever greater levels of skill and, more strongly, that this trend is accelerating as a result of the diffusion of information technology. This has led to concerns that there is a growing mismatch between the skills workers possess and the skills employers demand. Concern over whether young people have the skills needed for work in the new economy has motivated debates over education reform for the last fifteen years (Hunt and Staton 1996; Louis 1998) and generated specific policies, such as school-to-work programs. In a rather separate development, mainstream economists agree that technology-driven shifts in the demand for skilled workers is the leading explanation for the growth of earnings inequality in the 1980s-1990s (Autor, Katz, and Krueger 1998). However, others are more skeptical of the idea that the growth in inequality reflects a shortage of human capital rather than a shift in the balance of power between management and labor (Mishel, Bernstein, and Schmitt 1997) and a recent study finds no growth at all in workplace literacy requirements between 1986-1996 and 1996-2006, when using Labor Department occupational employment estimates for the latter calculation (Barton 2000, p.19).

However, the current debate over skill requirements, as well as the earlier debate between deskilling and post-industrial theories within sociology, suffer from a lack of direct measures of job skill requirements. In a previous working paper (Handel 2000) I examined trends in education and occupation as indicators of shifting job skill requirements but it is useful to supplement these measures because they have well-known limitations. Participants in the debates over deskilling within sociology have long complained that workers' educational attainment is not a direct measure of job content. They argue for direct measures of job skill requirements which are independent of the characteristics of the people who occupy jobs, since it is the changing nature of work rather than workers, that is of interest (Braverman 1974, pp.436ff.; Spenner 1983, p.827; Vallas 1990, p.380). Broad occupational categories (e.g., managers, clerical, craft) are a relatively coarse measure of skill and not even cleanly ordinal.

One way to avoid these problems is to use the Dictionary of Occupational Titles (DOT), which has ordinal ratings of job complexity from which mean scores at the three-digit Census occupation level

can be derived and merged onto representative survey samples (e.g., Spenner 1979). However, many question the quality of the DOT data and argue that no meaningful study of job skill demands will be possible until individual-level data is available, since all within-occupation variation is lost when using occupation-level means (Attewell 1990, p.429; Spenner 1980, p.247; for a summary of difficulties from proponents of using the DOT see Cain and Treiman 1981). Of course, this criticism assumes that individual-level data is currently not available.

In fact, many of these complaints are not quite true. There are individual-level measures of job skill requirements for several points in time for 1969-1985. They have been available throughout most or all of the skills debate in sociology and the more recent skills debate and have been simply overlooked for the most part. While not without problems and available only for selected years, they are an important addition to the various debates over trends in skill requirements and a useful validation tool for the DOT measures. Indeed, when compared to DOT scores, they confirm the reasonable quality of the DOT measures and suggest that criticisms of the DOT measures are exaggerated.

This paper uses these previously unexamined individual-level measures of job skill requirements to test for both the growth and acceleration of skill requirements over time and uses those measures to validate occupation-level measure from the DOT and to create a new set of occupation-level measures, both of which are used to examine a longer time-series of between-occupation skill shifts. The first section discusses the data and presents trends for the individual-level skill measures for the years they are available. This section also presents new measures of under- and over-education for these years. The second section validates occupation-level measures against the individual-level measures and presents a fuller time series of trends in skill requirements using occupation-level measures from both the DOT and measures created by converting the individual-level scores to occupation-level means. A final section summarizes the results.

The results show that job skill requirements have increased in the last several decades but provide little evidence of recent acceleration in mean job skill requirements and tend to show inequality in skill requirements has declined. These findings largely confirm the results of the previous working paper and are consistent with Spenner's (1979) thesis that job skill requirements rise at a consistent but modest rate over time.

Individual-Level Measures of Job Skill Requirements Data

The advantages of individual-level skill measures are clear. Job skill demands vary both within and between Census occupational groupings and only individual-level measures capture both components. Occupation-level means can be used for charting skill shifts that result from changes in the occupational composition of the workforce but necessarily wash out all within-occupation variation in the cross-section and over time if jobs are not subsequently re-rated, as is the case for the most part with the DOT.

The following uses individual-level measures of the formal level of education needed for the respondent's job and the time it would take the average person to learn the job. These variables will be referred to as education required and training time below and are analogous to the DOT variables known as General Educational Development (GED) and Specific Vocational Preparation (SVP), which are examined in the next section. The measures come from the Survey of Working Conditions (SWC) (1969), Quality of Employment Surveys (QES) (1972, 1977), and the Panel Study of Income Dynamics (PSID) (1976, 1985). In addition, household heads were re-asked the skill questions in 1978 and this information is used to estimate individual-level reliabilities in a separate validation exercise. Despite the difference in name, the SWC is part of the same data series as the two QES surveys and the three will be referred to collectively as the QES series.

Because of slightly different codes, the responses were recoded into consistent categories across the two data series. Since the QES series only covers employees working at least 20 hours per week,

the PSID samples were likewise restricted. The two PSID waves interviewed both household heads and spouses but no other household members so the QES samples were restricted to reflect this coverage. Unfortunately a variable indicating relationship to household head could not be located on the QES72 file, so all samples were restricted to workers over age 25. Analyses of the SWC and QES77 files indicate that roughly 95% of all workers in this age group are household heads or spouses and that basic statistics are not significantly and consistently affected by the further removal of the remaining 5% of respondents, so this restriction would seem to be a reasonable one for insuring comparability between the QES and PSID series. The SWC and QES77 samples were not further restricted to household heads and wives to insure maximal consistency within the QES series. There are some clear comparability problems across the QES-PSID divide which this adjustment would do little to improve, as will be evident below, so the non-comparability introduced within the QES series by this further sample restriction was not judged worth the cost. There are also differences in question wording and response choices across surveys within series as well as between them (see Appendix). Although issues of comparability make any examination of trends across the two series necessarily tentative, together these surveys provide data for representative samples for selected years between 1969-1985. This period covers the years when inequality growth was greatest (Handel 2000), though any effects of computer diffusion might be greater beyond this period.

With respect to data quality, while individual-level measures are generally seen as preferable to occupation means, some argue that worker self-reports are weaker than expert ratings. The relative agreement between self- and expert ratings will be investigated more fully in the section comparing QES and PSID responses to DOT ratings, but it should be said in defense of self-reports that most expert job evaluation techniques solicit workers' input on their job's skill requirements as part of the job evaluation, so much of the same information gathered in the worker surveys used here presumably finds its way into expert ratings in any case. Certainly few raters actually observe workers over 3-6 months to gauge training times, so this information must come from interviews of some kind. This is not to deny the advantages of ratings by experts, who use their knowledge and experience to weigh employee self-reports and solicit employer and supervisor input as well. And even occupation-level mean scores are not necessarily as limiting as critics argue since worker self-reports may well introduce error variance that is usefully averaged out at the occupation level, as well as additional true variation. In short, as between self- and expert ratings it is not clear where the advantage, if any, lies.

For present purposes it suffices to estimate some reliability measures as one measure of the quality of this kind of self-report data. The PSID provides a unique opportunity to estimate such reliabilities because it is a panel survey and repeated the same skill items to household heads in both 1976 and 1978 waves. Household heads were coded as job stayers if their reported tenure in current position in 1978 was greater than or equal to the time elapsed between administration of the two surveys and their reported three-digit occupation and industry were identical across the 1976 and 1978 interviews. The relative agreement between responses to the two job skill measures for this group can be used to estimate repeated-measures item reliabilities. For those whose responses job stayers, the cross-year correlation is about 0.83 (n=1,356) for the formal education item and 0.60 (n=1,446) for the training time measure. By contrast, the cross-year correlations for those who changed jobs and changed both three-digit occupation and industry were .51 (n=228) for the formal education item and .22 (n=257) for the training time measure. Clearly, answers to these questions show a reasonable level of consistency for those holding the same job across years, particularly for the formal education item, and are much less similar for those who changed jobs and entered a new line of work. Responses, then, are not simply error nor do they simply reflect individual characteristics (e.g. own education) unrelated to the job held.

However, the correlations do reveal some possible limitations of the measures which should be incorporated into future work on measuring job skill demands. While the remaining strength of the first correlation among job movers (i.e., 0.51) partly represents job changers' tendency to obtain new jobs similar to their old ones despite changing occupation and industry, it may also reflect some

tendency to respond to questions about job requirements in terms of own educational attainment, which would defeat the purpose of the item. There is a reasonably strong overall correlation between own education and reported job requirements (ca. 0.70–see Table 8) and it is unclear how much is due to good matches between people and jobs and how much is due to response bias. The relative weakness of training times correlation even among job stayers, on the other hand, reflects the absence of this kind of external reference point and the greater vagueness of the item.

Basic Analyses

Table 1 presents the basic time series for the educational requirements question. The first seven rows present trends in the percentage of workers reporting their job required a given level of education and the next two lines present trends in means and inequality of job demands, as measured by the coefficient of variation. The left panel presents raw figures and the right present annual change rates for different periods. There is a significant non-comparability issue for this item in both data series. The SWC (1969) and the PSID85 allowed respondents to say their jobs required high school plus vocational education, but none of the other surveys included this option. Since it is unclear how many of these respondents would have replied either "high school" or "some college" had this option not existed, all comparisons except those across 1972-1977 must aggregate figures for lines 3-5 to calculate consistent annual change rates in the right panel. For the 1969-1972 comparison, for instance, the average annual change in the percentage of jobs falling into these intermediate skill categories is [(43.7+14.4) - (25.6+12.6+9.0)]/3 = 3.6 percentage points. Although it is not necessary to perform such aggregation for 1972-1977, the corresponding calculation is presented in parentheses for comparison (i.e., 0.6). All means and coefficients of variation are calculated based on a 5-point ordinal scale which collapses the categories high school, high school + vocational education, and some college and gives this category a value of 3.

Despite the loss of variation for a large group of jobs, the table tells an interesting story. Fully one-quarter of respondents in 1969 report that their jobs require eight years of education or less. The figure is over one-third when those requiring grades 9-11 are added. These numbers drop substantially by 1972 and a bit more by 1977. Strangely, the level of the comparable PSID figures for 1976 are below that for QES72 rather than close to QES77, but the decline in the share reporting very low skill job demands falls by roughly the same amount. In fact, the eight-year QES series and the nine-year PSID series show almost exactly the same trend rates in the shift of jobs out of these two low skill categories, -1.9 and -1.5 percentage points per year respectively. For this reason comparisons of the two series below will mostly compare trend rates irrespective of level differences.

The story changes somewhat for the middle skill group. Between 1969-72 there was a rapid increase in jobs requiring high school-some college education, 3.6 percentage points, which then slowed to a roughly constant 0.6-0.7 percentage points for both 1972-77 and 1976-85. As with the previous comparison, the PSID76 suggests that the share of middle skill jobs in 1976 is more comparable to earlier years in the QES series, in this case the SWC69, than to the QES77.

Turning to the high skill groups, the PSID does indicate more rapid increase in the share of jobs requiring a college degree and a modest acceleration in the share of jobs requiring a postgraduate degree. Combining these two categories together suggests an annual percentage point growth of 0.2 for 1969-77 and 0.9 for 1976-85. For these groups the PSID76 suggests a *higher* level of skill demand than the QES77.

To obtain a summary measure of the trends, the categorical education required variable can be treated as numeric. The eighth line presents mean educational requirements when categories 3-5 are collapsed and recoded as 3 and the two higher skill groups are recoded as 4 and 5. Although the ordinal nature of the measure argues for caution in interpreting means, the growth rates are very similar for the two series, 0.03 (1969-77) and 0.04 (1976-85). Again, the level of the mean for

PSID76 is between that for SWC69 and QES72.

Since Braverman has made much of looking at polarization or inequality in job skill demands as well as levels, the final line presents trends in the coefficient of variation. Given the greater share of workers in both the lowest and highest skill categories in the PSID76 relative to the nearby QES years, it is not surprising that the level for this year is between that for the SWC69 and QES72. Nevertheless, the trend in both series is clearly toward less inequality of job requirements. This is consistent with trends Myles (1988) reports for Canada. The rate of decline is identical for 1969-1977 and 1976-1985.

In summary, there seems to have been somewhat faster decline of low skill jobs between 1969-1977 than 1976-1985, roughly similar rates of growth of middle skill jobs between 1972-1977 and 1976-1985, and faster growth of high skill jobs in 1976-1985 than previously, though even this growth at the top is about half the magnitude of the decline at the bottom. As will be shown in the next section, this may partly reflect the decline of blue collar jobs in the early 1980s rather than the rise of a high technology economy afterwards. On balance, the different trends translate into very modestly higher mean growth rates in the most recent period. Trends in the inequality of skill demands were identical between 1969-1977 and 1976-1985. Though the different levels between the figures from the PSID and the QES series suggests some caution in splicing the two series together, in general there is little in the growth rates that suggests extraordinarily rapid skill upgrading in the more recent period relative to earlier ones.

Since research using the DOT occupation means has made skill trends within occupations something akin to the quest for the Holy Grail, Tables 2 and 3 present raw trends by five major occupation group and annual change rates and the raw figures are graphed in Figures 1-5. The figures use only the collapsed 5-category coding of education requirements. In the figures the PSID series is set off from the QES series and more darkly shaded. Some figures show graphically how the PSID scores seem to have a negative intercept shift relative to the QES but similar growth rates. Since the periods 1969-77 and 1976-85 are nearly identical in length, the difference between the SWC69 and QES77 bars can be compared to the two PSID bars in the figures to examine relative growth rates visually.

Rather surprisingly, the QES series shows a significant increase in middle skill jobs and modest decline in upper skill jobs in the upper white collar group (managers, professionals, and technical workers) (Figure 1) and Table 2 indicates the mean is essentially flat for 1969-77. The PSID series shows consistent upgrading for this group, though Table 3 indicates the growth rate for the mean (0.019) is the lowest of all in the PSID series.

Similarly, the QES series indicates more of a trend toward middle skill jobs for lower white collar workers (sales, clerical) (Figure 2) and a general flatness in the mean (Table 2), while the PSID series indicates a greater trend toward higher skill jobs and a growing mean.

Trends for craft workers are in the direction of skill upgrading and very similar across the two data series (Figure 3). Both the absolute levels and growth rates for the means are virtually identical for 1969-77 and 1976-85 (Tables 15 and 16). Most of the upgrading in both series reflects the decline of low skill jobs and growth of middle skill jobs, rather than growth of jobs requiring a B.A.

Both series show skill upgrading among lower blue collar workers (operatives and laborers) (Figure 4). Even more than in the case of craft workers, the majority of this shift reflects declines in the share of the jobs in the very lowest skill category (grades 0-8). The PSID indicates somewhat faster growth in mean skill levels within this group (Table 3), though the reverse is true for service workers (Table 3, also Figure 3).

Finally, inequality in job skill requirements declined for all occupational groups in almost every period (Tables 2 and 3). There is no support for a thesis of skill polarization within occupational groups.

In sum, the increase in the overall skill levels and decline in inequality of skill requirements reflect skill upgrading and equalization within large occupational groups as well as any effects of compositional shifts toward a more skilled and skill-homogeneous occupational structure. There is no support for the notion of deskilling within occupational groups. Indeed, Table 3 indicates that the fastest rates of skill upgrading are found in craft, lower blue collar, and service occupations in both the QES and PSID series, mainly through the elimination of lower skill jobs rather than the expansion of high skill jobs. However, there is equally little compelling evidence of dramatic increases in skill demand recently that might explain the growth in wage inequality. Simple visual inspection of Figures 1-5 does not support the notion of a structural break between 1969-1977 and 1976-1985 in rates of skill upgrading within occupations.

It is possible that important shifts within the high school-some college category are masked by the need to combine these groups into one large aggregate in order to compare them across surveys, but this cannot be determined with the evidence available.

The second skill measure is training time or the time it takes the average person to learn the respondent's job. Unfortunately, this item is only available for 1977 in the QES series so Table 4 presents a comparison for QES77, PSID76, and PSID85 only. The virtue of including QES77 in the table in this case is as a check on the PSID76 data, which indicates much closer agreement than for the education required item. The training times variable, expressed in months, is highly right-skewed in all three years. The average training time is between 1.5 and 2 years, while the median is between one-half and two-thirds of a year. The raw trends between 1976 and 1985 for mean and median are flat and there is little change in the coefficient of variation either. The second panel gives a fuller percentage breakdown into different categories of training time required and does little to alter this picture. Some of the apparent differences between the QES77 and PSID76 distributions in this panel reflect the heaping of values around cutpoints between categories in the QES. This part of the table suggests that about a quarter of all jobs in all years can be learned in less than a month.

Of course some jobs may be easy to learn because much of the learning is done in school. However, the correlation between a job's education required and training time is over 0.4 in the PSID76 (see Table 8). The next part of Table 4 shows median training times by level of required education and confirms the dramatic differences. In most cases, jobs that require more formal education have longer median training periods as well. However, within education levels there is little change in job training times between 1976 and 1985, even for jobs requiring more formal education.

The situation is the same for trends in median training times within broad occupation groups. The occupational rankings make intuitive sense–lower blue collar and service workers require two months to learn their job and craft workers have a two-year apprenticeship, for instance. However, there is no difference of any kind between the two PSID years.

If there is any series that would seem to confirm Spenner's (1979) thesis of little or no changes in skill requirements, it is this training times variable. The PSID data seems to indicate no skill upgrading or deskilling either overall or within occupations. Likewise, there is no trend toward greater inequality in training times. Notably, there is no increase in training times even for upper and lower white collar jobs which experienced a surge of computer use during this time even though few could have learned to use them in school this early in the diffusion process. If the appearance of computers in the workplace in large numbers dramatically increased job training requirements, there is little evidence of it here.

Trends in Under- and Over-Education

While the preceding looked at trends in educational requirements, debates over the growth of a mismatch between workers' education and job educational requirements would argue for an explicit

comparison between the two. If the skills mismatch explanation of inequality growth is correct one might expect to see some increase in the number of workers with less education than their jobs require and corresponding decline in workers with more education than their job require, reversing the growth of over-educated workers in the 1970s. This section examines trends in under- and over-education using the QES and PSID data.

Table 5 presents trends in under- and over-education. Workers own education was grouped into categories corresponding to the education required item. If the worker's own attainment was less than they said their job required they were classified as under-educated, if the two were equal the worker was judged to be matched to his job, and if the worker's attainment was greater than their job required they were classified as over-educated. In the left panel of the table, the troublesome category of required education, "high school + vocational education" is treated as intermediate with respect to high school and some college. Since the SWC69 contains no information on workers' own vocational education, all workers in 1969 and 1985 holding jobs requiring "HS + voc." are classified as either undereducated, if they have a high school education, or overeducated, if they have some college schooling. This naturally decreases the estimated match rate, but allows for finer discrimination of match rates among the much larger high school and some college educated groups. The right panel combines the three middle categories for required education as in the previous section, which means that anyone with either a high school or some college education is counted as matched if they hold a job requiring high school, HS + voc., or some college. Figures from the left panel for lower and higher skill levels are not carried over into the right panel since they are not affected by this coding change. In general, where there are figures in the right panel they are to be preferred.

The top part of Table 5 presents results for all workers. Though differences in levels between the series argues for caution in splicing the results together, the QES series in the right panel indicates the percentage of under-educated workers grew by 2.4 percentage points (1969-72) then fell 1.2 percentage points (1972-77) and the PSID series indicates the percentage then grew by 2.3 percentage points (1976-85). The PSID growth rate in under-education is in the direction expected by the skills shortage thesis but does not seem especially high by the standards of the first period about a decade earlier, when inequality was not growing.

The over-education rate declined by 2.5 percentage points (1969-72), then grew by 6.1 percentage points (1972-77) in the QES series, confirming the impression of a growth in over-education during this period. By contrast, the PSID shows a decline of 6.2 percentage points (1976-85). Again, the direction of the trend supports the skill shortage explanation of inequality growth, but the magnitude suggests more a return to the status quo ante than a dramatic break with the past.

The remaining parts of the table present trends in under- and over-education by level of respondents' own education. One might think that workers with a primary education would be even more disadvantaged in the most recent period given the ostensible rapid growth in skill requirements. In fact, the growth in under-education within this group is almost identical between 1969-77 and 1976-85, though the small samples in the QES series argue for some caution in how strongly to take these results.

The figures for those with some high school education suggest a very rapid acceleration in the rate of under-education and deceleration in the rate of over-education, suggestive of an accelerated demand shift against such workers. However, the PSID series differs significantly from the QES in the number of respondents who report their jobs require some high school (see Table 1), resulting in much lower match rates between PSID76 and QES77. It is not clear why this is the case but it is possible that whatever underlying process generated this difference in levels may also have produced different trend rates, as well.

Among high school graduates, the right panel indicates almost identical increases in the percentage who are under-educated, that is holding jobs which they say require a B.A. or more, between 1969-77

and 1976-85. By contrast, the left panel, which treats all high school grads as under-educated in 1969 and 1985 if they hold jobs requiring HS+voc., indicates a 15.6 percentage point decline in under-education between 1969-77 and a virtually identical 15 percentage point increase for 1976-85. Even if one were to take these figures at face value, which would be unwise since they are in part an artifact of coding shifts within each series, the two trends are almost perfectly offsetting.

Trends in the over-education rate for high school grads are unaffected by the coding change, since over-education for this group refers to high school grads holding jobs requiring less than a high school degree in both panels. This means that there can be no question of the excessive aggregation of the high school, HS + voc., and some college categories masking different rates of change in the over-education rate across the two data series. In fact, the table indicates virtually identical declines in the over-education rate for this group for 1969-77 and 1976-85. Further, as the second to last column indicates, high school grads are by far the largest single group in all years, which means the similarity in these rates has great weight. If computers or other technology were upgrading the educational requirements of traditionally low skill job more rapidly in the latter period one would expect the over-education rate among high school grads to fall more rapidly in this period. However, this is not the case.

Among workers with some college education, the share of under-educated workers declined by 3.5 percentage points according to the QES (1969-77) and then increased by 2.7 percentage points according to the PSID (1976-85). In this case it is the under-education category that is unaffected by the coding differences between left and right panels, since workers with some college who are under-educated hold jobs they say require a B.A. or above under both coding schemes. However, even though the direction of the more recent trend is consistent with the skill shortage perspective, the magnitude is not because it largely suggests just a return to the previous state of affairs.

The over-education rate among workers with some college grew by 8.9 percentage points over an eight-year period (1969-77) and then declined by a rather larger amount, 15.4 percentage points, over a nine-year period (1976-85). This is the one series consistent with dominant views of both the skill-glutted 1970s and skill-short 1980s.

Among workers with four years of college, the rate of under-education rose modestly between 1969-77 and declined by a similar amount in 1976-85, so there does not appear to be a dramatic fall in rates of under-education even as middle skill jobs were upgraded to high skill positions according to Table 1. Even more significant, there was a nearly 20 percentage point rise in the rate of over-education between 1969-77, when Freeman (1976) and others wrote on the subject, but only an 8 percentage point decline between 1976-85. Again, the changes are in the expected directions but the magnitudes do not suggest that rates of over-education among those with a college education have declined dramatically by the standards of the recent past, contrary to the expectations of those arguing college-level skills are in short supply.

Similarly, the bottom part of Table 5 shows that over-education rates for those with a post-graduate education increased by 13 percentage points between 1969-77 and declined by 4.3 percentage points between 1976-85. Again, it does not appear that the number of jobs for those with advanced education attainment relative to the number of qualified workers has rebounded much by historical standards.

Of course, there are a number of possible objections to these measures of the quality of job-worker matches. In addition to the difficulties of comparing trends across data sets and the problem of measurement error, some workers who appear over-educated by the measure used above may be at the lower end of the distribution within their education group with respect to cognitive skills, interpersonal skills, or motivation and work habits and some who appear under-educated may be at the upper end of the distributions within their education group or may have acquired the necessary skills through work experience. In this case, people who appear mismatched may not be, though it is

not clear how this might affect trends, which is the main object of interest here, as opposed to levels. In addition, some who appear over-educated may be in line for a promotion or likely to move to more skilled jobs, but one would expect a skill short economy to reduce the incidence of this kind of temporary mismatch. Likewise, some who appear under-educated may soon face demotion or dismissal resulting in downward mobility to a less skilled job, but if the mismatch thesis is correct it is just this kind of misfit one would expect would become more prevalent even if membership in this group was constantly turning over. Some have questioned the concept of under-education altogether, asking how such workers could hold their jobs if they had not acquired the requisite competencies somewhere (Halaby 1994), but surveys indicate that employers rate about 20-25% of their employees as not proficient which suggests that under-education may be genuine (National Center on the Educational Quality of the Workforce 1994; Teixeira 1998).

One way to test the adequacy of these measures of under- and over-education is to examine their association with items that would appear on their face to be more direct indicators of skills mismatch. Table 6 presents correlations of under- and over-education with questions from the QES72, QES77, and PSID76 which asked workers whether they had skills they could not use on their present job and would like to use (Items 3, 6, and 7) and whether their job lets them use their skills and develop their abilities (Items 4 and 5). All of the correlations are properly signed, but almost none are even moderately large. Even Items 4 and 5, which seem quite similar are only moderately correlated (0.51). Presumably the low correlations between the under- and over-education variables and the more direct queries on skill utilization at work reflect either unreliability of the former or the latter measures. Given the low correlations amongst the direct queries themselves (Items 3-5), it seems likely that the problem lies mostly with them.

Finally, given that workers are mobile between jobs it is useful to consider whether trends in aggregate skill requirements and aggregate skill stocks give a different picture than trends in personal under- and over-education. In other words, if individuals could be allocated to jobs which require exactly their own level of education in each year, what would the pattern of surplus and shortage look like over time?

Table 7 presents trends in the distributions of workers' own education (Column 1), job educational requirements (Column 2), and the difference between the first and second columns (Column 3). When the numbers in Column 3 are negative there are more jobs than workers at that skill level (*worker shortage/job surplus*) and when the numbers are positive there are more workers than jobs at that skill level (*worker surplus/job shortage*).

Column 3 in the first panel (Grades 0-8) indicates that there are more very low skill jobs than very low skill workers in every year, but the surplus of low skilled jobs generally falls over time across both the QES and PSID series. The decline is more rapid during 1976-1985 (-6.4 = -14.8 + 8.4) than 1969-1977 (-1.9 = -7.1 + 5.2), but less rapid on an annual basis than the decline during 1969-1972 (-5.1).

Further, the second panel (Grades 9-11) indicates there is a surplus of low skill workers in every year whose size is very similar to the low skill worker "shortage" in the preceding panel. If workers and jobs at these two levels are considered relatively similar and the categories collapsed into a single low skill category, the shortage of low workers drops to a scant -0.4 percentage points (i.e., -7.1 +6.7) in 1969 and turns to a surplus of 2.0 percentage points in 1977, while the shortage of low skill workers also declines by an identical amount from -3.5 percentage points to -1.0 percentage points between 1976-85. If there was an increasing surplus of low skilled workers one would expect that the level of any shortage would shrink or level of any surplus would grow more rapidly in the more recent period. There is little such evidence in these figures.

The panels for high school through some college face the familiar problem of dealing with the presence of intermediate categories in 1969 and 1985. Column 4 deals with the problem by collapsing both workers and jobs falling belonging to these categories into a single aggregate and subtracting

percentage of jobs from the percentage of workers with this range of education. As with Column 3, positive numbers in Column 4 indicate a worker surplus and negative numbers indicate a worker shortage. The QES series indicates a 5.8 percentage point movement from worker surplus to shortage, while the PSID indicates a 1 percentage point increase in the worker surplus.

There seems to be a shortage of workers with a B.A. and a surplus of workers with postgraduate education in every year for both series. There is a moderate decline of the B.A. shortage between 1969-77 and a slightly larger increase in the shortage between 1976-85, but the differences in magnitude are not great. Conversely, there is an increase in the postgraduate surplus between 1969-77 and a rather smaller reduction of the surplus between 1976-85.

Given that some workers with more than 16 years of reported education probably have only a B.A., as the CPS education series presented earlier suggests, it might make sense to collapse these two categories as well. In this case, there is a movement from -1.5% skill shortage to 2% skill surplus (1969-77) and a movement of almost exactly equal magnitude from 1.3% skill surplus to -2.3% skill shortage (1976-85).

Summary

The preceding sections have examined previously unanalyzed time series of individual-level information on job education requirements, training times, and under- and over-education. There is little that suggests exceptionally rapid rates of skill upgrading during the more recent period 1976-85, when inequality grew at an exceptionally rapid rate. There is equally little indication that rates of personal under-education rose or over-education fell at exceptionally rapid rates during that time or that the overall stocks of workers skills became increasingly mismatched with job skill demands. There is also no evidence of a general tendency toward deskilling or an increasing polarization of job requirements. Rather, the preceding results support Spenner's view of a gradual, secular trend toward skill upgrading. The principal causes of the large, swift inequality growth in the early 1980s would seem to be distinct from this secular trend. Although the data used here are not free from problems, unless other sources of information covering both the 1970s and 1980s are uncovered this will remain the only direct measures of trends in job skill requirements for the period of greatest inequality growth.

Occupational-Level Measures of Job Skill Requirements

While individual-level data is in many respects preferable to occupation means, the advantage of data sets like the DOT is that they can be merged onto individual-level data for longer and more complete time series than are available for individual-level measures. They do not capture as much variation as individual-level data but they assign more precise scores to much finer categories than the broad occupational aggregates used in Handel (2000), which are much rougher ordinal rankings. The assignment of skill scores gathered at a single point in time to thirty years of Census and CPS microdata will capture only skill trends resulting from between-occupation composition shifts, since the score assigned to a given occupation is fixed. However, the fuller trend analysis adds information which compensates in part for the inability to capture within-occupation trends. The following section analyzes trends in job skill demands using DOT skill scores and mean occupational skill ratings derived from the QES77, PSID76, and PSID85. This analysis follows a validation exercise below.

Validation of Occupation-Level Measures using Individual-Level Data

As noted earlier, the question that has haunted previous uses of the DOT is the question of data quality, specifically the loss of information when using occupational means rather than individual-level scores and the reliability of the DOT measures themselves. Some sociologists have suggested avoiding their use altogether (Attewell 1990, p.429; Robert Althauser, personal communication; cf. Spenner 1980, p.247). Spenner (1980) made an effort to validate some lesser-used DOT items on job variety and closeness of supervision using some relatively weak items from the QES72. But in fact several

surveys (QES77, PSID76, and General Social Survey) contain information for a more a thorough validation of more widely-used DOT variables. These correlations are presented here for the first time, even though the data used to validate the quality of the DOT scores has been available since early in the sociological debates on skill.

The correlations in Tables 8 and 9 help to answer questions regarding information loss when using occupation means and speak to the issue of the quality of the DOT occupation-level scores in particular. For instance, Table 8 uses the PSID76 and QES77 samples, which are roughly contemporaneous with the DOT (Fourth Edition, 1977), to compare individual-level skill measures, occupation-level means derived from those individual scores, and analogous DOT occupation-level scores, which have been merged onto the two individual-level data sets. The correlations between individual scores and occupation means within the PSID and QES data sets measure how well occupation means capture individual variation. Since the DOT scores do not pretend to be anything more than occupational means, the correlations between DOT scores and occupation means derived from the PSID and QES measure how well they achieve that purpose, while the correlations of DOT scores with the PSID/QES individual-level scores show how well they measure what researchers wished they measured, assuming the individual reports are without error themselves, which the reliability estimates for job stayers in a previous section suggested is unlikely to be true. These six correlations are reported in boldface within each panel in Table 8.

The left panel of Table 8 presents results using the PSID76 sample and the right panel presents results using the QES77 sample. The PSID/QES variables are own education, job education requirements, and (ln) training time. The latter two are the same as used in the previous section and own education is included for comparative purposes as well as for its intrinsic interest. The DOT measures are General Educational Development (GED) and Specific Vocational Preparation (SVP), which are 6- and 9-point ordinal scales measuring formal educational requirements and training times, respectively.

The first point to notice is that with few exceptions all of the corresponding correlations are remarkably similar across the two panels. Since no sample restrictions have been made to make the two data sets comparable for this exercise and the wording of the questions differ somewhat, these similarities are reassuring. Even if the mean values of required education differ across PSID and QES samples, their relationships to other variables do not differ much. Indeed, the weighted correlations between the PSID76 and QES77 occupation-level means are 0.85 for required education (n=224) and 0.73 for training times (n=224), where the weights are an occupation's percentage of the workforce averaged across the two samples (not shown).

More importantly, the correlations between individual- and occupational-level measures of required education and training times are about 0.80 and 0.65, respectively, in both data sets. In other words, occupation means account for about two-thirds and 43% of the variation in required education and training times, respectively. The DOT measure of required education (GED) correlates 0.83-0.85 with the PSID76 and QES77 occupational means and 0.66-0.69 with the individual-level scores in those data sets. These are not low numbers for a variable that has received a fair amount of criticism (e.g., Halaby 1994). The DOT training time measure (SVP) fares somewhat worse–the correlation with PSID76 occupational means is 0.83 but only 0.65 with QES77 occupational means. The latter is a bit surprising since the correlations of SVP with the individual-level scores are so similar across the two data sets (0.58 and 0.55) and, as noted, the occupational means constructed from the microdata have such similar correlations with the underlying individual scores across the data sets as well (0.66 and 0.65).

Nevertheless, the generally strong correlations between DOT scores and occupational means calculated from individual-level data suggest the quality of the DOT scores is quite reasonable and that criticisms of their value as occupation scores are easily exaggerated (e.g., Attewell 1990, p.427ff.). Even the correlations of DOT and PSID/QES occupational measures with the individual

scores are respectable and if the latter were purged of error no doubt they would be higher.

Finally, using the PSID76 and PSID78 one can estimate the cross-year correlations between occupation means for those who did not change jobs between 1976 and 1978. The correlations are 0.95 (n=1,356) for required education and 0.85 (n=1,446) for training time. These correlations are significantly higher than the same figures based on individual-level reports (0.83 and 0.60) cited above, suggesting a fair bit of error variation may be averaged out using occupational means.

Table 9 presents correlations involving two other DOT measures used below, a six-point scale measuring a job's level of complexity in relationship to data (*Data*) and a five-point scale measuring the percentile range of the intelligence distribution a job requires (*Intelligence*). These are correlated with individual and occupation measures of job task complexity using eight job task variables from the January 1991 CPS, scores on the ten-word vocabulary test from workers in the General Social Survey between 1974-78, and the intelligence of wage and salary workers in the QES77 as rated by the interviewer on a five-point scale. Unfortunately, no survey contains items that would permit a similar exercise for other DOT measures used below measuring job requirements for interpersonal skills (*People*) and manual skills (*Things*).

Since the DOT variables in Table 9 code high skill values as 1, one would expect negatively-signed correlations with the other skill measures, which is indeed found in the all entries in the last two rows of the table except that which correlates the two DOT scores with one another. The discussion below refers to their absolute value for ease of exposition. The CPS index of task complexity in Panel A is a relatively strong measure of complexity of work with data because it combines responses to seven questions regarding reading, writing, math use, and computer use on the job into an additive scale (Cronbach's α =0.83). Both the Data and Intelligence variables correlate about 0.80 with the occupational mean calculated from the CPS data and about 0.57 with the individual scores. The correlations of Intelligence with the GSS vocabulary test and QES77 "rated intelligence" at the occupational level are 0.73 and 0.77, respectively. These are not unreasonable numbers, though the correlations with the individual-level data are only in the 0.45-0.50 range. The lower correlations relative to the CPS data may reflect greater measurement error in these GSS and QES variables. The DOT Data variable is more weakly correlated with the GSS and QES measures at both the occupational and individual levels, but also measures a somewhat less parallel concept.

In general, though not as strong as the results for GED, these results suggest that these DOT variables are reasonably good measures of job skill requirements, at least at the occupation-level. By the standards of most social science, the DOT variables would seem to be reasonable measures of occupational skill requirements.

Long-Term Trends in Job Skill Requirements using Occupation-Level Measures

Having examined the reliability of both DOT scores and occupation means derived from PSID and QES microdata, one can examine trends in mean skill requirements and inequality of job skill requirements by merging these mean scores onto Census data for 1960-90 and March CPS data for 1968-97. The Census series includes earlier trend data than the CPS, while the CPS extends to later years and provides more detail.

There are six DOT skill measures used below. The first, *General Educational Development* (GED), is a six-point scale measuring the formal educational requirements of an occupation. The second is *Specific Vocational Preparation* (SVP), a nine-point scale measuring the time required to learn an occupation exclusive of schooling without specific vocational content. There are three six-eight point scales rating the level of complexity at which the worker functions in relation to *Data* , *People* , and *Things* . Finally, *Intelligence* is a measure of required worker aptitude and uses a four point scale indicating the percentile range of the population from which members of the occupation are drawn. Unlike GED and SVP, lower numbers indicate higher levels of skill for these other four measures.

Figure 6 shows trends in all six measures for 1960-90 using Census data. GED and SVP slope upward, indicating increasing mean educational requirements and training times. Likewise, the trend for Data, People, and Intelligence measures is downward, indicating increasing skill requirements. By contrast, the trend for Things slopes upward, indicating an increasing prevalence of jobs with lower manual skill requirements. However, except for the trend for Things, few of the lines suggests much acceleration in skill upgrading. In fact, all of the other measures indicate skill upgrading was marginally more rapid in the 1960s than subsequently and least rapid in the 1980s. Figures 7 and 8 graph trends in the same measures using the March CPS for 1968-97, covering a more recent period and also allowing for annual detail. Clearly the series for Things indicates a more accelerated and sustained decline in manual skill requirements in the 1980s and into the 1990s than the corresponding Census series. However, almost all of the other series indicate comparable or somewhat slower rates of upgrading between 1983-1997 compared to 1968-1979. The most distinctive feature of most of the series in these figures is the notably rapid changes during the recession years 1979-1983. Otherwise there is very little distinctive about the 1980s-1990s such as one might expect from the spread of information technologies. For GED, SVP, Data, and Intelligence, in particular, the sharpest movements seem to be associated with recession years, not only 1979-1983, but also 1972-1974. While differing in details from a similar investigation by Howell and Wolff (1991) using the DOT, both sets of results are consistent in showing no acceleration in skills shifts for most of the 1980s.

Finally, Figure 9 presents trends in the inequality of job skill requirements using the coefficient of variation. Clearly England and Kilbourne's (1988) cross-walk of DOT scores to the 1980s Census occupational codes which are used here produces a large, artifactual reduction in the overall variation. Nevertheless, between 1983-1997 there does seem to be a significant trend upward in the Data series after 1986, while inequality in manual skill requirements (Things) declines consistently, and inequality in most other measures ends the period more or less where it began, sometimes after slight dips. Inequality in Data and to a lesser extent in the Intelligence measure also increase between 1979-82, while inequality in GED and SVP decline slightly during the same period. Clearly it would be difficult to draw strong conclusions from these data. However, while the different series do not move consistently together there does not appear to be an obvious consistent trend toward greater inequality of skill requirements but neither is there an unambiguous trend toward greater equality, as is evident in measures of educational attainment, for instance.

Figures 10-15 perform similar trend analyses using occupational means for required education and training time calculated from the PSID76, PSID85, and QES77 data sets which were merged onto microdata from the March CPS data for 1971-97. Figure 10 confirms the general smoothness of the trend in required education over the course of the 1970s-90s using all three sets of scores imputed to March CPS data. Figure 11 compares the three series using a measure of percentage change in which values in 1971 are set to 1 for all series. This does suggest a modest acceleration during the period of inequality growth (1979-83) but a subsequent moderation of growth. This seems more consistent with the decline of blue collar workers noted earlier than with an information revolution resulting from the diffusion of computers, at least insofar as it affects the occupational composition of the workforce Figures 12 and 13 perform a similar exercise for the mean months of training time variable. Again, there is evidence of acceleration in the early 1980s in Figure 13, particularly for the series using the QES occupational means. There also seems to be some acceleration after the early 1990s for all measures. But, again, the period of most rapid change is the early 1980s. There is no evidence that the period of greatest computer diffusion corresponds to a dramatic break with past trends in skill upgrading

Finally, Figures 14 and 15 present trends in the inequality of skill requirements, measured as the coefficient of variation in required education and the variance of (ln) months of training time, respectively. Both figures show an artifactual decline in the variance with the 1980s occupational coding scheme, similar to that noted for the crosswalk of DOT codes constructed by England and Kilbourne (1988). Nevertheless, the trend for inequality in required education is generally downward

regardless of the coding scheme, except for a slight rise in the early 1990s. Similarly, inequality in training times is virtually flat for all years across measures. There is no evidence that rising mean job skill requirements have been accompanied by polarization in skill requirements, as Braverman argued. It would appear that jobs are becoming more skilled and somewhat more similar in skill level over time.

Conclusion

It is widely perceived that job skill requirements are rising and even accelerating as a consequence of the diffusion of information technology. This thesis has animated long-standing discussions regarding increased education standards and more recent debates over the growth of inequality in the 1980s. However, direct measures of job skill requirements taken from microdata do not suggest that the period of rapid inequality growth (1976-1985) was a period of rapid growth in job skill requirements compared to the preceding decade (1969-1977). There is also little evidence that rates of under-education have grown or rates of over-education have declined particularly rapidly in the more recent period. Similarly, between-occupation skill shifts, whether measured using mean occupational skill scores derived from the microdata or the more familiar DOT occupational scores applied to longer time series, do not suggest discontinuities between the 1980s-1990s and 1960s-1970s, except for a brief period of acceleration in skill requirements corresponding to the early 1980s recession, when there was a dramatic loss of relatively low skill but well-paid blue collar manufacturing jobs (Handel 2000). There is no evidence of increasing inequality of job skill requirements.

In short, the pattern is one of relatively steady growth in skill requirements over time, but little evidence of accelerating skill demands or increasing skills mismatch in the 1980s-1990s. These results are consistent with the findings in Handel (2000) and cast doubt on the notion that the recent growth in U.S. wage inequality is a result of a skills shortage.

APPENDIX

Skill Items from the Quality of Employment Surveys and the Panel Study of Income Dynamics

Survey of Working Conditions (1969):

Formal Education –"What level of formal education do you feel is needed by a person in your job?" (0=no special level of education, vocational training/technical training, 10=some grade school; 11=some grade school plus vocational/technical training; 20=grade 8; 21=grade 8 plus vocational/technical training; 30=some high school; 31=some high school plus vocational/technical training; 40=high school; 41=high school plus vocational/technical training; 50=some college; 51=plus vocational/technical training; 60=college degree; 61=some college plus vocational/technical training; 70=graduate/professional degree).

Quality of Employment Surveys (1972):

Formal Education –"What level of formal education do you feel is needed by a person in your job?" (none, grades 1-7, 8, 9-11, 12, some college, college degree, graduate/professional degree).

Quality of Employment Surveys(1977)

Formal Education –"What level of formal education do you feel is needed by a person in your job?" (none, grades 1-7, 8, 9-11, 12 (including GED), some college (no degree), some college (with degree), graduate/ professional degree).

Training Time –"How long would it take the average person with that much education to learn to do your job reasonably well?" (1=one week or less, 997=997 weeks or more).

Panel Study of Income Dynamics (1976)

Formal Education –"How much formal education is required to get a job like yours?" (grades 0-5, 6-8, 9-11, 12, some college, BA, advanced or professional degree).

Training Time –"On a job like yours, how long would it take the average new person to become fully trained and qualified?" (1=one month or less, 97=ninety-seven months or more, 98="Always learning;" never fully trained).

Panel Study of Income Dynamics (1985)

Formal Education –"How much formal education is required these days to get a job like yours?" (grades 0-5, 6-8, 9-11, 12, grade 12 plus nonacademic training, some college, BA, advanced or professional degree).

Training Time –"On a job like yours, how long would it take the average new person to become fully trained and qualified?" (1=one month or less, 98=ninety-eight months or more).

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Table 1. Trends in Formal Education Requirements 1969-86 (SWC69, QES72, QES77, PSID76, PSID85)

Education Required	SWC/QES			PSID		Annual Change Rates			
	1969	1972	1977	1976	1985	69-72	72-77	69-77	76-85
1. Grades 0-8	25.7	16.2	14.7	25.1	11.7	-3.2	-0.3	-1.4	-1.5
2. Grades 9-11	10.5	8.1	6.7	1.9	1.5	-0.8	-0.3	-0.5	-0.0
3. High School	25.6	43.7	43.9	42.5	40.0	| 3.6 |	0.0 (0.6)	| 1.7 |	| 0.7 |
4. High School + Voc.	12.6	--	--	--	6.1				
5. Some College	9.0	14.4	17.1	7.9	10.2		0.5		
6. College Degree	10.2	9.8	10.6	17.1	23.4	-0.1	0.2	0.1	0.7
7. Post-graduate	6.6	7.8	7.0	5.5	7.1	0.4	-0.2	0.1	0.2
Mean	2.62	2.85	2.88	2.76	3.13	0.08	0.01	0.03	0.04
Coeff. of Variation	0.444	0.371	0.352	0.422	0.317	-0.024	-0.004	-0.012	-0.012
N	1,033	982	861	3,250	4,509				

Note: For comparability samples are restricted to workers over 25 working at least 20 hours per week. Figures in top part of table are percentages. Means and coefficients of variation calculated after collapsing high school, high school + vocational education, and some college categories (code=3) to form a 5-point scale. All figures calculated using sample weights. Sources of tabulations are Survey of Working Conditions (1969), Quality of Employment Surveys (1972, 1977), and Panel Study of Income Dynamics (1976, 1985).

Table 2. Trends in Formal Education Requirements within Major Occupations: *Raw Percentages, Means, and Coefficients of Variation*

Occupation	Percentage								
	Gr. 0-8	Gr. 9-11	H.S.	H.S. + Voc	Some Col.	BA	Postgrad	Mean	C.V.
Upper WC									
1969	3.9	1.6	12.5	7.8	16.0	33.2	25.0	3.74	0.262
1972	1.2	1.5	22.3	--	23.5	26.7	24.8	3.72	0.241
1977	1.8	2.8	20.3	--	23.1	29.8	22.1	3.68	0.247
1976	5.1	0.6	23.4	--	13.5	42.3	15.1	3.62	0.256
1985	2.4	0.1	15.2	3.0	12.9	49.1	17.2	3.79	0.215
Lower WC									
1969	8.9	7.1	46.7	16.4	13.3	5.8	1.8	2.84	0.257
1972	6.7	3.9	59.7	--	22.3	6.4	1.1	2.91	0.219
1977	4.2	5.9	60.9	--	26.5	2.5	0.0	2.88	0.170
1976	10.2	1.1	72.2	--	9.7	6.8	0.0	2.85	0.239
1985	5.0	1.1	60.1	4.5	14.1	13.9	1.3	3.05	0.204
Craft									
1969	24.4	19.3	21.6	25.0	8.5	1.1	0.0	2.33	0.368
1972	17.1	10.5	63.3	--	8.6	0.5	0.0	2.56	0.303
1977	11.1	7.9	62.4	--	16.4	2.1	0.0	2.72	0.252
1976	35.1	2.1	56.7	--	4.2	1.9	0.0	2.30	0.424
1985	16.1	1.7	52.0	16.8	7.4	5.7	0.3	2.73	0.297
Lower BC									
1969	50.8	17.5	24.0	5.3	1.6	0.8	0.0	1.82	0.497
1972	38.8	17.7	41.1	--	2.3	0.0	0.0	2.05	0.442
1977	37.5	12.1	43.8	--	6.6	0.0	0.0	2.13	0.437
1976	59.7	4.7	34.3	--	0.7	0.6	0.0	1.77	0.543
1985	30.7	3.6	60.4	3.0	1.7	0.6	0.0	2.36	0.393
Service									
1969	51.9	8.5	22.5	12.4	2.3	2.3	0.0	1.90	0.522
1972	28.5	11.4	48.1	--	7.6	3.2	1.3	2.37	0.411
1977	26.4	6.3	53.5	--	8.1	4.6	1.2	2.48	0.392
1976	54.1	3.5	37.7	--	3.3	1.4	0.0	1.90	0.526
1985	27.3	4.5	44.5	11.0	7.6	4.6	0.4	2.46	0.388

Note: Rows in left panel are percentage within occupation reporting different levels of job educational requirements. Means and coefficients of variation in right panel calculated after collapsing high school, high school + vocational education, and some college categories (code=3). All figures calculated using sample weights. For comparability samples are restricted to workers over 25 working at least 20 hours per week. Sources of tabulations are Survey of Working Conditions (1969), Quality of Employment Surveys (1972, 1977), and Panel Study of Income Dynamics (1976, 1985).

Table 3. Trends in Formal Education Requirements within Major Occupations: *Average Annual Change*

Occupation	Average Annual Percentage Change								
	Gr. 0-8	Gr. 9-11	H.S.	H.S. + Voc	Some Col.	BA	Postgrad	Mean	C.V.
Upper WC									
1969-72	-0.90	-0.03		3.17		-2.17	-0.07	-0.007	-0.007
1972-77	0.12	0.26	-0.4	(-0.48)	-0.08	0.62	-0.54	-0.008	0.001
1969-77	-0.26	0.15		0.89		-0.43	-0.36	-0.008	-0.002
1976-85	-0.30	-0.06		-0.64		0.76	0.23	0.019	-0.005
Lower WC									
1969-72	-0.73	-1.07		1.87		0.20	-0.23	0.023	-0.013
1972-77	-0.50	0.40	0.24	(1.08)	0.84	-0.78	-0.22	-0.006	-0.010
1969-77	-0.59	-0.15		1.38		-0.41	-0.23	0.005	-0.011
1976-85	-0.58	0.00		-0.36		0.79	0.14	0.022	-0.004
Craft									
1969-72	-2.43	-2.93		5.60		-0.20	0.00	0.077	-0.022
1972-77	-1.20	-0.52	-0.18	(1.38)	1.56	0.32	0.00	0.032	-0.010
1969-77	-1.66	-1.43		2.96		0.13	0.00	0.049	-0.015
1976-85	-2.11	-0.04		1.70		0.42	0.03	0.048	-0.014
Lower BC									
1969-72	-4.00	0.07		4.17		-0.27	0.00	0.077	-0.018
1972-77	-0.26	-1.12	0.54	(1.40)	0.86	0.00	0.00	0.016	-0.001
1969-77	-1.66	-0.68		2.44		-0.10	0.00	0.039	-0.008
1976-85	-3.22	-0.12		3.34		0.00	0.00	0.066	-0.017
Service									
1969-72	-7.80	0.97		6.17		0.30	0.43	0.157	-0.037
1972-77	-0.42	-1.02	1.08	(1.18)	0.10	0.28	-0.02	0.022	-0.004

1969-77	-3.19	-0.28	3.05	0.29	0.15	0.073	-0.016
1976-85	-2.98	0.11	2.46	0.36	0.04	0.062	-0.015

Note: Calculated from figures in previous table using the formula $(X_2 - X_1)/N$, where X_1 is cell value in year 1, X_2 is cell value in year 2, and N is number of years between observations. For 1969-72 (SWC-QES72) and 1976-85 (PSID), rates of change are calculated for high school, high school + vocational education, and some college as a single aggregated category. A comparable figure computed for 1972-77 is shown in parentheses below that figure.

Table 4. Trends in Estimated Training Times in Months (QES77, PSID76, PSID85)

Training Times	QES 1977	PSID 1976	PSID 1985
Mean (s.d.)	22.34 (37.81)	20.0 (25.5)	20.0 (25.9)
Median	6.5	9	8
Coeff. of Variation	1.69	1.28	1.29
Pct. Breakdown			
≤ one month	29.5	23.1	22.5
>1-3 months	11.5	13.3	12.3
>3-6 months	12.0	12.2	14.2
>6 months-1 year	1.4	16.2	16.3
>1-2 years	14.0	11.0	11.2
> 2 years	31.6	24.3	23.5
Education Required (median)			
Grades 0-8	1.0	2	2
Grades 9-11	2.3	1	1
High School	6.5	6	6
HS + Voc. Education	--	--	12
Some College	13.0	12	12
College Degree	26.0	24	24
Post-graduate	26.0	36	24
Occupation (median)			
Mgr./Professional	26.0	24	24
Sales/Clerical	3.3	6	6

Craft	26.0	24	24
Lower Blue Collar	1.0	2	2
Service	1.0	2	2

Note: Samples for the first three columns are household heads and spouses working at least 20 hours per week. The figures change little when the PSID samples are expanded to include all workers regardless of hours worked. Sample sizes are about 940 (Column 1), about 4,600 (3,600 for tabulations using occupation) (Column 2), and about 5,480 (5,380 for tabulations using occupation) (Column 3). See Appendix for question wording.

Table 5. Trends in Personal Under- and Over-Education, 1969-85 (SWC69, QES72, QES77, PSID76, PSID85)

Own Education	Undered.	Match	Overed.	Undered.	Match	Overed.	Pct.	N
All								
1969	25.8	47.5	26.7	18.7	57.1	24.2	100	1,032
1972	21.1	57.3	21.7	21.1	57.3	21.7	100	979
1977	19.8	52.5	27.8	19.8	52.5	27.8	100	857
1976	15.3	49.7	35.1	15.3	49.7	35.1	100	3,240
1985	21.3	48.1	30.6	17.6	53.5	28.9	100	4,489
Grade 0-8								
1969	26.2	73.8	--				18.6	191
1972	38.7	61.3	--				14.1	139
1977	46.6	53.4	--				9.4	84
1976	23.9	76.1	--				10.3	482
1985	45.1	54.9	--				3.3	201
Grade 9-11								
1969	41.8	22.6	35.6				17.2	177
1972	43.4	28.6	28.0				13.9	138
1977	45.1	24.3	30.6				13.8	119
1976	42.9	6.1	51.1				13.3	546
1985	57.3	5.9	36.8				8.9	484
High School								
1969	31.6	42.9	25.4	11.0	63.6	25.4	34.3	354
1972	16.0	71.7	12.3	16.0	71.7	12.3	37.2	355
1977	16.0	67.4	16.6	16.0	67.4	16.6	37.8	304
1976	10.9	67.3	21.8	10.9	67.3	21.8	38.2	1,156

1985	25.9	61.6	12.6	16.2	71.2	12.6	38.6	1,757
Some Coll.								
1969	13.7	33.3	52.9	13.7	50.3	36.0	14.8	153
1972	12.2	43.7	44.1	12.2	43.7	44.1	18.0	179
1977	10.2	44.9	44.9	10.2	44.9	44.9	19.5	174
1976	16.3	22.5	61.3	16.3	22.5	61.3	14.4	432
1985	18.9	27.0	54.0	19.0	35.1	45.9	20.9	989
B.A.								
1969	11.7	67.5	20.8				7.5	77
1972	18.1	54.3	27.6				7.7	81
1977	12.2	46.1	41.7				9.2	80
1976	5.4	60.5	34.1				12.1	323
1985	4.8	69.0	26.2				15.3	597
Postgrad								
1969	--	67.5	32.5				7.8	80
1972	--	65.9	34.2				9.1	87
1977	--	54.6	45.4				10.4	96
1976	--	40.4	59.6				11.8	301
1985	--	44.7	55.3				12.9	461

Note: Sample is all workers over age 25. Undereducation is defined as (own education-job educational requirements)<0 and overeducation is defined as (own education-job educational requirements>0. The left panel treats the high school + vocational education job requirement category for 1969 and 1986 as greater than high school but less than some college, so all individuals in such jobs are either over or undereducated by definition, since the 1969 data has no measure of own vocational educational attainment. The right panel treats those with high school and some college education as matched if they are in jobs requiring high school and vocational education. The column labeled "percent" gives the percentage of workers with that level of educational attainment in that year.

Table 6. Correlations of Under-and Over-Education with Other Measures of Job Match

	1	2	3	4
1. Undereducation				
2. Overeducation	-0.31			
3. Skill Underuse	-0.06	0.09		
4. Skill Use	0.05	-0.16	-0.15	
5. Skill Development	0.11	-0.16	-0.14	0.51
6. Skill Underuse (2)	-0.03	0.11		
7. Want More Skill	-0.03	0.07		

Note: Correlations based on item 3 use 1972 and 1977 QES data, those involving items 4 and 5 use 1977 QES data only. Correlations based on items 6 and 7 use the 1976 PSID sample. Note that when the correlations of under- and over-education with skill underuse (item 3) are calculated for the 1977 sample alone, they are -0.09 and 0.13, respectively. Sample sizes are about 2,860 for the pooled QES sample, about 845 for the 1977 sample, and 3,231 and 1,604 for items 6 and 7 respectively in the 1976 PSID sample. Under- and over-education defined as previously. Other items defined as follows:
3. *Skill Underuse* : "Do you have some skills from your experience and training that you would like to be using in your work but can't use on your present job?" (1=yes)
4. *Skill Use* : "My job lets me use my skills and abilities" (4=strongly agree)
5. *Skill Development* : "I have an opportunity to develop my own special abilities" (4=very true)
6. *Skill Underuse (2)* : "Do you have some skills or job experience that you cannot use in your present job?" (1=yes)
7. *Want More Skill* : If yes to previous item, "Do you think you might want to get a job some day which used that skill or experience?" (1=yes)

Table 7. Trends in Aggregate Under- and Over-Education, 1969-85

	1	2	3	4
	Own Educ.	Req'd Educ.	Col 1- Col 2	Col. 3--alt.
Grade 0-8				
1969	18.5	25.6	-7.1	
1972	14.1	16.1	-2.0	
1977	9.4	14.6	-5.2	
1976	10.3	25.1	-14.8	
1985	3.3	11.7	-8.4	
Grade 9-11				
1969	17.2	10.5	6.7	
1972	13.9	8.1	5.8	
1977	13.8	6.6	7.2	
1976	13.2	1.9	11.3	
1985	8.9	1.5	7.4	

High School				
1969	34.3	25.6	8.7	
1972	37.2	43.8	-6.6	
1977	37.8	44.1	-6.3	
1976	38.2	42.5	-4.3	
1985	38.6	40.1	-1.5	1.9
				-3.0
High School+Voc				-3.9
1969		12.6		2.2
				3.2
1972		--		
1977		--		
1976		--		
1985		6.0		
SomeCollege				
1969	14.8	9.0	5.8	
1972	18.0	14.4	3.6	
1977	19.5	17.1	2.4	
1976	14.4	7.9	6.5	
1985	20.9	10.2	10.7	
B.A.				
1969	7.5	10.2	-2.7	
1972	7.7	9.8	-2.1	
1977	9.2	10.7	-1.5	
1976	12.1	17.1	-5.0	
1985	15.3	23.4	-8.1	
Postgrad				
1969	7.8	6.6	1.2	
1972	9.1	7.8	1.3	
1977	10.4	6.9	3.5	
1976	11.8	5.5	6.3	
1985	12.9	7.1	5.8	

Note: Sample is all workers over age 25, restricted to household heads and spouses in the PSID samples. Figures are the percentage distributions of workers with different educational attainments ("own educ.") and the educational requirements of jobs ("req'd educ."). Column 3 subtracts Column 2 from Column 1. Column 4 collapses the categories high school, high school + vocational education, and some college in Columns 1 and 2 before subtracting.

Table 8. Correlations of Individual- and Occupation-Level Skill Measures from Panel Study of Income Dynamics (PSID) (1976), Quality of Employment Survey (QES) (1977), and Dictionary of Occupational Titles (DOT) (1977)

	Panel Study of Income Dynamics (PSID76)							Quality of Employment Survey (QE					
Variable	1	2	3	4	5	6	7	1	2	3	4	5	6
A. PSID/QES Measures													
Individual-level:													
1. Own education													
2. Education required	.68							.70					
3. (ln) Training time	.36	.46						.29	.42				
Occupation-level:													
4. Own education	.73	.65	.37					.79	.69	.35			
5. Education required	.68	.81	.47	.81				.68	.80	.44	.86		
6. (ln) Training time	.41	.49	.66	.49	.62			.29	.42	.65	.40	.53	
B. DOT Measures													
Occupation-level:													
7. GED	.60	.69	.53	.72	.85	.76		.57	.66	.51	.73	.83	.61
8. SVP	.47	.56	.58	.57	.69	.83	.88	.42	.52	.55	.54	.65	.65

Note: DOT measures merged onto PSID and QES data sets using the extended occupational classification scheme developed for mapping (DOT) codes into Census occupation and industry codes. All occupation-level measures from the PSID and QES are means of individual-level measures, where "occupation" refers to the extended occupation classification. "Own education" is respondent's actual level of education (measured in nine categories in the QES), "education required" is formal education required for job, "training time" is length of time required to learn job/become fully trained, "GED" (General Educational Development) is a DOT variable measuring level of formal education required on the job, and "SVP" (Specific Vocational Preparation) is a DOT variable measuring the amount of time a typical worker needs to achieve average performance in a specific job-worker situation (see U.S. Department of Labor 1991 for further details on DOT variables). The PSID includes all household heads and wives coded with 3-digit Census occupation and industry codes and the QES includes all persons working at least twenty hours per week. Sample sizes are approximately 3,500-4,000 for the PSID and 1,100 for the QES.

Table 9. Correlations of Individual- and Occupation-Level Skill Measures from Current Population Survey (CPS) (1991), General Social Survey (GSS) (1972-82), Quality of Employment Surveys (QES) (1972-3, 1977), and Dictionary of Occupational Titles (DOT) (1977)

	1	2	3	4	5	6	7
A. Task complexity scale (CPS) [1]							
1. Individual-level							
2. Occupation-level	.70						
B. Vocabulary test (GSS) [2]							
3. Individual-level							
4. Occupation-level			.63				
C. Rated intelligence (QES) [3]							
5. Individual-level							
6. Occupation-level					.63		
C. DOT Measures (occupation-level)							
7. Data	-.56	-.80	-.40	-.62	-.43	-.67	
8. Intelligence	-.58	-.83	-.46	-.73	-.49	-.77	.85

Note: Sample sizes are about 45,000 for correlations involving the CPS sample, about 2,000 for correlations involving the GSS, and about 2,400 for correlations involving the QES. "Occupation-level" for the GSS and QES correlations refers to the extended occupation-industry codes ("abcodes") used in the original DOT file mapped into the 1970s Census occupation codes. The CPS occupation-level correlations use simple Census occupations, which are the units of observation in the England/Kilbourne (1988) file mapping DOT scores into 1980 Census occupational codes.

1. This is an additive scale containing items measuring the frequency with which respondents' jobs involve reading letters, instruction manuals, and new/magazine articles, reading or using forms, writing memos or reports, using math/arithmetic, and using computers at work (Cronbach's α =.83) (See Table 1above for more details). The data are from the January 1991 Current Population Survey.
2. This is a ten-word vocabulary test score (WORDSUM) for all wage and salary workers in the General Social Survey given the test between 1974-1978.
3. This is a five-point scale in which the QES survey taker rated the respondent's "apparent intelligence" from "very low" (=1) to "very high" (=5). Data from the 1972-3 and 1977 surveys are pooled.
4. The DOT Data variable is a seven-point scale which rates a job's level of complexity with data. The intelligence variable is a four-point scale indicating which intelligence decile or tercile is most suited for the occupation. *For both variables, low numbers indicate higher skill levels.*

Figure 1

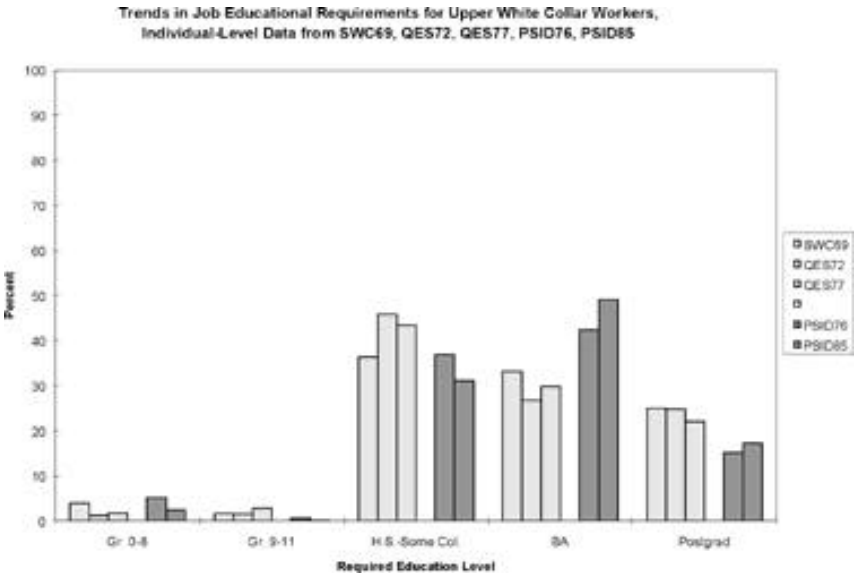


Figure 2

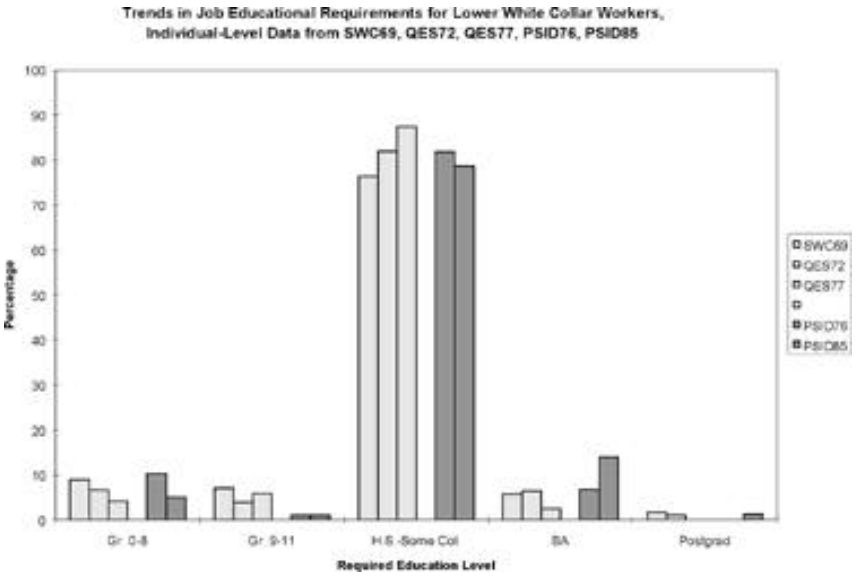
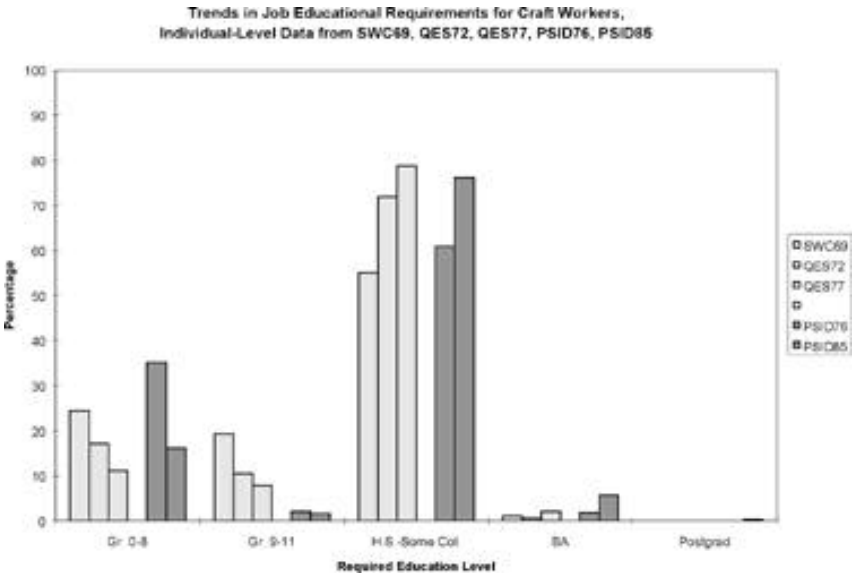


Figure 3



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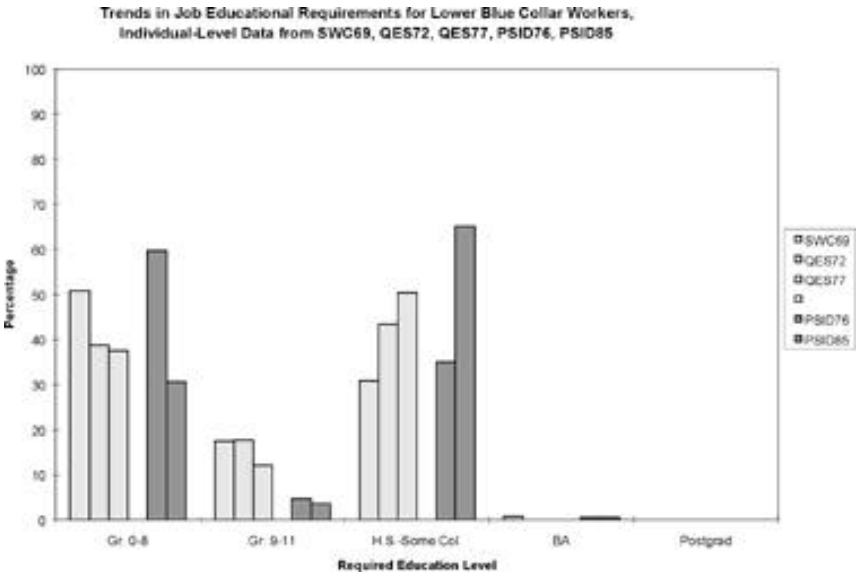


Figure 5

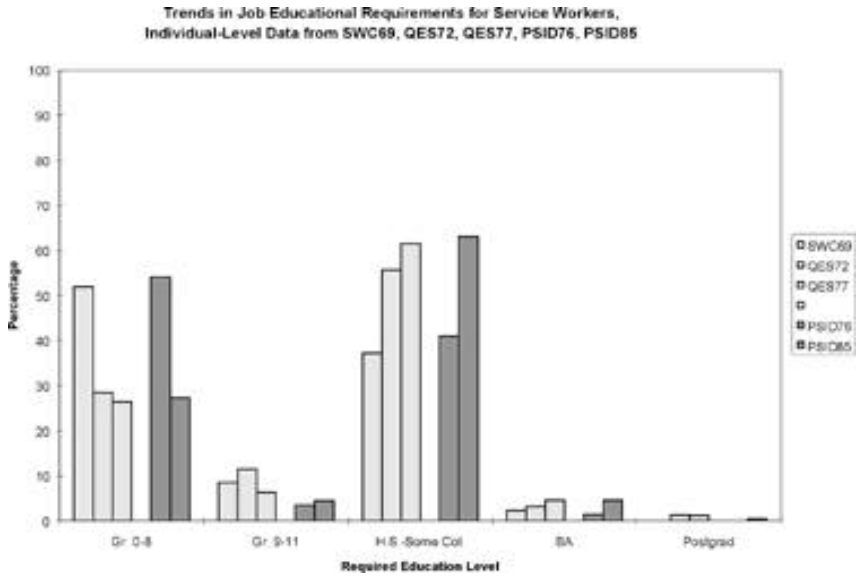


Figure 6

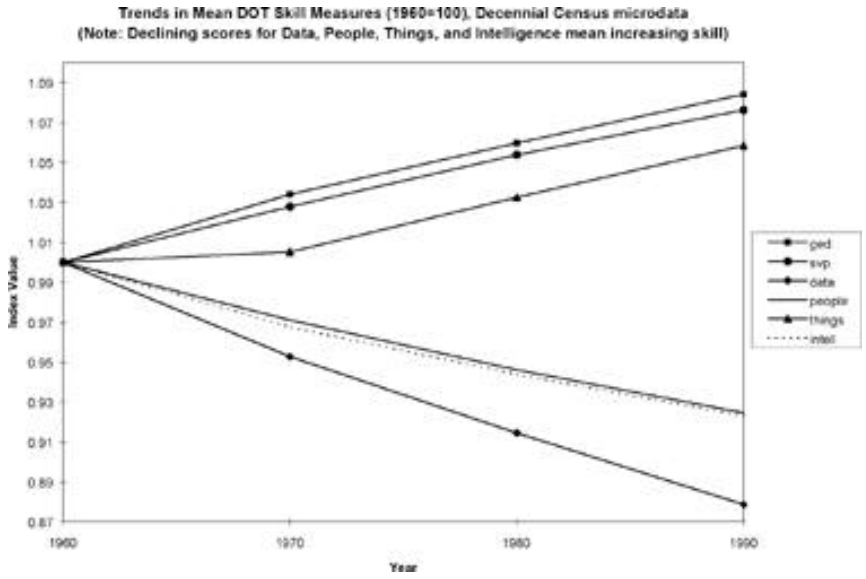


Figure 7

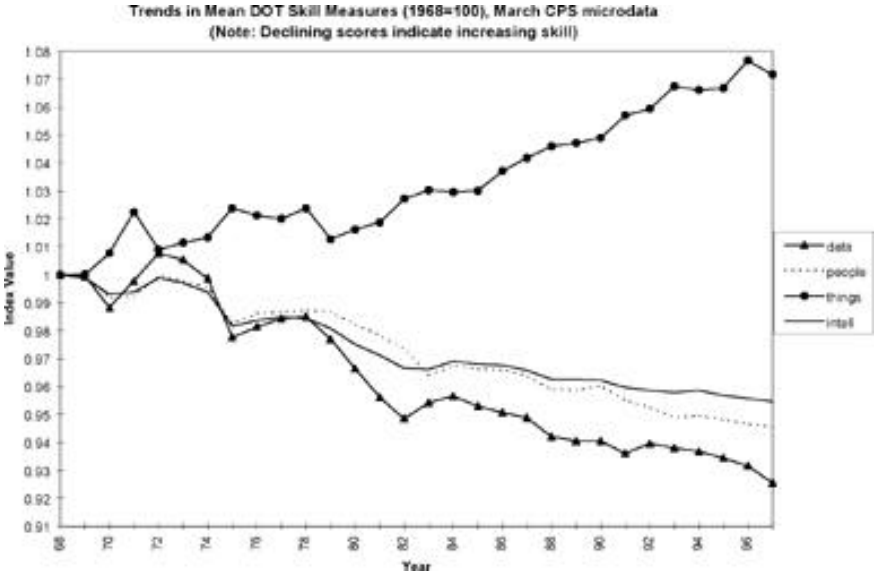


Figure 8

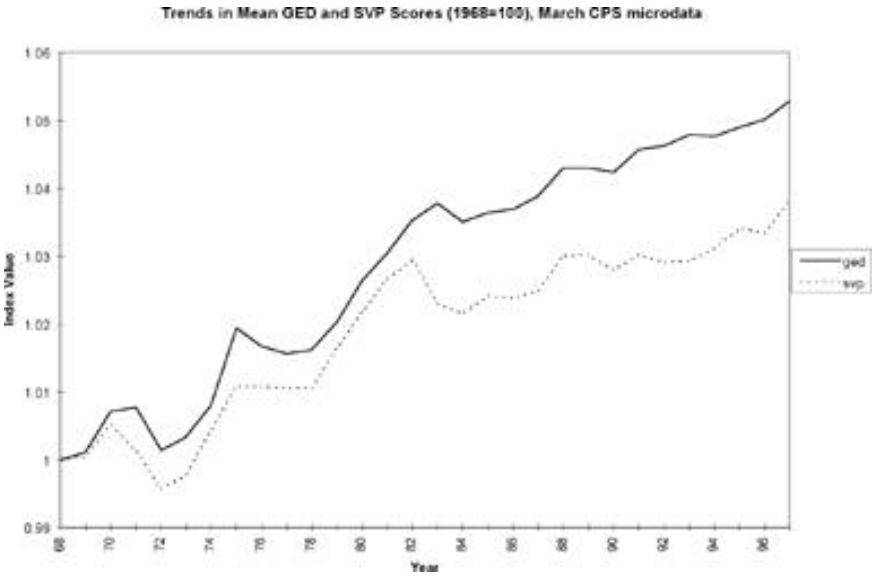
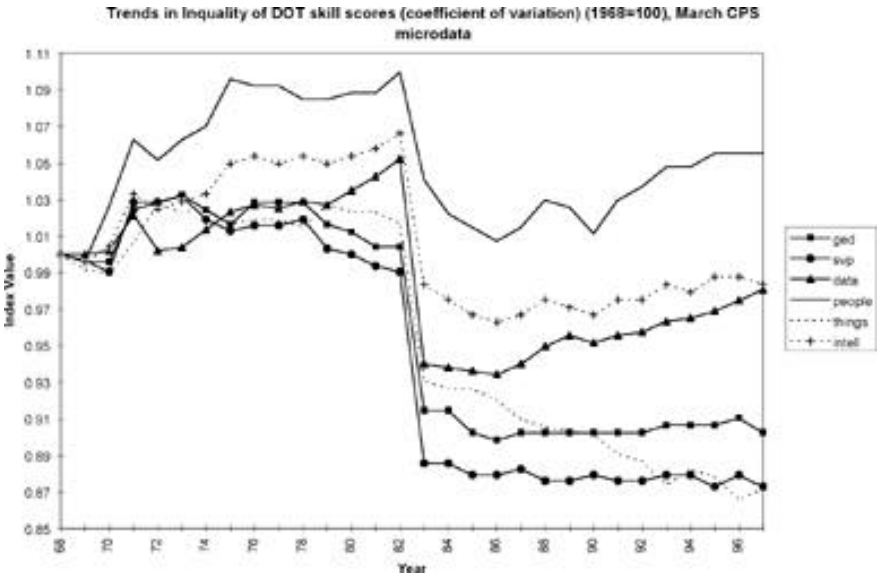


Figure 9



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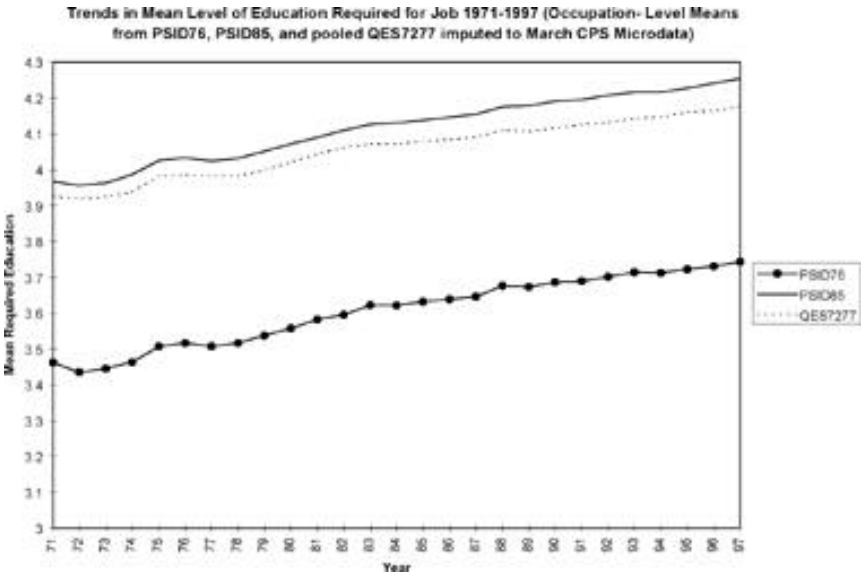

Figure 11

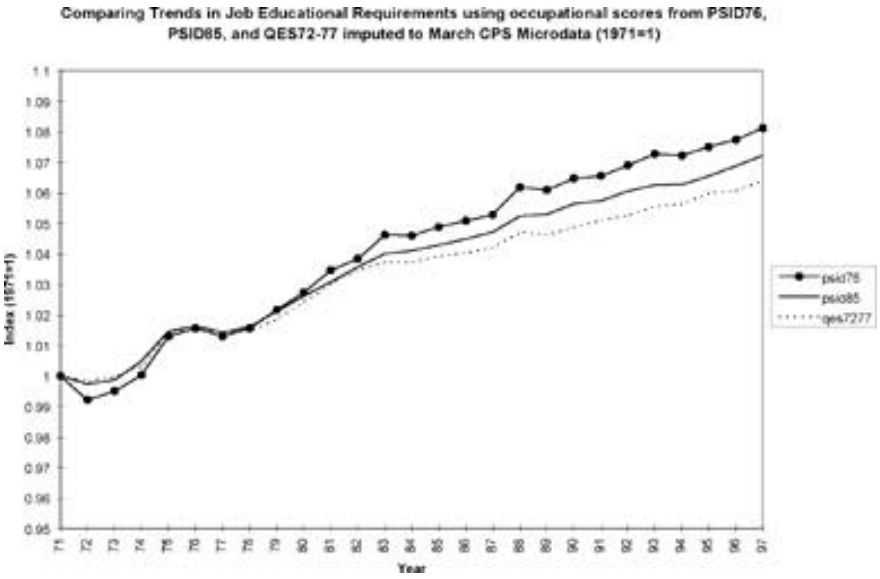

Figure 12

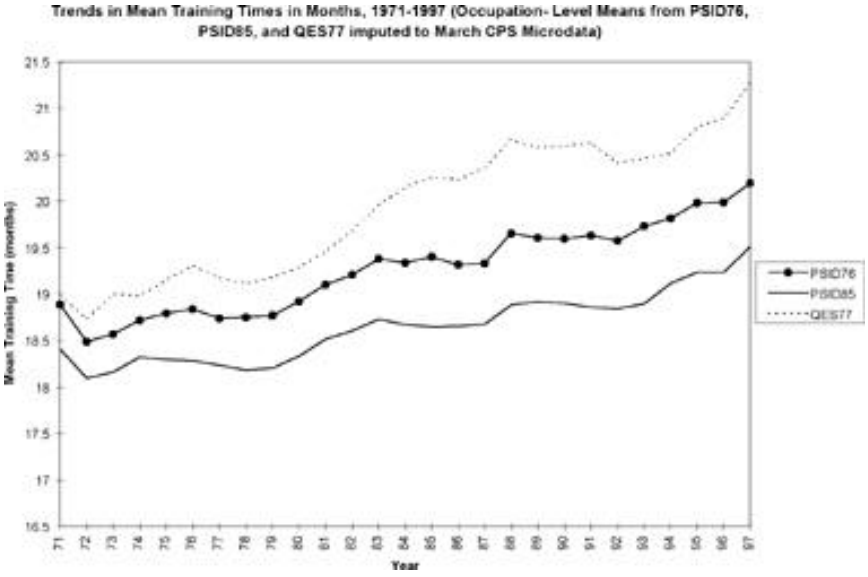

Figure 13

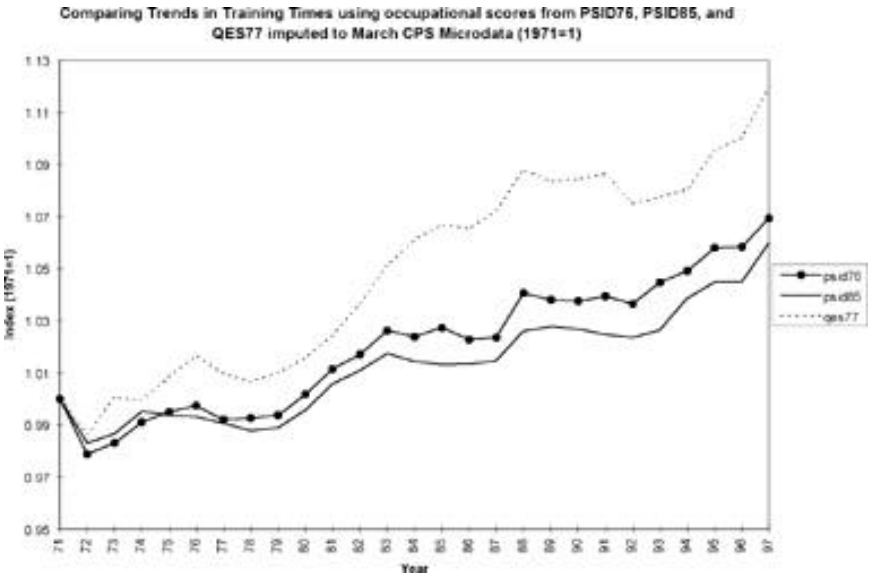

Figure 14

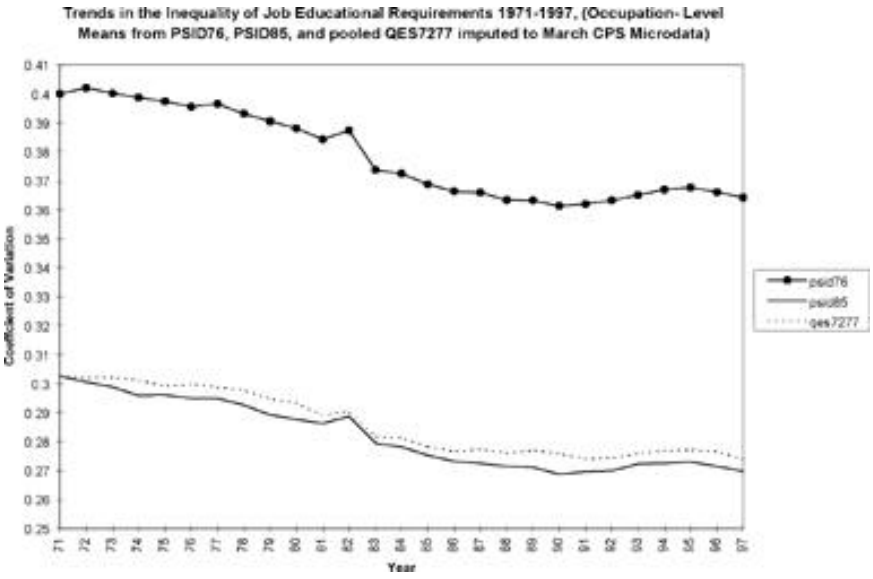

Figure 15

Trends in the Inequality of Training Times 1971-1997 (Occupation- Level Means from PSID76, PSID85, and QES77 imputed to March CPS Microdata)