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ABSTRACT

U.S. Bureau of Labor Statistics (BLS) projections of occupational employment growth have systematically underpredicted the growth of occupations that require the most education and training. The latest data on occupational growth rates show that the BLS's recent projections of occupational employment growth to the year 2000 probably suffer from the same bias. Based on a regression analysis of trends in occupational shares, forecasts of occupational employment demand imply substantially faster growth of higher level occupations. A comparison of past and projected percentage rates of change in employment in high skill jobs to actual and projected rates of change in the stock of well-educated workers illustrates the supply/demand balance for college graduates. Findings show that, during the 1980s, employment in high skill occupations grew at nearly the same rate as the stock of workers with one or more years of college, employers wished to increase the proportion of workers in these ocupations who had a college education. A shortage developed and the wage premium for college graduates rose to unprecedented levels. Policy implications include the following: (1) the social returns to a college education are extremely high and likely to go higher; (2) continuing inequality in wage premiums will put U.S. corporations at a competitive disadvantage; and (3) public policy must focus on increasing the supply of technically and scientifically trained individuals. (40 endnotes) (YLB)

THE WORSENING SHORTAGE OF COLLEGE GRADUATE WORKERS

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Working Paper #90-15

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EXECUTIVE SUMMARY

The Bureau of Labor Statistics projections of occupational employment growth have consistently underpredictied the growth of skilled occupations and overpredicted the growth of unskilled occupations. In August 1981, for example, the BLS predicted that professional, technical and managerial jobs would account for only 28 percent of employment growth between 1978 and 1990 and that operatives, laborers and service workers would account for 34 percent of growth. In fact, professional, technical and managerial jobs accounted for 52 percent of employment growth during this period and operatives, laborers and service workers accounted for cnly 9 percent of job growth.

Workforce 2000's forecasts of occupational skill demands are based on the BLS methodology, so its projections probably also understate the upskilling trend of occupational demand. **This implies that the forecasted shortage of skilled and educated workers is probably more serious than projected in Workforce 2000.**

This possibility was investigated by analyzing changes in employment shares during the 1972-1989 period in a regression framework and then using the estimated models to forecast employment shares in the year 2000. For all specifications and scenarios, the regression forecasts predict substantially larger increases in the employment of professional and technical workers than the BLS's judgmental forecasts. BLS now projects that professional, technical and managerial jobs will account for only 44.5 percent of employment growth. Our preferred model predicts that these occupations will account for 70 percent of employment growth.

The paper also evaluated BLS's projections of the supply/demand balance for college graduates. They were found to have been consistently wrong. At the beginning of the 1970s, BLS projected rough balance of supply and demand during the subsequent decade. In fact, however, the supply of college graduates grew more rapidly than demand and, as a result, the college/high school wage ratio for workers with 1 to 5 years of post-school work of experience fell 6.7-7.6 percentage points by 1980. In the later half of the 1970s, BLS projected very large surpluses of college graduates during the subsequent decade. According to their projection, the surplus of college graduates was going to grow at a rate equal to 30 percent of the annual flow of bachelors degrees awarded. If correct,

this surplus should have caused the relative wage of college graduates to fall during the subsequent decade. In fact, however, the nation entered a decade in which demand for college graduates substantially outstripped supply and the college/high school wage ratio for those with 1-5 years of experience rose by 23 to 26 percentage points to all time highs.

The problems are much deeper than simple errors in forecasting the future. The description of the present and recent past is wrong as well. It is stated, for example, that 27 percent (6,659,000) of college graduates were "underemployed" in 1988 and that "underemployment" increased by 1,655,000 between 1983 and 1988. Clearly, a measure of "underemployment" for a group that increases simultaneously with the group's relative wages is seriously flawed.

In our view, the task that BLS has set for itself--measuring the level and forecasting changes in the absolute number of jobs which "require a college degree"--is impossible. The classification of occupations into a "requires a college degree" category is inherently arbitrary and idiosyncratic to the analyst; yet the validity of the whole effort to measure "underemployment" depends on this classification being done correctly in every detail.

We then do our own examination of the supply/demand balance for college graduates by comparing past and projected percentage rates of change in employment in high skill jobs to actual and projected rates of change in the stock of well educated workers. During the 1980s, employment in professional, technical, managerial and sales representative occupations grew at nearly the same rate as the stock of workers with one or more years of college. Employers demonstrated a strong desire to upgrade educational hiring requirements. A shortage developed and the wage premium for college graduates rose to unprecedented levels. Our projections for the 1990s predict that the labor market for college graduates will get even tighter. We expect a bidding war to break out for skilled workers and to see further increases in wage premiums for professional and technical training and for college generally. Early evidence indicates that indeed skill premiums are continuing to grow. Between 1987 and the second quarter of 1990, real weekly earnings rose 2.3 percent for professionals and 2.0 percent for technicians and fell 1.4 percent for managers. Meanwhile, real wages fell 0.5 percent for clerical workers, 3.3 percent for operatives and laborers and 2.5 percent for sales clerks. Real wages of non-

supervisory workers continued to decline in 1990--falling 1.1 percent between 1989 and June 1990.

The growing shortage of professionally trained workers and the rising skill premiums will tend to cause supply to increase more rapidly than we have projected. But the gap between the projected growth of demand and supply is huge. Just to maintain the balance between the growth of supply and the growth of occupational demand that prevailed in the 1980s, itself a period of shortage, it will be necessary to increase in the stock of college graduates in the year 2000 by 2.28 million or, put another way, to raise the number of college graduates entering the labor forces by 286,000 or 29 percent between 1992 and the year 2000. Policy Implications: The social returns to a college education are extremely high and are likely to go even higher. Supply responses to the strong market do not appear to be sufficient to prevent a continuation of the current escalation of college wage premiums. If wage premiums for college educated workers continue to escalate, inequality will continue to grow, American corporations will be at a competitive disadvantage and multinational corporations will probably transfer offshore functions which intensively employ college graduates such as research, product development, design and marketing.

Education is a public function and a public policy response to the shortage appears to be in order. Probably the most cost effective way of ameliorating the shortage is to change immigration policy. There is a long queue of highly skilled university graduates (many of them with graduate degrees from American universities) seeking permanent residence in the United States and it only requires a change in immigration policy to double the number of college educated immigrants to 200,000 a year. The number of American born college graduates can be increased by strengthening academic standards in high schools, by reducing the very high dropout rates in American colleges, by encouraging adults to return to college to complete their degree, by keeping public tuition levels low and by shortening the time required to get a degree by expanding Advanced Placement programs in high schools and encouraging college students to take courses during summers.

There needs to be a special focus on increasing the supply of technically and scientifically trained individuals. Shortages are particularly severe in business and technical

fields and this has resulted in graduates of business and engineering programs receiving much higher wages than graduates who have majored in the humanities, education and social sciences other than economics. These wage differentials have helped induce a very rapid growth in the numbers of students majoring in business and engieering. The wage advantage of graduates in engineering and physical science over those in the liberal arts has fallen a little from the peak reached in 1980, but it remains substantially above the premiums that prevailed during the 1960s.

THE WORSENING SHORTAGE OF COLLEGE GRADUATE WORKERS

Are we heading into an era of strong demand and insufficient supply of college graduate workers? If Workforce 2000 is to be believed, the answer is yes. Others are skeptical, however. Henry Levin and Russell Rumberger have stated:

> In summary, the evidence suggests that new technologies are unlikely to have a profound effect in upgrading the education and skill requirements of jobs, and that most new jobs or job openings will be in occupations that require relatively low skills and education (1987, p.344).[1]

Lawrence Mishel and Ruy Teixeira predict:

> Growth in skill levels from occupational upgrading will actually slow down in the 1990s. In fact, future growth rates in skill levels are likely to be only one-fourth to one-third as fast as those in the recent past. (p. 1)[2]

Jon Sargent of the Bureau of Labor Statistics (BLS) would also appear to be skeptical for he predicts:

> The number of college graduates entering the labor force over the 1986-2000 period is projected to continue to exceed the number of openings in jobs requiring 4 or more years of college education by an average of 100,000 annually, or a total of about 1.4 million (1988, p. 8).[3]

In 1990 the BLS projected the number of graduates entering the labor force over the 1988-2000 period "to exceed the number of job openings in jobs requiring 4 or more years of college by an average of 150,000 annually."[4]

The issue under debate here is the skill and education requirements that are implied by a given occupational employment distribution, not the occupational employment distribution that is projected to prevail in the year 2000. Both Workforce 2000 and the statements quoted above are based on manipulations of BLS projections of occupational employment published in September 1987 and November 1989. Until now, participants in this debate have not questioned the BLS projections. In fact, some participants (those who do not work at the BLS) appear to put so much faith in these projections that they use verbs like "will" and "shall" when describing the year 2000 scenario projected by the BLS's computer.

This paper takes a look at these BLS projections and finds them wanting. In section 1 of the paper it is demonstrated that BLS projections have, in the past,

systematically underpredicted the growth of occupations that require the greatest amount of education and training. In section 2 the paper examines the latest data on occupational growth rates and concludes that the BLS's recent projections of occupational employment growth out to the year 2000 probably suffer from the same bias. A regression analysis of trends in occupational shares is conducted and the forecasts of occupational employment demand in the year 2000 based on these regressions imply substantially faster growth of higher level occupations than the BLS projects.

In section 3 of the paper we do our own examination of the supply/demand balance for college graduates by comparing past and projected percentage rates of change in employment in high skill jobs to actual and projected rates of change in the stock of well educated workers. During the 1980s, employment in professional, technical, managerial and sales representative occupations grew at nearly the same rate as the stock of workers with one or more years of college. Employers wished to increase the proportion of workers in managerial and sales occupations who had a college education but a shortage developed and the wage premium for college graduates rose to unprecedented levels. Our projections for the 1990s predict that the labor market for college graduates will get even tighter.

We conclude the paper with a discussion of its implications for policy. If the supply of college educated workers can not be expanded more rapidly than is projected (either through greater immigration of highly educated skilled workers or by increasing the number of Americans attending and graduating from college), wage premiums for college are likely to continue to grow. Shortages are particularly severe in business and technical fields and this has resulted in graduates of business and engineering programs receiving much higher wages than graduates who have majored in the humanities, education and social sciences other than economics. These wage differentials have helped induce a very rapid growth in the numbers of students majoring in business and engieering. The wage advantage of graduates in engineering and physical science over those in the liberal arts has fallen a little from the peak reached in 1980, but it remains substantially above the premiums that prevailed during the 1960s.

1. The Skill Shortage Debate at the Beginning of the 1980s

The Bureau of Labor Statistics and Levin and Rumberger have been in the business of forecasting occupational employment growth for a number of years. What does the track record of their forecasts look like?

At the beginning of the 1980s there was a lively debate over the effects of technological change on skill demands and the likely supply demand balance for college graduates. The Education Commission of the States, for example, argued in 1982 that:

> Occupational growth throughout the 1980s is projected to expand most rapidly in the higher-skilled, technical occupations. Tomorrow's workers will likely need improved skills in the selection and communication of information. Many of today's skills considered to be of a "higher" level are the potential basic skills of tomorrow.[5]

Basing there judgements on BLS projections published in August 1981, Henry Levin and Russell Rumberger argued to the contrary that:

> The expansion of the lowest skilled jobs in the American economy will vastly outstrip the growth of high technology ones; and the proliferation of high technology industries and their products is far more likely to reduce the skill requirements of jobs in the U.S. economy than to upgrade them (February 1983).[6]

In February 1984, they said, "future job growth will favor service and clerical jobs that require little or no post-secondary schooling and that pay below-average wages."[7]

Parallel disagreements existed over whether college graduates were likely to be in surplus or shortage during the 1980s. During the 1970s college graduates had been in excess supply and many graduates were apparently forced to take jobs in occupations that were not traditionally considered to require a college degree. The ratio of college graduate wages to high school graduate wages fell 11 percent between 1973 and 1979. The Bureau of Labor Statistics projected that this situation would continue in the 1980s. Testifying before the Senate Committee on Labor and Human Resources, Janet Norwood stated:

> College graduates entering the labor force through the 1980s are likely to face job market conditions very similar to those faced by graduates during the 1970s as entrants continued to exceed openings in jobs traditionally sought by graduates (1979).[8]

In 1982 Jon Sargent predicted that "A surplus of between 2 and 3 million college graduates is expected to enter the labor force during the 1980s."[9]

On the other side of the issue was Richard Freeman, the economist who had been the first to call attention to the surplus of college graduates in the 1970s and the resulting declines of college wage premiums. In his 1976 book, The Overeducated American, he presented an empirical model of the college graduate labor market which predicted continued moderate declines of the college wage differential during the 1970s and an upswing during the 1980s. He reiterated this prediction in a 1982 article:

> The most interesting prediction of the model--that of an increase in [the college] enrollments ratio, as well as in [college] salaries in the mid to late 1980s--cannot be examined at this time.[10]

The decade is over so it is now possible to settle these two controversies.

BLS Projections of Occupational Employment Growth in the 1980s

In August 1981 the BLS projected that professional, technical and managerial (PT&M) jobs would increase only slightly more rapidly than total employment during the 1980s. It was estimated that PT&M jobs would account for 28 percent of employment growth between 1978 and 1990 and that operatives, laborers, farm laborers, and service workers (OL&S) would account for 34 percent of employment growth.[11] In November 1983, BLS projected that professional, technical and managerial employment would account for 30.7 percent of employment growth through 1995 from the 1982 base and for 37 percent of the growth from the 1979 base. BLS projected that OL&S would account for 31.5 percent of growth from the 1982 base and 27.9 percent of growth from the 1979 base.[12]

What were the actual patterns of job growth between 1978 and 1989? Professional, technical and managerial jobs, which were 24.9 percent of the nation's jobs in 1978, accounted for 52 percent of the job growth between 1978 and 1989. High level sales representative and manager jobs accounted for another 10 or 11 percent of job growth. Operative, laborer, farm laborer and service jobs, which were 37 percent of jobs in 1978, accounted for only 9 percent of the job growth between 1978 and 1989.[13]

Table 1 presents a detailed comparison of BLS's 1981 projections of occupational employment growth between 1978 and 1990 with actual growth rates between 1978 and 1989. The comparison employs the 1980 Census occupational categories so adjustments were made to the BLS projections to account for the occupations that were switched from

one major occupational group to another.[14] The first column of the table presents the actual percentage growth of occupational employment between 1978 and 1989. The second column of the table presents the low-trend projected percentage growth for 1978 to 1990 that was published by BLS in 1981. The low-trend is used for comparison because actual employment levels in 1989 were very close to BLS's low-trend prediction for 1990. The third column presents the difference between the actual and projected percentage increases for each occupation. The fourth column presents the difference between actual and projected numbers of people in the occupation in 1989. The largest error was in BLS's projection of the growth of managerial occupations. **It underestimated the growth of managerial employment by 36.4 percent of the 1978 level of managerial employment or by 3.4 million jobs. The error in projecting managerial employment was roughly equal to the total number of bachelors and masters degrees awarded in business, marketing and accounting between 1978 and 1989.**[15] The growth of professional employment was underestimated by 1.86 million jobs (17 percent of the 1978 level of professional employment). Operative employment was projected to grow by 14 percent; it fell instead by 10 percent, resulting in an overprediction of 2.2 million jobs. Employment in other services was projected to grow 36 percent; it grew by 24 percent resulting in an overprediction of 1.2 million jobs.[16]

Just as one sided in its testimony on the issue is the recent behavior of occupational wage differentials. The wage premium that employers must pay for skilled workers tells us a lot about the demand/supply situation for skills. If demand for more skilled workers shifts out more rapidly than the supply, the relative wage of skilled workers will rise. And indeed, skilled workers have been getting higher real wages: the increase in real weekly earnings between 1983 and 1989 was 16.1 percent for technicians, 12 percent for professional workers, 1.5 percent for managers, 6.4 percent for sales representative selling commodities outside of retailing and 1.5 percent for sales representatives in finance and business services. If the demand for unskilled workers shifts out less rapidly than their supply, they will tend to suffer declines in relative wages. During the last six years, a period of recovery from a deep recession, real weekly earnings of operators, fabricators and laborers declined 5.3 percent and the real weekly earnings of service workers declined 1.3

percent.[17] Real hourly wages of non-supervisory employees fell 8.1 percent in retailing and 4.4 percent in manufacturing.

BLS Projections of Supply/Demand Balance for College Graduate Workers

What about The Bureau of Labor Statistics' 1980 forecasts of a continuing surplus of college graduates? It is extremely difficult to make accurate forecasts of rates of change of the supply demand balance for college educated labor; much more difficult than projecting occupational employment alone. Small errors in forecasting rates of change of demand or supply can translate into big errors in projecting the gap between supply and demand.

Despite the difficulties, BLS has been publishing biannual projections of the supply demand balance for the past two decades. The starting point of its projections are its forecasts of occupational employment growth. It then projects changes in the proportion of particular occupations that "require a college degree", the number of bachelors degrees to be awarded per year and the annual rates of flow into and out of jobs by workers with a college degree. Comparisons are then made between the projected number of job openings "requiring a college degree" and the projected flow of college graduates seeking work.[18] The record of these projections is presented in column 3 of Table 2.

Quite clearly the BLS effort to project the supply/demand balance for college graduates has been a failure. Such a judgement is possible, because changes in the ratio of young college graduate wages to young high school graduate wages over the projection period provide an ex post criterion for evaluating the accuracy of the projections of supply/demand balance. At the beginning of the 1970s, BLS projected rough balance of supply and demand during the subsequent decade. If the projection had been correct, the relative wage of college graduates should have been stable during the period as indicated by column 4 of the table. In fact, however, the supply of college graduates grew more rapidly than demand and, as a result, the college/high school wage ratio for workers with 1 to 5 years of post-school work of experience fell 6.7-7.6 percentage points by 1980 (see column 5).[19] At the end of the 1970s, BLS projected very large surpluses of college graduates during the subsequent decade. According to their projection, the surplus of college graduates was going to grow at a rate equal to 30 percent of the annual flow of bachelors degrees awarded. If the projections had been correct, the surplus should have

caused the relative wage of college graduates to fall during the subsequent decade. In fact, however, increased demand for college graduates substantially outstripped increased supply and the college/high school wage ratio for those with 1-5 years of experience rose by 23 to 26 percentage points to all time highs. Thus, the projections were much worse than uncorrelated with the truth, they were negatively correlated with the truth.

The problems are much deeper than simple errors in forecasting future occupational employment levels. The description of the present and recent past is wrong as well. It is stated, for example, that 27 percent (6,659,000) of college graduates were "underemployed" in 1988 and that "underemployment" increased by 1,655,000 between 1983 and 1988. Clearly, a measure of "underemployment" for a group that increases simultaneously with the group's relative wage is seriously flawed. One of the problems with the approach is the lack of symmetry in the handling of possible mismatches between educational qualifications and occupation. Workers whose education appears to leave them under qualified to perform their job are not characterized as "undereducated." By ruling out the possibility of undereducation, the conceptual framework makes a conclusion that there are too many college graduates inevitable.

The task that BLS has set for itself--measuring the level and forecasting changes in the absolute number of jobs which "require a college degree"--is just about impossible. The classification of occupations into a "requires a college degree" category is inherently arbitrary and idiosyncratic to the analyst; yet the validity of the whole effort to measure "underemployment" depends on this classification being done correctly in every detail not only for the present but also for ten years in the future. This is impossible for four reasons. First, the occupational coding system used by the CPS and the Census is not reliable and comprehensive enough to allow accurate measurement of a concept like underemployment. Many of the apparent mismatches between occupation and education are the result of errors in reporting occupation. Census Bureau studies have found that between 18.3 and 27.3 percent of the individuals recorded as professionals, technicians or managers in one interview, are recorded in an entirely different major occupational category in a subsequent interview 4 to 7 months later.

Second, there are also substantial errors in measuring educational attainment. Between 5.5 and 9 percent of respondents who are recorded to have more than 16 years of

schooling in one interview are recorded as having fewer than 16 years of schooling in a later interview.[20] Still another problem arises from the fact that about 11 percent of those who tell Census interviewers that they have completed 16 years of schooling also report that they do not have a bachelors or higher degree.[21]

The third problem is that for most occupations, the question "Does it require a college degree?" does not have a yes or no answer. Its a matter of degree. Some employers structure their management jobs in ways that make the skills normally developed in college absolutely essential, at other employers the skills are very helpful, and at still others the skills are of little advantage. The magnitude of the college graduate productivity advantage also depends on the quality of the alternative labor supply. If the competence of those who ended their schooling with high school deteriorates (as it did during the 1970s), the demand for college graduates will increase. The correct answer to the question of whether a college degree is required is, "It depends." It depends on circumstances that analysts and researchers have little knowledge of and no ability to forecast a decade ahead.

The fourth problem is the great heterogeneity of the college graduate category. A psychologist recently asked a community college student who wants to become a teacher, "How many weeks in a year?" She replied "Hmmm.., there are 365 days in a year. I don't know! Oh I'll just double it...730." This student is no doubt an extreme case, but not as extreme as one would like. **More than 40 percent of young adults with Associates and/or Bachelors degrees cannot calculate change from a menu. Seventeen percent of young college graduates read at a level below the typical 11th grader.[22] How can someone with an 11th grade reading level be considered underemployed in a secretarial, a carpentry or retail sales job?** We conclude that the BLS method of evaluating the balance between supply and demand of college graduates is a blind alley.

If something useful is to be said about the balance between supply and demand, one must put both price and quantity data to work and give up on the idea of measuring how many people are "underemployed."

2. An Evaluation of BLS Occupational Projections for 2000

The projections of occupational skill demands for the year 2000 used by Workforce 2000, by Levin and Rumberger and by Sargent are based on the same flawed methodology that failed to predict the strong growth of high skill occupations during the 1980s. It is, therefore, reasonable to hypothesize that the latest projections will understate upskilling trends of the 1990s. If so, the forecasted shortage of skilled and educated workers is probably even more serious than Workforce 2000 projects.

One can see this unfolding in Table 3. The actual growth shares calculated for 1986 through 1990 presented in columns 1 and 2 may be compared to BLS's forecasted growth shares for 1986 to 2000 in column 3 and for 1988 to 2000 in column 4.[23] BLS forecasts that managerial, professional and technical jobs will account for 41.4 and 44.5 percent respectively of job growth to the year 2000.[24] Actual employment growth in the latter half of the 1980s has turned out to be more heavily weighted toward high skill jobs than projected. The three occupations listed above accounted for 52 percent of job growth between 1986 and 1988 and 52.6 percent of growth between March 1988 and March 1990. In 1987 and 1989, BLS projected that operative, laborer, farm laborer and service jobs would account for 23.3 and 20.5 percent respectively of job growth to the year 2000. These low skill jobs did account for 25.1 percent of job growth between 1986 and 1988 out only 11.1 percent of job growth between 1988 and 1990.

Still another way to evaluate BLS projections is to compare their predictions to forecasts based on a regression analysis of changes in occupational employment shares during the 1972 to 1989 period. The source of the yearly data on occupational employment is the Current Population Survey. Consequently, the dependent variable is the share of workers who describe themselves as being in a given occupation not the share of jobs that are in a particular occupation as described by employers. The advantage of CPS data is that there is no double counting of workers with more than one job and there is no danger of missing jobs being generated at new companies as there is with data derived from establishment surveys. For supply/demand comparisons CPS data has the further advantage of also being the source of data on educational attainment. This means that under enumeration of undocumented workers and homeless individuals have little effect on

estimates of the balance between supply and demand because these individuals are excluded from both sides of the equation. The disadvantage of CPS data is the possibility that self reports of occupation are less accurate than data collected from employers (see Appendix A for a detailed comparison of CPS and OES data on the occupational composition of the workforce).

Changes in occupational employment shares was assumed to follow a logistic growth path. The logistic function was assumed to have a ceiling of 20 percent. The ceiling was set at the rather low 20 percent level because this fit the data slightly better than a ceiling set at 25 percent and because it would build in a slow down in the rate of growth for three large fast growing occupations--managers, professionals and sales workers. The variables that were found to have significant effects on occupational shares during the 1972 to 1989 period were: a simple trend, the unemployment rate, the merchandise trade deficit as a proportion of GNP, and the ratio of personal computers used in business to total employment. The personal computer variable captures the acelerated introduction of computer technology during the 1980s as well as the direct effects of microcomputers. Full details on model specification, the results obtained and how the projections were calculated is given in Appendix B.

In order to predict occupational shares for the year 2000, we must first project unemployment, the trade deficit and the ratio of microcomputers used by business to employment in the year 2000. Since the foreign debt of the US cannot grow at current rates indefinitely and the growing debt must eventually be serviced by exporting more goods than are imported, our projections assume that merchandise trade will be in balance in the year 2000. It was further assumed that unemployment will be 5.5 percent and the ratio of microcomputers to employment will increase from its 1989 level of 21 percent to 45 percent in 2000.[25]

The results of these projections are summarized in column 5 of Table 3. We project that growth of managerial, professional and technical jobs will remain strong and we expect these occupations to account for nearly 70 percent of growth of occupational demand between 1988 and 2000. BLS, by contrast, projects that the growth of managerial and professional jobs will slow and that these three occupations will account for only 44.5 percent of job growth. We are projecting absolute declines of employment for raft

workers, factory operatives, transport operatives, laborers and private household workers. Protective service employees are projected to grow rapidly but remaining service occupations are projected to grow at roughly the same rate as total employment. We project that low skill jobs--operatives, laborers (farm and factory), service workers and sales clerks--will account for only about 10 percent of job growth to the year 2000. BLS, by contrast, projects that 26 percent of job growth will be in these low skill occupations.

It is also useful to contrast our projections with the actual shares of job growth for 1986 to 1990 that are reported in columns 1 and 2 of the table. Our regressions do not predict that differentials in growth rates between high skill and low skill jobs will be larger in the 1990s than in the 1980s. Nevertheless, we project that the high skill share of job growth between 1990 and 2000 will be substantially higher than it was during the 1980s. The reason for this is the expected slowdown in the growth of the total labor force during the 1990s due to the baby bust of the early 1970s. Since all occupations are expected to grow more slowly in the 1990s than in the 1980s, the occupations which are a rapidly declining share of all jobs are projected to experience absolute declines in employment. Growth of high skill occupations is projected to slow as well, but their share of total job growth is projected to increase because the denominator, total job growth, has been reduced by an even larger percentage.

3. The Supply/Demand Balance for College Educated Workers

A Framework for Interpreting Data on the Supply/Demand Balance

The approach employed in this paper is simply to compare percentage changes in supply and demand over time and interpret these changes in the light of contemporaneous shifts in the wage premium for college.[26] Changes in the employment of college graduates can be decomposed into two components: (1) shifts that can be explained by changes in the occupational composition of employment and (2) changes in college graduate share of individual occupations. The growth of the engineering profession from 0.13 percent of the workforce in 1900 to 1.6 percent of the workforce in 1988 is an example of the first source of change. When one projects future occupational employment, one is effectively also projecting this source of change in the demand for college graduates. Historical rates

of growth of occupational demand for college graduates are given in the first two rows of Table 4. The second row of the table contains rate of change data for an index of occupational demand for college graduates that was calculated by multiplying employment in each major occupational group in year t by the 1988 proportion of workers in that occupation group who had a college education and then summing across occupational groups.[27]

The third and fourth rows of table 4 present data on annual rates of change for the supply of college educated workers. Rates of change for the difference between ex post supply and ex post occupational demand are given in the fifth and sixth rows of the table. The normal state of affairs is for college graduate supply to increase more rapidly than an index driven by shifts in occupational employment shares and for the difference to be made up by increases in skill and educational requirements of specific jobs.

Engineers work at a knowledge frontier that has been shifting out at an extraordinary pace during the twentieth century. Consequently, the skills and training required to perform satisfactorily in this occupations have increased. At the beginning of the century most engineers did not have a bachelors degree; now a bachelors degree is required of just about all new entrants and 20 percent of engineers have a masters degree. This demand driven escalation of the educational requirements for being an engineer illustrates the primary reason why college graduate shares of many occupations have increased over time.

This is not, however, the only reason why the share of college graduates in an occupation might increase. During a period when college graduates are in abundant supply, some college graduates may find themselves forced into lower paying occupations which are thought to not require the skills developed in college. The signal that this is happening is declining wage premiums for recent college graduates. If, on the other hand, wage premiums for college graduates and professional occupations are stable or growing at the same time as the share of college graduates in specific occupations is rising, it is reasonable to infer that an outward shift of demand within occupations not an increase in supply caused the increase. Rows 7 and 8 of the table provide the data on annual rates of change in the college/high school wage ratio that is essential for interpreting changes in the supply minus occupational demand index reported in rows 5 and 6.

Interpreting the Past

During the 1960s the relative wage of college graduates rose, even though managerial, professional, technical and sales representative and manager (MPT&SR) jobs grew 1.4 percent per year more slowly than the number of college graduates in the labor force. This means there was an exogenous outward shift in demand for college graduates holding occupation constant of substantially more than 1.4 percent per year during this period. Despite the rise in their relative cost, firms tended to expect new hires to have more schooling than had been expected in previous decades.

The leading edge of the baby boom generation graduated from college in 1970. The Vietnam War induced a large share of this generation to attend college, and the result was that the number of college graduate workers grew at a 6.22 percent annual rate during the 1970s. The number of workers with 12 or fewer years of schooling grew as well so the ratio of college graduate supply to non-college supply grew at a rate of 4.88 percent per year (see row 10). The number of college graduate workers grew 2.8 percent (see row 6) more rapidly than the college graduate demand index and relative supply of college graduates grew 3.34 percent (see row 11) more rapidly than relative occupational demand.[28] Exogenous demand driven increases in the college graduate shares of particular occupations were not sufficient to make up this gap. A surplus of college graduates developed, wage premiums for college and professional occupations fell and some graduates were forced into lower level occupations.

During the 1980s, the number of college graduates in the labor force grew 2.46 percent per year more slowly than in the 1970s.[29] Growth rates of relative college graduate supply were 1.36 percent per year below their level during the 1970s (see row 10) while relative occupational demand for college graduates continued to expand at the rates that prevailed during the 1970s. This meant that college graduate supply was growing only 0.3 to .9 percent faster than the occupational composition demand indexes. Exogenous increases in demand for college graduates within occupations must have been quite strong, for the wage premium for recent college graduates increased 2.8 percent per year between 1979 and 1987 and the premium for all graduates rose 1.5 percent per year. The first eight years of the 1980s were clearly a period of shortage for college graduates.

Projecting the Future

We project that percentage growth rates of the supply of college graduates will be substantially smaller during the twelve year period beginning in 1988 than in the previous decade. Our forecast of the average annual number of BAs awarded is 1,001,000. This is 1.3 percent greater than the latest Department of Education projection for this period. This forecast implies that annual percentage rates of growth in the supply of college graduates will be 1.26 percentage points lower than in the 1980s.[30] This precipitous decline in the growth of college graduate supply is caused by three phenomena: falling achievement levels and high non-completion rates in American high schools, the projected decline in the size of the 20-30 year old age cohort which accounts for most students receiving BAs and the growing number of college educated workers reaching retirement age during the 1990s.

The growth of demand is also projected to slow, but only by 0.75 percent per year. In other words, the shortage of college graduates that prevailed in the 1980s will definitely not end and will almost certainly get worse. This forecast of a worsening shortage of college graduates does not depend on selecting a particular forecasting model or a particular scenario regarding the trade deficit or the spread of microcomputers.

Other ways of measuring the gap between projected supply and demand for college graduates yield similar conclusions. In rows 9-11 of the table, we present estimates of growth rates of the relative college graduate supply and relative occupational demand for college graduates. The projected slowdown in the growth of relative occupational demand is only 0.05 percent per year, considerably smaller than the 0.36/0.76 percent projected decline in the growth of the relative supply of college graduates.

The BLS projections imply a major reduction in the growth of occupational demand for college graduates relative to those with 12 or fewer years of schooling to levels not seen since the 1950s. If BLS projections are correct and within occupation demand for college graduates continues to escalate at the rates that prevailed in the 1980s and the 1950s, the college graduate labor market will remain as tight as it was in 1988 and college wage premiums will probably either continue to rise slowly or stabilize at current levels. The BLS projection of slowly growing relative occupational demand (.61 percent per year) and modestly growing relative supply (2.7 to 3.1 percent per year) is very similar to the

pattern that prevailed in the 1950s, a period of slowly rising relative wages for college graduates.

During the 1980-88 period employers demonstrated a strong desire to upgrade educational hiring requirements. Despite a 24 percent increase in the wage cost of recent college graduates relative to young high school graduates, employers increased the ratio of college graduates workers to the occupational demand index by 7.2 percent. During the 1990s, the supply of college graduates is not going to be sufficient to allow further general increases in hiring requirements. We project that the supply of college graduates will, for the first time this century, grow at almost the same rate as demand created by shifts in the occupational composition of employment. During the 1990s a rise in the educational qualifications required by one group of employers will force other employers to lower the educational qualifications that they expect of new hires. We predict a bidding war will break out and further increases in wage premiums for professional, technical and business training. Early evidence indicates that indeed skill premiums are continuing to grow. Between 1987 and the second quarter of 1990, real weekly earnings rose 2.3 percent for professionals and 2.0 percent for technicians and fell 1.4 percent for managers. Meanwhile, real wages fell 0.5 percent for clerical workers, 3.3 percent for operatives and laborers and 2.5 percent for sales clerks. Real wages of non-supervisory workers continued to decline in 1990--falling 1.1 percent between 1989 and June 1990.[31]

4. Policy Implications of the Skills Shortage

For policy, what matters is (1) the balance between current supply and current demand as indicated by the magnitude of the college wage premium, (2) the balance between forecasted growth of supply and forecasted growth of demand and (3) the magnitude of the changes in wage premiums necessary to bring ex ante differences in supply and demand into ex post equilibrium. Let us begin by examining the current balance between supply and demand. The wage premiums for obtaining a college degree grew substantially during the 1980s and are now at historic highs. This implies that either the demand for college graduates grew more rapidly than supply or the demand for high school graduates grew much less rapidly than their supply. Either way, social rates of

return to a college education have seldom been higher. This implies that public policies which increase college attendance and completion (eg. better academic preparation in high school, low tuition at state colleges and larger grants for needy students) now yield larger benefits than ever before.

Possible Market Responses to the Skill Shortage

The growing shortage of professionally trained workers and the rising skill premiums will tend to cause supply to increase more rapidly than we have projected. But the gap between the projected growth of demand and supply is quite large. Just to maintain the balance between the growth of supply and the growth of occupational demand that prevailed in the 1980s, itself a period of shortage, the growth rate of college graduate labor supply must increase by 0.51 percent per year. This involves increasing the stock of college graduate workers 2.28 million above the level projected for the year 2000 or, put another way, a 286,000 (29 percent) increase in the annual flow of bachelors degree recipients into the labor force between 1992 and the year 2000. Even if an increase in the supply of college graduates of this magnitude were to occur, it would not prevent further increases in the college wage premium. All it is likely to do is slow the rate of increase.

College attendance and graduation rates have risen recently in no small measure due to the strong market for college graduates. Our projections take past responses into account and in addition forecast a further 5 to 10 percent increase in the ratio of BAs to 22-24 year olds during the latter half of the 1990s. Even much larger responses to the improved incentives would not change the basic situation; a 15-20 percent increase rather than a 5-10 percent increase in college graduation rates, for example, would raise the number of college graduates by only 100,000 annually and reduce the number of workers with 12 or fewer years of schooling by a similar amount.

Another possible natural market response to the strong demand for college graduates is further increases in labor force participation rates. The participation rate of male college graduates 25 to 54 years old was 96.7 percent in 1988, so there is not much room for an increase. Participation rates for female college graduates 25 to 54 years old were 81.5 percent so significant increases in labor supply are possible here. A five percent increase

in labor force participation rates of women with a college degree would increase the supply of college graduate labor by 850,000 in the year 2000 (an increment of 106,000 per year between 1992 and 2000). Still another way to increase labor supply is to postpone retirement. In 1988 labor force participation rates for 60-64 year old college graduates were 65 percent for males and 46 percent for females. Phasing in a two year increase in the age at which all college graduates retire would have the same impact as an 81,000 increase in the annual number of BAs awarded between 1992 and 2000. Even if all three of these possibilities became reality by the year 2000 (and there is no guarrantee than any of these responses will occur), there would still be strong labor market pressures for further increases in college wage premiums.

Possible Policy Responses

The social returns to a college education are extremely high and are likely to go even higher. Supply responses to the strong market do not appear to be sufficient to prevent a continuation of the current escalation of college wage premiums. wage premiums for college educated workers continue to escalate, inequality will continue to grow, American corporations will be at a competitive disadvantage and multinational corporations will probably transfer offshore functions which intensively employ college graduates such as research, product development, design and marketing. Hewlett-Packard recently announced, for example, the relocation of the headquarters of its personal computer division from the United States to Grenoble, France. The resulting escalation of wage premiums for professional and managerial workers will probably slow down the growth of these occupations and our projections may well not be realized. Absent a policy response to stimulate the supply of college graduates, difficulties in recruiting high skill workers will force the economy off the upskilling path generated by the growth scenarios we have simulated and the rapid upskilling of the 1970s and 1980s may slow considerably.

Education is a public function and a public policy response to the shortage appears to be in order. Cost effective ways of stimulating a substantial increase in the supply of college graduates are needed. Probably the most cost effective way of ameliorating the shortage is to change immigration policy. There is a long queue of university graduates (many already fluent in English and some with degrees from American universities) seeking permanent residence in the United States and it only requires a change in immigration

policy to double the number of college educated immigrants to 200,000 a year.[32] If total immigration were held constant, the supply of workers with limited amounts of education would be reduced simultaneously.

The number of American born college graduates can be increased by strengthening academic standards in high schools, by reducing the very high dropout rates in American colleges,[33] by encouraging adults to return to college to complete their degree, by keeping public tuition levels low and by shortening the time required to get a degree by expanding Advanced Placement programs in high schools and encouraging college students to take courses during summers. The "increase the home grown supply" approach has two advantages: (1) since college training occurs in the US, it will probably be adapted to the requirement of American jobs and (2) the number of unskilled workers is decreased at the same time as the number of skilled workers is increased.

The Growing Demand for Graduates Trained in Business and Technical Fields

There needs to be a special focus on increasing the supply of individuals with training in business, technical and scientific fields. The shortage of college graduates appears to be particularly acute in these fields. Evidence of this shortage is provided by the very large salary premiums commanded by graduates who have majored in physical science, engineering and business. The first four columns of Table 5 present data from the College Placement Council on how field of study effected the starting salaries received by college graduates whose placement outcomes were reported to the school's placement office for 1963, for 1969-70, for 1979-80 and for 1989.[34] The differences across field are sometimes as large as the wage gains accruing to those obtaining higher level degrees. Engineers currently receive 38-53 percent higher starting salaries than humanities majors and computer scientists 54 percent higher starting salaries than majors in sociology, psychology and government. Starting salaries for MBAs with less than a years work experience prior to beginning their program are 58 percent higher than the starting salaries of college graduates who have majored in the liberal arts.

Data on the earnings of college graduates years after leaving school solidify the finding that majors in humanities, education and social sciences other than economics earn far less than graduate in business and engineering. The salaries of business majors tend to

catch up with the engineers, but education and liberal arts majors remain far behind those with engineering and business degrees even when the quality of one's college is controlled. The seventh and eighth columns of Table 5 present data on the relationship between college major and yearly earnings of men aged 21 to 70 from the 1967 Survey of Economic Opportunity. Holding college rank constant, undergraduate business majors earn 31 percent more and engineers 51 percent more than humanities majors. Men with masters degrees in business or engineering earn 62-65 percent more than those with a bachelors degree in humanities[35] The ninth column of Table 5 presents 1984 data on monthly earnings by major for men and women combined.[36] Physical science majors earned 93 percent more, engineers earned 114 percent more and business majors 103 percent more than humanities majors. Workers with masters degrees in an engineering field earn 2.69 times and MBAs earn 2.98 times as much as those with bachelors degrees in humanities. Education majors earned slightly less than humanities majors.[37]

These large differentials by college major remain even when one controls for family background and life goals expressed in high school. The fifth and sixth columns of the table present estimates of the effects of college major on 1979 hourly earnings of young men and women who had graduated from high school in 1972 while controlling for family background and the student's preferences regarding life goals (eg. the importance of being wealthy and of helping others.[38] Humanities, social science and education majors received the lowest wage rates. Male engineers obtained 34 percent more than male humanities majors. Male business majors were paid 13 percent more. Female engineers were paid 27 percent more than female humanities majors and female business majors were paid 25 percent more. Clearly, the market values some of the skills developed in college much more highly than others.

Partly because of these large wage differentials, there has been a dramatic growth in the relative supply of graduates in engineering, computer science and business administration. Figures 1 and 2 present cumulative proportions of the bachelors degrees awarded by college major arranged in a hierarchy that roughly corresponds to the average wage of males or females who received their bachelors degree in that field. Starting at the bottom of figure 1 for males, the fields are education, humanities/social science, natural science, business administration, engineering and computer science. Reading up from the

bottom of the figure we see that in 1973 degrees in education, humanities and social science accounted for 50.5 percent of bachelors degrees awarded to men and 83.5 percent of the bachelors degrees awarded to women. By 1986 these percentages had dropped to 35.1 percent and 54.7 percent respectively. Reading down from the top we see that, for males degrees in engineering, computer science and business which accounted for 33.2 percent of all BA's in 1973 rose to 50.8 percent of all bachelors degrees in 1986. For women degrees in engineering, computer science and business grew from 3.5 percent to 26.6 percent of degrees awarded. As a result, the ratio of degrees awarded in engineering and computer science to degrees awarded in humanities, social science or education grew 5.2 percent per year in the 1970s and 10.7 percent per year in the 1980s. The ratio of business degrees to humanities, social science, and education degrees grew 5.8 percent per year in the 1970s and 5.1 percent in the 1980s.

The very rapid growth during the last 20 years of the relative supply of college graduates trained in business and engineering fields has surprisingly not significantly diminished the wage premiums these fields command. Trends in wage premiums for business and technical degrees can be followed by comparing the first four columns of Table 5. Relative to humanities majors, wage premiums for engineering degrees grew dramatically during 1970s and then dropped slightly by 1989, but remained significantly above the levels that had prevailed in the 1960s. Wage premiums for chemistry and mathematics majors over humanities majors rose from 17 percent in the 1960s to 36 percent in 1979-80 and then fell to 23 percent in 1989. Starting wage premiums for BBAs rose from essentially zero in the 1960s to 10-11 percent during the late 1970s and 1980s. The starting wage premium for masters level training in business and engineering also appears to be substantially greater now than it was in the 1960s.

Trends in the effect of college major on salaries of college graduates who have been working for many years can be examined by comparing columns 8 and 9 of Table 5. These data suggest that the premiums for training in business and technical fields were significantly higher in 1984 than in 1967. The evidence is pretty nearly overwhelming. The economic payoff to business and technical education is considerably greater than the payoff to majors in the humanities and social sciences other than economics and the advantage of these fields of study has not diminished appreciably in the face of the

massive increase in the number of students choosing these fields of study. Clearly, there has been a substantial shift in market demand favoring graduates with business and technical degrees over graduates with liberal arts and education degrees. It would appear that the market will be able to absorb even larger numbers of graduates in business and engineering without significant trouble. Therefore, public policy should not attempt to discourage this shift of students into business and engineering and should, in fact, facilitate it by focussing special effort on improving math, science and economics instruction in the hopes of increasing the pool of students entering scientific, technical and business careers.

Figure 1

Proportion of Degrees Awarded (by subject)

Bachelor's Awarded to Males

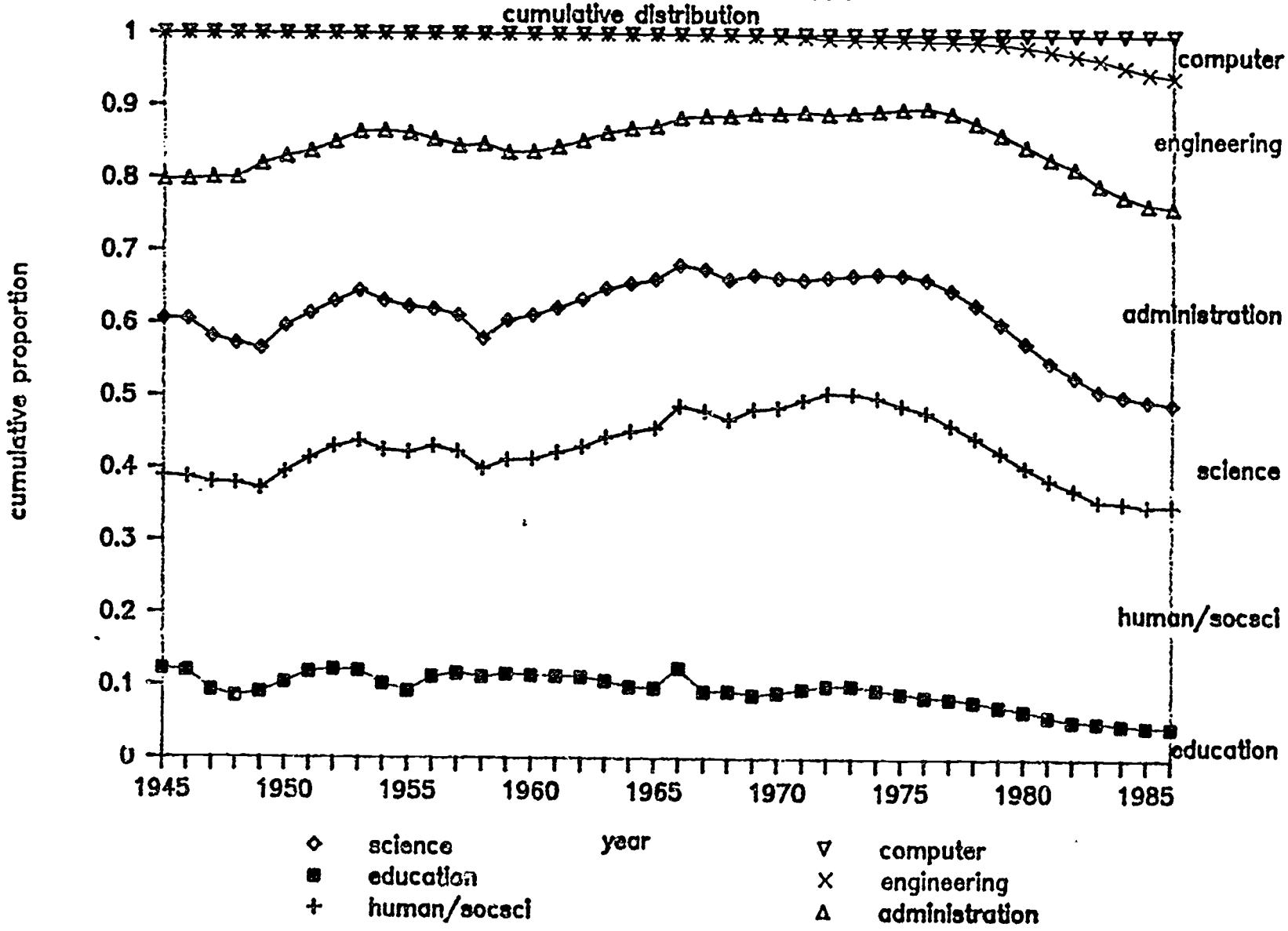

Figure 2

Proportion of Degrees Awarded (by subject)

Bachelor's Awarded to Females

cumulative distribution

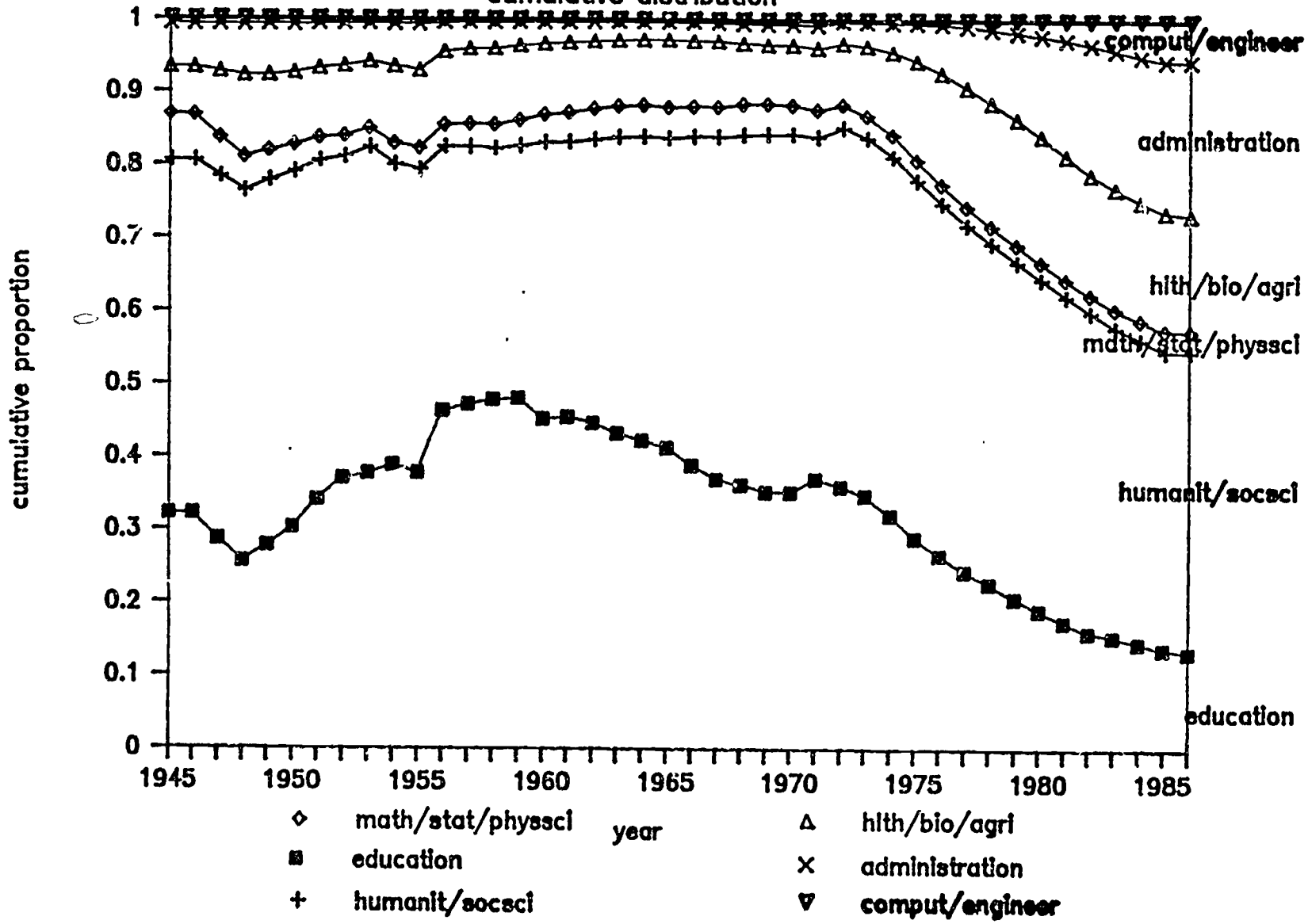

Table 1

Comparison of Actual and Projected Growth of Major Occupational Groups in the 1980s

Major Occupation	Actual Growth Rate 1978-89	BLS Projected Growth Rate 1978-90	Actual Minus Projected as Percent of Base	Actual Minus Projected ('000s)	Share of Employment Increase
Total	22.1%	22.5%	-.4%		21,294
Exec., Admin., Pub. Admin.	56.7	20.3	36.4	3401	25
Professional	42.3	25.3	17.0	1858	22
Technical	45.8	41.8	4.0	100	5
Sales Occupations	36.7	26.3	10.4	1070	18
Administrative Support	18.4	23.6	-5.2	-809	13
Protective Service	35.9	32.3	3.6	52	2
Private Household	-26.1	-15.3	-10.8	-127	-1
Other Services	24.3	36.0	-11.7	-1198	12
Precision Production, Craft	13.9	23.9	-10.0	-1214	8
Machine Operators	-10.0	14.1	-24.1	-2209	-4
Transportation Operatives	7.9	20.4	-12.5	-566	2
Laborers	-3.9	16.9	-20.8	-1057	-1
Farm, Forestry, Fish	-7.9	-13.1	5.2	193	-1

Source: Data on the actual levels of employment is from Employment and Earnings, Jan. 1984, p. 14, and Jan. 1990. Information on the changes in occupational definitions in 1982 is from Gloria Peterson Green, Khoan tan Dinh, John A. Priebe and Ronald R. Tucker, "Revisions in the Current Population Survey Beginning in January 1983," Employment and Earnings, February 1983, pp. 7-15. Projected low trend percentage growth is from Max Carey, "Occupational Employment growth through 1990," Monthly Labor Review, August 1981, pp. 42-55. The comparison employs the 1980 Census occupational categories so adjustments were made to the BLS projections to account for the occupations that were switched from one major occupational group to another.

Table 2
BLS Projections of the Supply/Demand for College Graduates
and
Subsequent Changes in the College Wage Premium

When Published	Projection Period	Projected Avg. Annual Surplus (in 1,000's)	Implied Chg. in CG/HS Wage Ratio	Actual Chg. in CG/HS Wage Ratio
1970	1968-80	8	Stability	- 6.7%
1972	1970-80	20	Stability	- 7.6%
1974	1972-85	62	Stable/Decline	+14.2%
1976	1974-85	86	Stable/Decline	+18.9%
1978	1976-85	300	Big Decline	+23.2%
1980	1978-90	275	Big Decline	+26.5%
1982	1980-90	300	Big Decline	+23.6%
1984	1982-95	300	Big Decline	
1986	1984-95	200	Decline	
1988	1986-2000	100	Small Decline	
1990	1988-2000	150	Decline	

Source: The record of past BLS forecasts of the supply demand balance is from an unpublished BLS memorandum. The data on subsequent changes in the ratio of college and high school wages for workers with 1 to 5 years of experience is from Lawrence Katz and Kevin Murphy, "Changes in Relative Wages, 1963-1987: Supply and Demand Factors," 1990, which is to published in the Quarterly Journal of Economics next year.

Table 3

Occupational Shares of Employment Growth

	Actual		Projected		
	1986-88	1988-90	BLS 1986-2000	BLS 1988-2000	Bishop & Carter 1988-2000
Managerial	29.3%	20.9%	17.3%	17.8%	34.8%
Professional	19.8	22.1	17.9	20.4	26.7
Technical	2.9	9.6	6.1	6.3	8.2
Sales Reps. & Mngrs.	6.8	6.9	10.3	10.0	9.9
Sales Clerks	2.5	10.5	8.4	5.9	7.8
Clerical	9.7	10.5	9.6	12.3	13.5
Craft	4.8	4.6	7.7	7.7	- 1.4
Factory Operators	3.8	- 4.9	- 1.5	- 2.7	- 9.0
Transportation Oper.	5.0	2.0	2.3	3.2	- .1
Laborers	3.4	4.0	1.3	.6	- 2.2
Private HH	- 1.3	- 2.4	- .1	- .2	- 1.3
Protective Service	2.9	4.2	2.7	2.5	3.8
Other Service	10.5	12.1	18.7	17.2	11.7
Farm Managers	- 0.9	- .3	- 1.4	- 1.3	- 1.4
Farm Laborer	+ 0.8	.1	.6	.4	- 1.1
Total	100.0	100.0	100.0	100.0	100.0
Total Employment Growth	5371	4226	20929	17590	17590
Share of Managers Professionals & Technicians	52.0%	52.6%	41.4%	44.5%	69.8%
Share Managers, Prof., Tech., Sales Rep. & Sales Mgrs.	58.8	59.2	51.7	54.4	79.7
Share Operatives, Laborers, Farm Laborers & Service	25.1	11.1	23.3	23.5	1.9
Share Operatives, Laborers, Farm Lab., Service & S. Clerks	27.6	21.6	32.3	26.4	9.7

Table 4
Annual Growth of College Graduate Demand, Supply and College Wage Premiums

	1950-60	1960-70[a]	1972-80[a]	1980-88	Projected 1988-2000 Bishop & Carter	Projected 1988-2000 BLS
Demand Indicators						
Prof, Tech, Man. & SalesRep Emp.	2.69	3.00	3.92	3.45	2.49	1.7
Occup. Demand for College Graduates[d]	2.29	2.93	3.43	2.89	2.14	1.6
Supply						
College Graduate LF (16+ yrs)	4.96	4.74	6.22	3.76[f]	2.50	2.5
College Educated LF (13+ yrs)	4.30	4.62	6.11	3.63	2.1/2.5	2.1/2.5
Supply minus Demand						
College Grad/Prof, Tech, Man & SReps	2.27	1.34	2.30	.31	.01	0.8
College Grad/C.G. Occ. Demand	2.67	1.41	2.79	.87	.36	0.9
College/HS Wage Ratio						
All Exp. Levels	?	1.1[b]	-1.4[b]	1.5[b]	?	?
1-5 Years Experience	1.2[c]	0.5[c]	- .9[b]	2.8[b]	?	?
Relative College Supply/Relative Occ. Demand						
CG Occ Dem/LE High School Occ Dem[e]	.66	1.58	1.54	1.52	1.46	0.61
Coll Grad Supply/LE HighSchool Sup.	3.06	3.53	4.88	3.51	2.7/3.1	2.7/3.1
CG Supply/LE High School Supply / CG Occ Dem/LE High School Occ Dem	2.40	1.95	3.34	2.00	1.24/1.64	2.1/2.5

[a] Data sources are not comparable before and after 1972 because of changes in occupational coding and because prior to 1972 data on the educational breakdown of the workforce is for individuals above age 18 rather than for those over 16 as in the period after 1972. Rates of change are calculated for periods for which consistently defined data are available.

[b] Annual rates of change in the college/high school wage ratio are for 1963 to 1971, 1971 to 1979 and 1979 to 1987. Lawrence Katz and Kevin Murphy, "Changes in Relative Wages, 1963-1987," 1990, forthcoming Quarterly Journal of Economics.

[c] Annual rates of change for the ratio of yearly earnings of 25-34 year old white male college grads to 20-29 year old white male high school grads. Dieter Marenbach, "Rates of Return to Education in the United States from 1939 to 1959." Stanford Univ. PhD Dissertation, University Microfilms, 1973, p. 89-90 and 1970 Census.

[d] Occupational demand for college graduates index was calculated by multiplying the proportion of the occupation that had a college degree in 1988 by the actual or projected number of employees in each occupation and summing across occupations.

[e] Relative college graduate occupational demand was calculated by dividing the occupational demand index for college graduates by an occupational demand index for workers with 12 or fewer years of schooling.

[f] The 4.18 percent per year growth of workers reporting college degree to CPS interviewers has been lowered to 3.76 percent per year because over reporting of educational attainment went up substantially during the period. See footnote 29.

Source: Occupational employment data is from Historical Statistics of the U.S., D184,D185 & D359-D370 and from Deborah Pisetzner Klein, Employment and Earnings, Jan. 1984 & Jan 1990. Data on the educational breakdown of the Labor force is from Handbook of Labor Statistics, Table 65, 1982 and from the 1950 Census, Special Report on Occupation, Table 11.

Table 5
Wage Premiums by College Major
(Relative to Bachelors Degree in Humanities)

	Starting Salaries 1963-89[a]				Hourly Earnings of 25 Year Olds in 1979[b]		Median Earnings Males age 21-70 BAs in 1966[c]		Average Monthly Earnings in 1984[d]
	Year						Medium Rank College	Col.	Both Sexes
	63	69-70	79-80	89	Male	Female			
Bachelors in Low Wage Major									
Humanities	0	0	0	0	0	0	0	0	0
Social Sciences					2%	5%	15%	14%	—
Economics	—	—	8%	15%	ns	ns	ns	ns	111%
Other Social Sciences	0	0	-1	-1	ns	ns	ns	ns	28
Education	—	—	—	-13	—	5	2	-9	-6
Biological Sciences	—	—	—	23	0	28	4	-11	12
Agriculture	—	—	—	-2	ns	ns	ns	ns	45
Health	—	—	—	36	ns	ns	—	—	12
Bachelors in High Wage Major									
Physical Science	17	17	36	23	15	35	31	28	93
Mathematics	18	15	36	23	ns	ns	ns	ns	68
Engineering					34	27	51	52	114
Chemical Eng.	23	28	67	53	ns	ns	ns	ns	ns
Electrical Eng.	27	24	56	43	ns	ns	ns	ns	ns
Industrial Eng.	20	21	53	38	ns	ns	ns	ns	ns
Mechanical Eng.	24	23	57	42	ns	ns	ns	ns	ns
Computer Science	—	—	44	33	19	13	—	—	ns
Business					13	25	32	28	103
Accounting	10	17	21	21	ns	ns	ns	ns	ns
Other Business	0	2	11	10	ns	ns	ns	ns	ns
Masters in Business Admin.[e]	27	47	66	58	—	—	—	62	198%
Masters in Engineering[f]	50	45	78	67	—	—	—	65	169%

[a] Percentage differential between the starting salary in the designated major over that received by humanities majors. The College Placement Council "Inflation and the College Graduate" 1985 and CPC Salary Survey, Sept. 1989.

[b] Percentage differential implied by regressions predicting hourly wage rate of college graduates who have been out about 3 years controlling for degree and preferences using 1835 observations from Class of 1972 data. Daymont and Andrisani, "Job Preferences, College Major and the Gender Gap in Earnings," JHR, 1984, 408-428.

[c] Percentage differential for median yearly earnings of male BA holders with designated major (and MBAs and Masters in Engineering) relative to median earnings of humanities majors. Current Population Reports, P-20, No. 201.

[d] Percentage differential for mean monthly earnings of BA holders with designated major (and MBAs and Masters in Engineering) relative to earnings of humanities and liberal arts majors. Current Population Reports, P-70, No. 11, p. 13.

[e] CPC starting salary data is for MBAs with non-technical undergraduate degrees and less than one year of work experience before starting the program.

[f] CPC starting salary data is an unweighted average of chemical, electrical and mechanical engineers. Data for working adults is for all masters level engineers combined.

Appendix A

Occupational Employment in 1988
From Two Different Surveys

	OES	CPS	OES-CPS (000's)
Executive & Administrative	10.25%	12.37%	-2112
Professional	12.99	13.02	-346
Technical	3.27	3.06	346
High Level Sales	5.08*	6.63	-1614*
Retail Sales	6.19*	5.33	1183*
Clerical	17.84	15.89	2808
Protective Service	1.80	1.69	185
Private Household	.76	.79	-7
Other Services	13.08	10.85	2969
Precision Production, Craft	11.99	11.89	495
Machine Operatives	6.33	7.06	-604
Transport Operatives	3.90	4.20	-219
Laborers	4.14	4.23	28
Farms, Forestry & Fisheries			
Owners & Managers	1.07	1.12	-14
Laborers	1.89	1.87	+89
Total	100.00	100.00	3136
Professional, Technical & Managerial	25.01	28.41	-2112
Professional, Technical & Managerial and Sales Representatives and Managers	30.99	35.04	-3726
Operatives, Laborers, Farm Laborers and Service Workers	31.90	30.69	2396
Operatives, Laborers, Farm Laborers, Service Workers and Retail Sales Clerks	38.09	36.02	3579

APPENDIX B

The growth of occupational employment shares was assumed to follow a logistic growth path. The logistic function was assumed to have a ceiling of 20 percent. The ceiling was set at the rather low 20 percent level because this fit the data slightly better than a ceiling set at 25 percent and because it would build in a slow down in the rate of growth for three large fast growing occupations--managers, professionals and sales workers.

In our preferred model, the log of the ratio of the "j"th occupation's share of employment in year t to .2 minus that same occupational share, $[S_{jt}/(.2-S_{jt})]$, is assumed to depend on the year (T_t), the unemployment rate (U_t), and one or more structural variables, (X_t), intended to capture the influence of the economic changes that have occurred in the 1980s. The independent variables have been defined relative to their projected value in the year 2000.

1) $\log[S_{jt}/(.25-S_{jt})] = a_0 + a_1(T_t-2000) + a_2(U_t-.055) + a_3(X_t-X_{2000})$ $\quad t = 1972...1989$

For the three smallest occupations, farm workers, protective service workers and private household workers, X_t is a trend shift variable for the years after 1980. For the other ten occupations th X variables were the ratio of the merchandise trade deficit to GNP, ($TRADEF_t$), and the ratio of personal computers used in business to civilian employment, ($PCUSE_t$).[39] The advantage of deviating all independent variables from their projected level in the year 2000 is that the intercept term, a_0, then provides an estimate of the forecasted logit of the "j"th occupation's share of employment in the year 2000.[40] The means and standard deviations of the variables are given in Table B1.

The estimation results for the 13 occupational categories are presented in Table A2. T statistics are located in parenthesis under the coefficient. The final column of the table contains the multiplier for calculating the proportionate impact on that occupation's 1989 share of a unit change in an independent variable.

Managers, professionals, technicians and clerical workers have large positive coefficients on the trend variable. The occupational shares of sales workers and service workers has been growing but only very slowly. Shares for craft workers and protective service workers share of employment were pretty stable through 1980. The shares of all other occupations fell. Declines were quite rapid for operatives, private household workers and farmers.

The employment shares of craft, operative and laborer occupations rise strongly during booms and decline during recessions. A one percentage point rise in unemployment decreases the laborer share of total employment by 2.2 percent, the transportation operative share by 1.1 percent, the factory operative share by 3.7 percent and the craft share by 1 percent. Managers and clerical workers experience more modest share declines during recessions. Professionals, technicians, sales workers and service workers gain in share of total employment during recessions.

Trade deficits reduce the occupational share of factory operatives, laborers and managers and increase the shares of sales workers and craft workers. The coefficients on the trade deficit imply that the switch from a merchandise trade surplus of 0.7 percent of GNP in 1976 to a trade deficit of 3.6 percent of GNP in 1987 decreased factory operative employment shares by 11 percent and increased precision production and craft employment shares by 5 percent. The business press appears to have been correct when, in the face of rising aggregate employment of managers, it pointed to losses of managerial jobs resulting from the recession and the loss of international competitiveness and the strong dollar. Compared to the cutbacks in factory operative jobs, however, the resulting managerial layoffs were modest indeed. Since the overall upward trend of the managerial employment is so strong (1 percent per year in 1989), these setbacks turned out to be temporary. Almost all of the growth of managerial jobs has been outside of manufacturing.

The effects of the microcomputer revolution and the associated reorganization of manufacturing were tested by including the ratio of personal computers used in business to civilian employment, (PCUSE), in the preferred model for most occupations. The microcomputer revolution appears to have had a substantial negative effect on the employment share of technicians, clerical workers, machine operatives and craft workers. The results imply that the rise in PCUSE from zero in 1978 to 18 percent in 1988 lowered factory operative employment by 14 percent, craft employment by 6 percent and technician and clerical employment by 9 percent. These machines have resulted in a large decline in the demand for board drafters and have improved labor productivity in a host of other technical and clerical occupations. Electrical and electronic technicians and health technicians both of which grew at a torrid 7.2 percent per year between 1972 and 1982, slowed to yearly rates of only 0.5 and 3.1 percent respectively between 1982 and 1989. The occupations that gained share as a result of the microcomputer revolution were managers, professionals and sales occupations. Employment in sales grew more rapidly in

the 1980s than in the 1970s largely because of the trade deficit and increased use of microcomputers.

Three occupations--farmers, private household workers and protective service workers-- were best represented by a simpler model which simply allowed for a trend shift in 1980. In the case of farmers and private household workers the trend shift implied a slowdown in their rate of decline. For protective service workers the trend shift implies that its share was rising nearly 1.5 percent per year during the 1980s.

Projections: What do these estimation results tell us about the future? This, of course depends on future levels of unemployment, the trade deficit and PC use. Since the foreign debt of the US cannot grow at current rates indefinitely and the growing debt must eventually be serviced by exporting more goods than are imported, our projections assume that merchandise trade will be in balance in the year 2000. It was further assumed that unemployment will be 5.5 percent and PCUSE will increase from its 1989 level of 21 percent to 45 percent in 2000. The intercept terms of the equations provide an estimate of the forecasted $S_j/(.2-S_j)$ from which the share of employment for each occupation may be calculated.

Our forecasts of occupational growth are presented in the fifth column of Table 3. We forecast strong increases in demand for managers, professionals, technicians and sales workers and absolute declines in the number of craft workers, operatives, laborers, farm workers and private household workers. Clerical and service jobs are projected to grow but at the rate that is slightly below the growth of total employment.

Some sales occupations require a great deal of education and training--eg. sales representatives in manufacturing, finance, communications and professional services--and others such as sales clerks in retailing and personal services require very little. Which type of sales job is growing most rapidly? When the share of sales workers who are sales clerks in the retail and personal service sector is regressed on time, a significant negative coefficient is obtained, suggesting that low skill sales jobs grew less rapidly than high skill sales jobs in the 1980s (see Table B3) However, the shakeout in the financial sector has slowed the growth of sales workers in that industry and the sales clerk share has been stable since 1987. Consequently, we project the sales clerk share of sales jobs in 2000 to be the same as it is in 1988.

Table B1

Means and Standard Deviations

Independent Variables	Mean	Standard Deviation	Mean Deviated From Value in 2000
Year	1980.5	5.30	-19.51
Unemp. Rt.	.0689	.0140	.0139
Year C-T 80	4.5	3.185	-17.5
Trade Def.	.01506	.01263	.01506
PC Use	.04896	.06925	-.40104

Dependent Variables	Arithmetic Mean	Standard Deviation	Value in 1989	Mean of Logit
Managers	.1050	.0112	.1265	.1029
Professionals	.1203	.0081	.1325	.4152
Technical	.0279	.0027	.0311	-1.824
Sales	.1120	.0064	.1319	.2422
Clerical	.1617	.0028	.1569	1.441
Craft	.1234	.0031	.1176	.4767
Factory Operative	.0864	.0129	.0703	-.2771
Transportation Operative	.0451	.0032	.0416	-1.2356
Laborer	.0477	.0055	.0417	-1.1673
Private Household	.0113	.0028	.0074	-2.8428
Protective Service	.0157	.00082	.0167	-2.4646
Other Service	.1063	.0034	.1084	.1270
Farm	.0374	.0054	.0292	-1.4785

Table B2
Determinants of Occupational Employment Shares for 1972-1989
Logit Model with Ceiling of 20%

	Trend	Unemp	Trade Deficit	PC Use	Trend GT80	Intercept	MSE	R^2	Proportion Multiplier
Managers	.0407*** (13.86)	-1.293** (2.95)	-2.78*** (3.97)	.618*** (3.58)		1.204 (27.72)	.0174	.996	.246
Professionals	.0227*** (8.82)	3.599*** (9.36)	-.258 (.42)	.657*** (4.34)		1.075** (28.23)	.0152	.994	.277
Technicians	.0304*** (9.46)	.923* (1.92)	-1.607* (2.10)	-.610*** (3.22)		-1.465*** (30.80)	.0190	.979	.817
Sales	.0057 (1.19)	2.246*** (3.22)	4.233*** (3.67)	.761** (2.67)		.564*** (7.89)	.0286	.964	.341
Clerical	.0359*** (3.64)	-.747 (.51)	-4.437* (1.88)	-2.372*** (4.07)		1.268*** (8.67)	.0585	.696	.216
Craft	-.0056 (1.18)	-2.338*** (3.28)	3.088*** (2.71)	-.803*** (2.86)		.0308 (.44)	.0282	.859	.412
Factory Operatives	-.0253*** (6.13)	-5.703*** (9.25)	-3.934*** (4.00)	-1.201*** (4.94)		-1.113*** (18.23)	.0244	.992	.649
Transportation Operatives	-.0175*** (5.22)	-1.373*** (2.73)	- .10 (.13)	.139 (.70)		-1.501*** (30.16)	.0199	.954	.792
Laborers	-.0234*** (3.86)	-2.738*** (3.02)	-1.175 (.81)	-.033 (.09)		-1.581*** (17.62)	.0359	.957	.791
Private Household	-.0580*** (12.34)	.451 (.59)			.0196** (2.48)	-3.638*** (61.62)	.0367	.983	.963
Protective Service	-.0002 (.08)	1.806*** (4.35)			.0162*** (3.76)	-2.210*** (68.55)	.0200	.897	.916
Other Service	.0086** (2.30)	2.319*** (4.14)	1.239 (1.38)	-.110 (.50)		.200*** (3.61)	.0222	.920	.458
Farm	-.0421*** (18.00)	2.404*** (6.36)			.0157*** (3.99)	-2.059*** (70.09)	.0183	.991	.854

* Prob. LT .05
** Prob. LT .025
*** Prob. LT .01

Table B3
Analysis of Trends for Sales Occupations

Growth rates differ across sales occupations. This was determined by regressing the share sales job that were (a) sales clerks in retail and personal services (incl. other sales occupations), (b) sales representatives in finance and business services, (c) sales representatives selling commodities, and (d) supervisors and proprietors on time. The data conformed to the occupational definitions introduced in 1982. The results are given below:

C1) $(SalesClerk_t/SALES_t) = .4117 - .003136*(YEAR_t-2000)$ (4.21) t=1982-1990 R2 = .717

C2) $(SalesFin_t/SALES_t) = .1883 + .001611*(YEAR_t-2000)$ (2.38) t=1982-1990 R2 = .448

C3) $(SaleManag_t/SALES_t) = .3084 + .003303*(YEAR_t-2000)$ (14.19) t=1982-1990 R2 = .966

C4) $(SaleCommod_t/SALES_t) = .09185 - .001761*(YEAR_t-2000)$ (5.94) t=1982-1990 R2 = .834

It appears that the sales jobs which grew most rapidly during the 1980s tend to require the greatest amount of education and training.

Regressions were also estimated to examine the trend in the farm operator and manager share of all farm workers.

C5) $(FarmOper_t/FarmWkr_t) = .3486 - .002662*(YEAR_t-2000)$ (2.72) t=1982-1990 R2 = .514

ENDNOTES

1. Henry Levin and Russell Rumberger, "Educational Requirements for New Technologies: Visions, Possibilities, and Current Realities" Educational Policy, Vol. 1, No. 3, 1987, p. 344.

2. Lawrence Mischel and Ruy Teixeira, "The Myth of the Coming Labor Shortage: Jobs Skills and Incomes of America's Workforce 2000," Washington DC: Economic Policy Institute, 1990, p. 1.

3. Jon Sargent, Occupational Outlook Quarterly, Summer 1988, 1-8.

4. Jon Sargent and Janet Pfleeger, "The Job Outlook for College Graduates to the Year 2000: A 1990 Update" Occupational Outlook Quarterly, Summer 1990, p. 8.

5. Education Commission of the States, "The Information Society: Are High School Graduates Ready?" Denver, Colorado: Education Commission of the States, 1982, p. 1. quoted in Levin and Rumberger, Feb. 1983, p. 2.

6. Levin and Rumberger, Feb. 1983, p. i.

7. Russell Rumberger and Henry Levin, "Forecasting the Impact of New Technologies on the Future Job Market," Feb. 1984. pp. 1-32.

8. Janet Norwood, "The Outlook for College Graduates through 1990," Occupational Outlook Quarterly, Winter 1979, pg. 2-7.

9. Jon Sargent, "The Job Outlook for College Graduates during the 1980s," Occupational Outlook Quarterly, Summer 1982, p. 7.

10. Richard Freeman and John Hansen, "Forecasting the Changing Market for College-Trained Workers," Responsiveness of Training Institutions to Changing Labor Market Demands, Edited by Robert Taylor, Howard Rosen and Frank Pratzner, Columbus Ohio, National Center for Research in Vocational Education, 1983. p. 98.

11. Max Carey, "Occupational employment growth through 1990," Monthly Labor Review, August, 1981, pp. 42-55.

12. George Silvestri, John M. Lukasiewicz and Marcus E. Einstein, "Occupational Employment Projections through 1995," Monthly Labor Review, November 1983, pp. 37-49.

13. Calculated from data in Deborah Pisetzner Klein, "Occupational Employment Statistics for 1972-82," Employment and Earnings, Jan. 1984, 13-16 and Employment and Earnings, Jan. 1990.

14. Gloria Peterson Green, Khoan tan Dinh, John A. Priebe and Ronald R. Tucker, "Revisions in the Current Population Survey Beginning in January 1983," Employment and Earnings, February 1983, pp. 7-15. For managers this involved adding accountants, personnel and labor relations workers and inspectors, n.e.c. to

and subtracting ships officers and conductors from both the 1978 base and the 1990 projection. For professional workers it involved adding decorators and window dressers and health trainees and subtracting accountants, personnel and labor relations workers, computer programmers and sales engineers. When separate data was not available for some of the smaller occupations that were reclassified, they were left in the major group they had been prior to 1983. The BLS has published CPS based yearly estimates of employment by major occupation all the way back to 1972 using the 1980 Census classification system in Deborah Pisetzner Klein, "Occupational Employment Statistics for 1972-82." This data series was used to calculate actual percentage rates of growth and actual shares of employment growth. Thus percentage growth calculations are based on definitions of major occupation that are consistent over time but there are slight differences in the detailed occupations included in a major occupation for the two calculations. The data on 1989 employment is from Employment and Earnings, Jan. 1990.

15. The causes of this very rapid increase in the number of managerial jobs is the subject of Shani Carter's dissertation. The initial findings are that substantially over half (74% of the growth in the 1983-1989 period) of these additional jobs were filled by women. Women, who accounted for only 17.6 percent of managers in 1972, now account for 40 percent of the nation's managers. Another important finding is that almost all the growth of managerial jobs has been outside of manufacturing in industries where women now account for a large share of the managers such as professional services (57%) and finance (50%).

16. The reasons for the downward bias in BLS projections of the growth of skilled jobs during the 1980s are discussed in detail in John Bishop and Shani Carter, "The Deskilling vs Upskilling Debate: The Role of BLS Projections," Center for Advanced Human Resource Studies Working Paper 90-14. Two causes stand out: the failure to predict the large decline of employment in manufacturing and the failure to predict the substantial increases in the managerial and professional share of employment in many industries. BLS's forecasts of future staffing patterns must be extrapolated from Occupational Employment Survey (OES) data which is available only every three years and which has generally not been comparable from year to year. Complicating matters further was the change in the occupational classification system for the 1980 Census which was introduced into the CPS and the OES in 1982 and 1983. This meant that observed changes in staffing patterns between the 1970 and 1980 Censuses could not be simply extrapolated into the future. It also meant that much of the data collected in the third and fourth waves of OES surveys was inconsistent with data collected prior to 1983. Given these data problems and the BLS's focus on projecting over 500 different occupations, it is easy to see why BLS has not chosen to systematically extrapolate past trends in occupational staffing ratios derived from OES or Census data into the future, but rather to rely on the judgement of analysts who can take data quality problems into account. Systems which rely on the judgement of analysts are inherently conservative, however. Sometimes the analysts feel that they are knowledgeable enough about the situation in a particular industry to project substantial changes in staffing patterns. But forecasting big changes in staffing patterns is definitely perceived by them as "going out on a limb." The staff is small and they cannot be expert about all industries and occupations. As one analyst described the situation,

"In a lot of cases, if we did not know a lot about the occupation, we just left it alone." These problems also plague the projections published in 1987 and 1989.

17. Employment and Earnings, January 1984 and January 1990, Table 56 and Table 60. Nominal weekly earnings figures were deflated by the CPI for all urban consumers which rose 24 percent between 1982-84 and 1989.

18. Jon Sargent and Janet Pfleeger, "The Job Outlook for College Graduates to the Year 2000: A 1990 Update" Occupational Outlook Quarterly, Summer 1990, 1-12 and "1988-2000--Outlook for College Graduates," excerpts from BLS Technical Memorandum, 1990.

19. Lawrence Katz and Kevin Murphy, "Changes in Relative Wages, 1963-1987: Supply and Demand Factors," 1990, forthcoming Quarterly Journal of Economics.

20. Bureau of the Census, "Effects of Different Reinterview Techniques on Estimates of Simple Response Variance," Evaluation and Research Program of the U.S. Censuses of Population and Housing 1960, Series ER60 No. 11, Tables 30 and 46.

21. Douglas L. Adkins, The Great American Degree Machine. The Carnegie Foundation for the Advancement of Teaching, 1975. p. 65. In the 1984 Survey of Income and Program participation, for example, 15.5 percent of the population over the age of 18 reported a bachelors or higher degree. In CPS data for that year, 17 percent of those over 18 reported they had completed 16 or more years of schooling. U.S. Bureau of the Census, Current Population Reports, Series P-70, No. 11, What's it Worth? Educational Background and Economic Status: Spring 1984, U.S. Government Printing Office, Washington, D.C., 1987.

22. Irwin Kirsch and Ann Jungeblut, Literacy: Profiles of America's Young Adults, National Assessment of Educational Progress, Educational Testing Service, 1986, Table 6, pgs. 33, 37 and 40.

23. George Silvestri and John Lukasiewicz, "A Look at Occupational Employment Trends to the Year 2000," Monthly Labor Review, September 1987, pp. 46. George Silvestri and John Lukasiewicz, "Projections of Occupational Employment, 1988-2000," Monthly Labor Review, November 1989, pp. 42-65. In order to maintain comparability of the BLS projections to the CPS data on actual employment growth, the percentage growth rates projected by the BLS for each major occupation group were applied to the CPS estimates of the number of workers in each occupation in 1986 and 1988. Since high skill jobs account for a larger proportion of total employment in CPS data, this adjustment raises our estimates of BLS projected share for high skill jobs about 4-5 percentage points above the shares calculated directly from BLS publications. BLS's occupational projections are based on OES data collected from employers which count people with multiple jobs more than once. CPS data classifies people rather than jobs and tends to classify multiple job holders into their highest level occupation. A second reason for preferring CPS data on occupational employment is that it comes from the same survey as data on educational attainment. This means that, if the CPS obtains an incomplete count of undocumented workers and homeless individuals, the bias effects estimates of supply

and demand equally so calculations of the balance between supply and demand remain unbiased.

24. In 1989 median weekly wages for full time wage and salary workers in sales jobs included in the high skill category were $561 for sales representatives, commodities except retail, $502 for sales representatives in finance and business services and $424 for supervisors and proprietors. Median weekly wages for the other high skill occupations were $583 for managers, $586 for professionals and $475 for technicians. In contrast, median weekly wages for the low skill occupations were $235 for sales workers in retail and personal services, $253 for service occupations, $323 for operatives, fabricators and laborers. Between 1983 and 1989 the ratio of high skill occupation wages to low skill occupation wages rose from 1.68 to 1.88.

25. According to Future Computing, there were 20,330,000 PCs in use in private business in 1988. An alternative source of data, the COMTEC survey of a stratified random sample business, governmental and non-profit establishments, yields a substantially smaller estimate of the number of PCs in use. The 1989 COMTEC survey estimates there were 9,693,000 microcomputers and 10,462,000 CRT terminals and dedicated word processors in use at work places outside of the education sector. Bureau of the Census, "Computers in the Office," Statistical Abstract 1990, pg 943-952. The large discrepancy between these two data sources appears to be due to: (a) the very low scrappage assumed by Future Computing, (b) inflation of sales figures by some of the vendors supplying data to Future Computing (c) delays in the actual installation of the computers, (d) the allocation to business of some PCs that the COMTEC survey appears to place in schools, (e) the exclusion of zero employee firms and home offices from the COMTEC survey and (f) problems with the Dun & Bradstreet list of establishments. The Future Computing data series was used in the analysis because it is available for a longer span of time and because there did not appear to be a good way of extending the series on CRT terminals back into the 1970s. To project this variable ten years into the future, we need an estimate of the possible extent of the eventual work place market for these machines. Conventionally comparisons are made with white collar employment. The education industry needs to be excluded from both numerator and denominator because students not teachers are the primary users of PCs. Point of sales terminals are not included in the counts of PCs or workstations, so retail sales clerks also need to be excluded from the denominator. The Future Computing estimate of PCs is equal to 37.5 percent of the number of white collar employees minus teachers and sales clerks. In Comtec data, the ratio of PCs to white collar employees who are not teachers or retail clerks was 17.4 percent and the ratio for workstations of all kinds was 35.5 percent. To us, there appears to be considerable room for current levels of PC use to grow, so we assume that it doubles from current levels. THe substitution of Comtec data for Future Computing data does not change our forecasts for the year 2000 as long as one retains the assumption that the year 2000 impact of the PC will be slightly more than double its 1989 impact.

26. Comparisons of percentage rates of change are much less sensitive to arbitrary assumptions regarding which jobs "require a college degree" than comparisons between numbers of openings requiring a degree and the growth in numbers of college graduates. The BLS approach to comparing supply and demand depends

critically on analyst judgments regarding which jobs "require a degree" now and which jobs will require a degree 10 years in the future. Ours does not.

27. Workers are divided into 15 major occupational groups: managerial, professional, technical, sales representatives and managers, sales clerks, clerical, craft, factory operatives, transportation operatives, handlers and laborers, private household workers, protective service workers, other service workers, farm owners and managers, and farm laborers.

28. The source of data on the educational attainment of the labor force was the 1983 Handbook of Labor Statistics, Table 65 and unpublished BLS data for 1988. Before 1972 the tabulations were for workers over the age of 18. After that date, tabulations were for workers over the age of 16. Consequently, rates of change of educational attainment for the 1970s are for the 8 year period from 1972 to 1980 for which data is consistent over time.

29. Comparisons of CPS estimates of increases in the number of college graduates in the population to estimates derived from data on bachelors degrees awarded for period prio to 1980 suggest rough consistency. Durin the 1980s, these two data sources diverge. The number of individuals born after 1935 claiming to have completed 16+ years of schooling increased by 9,181,000 between 1980 and 1988. During this eight year period period, there were only 6,543,000 bachelors degrees awarded in the US. Immigration probably accounts for another 734,000 of this increase and individuals with 16+ years of schooling but no degree for another 1,019,000. This leaves a remaining discrepancy of 885,000 that is probably increased misreporting of years of schooling. This means that the true growth rate of college graduate workers is not the 4.18 percent per year figure calculated directly from CPS data, but rather 3.76 percent per year that results from subtracting 885,000 from 26,814,000, the 1988 CPS estimate of the number of college graduate workers, when calculating the rate of gain between 1980 and 1988. John Bishop, "Achievement, Test Scores and Relative Wages," forthcoming in Wages in the 1980s, edited by Marvin Kosters, American Enterprise Institute. This correction of the data helps explain why the college graduate labor market tightened so dramatically during the 1980s. It also results in the 1990s looking more like the 1980s and thus reduces our estimates of the magnitude of the shortage during the 1990s.

30. The no policy change projection of the increase in the stock of workers with 16 or more years of schooling was developed in the following manner. We project that an average of 1,001,000 BAs will be awarded each year during the early 1990s, a 3.7 percent increase from the level that prevailed from 1980 to 1987 (Digest of Education Statistics, Table 200). The number of 17 year olds is now 13 percent below its 1979/80 peak and will fall another 10 percent by 1993/94. If educational policies and the payoff to college do not change, we do not project further increases in BAs awarded because the declining size of the 21-24 year old age cohort is assumed to offset a projected 10 percent rise in the proportion of the age cohort that obtains a BA. Immigration of people with a college degree was about 100,000 per year in the first part of the 1980s and this flow is assumed to continue (data provided by George Borjas). Adkins reports that for every 100 individuals with a

BA degree there are about 12.5 individuals reporting 16 or more years of schooling without having a BA or first professional degree. (Douglas L. Adkins, The Great American Degree Machine. The Carnegie Foundation for the Advancement of Teaching, 1975, p. 65) Therefore, our estimate of the flow into the college graduate category is obtained by multiplying 1.1 million by 1.125. The share of the flow of new college graduates assumed to be employed was set equal to the labor force participation rate for this group, .90. The result was a projection of 13,363,000 individuals added to the stock of employed college graduates over the 12 year period. In the March 1988 CPS, there were 3,018,000 college graduates over the age of 65, 3,245,000 between 55 and 64 and 4,982,000 between 45 and 54 years of age. Their labor force participation rates were .906 for 45-54 year olds, .706 for 55-64 year olds and .222 for those 65 and over. (Bureau of Labor Statistics, "Educational Attainment of Workers: March 1988" July 1988). Based on life tables, the estimated 10 year survival rate is .9083 for the 45-54 year old college graduates and .8136 for the 55-64 year old group. (Statistical Abstract, 1990, Table 108). An estimate of the number of college graduates from the 45-64 year old group in 1988 that are still in the labor force 10 years later was obtained by multiplying the population figures by the survival rate and then by the labor force participation rate for the next older group. Exits from the labor force for the 12 year period were estimated to be 1,585,000 of the age 45-54 in 1988 group, 1,729,000 in the 55-64 in 1988 group and 670,000 (all) of those over 65 in 1988. Thus, the projected net growth in the number of college graduates over the 12 year period is 9,379,000 from a 26,812,000 level in 1988. BLS predicts an almost identical--9,105,000--increase in the college graduate labor force (BLS, "1988-2000 Outlook for College Graduates, unpublished technical memorandum, 1990).

31. Bureau of Labor Statistics, Employment and Earnings, Jan. 1988 and Jan. 1990, Table 56, pg. 226-230 and July 1990, Table A75 and C4.

32. In 1986-87, non-resident aliens were awarded 29,306 bachelors degrees, 29,898 Masters degrees and 6587 doctors degrees from American universities. Nearly 2/3rds of these degrees were in science, engineering or business. (NCES, Digest of Educational Statistics: 1989). Jobs for the highly educated are so scarce in India, some PhDs are driving taxis. Hiring quotas favoring scheduled castes in India and Malays in Malasia have prevented many highly educated individuals from obtaining work that employs their skills. The upsurge of anti-semitism in the Soviet Union has stimulated a massive increase in emigration. American immigration policy denies these individuals the opportunity of coming to a country that could use their specialized skills and has plenty of vacant housing and forces them instead to go to a country that needs carpenters and mechanics not violinists and mathematicians and which does not have sufficient housing to absorb the influx. While their skills would probably be better used in the US than elsewhere, it must be recognized that many college educated immigrants will not be able to find jobs that employ their college training. There are not many colleges or banks that want to hire Soviet trained economists, for example. The impact of additional immigrants on the skills shortage will be maximized if priority is given to applicants who have an employer sponsor who will make use of their special skills.

33. About 21 percent of the freshman in October 1985 did not return the following fall and 27 percent of the sophomores did not return. Nabeel Alsalam, The Condition of Education: 1990, Volume 2, Postsecondary Education, National Center for Education Statistics, 1990, p. 26.

34. College Placement Council, "Inflation and the College Graduate: 1962-1985," 1985 and "CPC Salary Survey," September 1989.

35. U. S. Bureau of the Census, Characteristics of Men with College Degrees: 1967, Current Population Reports, Population Characteristics, Series P20, No. 201, p. 23.

36. U.S. Bureau of the Census, Current Population Reports, Series P-70, No. 11, What's It Worth? Educational Background and Economic Status: Spring 1984, U.S. Government Printing Office, Washington, D.C., 1987. The very large differentials between college majors found in these data reflect both differences in wage rates and in hours worked per month. If gender were controlled, the differentials would be smaller.

37. Clearly teachers are paid a great deal less than most other college graduates and their disadvantage appears to have grown between 1967 and 1984. No wonder it is so difficult to attract the best and brightest to the profession.

38. Thomas N. Daymont and Paul Andrisani, "Job Preferences, College Major, and the Gender Gap in Earnings." The Journal of Human Resources, Summer 1984, pp. 408-428.

39. The estimates of the number of PCs in use in business were made by Future Computing/Datapro Inc and can be found in Table 1340 of The Statistical Abstract, pg. 179. They are derived by cumulating numbers of machines sold. A very low scrap rate of 3.4 to 6 percent depending on the year was assumed. Where possible vendor reports were used to allocate sales of computers between categories of end user--business, education and home. Quite often, however, rules of thumb were used to make these allocations. Future Computing is no longer in business so more detailed information on how the series was constructed and data for 1989 are not available. Point estimates of PCs in use were made for 1989 and for 1979-80 by extrapolation.

40. A number of alternative models were estimated in order to see how sensitive the results are to changes in functional form, specification and in the scenario projected for the year 2000. Such tests were needed because there were only 18 years of data on which to estimate the forecasting model and theory did not yield only one plausible specification. The results of some of these tests are detailed in Bishop and Carter (1990). While specification and scenario do effect projected occupational shares, all of the specifications yielded substantially larger increases in skilled jobs than the BLS projections. Other findings were robust with respect to specification and scenario as well.