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Clerical Employment and Technological Change: A Review of Recent Trends and Projections

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CLERICAL EMPLOYMENT AND TECHNOLOGICAL CHANGE: A REVIEW OF RECENT TRENDS AND PROJECTIONS

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and
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The conclusions and recommendations in this report are those of the contractor and do not necessarily reflect the views of the National Commission for Employment Policy or any other agency of the Federal Government.

PREFACE

The National Commission for Employment Policy has been studying issues related to computers in the workplace, and will soon publish a Policy Statement with an accompanying staff background report. The present paper is one of a series of research reports that have been published as part of this project. The Commission is happy to have joined with the Panel on Technology and Women's Employment of the National Research Council in supporting this report, as well as the authors' earlier report on linking data on employment with data on technological change. The Commission thanks the Panel, and especially its Chair, Professor Louise Tilly, and Study Director, Dr. Heidi Hartmann, for their cooperation in this effort.

The Commission also thanks the authors, Dr. H. Allan Hunt and Dr. Timothy L. Hunt, for their careful sifting of the available evidence on how technological change alters patterns of clerical employment. They have drawn some important conclusions regarding research methods, and also regarding the limits of policy and prediction. Their position might be called knowledgeable agnosticism. They find "no persuasive evidence today that there will be a significant decline in clerical jobs in the future." (p.65) They caution, however, that the vast uncertainty surrounding technological change makes long term prediction of limited value to planners and policymakers.

In their review of Bureau of Labor Statistics studies, Hunt and Hunt conclude that the occupational projections are produced in a comprehensive and consistent way, although somewhat more explicit information on adjustment procedures would be desirable as an aid to evaluation. Hunt and Hunt also review three projection studies by university-based researchers. They applaud the detail provided on the assumptions and procedures underlying these studies, even though they disagree with many of the specific conclusions. It should be noted that the three independent studies were sponsored by Federal agencies. This underlines the key role of the Federal government in supporting basic research on technological change.

The series of Commission-sponsored reports on computers in the workplace was designed by the Commission project staff: Carol Jusenius Romero, team leader; Sara B. Toye and Stephen E. Baldwin. This team worked closely with the authors in organizing this study; however, the information presented and the conclusions drawn do not necessarily reflect the views of the Commission or its staff.

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EXECUTIVE SUMMARY

CLERICAL EMPLOYMENT AND TECHNOLOGICAL CHANGE: A REVIEW OF RECENT TRENDS AND PROJECTIONS

by

H. Allan Hunt and Timothy L. Hunt*

I. INTRODUCTION

Clerical jobs are the largest single occupational group in the economy; they are also one of the most diverse. Generally people associate the traditional office occupations with the term clerical workers. Indeed, the secretaries, typists, stenographers, file clerks, office machine operators and receptionists do make up a large proportion of all clerical workers. But bookkeepers and bank tellers are also clerical workers according to the U.S. Bureau of the Census, as are bill collectors, insurance adjusters, post office mail carriers, factory expediters, and most enumerators. The purpose of this paper is to review the trends in clerical employment over the last 30 years and to assess the existing forecasts for clerical jobs. Of particular concern is the potential impact of office automation on these jobs.

In summary, we found no persuasive evidence that there will be a significant decline in clerical jobs in the future. The forecasts of declining clerical employment are based on overoptimistic expectations of technological improvements or exaggerated productivity claims on behalf of existing technology. In our opinion, current office technology offers significant improvements in product quality and modest improvements in productivity. There is as yet no empirical evidence of an office productivity revolution that will displace significant numbers of clerical workers.

On the contrary, we think there are many factors which will contribute to the job growth of clericals in the future. Chief among these is the simple fact that clericals are so diffused in the national economy. Moreover, to the extent that clerical jobs are concentrated in particular industries, it has been in sectors growing faster than average. Therefore, even allowing for negative employment impacts from office automation, it is extremely difficult to believe that the growth of this large, diverse, and diffused major occupational group could be much below the average growth for all occupations for the next decade.

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There are precious few hard data on which to base an assessment of clerical jobs and office automation. Data are not available on yearly office automation spending by industry or even detailed clerical employment by industry. The existing data are so fragmentary and so uneven that conclusions drawn from them must be somewhat tenuous. It is easy to use data which look similar on the surface and end up drawing inferences which reflect nothing more than differences in measurement.

Every effort has been made to insure that the data reported in this paper are reasonably consistent. Undoubtedly, some will object that time series data were not developed for enough clerical occupations or that the analysis ends with 1982 in some cases. Suffice it to say that the goal was to avoid reporting results which might be misleading, but yet to get as much from existing data sources as possible.

II. TRENDS IN CLERICAL EMPLOYMENT

The tremendous growth in the number and labor force share of clerical workers in the U.S. is well known. In 1940, just under one employee in ten was a clerical worker. By 1980, this proportion had risen to one in five, a doubling of the relative importance of clerical workers. One of the most stimulating questions about the future employment outlook is whether this trend will continue.

Those who expect that automation will stem the tide of growth in clerical employment cite the apparent reduction in the rate of increase in the proportion of clerical workers. The rate of increase of clerical workers relative to all employment was much slower in the 1970s than it was in the 1960s. The recession of 1980-82 was unique in that the proportion of clerical jobs in total employment did not increase significantly as it has in past recessions. Whether the trend of the early '80s is permanent remains to be seen.

There were just over 19 million clerical workers employed in 1980 (using consistent 1970 definitions of occupations). Collectively, clerical workers represented 19.6 percent of all employed persons in 1980, up from only 12 percent in 1950. Most clerical workers are women, and this is even more true today than it was 30 years ago. From just over 60 percent in 1950, the female proportion has grown to nearly 80 percent by 1980. It is also true that a rising percentage of women who are employed outside the home are employed as clerical workers. In 1950, about 27 percent of employed women worked in clerical jobs. By 1980, over 35 percent of all women who were gainfully employed outside the home worked at clerical jobs. Clearly, clerical jobs are predominantly female jobs.

The largest single category of clerical workers in 1980 was secretaries. There were over 4 million secretaries employed; they represented just over 4 percent of total employment and 21 percent of clerical employment in that year. The second biggest category was bookkeepers, with about 1.8 million employed, followed by cashiers, with 1.7 million. The only other clerical occupation that has approached 1 million employees is typists. All together,

these "big four" clerical occupations accounted for 8.5 million jobs, or about 45 percent of all clerical employment in 1980. It is interesting to note that these same four occupations only accounted for 27 percent of clerical employment in 1950. All four of these occupations have grown substantially in employment during the last 30 years, although the number of typists declined between 1970 and 1980.

On the other end of the scale in terms of size, there were only about 3,300 tabulating machine operators and about 7,600 telegraph operators employed in 1980. These occupations have been declining for some years, as have the next two smallest occupations, duplicating machine operators and calculating machine operators. Each of these occupations has been adversely impacted by changes in technology.

Computer and peripheral equipment operators far exceeded all other clerical occupations in their rate of increase over this period. This occupation has grown from an employment level of 868 persons in 1950 at the dawn of the computer age to over 400,000 persons in 1980, an annual rate of growth of over 22 percent. This is one labor market expression of the computer revolution, which began to substantially affect employment levels in computer-related occupations in the 1960s.

It is interesting to note that the second fastest growing clerical occupation over the 1950 to 1980 period was teachers' aides; from high-tech to high-touch in one easy step! The number of teachers' aides increased from 6,000 to over 200,000 in this 30-year period, or over 12 percent per year. The third fastest growing clerical occupation was typists, even with their 23 percent decline in employment from 1970 to 1980. The phenomenal growth of typists in the 1950s and 1960s was not fully offset by the recent reversals. Following in order of rate of growth are library attendants, clerical supervisors, bank tellers, receptionists, and cashiers.

With the spectacular exception of the computer operator category, the rapid growth jobs do not show any particular high-technology bent. On the other hand, the declining occupations do seem to offer a technological interpretation, at least in part. It is clear that the bulk of clerical employment is in a few very large, very diffuse occupational titles, such as secretary and bookkeeper. This was less true in 1950 than in 1980. The evolution of office technology over the last 30 years may have fostered more generality in job title and perhaps job content as well, but the existing data do not permit a test of this hypothesis.

In general, the analysis of employment in specific occupations yielded few results. The amazing variety of clerical jobs was depicted, and the diversity in their employment trends clearly emerged from the analysis. But the trends in employment proved to be very difficult to tie conclusively to technological change or any other single cause. The general conclusion was that an aggregate analysis of occupational employment data is not sufficient to reveal the causes behind the trends.

Thus, it is necessary to look beyond the number of workers in a specific occupation to determine what might be causing those movements. It is also critical to put clerical employment growth into some larger perspective. These objectives were accomplished by decomposing occupational employment changes into three components: (1) those due to overall economic growth, (2) those due to differences in the rates of growth of industries (the changing sectoral composition of output), and (3) those due to changing staffing ratios or the relative importance of clerical workers within individual industries.

The general health of the economy exerts the strongest influence on the employment in individual occupations. With sufficient growth in total demand, employment in most occupations will surely rise. Therefore, it should not be surprising to learn that about 3 million of the 4 million new clerical jobs from 1972 to 1982 were added as a consequence of the overall growth of the economy.

There is wide variance in the proportion of clerical employment in different industries, with the largest concentrations being in the service sector. Obviously, to the extent that any occupation is concentrated in fast growing industries, it will also tend to be fast growing. Thus, in the long run there is no doubt that the evolution of the service economy has favorably influenced clerical employment levels. From 1972 to 1982 about 600,000 net clerical jobs were added because clerical workers were more prevalent in industries that were growing faster than the average for all industries.

Changing staffing ratios are probably the most visible manifestation of the specific effects of technological change on occupational employment. If the net effect of office automation is the displacement of clerical jobs, clerical staffing ratios will fall over time as clerical workers become relatively less important in the total employment of the firms. But staffing ratios may change for other reasons and the broad occupational and industrial groupings used in this analysis may mask the true changes which are occurring at more disaggregated levels.

Nevertheless, the aggregate analysis of this study indicated that the net effect of changing staffing ratios was moderately positive from 1972 to 1982, creating at most 450,000 new clerical jobs. Given the rapid growth in clerical jobs over the last 30 years or so, it appears reasonable to conclude that many goods and services have been growing more information-intensive per unit of output over time. This has tended to boost clerical employment.

Although the net effect of changing staffing ratios on clerical employment was modestly positive across all industries, there were a few sectors, notably finance, where the effect was negative. This is taken as evidence of the adverse impact of technological change on clerical employment. Even in finance, however, the strong industry mix effect and overall economic growth dwarfed the negative staffing ratio effect by a margin of more than 6 to 1. So employment of clericals continued to rise significantly despite the impact of automation.

In brief, clerical workers have had a favorable industry mix in their employment pattern, benefiting from the shift toward finance and other service-related industries because those industries employ much higher proportions of clerical workers. Furthermore, the relative importance of clerical jobs has tended to rise within industries. Thus in the past all the factors have tended to be positive and the result has been spectacular growth in clerical employment.

The attempt to find direct empirical evidence on the productivity gains from office automation met with little success. What is available consists mostly of undocumented trade journal articles rather than sound empirical research. It was shown that the measured industry-wide productivity gains in finance and insurance did not support the thesis that office automation was having a significant impact. Yet it is a fact that investment in this sector has been dramatically higher than the historical average for that sector for the last 15 years, so this lack of measured productivity results remains a puzzle.

III. THE FORECASTS OF CLERICAL EMPLOYMENT

The Bureau of Labor Statistics (BLS) occupational projections are the major effort of the U.S. government to anticipate the needs for specific occupations. The BLS methodology is based on a modeling framework that accounts for many economic variables. The resulting occupational projections are not necessarily superior to others but they do have the advantage of being produced in a comprehensive and reasonably consistent manner.

The other forecasts of clerical employment growth are not nearly as comprehensive as that of the BLS. Wassily Leontief and Faye Duchin of New York University analyze the impacts of computer automation on employment, 1963-2000, focusing on certain modeling questions and to a much lesser extent, the technology assessment. The research is limited to certain specified computer technologies and does not consider other productivity enhancing technologies or any other source of productivity growth. J. David Roessner, Georgia Institute of Technology, examines clerical jobs in two industries, banking and insurance, concentrating on the technology forecast and its relationship to job tasks or functions. Roessner develops the job functions in such a way that they are independent of the technologies currently in use. Finally, Matthew P. Drennan of Columbia University looks at clerical employment in six industries. His projection methodology utilizes extrapolation of historical trends after accounting for the effects of the 1980-82 recession.

The existing forecasts of employment in clerical occupations are unanimous in predicting that staffing ratios for clerical jobs will fall in the years ahead, presumably due to office automation. The fall in staffing ratios anticipated by BLS is modest and will be just about offset by employment growth due to the favorable industry mix of clerical jobs. So the BLS anticipates average growth for clerical jobs. Still, it is significant that the only turnaround from historical trends anticipated by BLS at the major occupational group level due to changing staffing ratios is that for clerical workers. At least through 1982, the decomposition analysis discussed earlier showed that

the staffing ratios for clerical jobs were rising, whereas the BLS forecast (base year 1982) and other forecasts expect that this trend will be reversed in the years ahead.

Roessner, Drennan, and Leontief-Duchin all conclude that office automation will have a much greater impact on clerical jobs than the BLS predicts. Roessner is particularly pointed about his concerns regarding the BLS methodology and forecasts, while Drennan's projections appear to be nearer the BLS position. Unfortunately, we find the studies of Leontief-Duchin and Roessner to be seriously flawed for serving policy needs. This is not an unqualified endorsement of the methodology or projections of BLS or Drennan. But it does mean that we think that Leontief-Duchin and Roessner are unduly pessimistic about the outlook for clerical jobs.

There are a variety of reasons that support our contention. First, it is important to note that Leontief-Duchin actually use the BLS demand forecast in their research, whereas both Drennan and Roessner use simple extrapolation methods to obtain estimates of demand for their studies. What this means is that demand for final goods and services is assumed to grow as it has in the past or as anticipated by BLS, but the impacts of technological change (i.e., office automation) will be much different than they were previously. The revolution in office automation is assumed to leave the demand side of the marketplace unchanged.

But that is not the way a complex, dynamic market economy operates. If office automation were adopted rapidly, it would change the relative costs of production for those goods and services which are intensive users of office automation. Those lower production costs will generate lower prices. Since office work is concentrated in the service sector, where demand growth has been above average, there is every reason to think that both the lower prices and income growth over time will generate additional demand.

This scenario is even more plausible when one realizes that the product markets themselves are not static. So the new electronic office technologies may themselves provide the impetus for the development of entirely new goods and services. Industry interrelationships may change or scale economies may be so significant that they fuel the development of a mass market that heretofore was undreamed of. In our opinion it is inappropriate to fix demand or the growth of demand and then assume a revolutionary change on the supply side of the market. Obviously, such a partial analysis can create false impressions about the true impacts of office automation.

Second, it appears that none of these other studies account for the tendency of output to become more information-intensive over time. Yet this is a process which has been occurring for a long time. The production recipes for many different goods and services today require more information processing than yesterday. This is not simply a function of the changing composition of demand, but relates to the composition of a standard unit of output. To the extent that this trend continues in the future, it implies that office automation may have less impact on clerical employment levels than anticipated by some researchers.

Third, these studies do not account for the fact that the new technologies must be cost-effective and relatively reliable for widespread application. The technologies may appear to be costless, producing quantum leaps in productivity for the users. Yet there are purchase costs, installation costs and ongoing costs that must be accounted for. The ongoing costs include system maintenance, software development and training, among others. There is also the cost of unscheduled downtime, which may become even more significant with integrated systems.

Fourth, it should be mentioned that office automation is likely to lower the marginal cost of some new types of work so much that the required labor input rises by more than the impact of the new techniques themselves. The common example is redrafts of documents with word processing. The probability that this will occur may be enhanced by our inability to measure output from offices in the first place. This type of new work or rework is explicitly rejected by Leontief-Duchin, and perhaps implicitly by Roessner.

Finally, Leontief-Duchin and Roessner appear to us to be truly overoptimistic technologically, both in terms of what office automation equipment can do and in the speed of diffusion of that equipment. Leontief-Duchin assume that word processors alone will produce productivity gains for typists and secretaries of 500 percent. Yet this assumption is based upon a short, unauthored trade journal article which is fives times more optimistic than the other articles which Leontief-Duchin reference. Roessner, on the other hand, emphasizes the potential for two breakthrough technologies, voice input and artificial intelligence. He assumes that innovations will occur in these technologies in the years ahead, they will be successfully marketed, and they will dramatically reduce clerical employment in banking and insurance during the 1990s.

Our major complaint with the technological assumptions of both Leontief-Duchin and Roessner is not that they may be technically wrong, although there is ample reason to question them, but that the level of uncertainty about the technical forecast is so great that interpretation of the occupational employment forecasts which are derived from it becomes little more than an academic exercise. Does anyone seriously wish to base policy decisions on a forecast of the capabilities of artificial intelligence, a technology which has been kicking around research labs since the 1950s? Perhaps we will always be optimistic about new technologies; it seems to be part of the human condition. But that is no justification to shape public policy based on our dreams of the future.

Suffice it to say that we are unconvinced that technology will evolve as far or as fast as Leontief-Duchin and Roessner predict. But even if it does, the derivative employment impacts foreseen by these researchers may still be very far off the mark. The overgeneralization to broad employment impacts based on assumptions about labor productivity at the task or firm level is very dangerous. This is the kind of analysis that leads to the fear that we will experience massive technological unemployment at some point in the future. Various analysts have been predicting such an event at least since the dawn of the industrial age. Somehow the employment apocalypse is always just ahead,

yet thankfully we never quite reach it. In any event, when evaluating these studies it is important to remember that the model simply processes the technological assumptions about the economy. It is the technological assumptions that drive the employment impacts in these studies.

Because of the uncertainties about future demand and the capabilities of future technologies, we would encourage a focus on shorter range occupational forecasting, exactly the opposite approach being suggested by Leontief-Duchin and Roessner. Roessner says that public policymakers need a longer time period for planning. But, if technological change is occurring faster today, then it is becoming even more impossible to develop long-run employment forecasts. Surely it is folly to think that we can peer 15 to 20 years into the future and see the detailed occupational and industrial structure of this nation. In fact, we think that the current BLS efforts, which produce about a 10-year planning horizon, tax existing forecasting abilities to the limit.

IV. THE OUTLOOK FOR CLERICAL EMPLOYMENT

What has this review shown for the future of clerical jobs? First, we think the pessimists are wrong who claim that these jobs will either stop growing absolutely or actually decline. The forces of economic growth, the shift toward services, the current limitations of office automation technologies all argue strongly against this scenario.

However, it is clear that the historical rate of growth of clerical jobs has slowed. Clericals did not benefit from the last recession as they have in earlier recessions, nor are some of the sectors that are important employers of clericals growing as fast as they once were. Finally, although office automation may not be producing a revolution, it should at least contribute to the slowing of employment growth in these occupations in the future. We think that the overall growth of clerical jobs in the future will be average to slightly below average.

The common wisdom today is that the back office jobs will go away. We think this is a glittering generality, but there is an analogy to manufacturing which may be useful. Automation has not caused the total elimination of production workers in manufacturing, but these jobs have not been increasing in absolute terms for 40 years either. We think the so-called back office jobs are more threatened by automation than other positions. They share with production workers a routinization of tasks which tends to support automation. This will not necessarily lead to their demise, but their growth will probably be well below average.

As mentioned earlier, it is definitely much easier to provide a technological explanation for declining occupations than growing occupations. There is an important message here. It is far easier to identify the impacts of labor-saving technology than the new jobs which are created by a growing, dynamic economy. Technology is only one aspect of economic growth, whereas the examination of the potential job losses is much more narrow and focused.

Many people today are ready to add bank tellers to the list of declining occupations. Unfortunately tellers is one of the occupations for which the time series data are especially poor, but it does appear that the growth of this occupation has slowed in recent years. It also appears that to some extent the future growth prospects for bank tellers is directly tied to the public's acceptance of automatic teller machines. But these machines today are being used mostly for withdrawals and cannot be thought of as a substitute for a fully staffed bank. Furthermore, it is difficult to know if and when the public will be willing to break the human link in making banking transactions. As a result, the future for bank tellers is extremely cloudy.

Secretaries fall somewhere between the back-office jobs and those positions which involve considerable customer interface. Therefore, secretarial employment growth may slow but these jobs will not go away. It is also true that many of these positions are generalist in nature and more difficult to threaten with automation. It seems clear that the secretaries of the future will require a greater variety of skills and will utilize much more capital equipment. We think that the growth of secretaries will be average to below average, but the absolute number of these jobs will definitely increase.

Roessner notwithstanding, we think that the growth of technology positions will continue to be rapid, particularly computer-related positions. Office automation is not sufficiently advanced at this point to slow the growth of these jobs. It remains to be seen if that will ever occur. We also think that those clerical positions which require the worker to deal with customers will likely experience average growth or better. Except possibly for bank tellers, there appears to be more emphasis on customer service and the quality of that service. The office of the future will require both "high-tech" and "high-touch."

CLERICAL EMPLOYMENT AND TECHNOLOGICAL CHANGE: A REVIEW OF RECENT TRENDS AND PROJECTIONS

I. INTRODUCTION

Clerical jobs are the largest single occupational group in the economy, they are also one of the most diverse. Generally people associate the traditional office occupations with the term clerical workers. Indeed, the secretaries, typists, stenographers, file clerks, office machine operators and receptionists do make up a large proportion of all clerical workers. But bookkeepers and bank tellers are also clerical workers according to the U.S. Bureau of the Census, as are bill collectors, insurance adjusters, post office mail carriers, factory expediters, and most enumerators and interviewers.

The tremendous growth in the number of clerical workers in the U.S. is well known. But the true magnitude of this expansion cannot be appreciated without comparing it to the growth in total employment. Figure 1.A shows that the proportion of clerical workers in total employment has doubled in the last 40 years. In 1940, just under one employee in ten was a clerical worker. By 1980, this proportion had risen to one in five.[1] One of the most puzzling questions about future employment is whether this trend will continue. Such questions derive from the general recessionary conditions of the last five years, but they also arise in the face of the developments of the last ten years or so in office technology.

The first "computer revolution" in the 1960s was expected to impact clerical work adversely as well. Despite the fact that the dire consequences predicted by some for clerical worker employment in the 1960s did not materialize, these fears have been aroused again in the 1980s. Those who are convinced that this time the fears are well-founded base their case primarily on the introduction to the office of microprocessor-based technologies. The incredible reductions in the cost of computing power, combined with the reductions in bulk made possible by microprocessor technology, may possibly constitute a new revolutionary development.

Those who expect that automation will stem the tide of growth in clerical employment cite the apparent reduction in the rate of increase in the proportion of clerical workers. This can be seen in Figure 1.A as well. While the clerical proportion rose almost linearly from 1940 to 1970, there is a slight reduction in the rate of increase between 1970 and 1980. Is this the beginning of the end of clerical employment growth?

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1. These data have been adjusted rather extensively for consistency. Thus the figures reported here do not correspond exactly with Census figures from other sources. See Hunt and Hunt (1986) chapter 2 for a complete discussion of Census consistency problems and the methods used to overcome these problems.

Figure 1.A

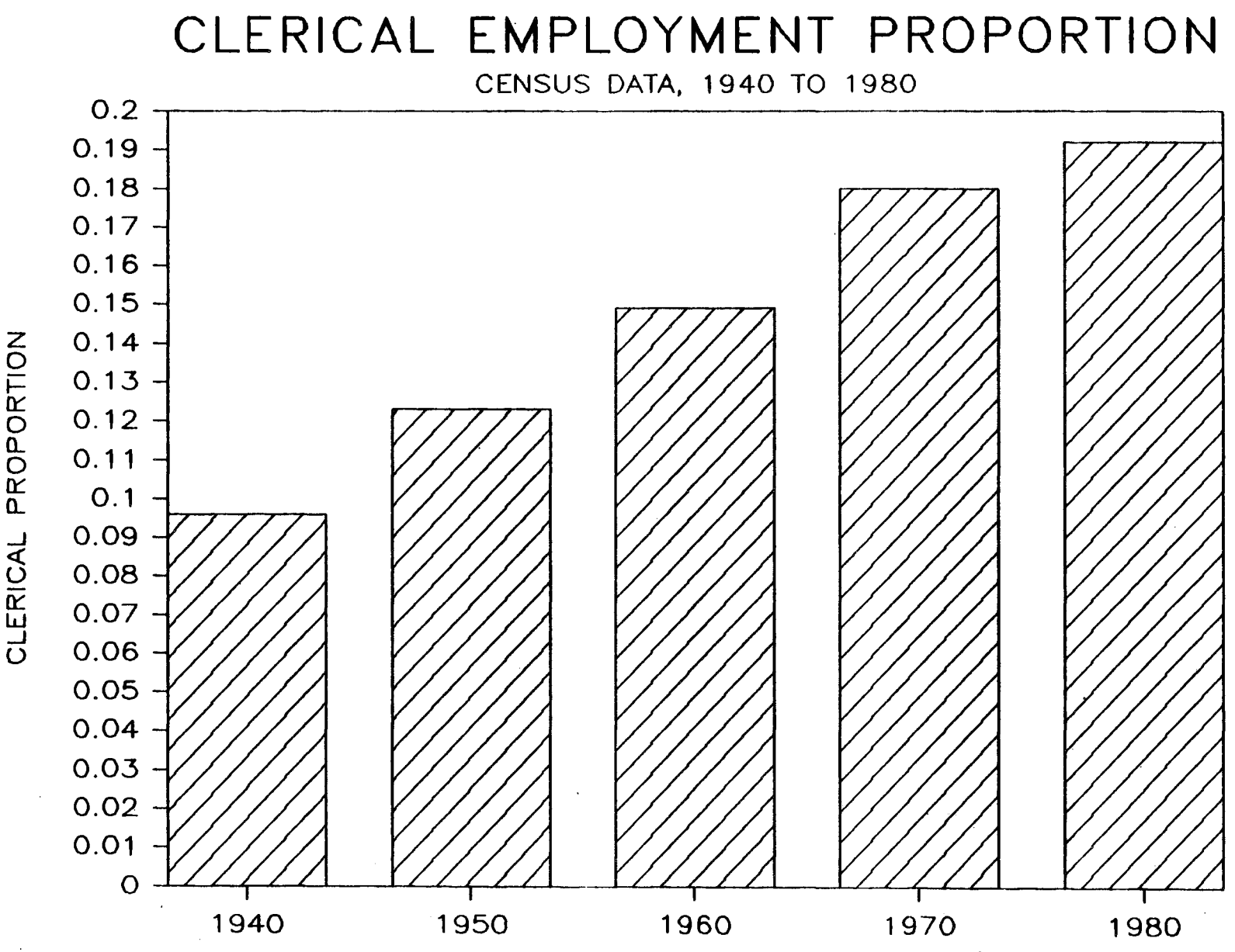
CLERICAL EMPLOYMENT PROPORTION
CENSUS DATA, 1940 TO 1980
CLERICAL PROPORTION
0.2
0.19
0.18
0.17
0.16
0.15
0.14
0.13
0.12
0.11
0.1
0.09
0.08
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0
1940
1950
1960
1970
1980

Figure 1.B shows clerical employment as a proportion of total employment on an annual basis from 1958 to 1984. When total employment declines and clerical employment rises, the proportion clerical rises very rapidly as indicated in Figure 1.B for 1975. What is obvious in Figure 1.B is that the rate of increase of clerical workers relative to all employment was much slower in the 1970s than it was in the 1960s.[2]

What is even more apparent is the stagnation in the proportion of clerical workers since 1980. Clearly, clerical workers have not fared as well in the last recessionary period as they did earlier. It is less clear what the downturn in the clerical proportion in 1984 means. Such a decline has been typical of recovery periods in the past (as in 1976-77) when the number of production workers rises rapidly to restore the prerecession balance between production and non-production workers, including clericals. Whether the trend of the early 1980s is something different is not yet clear. The magnitude of the drop is unprecedented, but that does not prove the cause is fundamentally different.

The last issue to be discussed in this introduction is the extent to which clerical jobs are also female jobs. Is it a coincidence that the expansion of clerical employment occurred simultaneously with the expansion of female labor force participation rates? To what extent have female job opportunities been linked to the expansion of the clerical work force?

Figure 1.C shows that the overwhelming majority of clerical workers are in fact female, and that this is even more true today than it was 30 years ago! From just over 60 percent female in 1950, the proportion grew to nearly 80 percent by 1980. A closer examination of individual occupations later will show that this reflects the relative growth trends among clerical jobs as well as the increasing supply of female labor. But it is clear that clerical jobs are more than ever women's jobs.

Figure 1.D demonstrates that the obverse is also true. A growing proportion of females who are employed outside the home are employed as clerical workers. In 1950, about 27 percent of employed females worked in clerical jobs. By 1970, over 35 percent of females were employed as clerical workers. Thus, the sex-segregation of clerical occupations appears to have been increasing. This trend may have abated somewhat during the 1970s since there was very little increase in the proportion of females employed as clerical workers between 1970 and 1980.[3] Nevertheless, in 1980 over 35

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2. The apparent drop in 1971 should be ignored as it reflects the conversion to new Census codes rather than any actual change in clerical employment levels.

3. See Reskin and Hartmann (1985) for a discussion of sex segregation on the job.

Figure 1.B

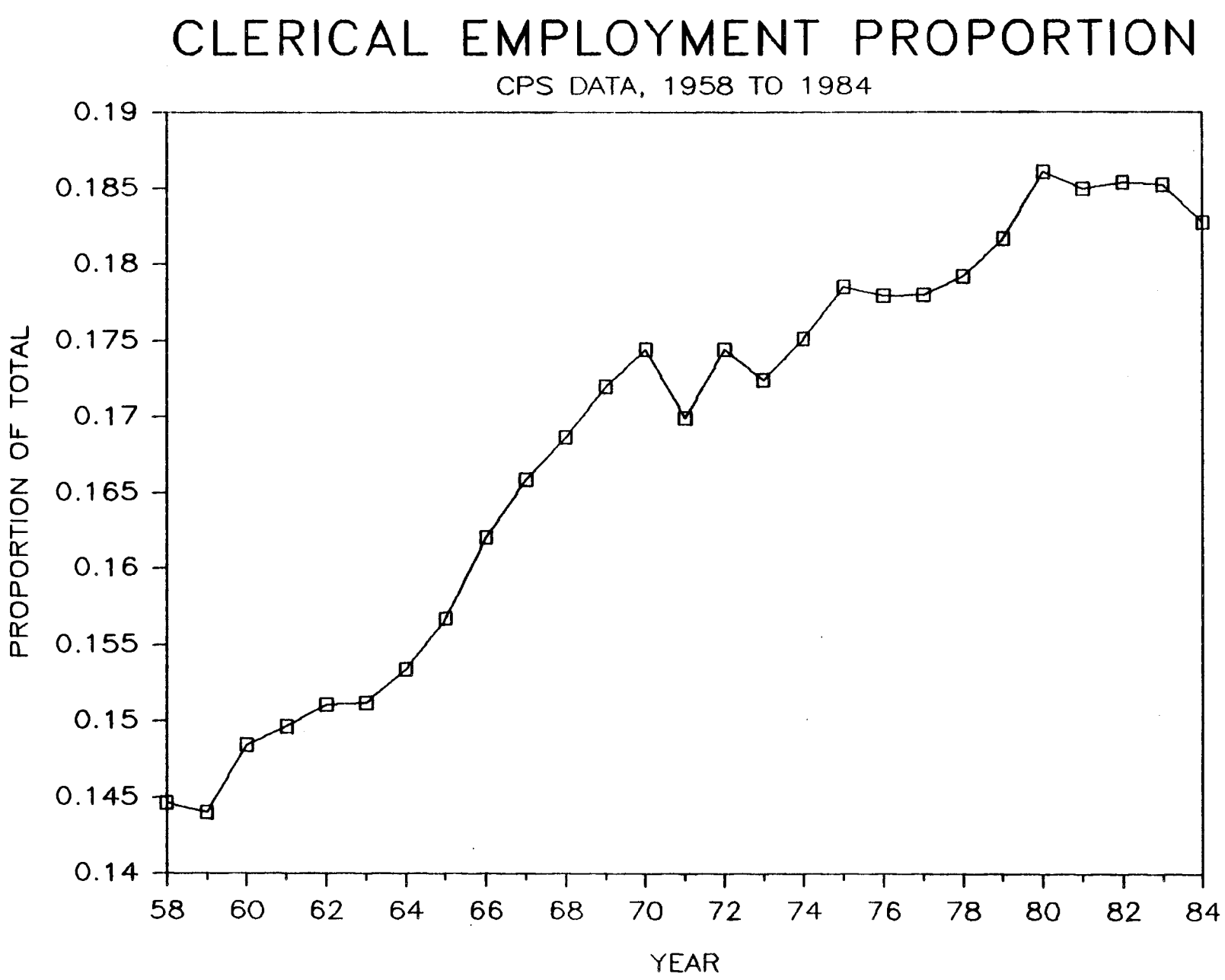

CLERICAL EMPLOYMENT PROPORTION
CPS DATA, 1958 TO 1984
PROPORTION OF TOTAL
0.19
0.185
0.18
0.175
0.17
0.165
0.16
0.155
0.15
0.145
0.14
58
60
62
64
66
68
70
72
74
76
78
80
82
84
YEAR

Figure 1.C

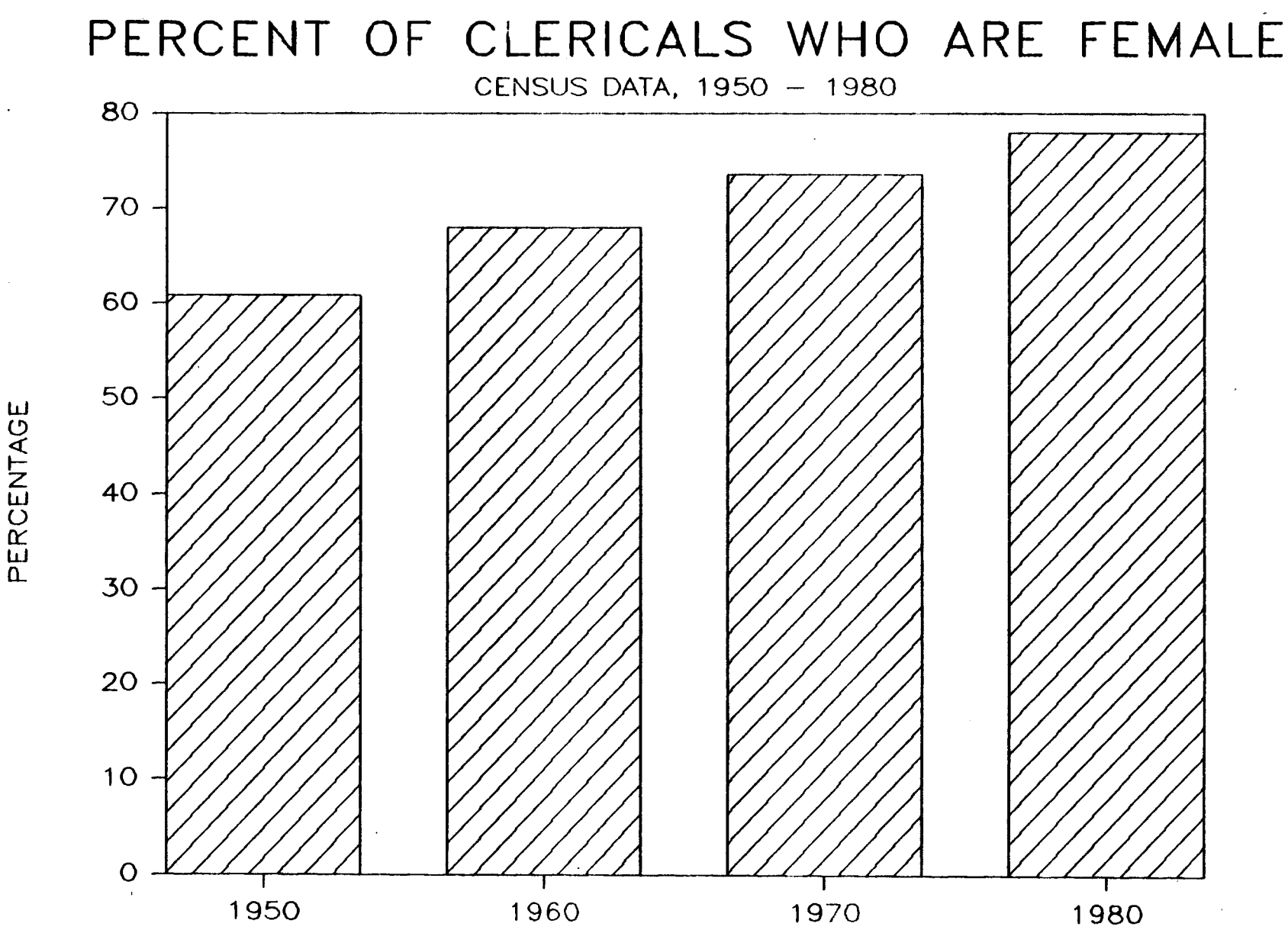
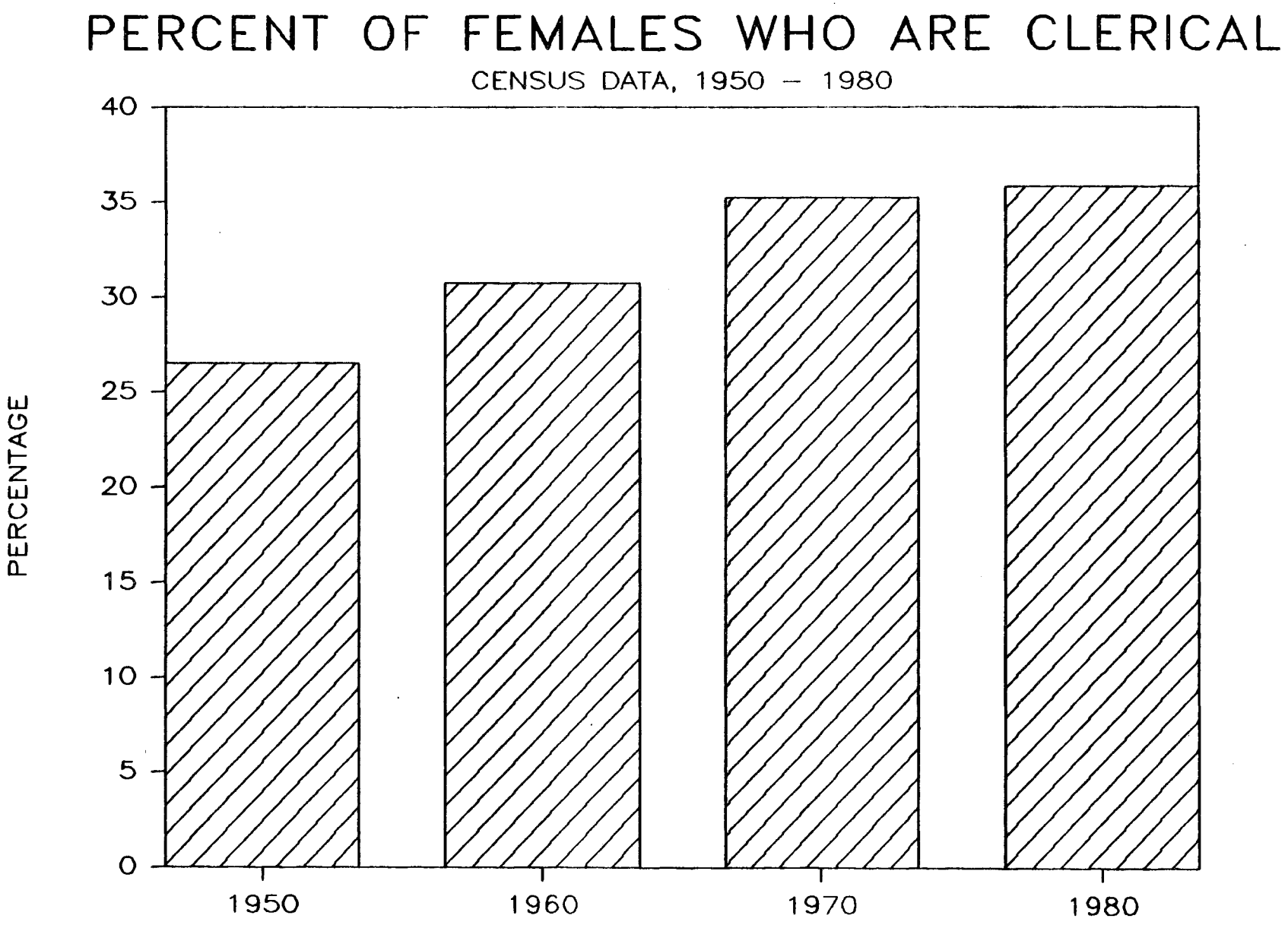

PERCENT OF CLERICALS WHO ARE FEMALE
CENSUS DATA, 1950 – 1980
PERCENTAGE
80
70
60
50
40
30
20
10
0
1950
1960
1970
1980

Figure 1.D


PERCENT OF FEMALES WHO ARE CLERICAL
CENSUS DATA, 1950 – 1980
PERCENTAGE
40
35
30
25
20
15
10
5
0
1950
1960
1970
1980

percent of all females who were gainfully employed outside the home worked at clerical jobs. This contrasts very strongly with the overall figure of about 20 percent of all employees presented earlier. Clearly, clerical jobs are predominantly female jobs and females are much more likely than males to work as clerical workers.

Plan of Presentation

This report reviews trends in clerical employment over the last 30 years and looks for evidence of the impact of changes in process technology on those trends. Section II specifically reviews clerical employment trends from 1950 to 1980, and from 1972 to 1982.[4] This period encompasses the introduction of mainframe computers to the office as well as the beginnings of the microcomputer age. Thus one can interpret the review as an indirect search for the employment effects of technological change. If changing office technologies displaced large number of clerical workers during the first computer revolution, the evidence should be in the employment record of the 1960's and 1970's. Similarly, if the current office technologies threaten clerical jobs, some evidence of this should be found in the employment figures of the early 1980's. Hopefully, this analysis will aid in assessing the likelihood of significant displacement among current clerical workers accompanying the introduction of the new microprocessor-based office technologies of the future.

The third section of the paper discusses the determinants of clerical employment in the broadest sense. The influence of industry occupational structure and industry employment trends on clerical employment totals are examined. The aggregate change in clerical employment from 1972 to 1982 is decomposed into portions due to general economic growth, changes in the sectoral composition of the economy, and changes in occupational staffing patterns. Evidence of the direct impact of technological change on office employment levels is sought for the finance and insurance industry, reputedly the most advanced user of office automation systems.

A review of existing forecasts of clerical employment is offered in the fourth section. The obvious purpose is to provide information about other researchers' expectations about clerical employment trends. But it also provides an opportunity to examine the way in which assumptions about technological change and its future employment impacts have shaped those employment forecasts.

This report does not try to assess the influence of other important factors that will determine future labor market outcomes for clerical workers. In particular, there is no consideration of future supply issues. If female labor force participation rates continue to rise as they have in the past, the issue

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4. A much more thorough review of existing data is provided in Hunt and Hunt (1986) chapters 2 and 3.

of job creation for women will be of even greater significance. On the other hand, if women increase their penetration of non-traditional female occupations, the number of females seeking clerical positions in the future may decline. Whether men are more likely to begin to look to clerical positions for career opportunities in the future presumably depends on labor market developments for clericals, as well as the job outlook in more traditional male occupations.[5]

Clearly these considerations are crucial to understanding whether the supply and demand of clerical workers will be in approximate balance in the labor market of the future, but these questions are beyond the scope of the present effort. We seek only to (1) illuminate past trends in clerical employment, (2) investigate the causes behind those trends, and (3) evaluate existing clerical employment forecasts. Throughout the analysis we will be searching for an understanding of the employment implications of technological change for clerical workers. It is hoped that this critique and systematic review of what is known about past clerical employment trends will help to narrow the range of uncertainty about the probable future impact of technological change on the demand for clerical employment.

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5. Many of these issues are addressed in Technology and Women's Employment, Report of the Panel on Technology and Women's Employment, Committee on Women's Employment and Related Social Issues, National Research Council to be published in 1986.

II. CLERICAL EMPLOYMENT TRENDS

A. Introduction to the Data

The Decennial Census produces the most detailed occupational employment data that are available from household reporting. This reflects the extremely large number of observations that are available. Even though the detailed occupational employment data come from a sub-sample of all Census respondents, the numbers are still very large by normal sampling standards. However, even large numbers of responses cannot obviate the inevitable measurement problems when dealing with occupational information.[6]

Comparisons among Census observations are further complicated by the serious problems with the measuring rod, the occupational classification system. In 1950, occupational employment was tabulated in 12 major groups and 469 detailed occupational categories. In 1960 the same 12 major groups contained 494 detailed occupations, in 1970 there were only 417 detailed occupations but still accumulated into 12 major occupational groups. The overall changes in the classification system can be regarded as relatively minor over this period. With regard to individual occupations, there can be major distortions when an occupational category is added or deleted. Sometimes the slack is taken up by the ubiquitous "not elsewhere classified" or "nec." But on other occasions there are major changes in the coverage of particular occupational titles.

When it comes to the 1980 Census data, the magnitude of the differences in the occupational coding system are astounding. There are 503 detailed occupations which have been reshuffled into 13 new major groups, and the lack of comparability is very serious indeed. For example, cashiers have always been regarded as clerical workers in the Census occupational classification schema. The 1980 Census system, however, reclassifies them as sales workers, thereby moving 1.65 million workers from one major occupational group to another. Clearly this seriously complicates the task of comparing the employment levels of both sales workers and clerical workers to their historical antecedents. Similar transfers occurred for legal aides and counter clerks among clerical occupations. For the first time, there is a fundamental lack of consistency at the major occupational group level between adjacent Census observations.

To avoid being misled by these measurement problems, it is necessary to convert all occupational employment numbers to a consistent basis. Upon the advice of the U.S. Bureau of the Census, the classification system of 1970 was chosen as the standard for this analysis. Since the Bureau of the Census

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6. These issues are discussed more fully in Hunt and Hunt (1986) chapter 2. This review of clerical employment trends is shortened considerably from that in Hunt and Hunt (1986) chapters 2 and 3.

always publishes detailed occupational employment for the last Census and the current one using current definitions, this means that the comparison between 1960 and 1970 employment in terms of the 1970 classifications was readily available.[7]

These data are developed by the Bureau of the Census through a dual classification of a sample of all household units. Thus the proportions of those whose occupation would have moved them from any one detailed occupational group to another can be estimated. After each Decennial Census, such a reclassification study is conducted as a part of the benchmarking to Census observations and the results are published in a Technical Paper.[8]

With painstaking effort it is possible to bridge from one Decennial Census to the next using these estimates of the proportions in each occupational category that moved to another category. It should be mentioned that it was also necessary to standardize the treatment of the "occupation not reported" group across the various Census observations. The numbers reported here include allocation of the occupation not reported group to the detailed occupational level as was done by the Census in 1980. Adjustments were not made for the deletion of 14- and 15-year olds from the labor force beginning in 1970, nor for the fact that the 1960 to 1970 conversion factors published were based on the experienced civilian labor force rather than the number of individuals employed.[9]

Because of the wide discrepancies between the 1980 occupational classification system and all those that went before, it is not possible to be completely accurate in reclassifying all occupational employment into 1980 terms without special reclassification studies for each pair of Census observations (i.e., 1950-1980, 1960-1980, 1970-1980). However, it is possible to use the unpublished Census numbers to estimate the 1980 employment in terms of 1970 Census categories. Of course, it should be understood that all of the reclassification work is done on the basis of sample results. Thus the reclassified employment figures are subject both to the original sampling error

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7. See 1970 Census of Population, Detailed Characteristics, United States Summary PC(1)-D1, Table 221, pp. 718-724.

8. See John A. Priebe, Joan Heinkel, and Stanley Greene, "1970 Occupation and Industry Classification Systems in Terms of Their 1960 Occupation and Industry Elements," Technical Paper No. 26, issued July 1972, Washington, D.C.: U.S. Department of Commerce, Bureau of the Census. The 1950 to 1960 conversion was published as Technical Paper No. 18. Unfortunately, the 1970 to 1980 conversion has not yet been published. The Bureau of the Census was good enough to make preliminary unpublished results available for this study.

9. Neither of these factors are thought to introduce serious distortions in clerical worker employment figures. In any event there is no information available with which to make the adjustments at the specific occupational level.

in estimating occupational employment and the secondary sampling error involved in the reclassification study.

The 1950 Census employment could not be converted directly into 1970 categories since no such reclassification study has ever been done. Therefore the 1950 occupational employment figures were first reclassified into 1960 terms; then those numbers were converted to a 1970 basis using the 1960 to 1970 translation. Suffice it to say that while the numbers reported here were derived as carefully as possible from the information available, it is not clear precisely how accurate they may be.

B. Census Employment from 1950 to 1980

The numbers reported in Table 2.1 represent the best derivable estimates of detailed clerical employment on a consistent basis across the 1950 to 1980 time span. They are far from perfect, but everything that can be done has been done to maximize the consistency of the estimates and thereby minimize the distortions introduced by the measurement system itself.

Table 2.1 shows that there were just over 19 million clerical workers employed in 1980 (using the consistent 1970 definitions). Employment levels for 1950, 1960, 1970, and 1980 are indicated for 42 separate clerical occupations ranging from secretary, the largest, to tabulating machine operator, the smallest. Collectively, clerical workers represented 19.6 percent of all employed persons in 1980, up from only 12 percent in 1950. Table 2.1 reports the individual clerical occupations ranked from largest to smallest according to their level of employment in 1980. The largest single category of clerical workers in 1980 was secretaries. There were over 4 million secretaries employed; they represented just over 4 percent of total employment and 21 percent of clerical employment in that year.

The second biggest category was bookkeepers, with about 1.8 million employed, followed by cashiers, with 1.7 million. The only other clerical occupation that has approached 1 million employees is typists. All together, these "big four" clerical occupations accounted for 8.5 million jobs, or about 45 percent of all clerical employment in 1980. It is interesting to note that these same four occupations only accounted for 27 percent of clerical employment in 1950. All four of these occupations have grown substantially in employment during the last 30 years, although typists declined between 1970 and 1980.

On the other end of the scale in terms of size, there were only about 3,300 tabulating machine operators and about 7,600 telegraph operators employed in 1980. These occupations have been declining for some years, as have the next two smallest occupations, duplicating machine operators and calculating machine operators. Each of these occupations has been adversely impacted by changes in technology.

Table 2.1
Employment in Clerical Occupations, 1950 to 1980
Ranked by Level of Employment in 1980

Occupational title	Employment			
	1950	1960	1970	1980
Total employment	**57,178,206**	**64,639,256**	**76,553,599**	**97,639,355**
Clerical workers	6,875,546	9,575,247	13,856,074	19,119,280
Secretaries	1,005,968	1,539,017	2,875,826	4,058,182
Not specified clerical workers	1,185,906	1,610,020	862,394	1,880,102
Bookkeepers	744,053	973,224	1,633,490	1,804,374
Cashiers	252,252	510,179	884,531	1,654,151
Miscellaneous clerical workers	253,633	328,399	506,677	1,163,635
Typists	60,534	547,923	1,041,804	799,561
Stock clerks and storekeepers	274,089	384,115	482,259	580,979
Receptionists	77,965	164,446	323,552	536,963
Shipping and receiving clerks	323,785	325,307	400,890	483,183
Bank tellers	66,944	139,477	265,197	476,233
Estimators and investigators, n.e.c.	112,469	171,901	282,074	442,553
Counter clerks, except food	96,313	127,630	243,697	398,029
Computer & peripheral equipment operators	868	2,023	124,684	391,909
Keypunch operators	75,091	169,000	290,119	382,118
Clerical supervisors, n.e.c.	44,348	56,887	119,887	340,946
Expediters and production controllers	123,277	151,191	217,107	329,621
File clerks	118,211	152,160	382,578	316,419
Postal clerks	216,164	242,872	321,263	315,111
Telephone operators	363,472	374,495	433,739	314,674
Statistical clerks	109,956	143,922	265,431	297,939
Mail carriers, post office	164,851	203,116	268,612	258,966
Payroll and timekeeping clerks	65,697	112,901	165,815	218,387
Teachers' aides, except school monitors	6,105	17,804	139,790	207,391
Mail handlers, except post office	53,563	67,300	133,839	182,223
Insurance adjusters, examiners, & investigators	33,061	58,726	102,043	159,124
Ticket, station, and express agents	69,807	76,994	104,285	152,841
Library attendants and assistants	16,235	38,203	133,911	140,808
Billing clerks	32,357	45,254	112,876	117,943
Stenographers	429,424	283,486	136,197	91,593
Enumerators and interviewers	85,013	118,723	68,697	88,712
Dispatchers and starters, vehicle	33,746	49,205	63,699	87,622
Messengers and office helpers	111,508	61,303	61,050	82,225
Collectors, bill and account	25,395	34,229	54,728	76,982
Meter readers, utility	40,696	39,712	35,144	41,407
Real estate appraisers	11,754	15,822	22,735	41,343
Office machine, n.e.c.	9,788	21,352	38,669	39,864
Bookkeeping and billing machine operators	26,610	53,914	67,341	37,200
Weighers	80,915	44,548	41,410	29,717
Proofreaders	12,708	17,171	29,940	27,321
Clerical assistants, social welfare	0	0	1,279	24,128
Duplicating machine operator	5,520	14,392	21,682	17,971
Calculating machine	19,176	38,903	37,153	17,881
Telegraph operators	34,811	21,064	13,052	7,604
Tabulating machine operator	9,725	26,937	8,685	3,345

SOURCE: Decennial Census. Data were adjusted for consistency by the authors.

Table 2.2 ranks these same clerical occupations by the annual compound rate of change in employment level from 1950 to 1980.[10] Computer and peripheral equipment operators far exceeded all other clerical occupations in their rate of increase over this period. This occupation has grown from an employment level of 868 persons in 1950 at the dawn of the computer age to nearly 400,000 persons in 1980, an annual rate of growth of over 22 percent. This is the labor market expression of the computer revolution which began to substantially affect employment levels in computer-related occupations in the 1960s.

It is interesting to note that the second fastest growing clerical occupation over the 1950 to 1980 period was teachers' aides; from high-tech to high-touch in one easy step! The number of teachers' aides increased from 6,000 to over 200,000 in this 30-year period, or about 12 percent per year. The third fastest growing clerical occupation was typists, even though there was actually a 23 percent decline in employment from 1970 to 1980. The phenomenal growth of typists in the 1950s and 1960s was sufficient to offset the recent reversals when the entire 30-year period is considered. Following in order of rate of growth are library attendants, clerical supervisors, bank tellers, receptionists, and cashiers. Clearly, there is not a high-tech occupation among them, although they have all been impacted in one way or another by technological change as well as many other influences.

There were also a few clerical occupations that showed absolute declines during this 30-year period. The most rapid declines were among stenographers and telegraph operators, declining in employment by about 5 percent annually. Both occupations have been impacted by technology, but not in a direct and obvious way. The telegraph has been all but replaced by superior communication devices, and this has nearly eliminated the jobs of telegraph operators. Improvements in dictation equipment and changing habits of users have spurred the decline in the stenographer occupation. In 1950, there were 2.3 secretaries per stenographer while by 1980 the ratio had risen to 44 to one.

Fairly rapid declines were also shown by tabulating machine operators and weighers. Actually, the tabulating machine operators would have been the most rapidly retreating if 1960 had been taken as the base year. This occupation provides an excellent example of a technology-specific occupation that experiences rapid growth and then decline. Tabulating machines were very popular in the 1950s for analyzing data on punched paper cards. The number of tabulating machine operators nearly tripled between 1950 and 1960. But data processing technology moved rapidly beyond the capabilities of tabulating machines, and the number of employees in this occupation has fallen by nearly 90 percent since 1960. Rounding out the declining occupations are messengers and office helpers, calculating machine operators, and telephone operators. All appear to be office technology related declines since the communications

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10. The category of clerical assistants, social welfare was omitted since it was only added in 1970.

Table 2.2
Employment in Clerical Occupations, 1950 to 1980
Ranked by Relative Change 1950 to 1980

Occupational title	Employment				Annual percent change
	1950	1960	1970	1980	
Computer & peripheral equipment operators	868	2,023	124,684	391,909	22.6
Teachers' aides, except school monitors	6,105	17,804	139,790	207,391	12.5
Typists	60,534	547,923	1,041,804	799,561	9.0
Library attendants and assistants	16,235	38,203	133,911	140,808	7.5
Clerical supervisors, n.e.c.	44,348	56,887	119,887	340,946	7.0
Bank tellers	66,944	139,477	265,197	476,233	6.8
Receptionists	77,965	164,446	323,552	536,963	6.6
Cashiers	252,252	510,179	884,531	1,654,151	6.5
Office machine operators	146,778	326,521	588,356	890,288	6.2
Keypunch operators	75,091	169,000	290,119	382,118	5.6
Insurance adjusters, examiners, & investigators	33,061	58,726	102,043	159,124	5.4
Miscellaneous clerical workers	253,633	328,399	506,677	1,163,635	5.2
Counter clerks, except food	96,313	127,630	243,697	398,029	4.8
Office machine, n.e.c.	9,788	21,352	38,669	39,864	4.8
Secretaries	1,005,968	1,539,017	2,875,826	4,058,182	4.8
Estimators and investigators, n.e.c.	112,469	171,901	282,074	442,553	4.7
Billing clerks	32,357	45,254	112,876	117,943	4.4
Real estate appraisers	11,754	15,822	22,735	41,343	4.3
Mail handlers, except post office	53,563	67,300	133,839	182,223	4.2
Payroll and timekeeping clerks	65,697	112,901	165,815	218,387	4.1
Duplicating machine operator	5,520	14,392	21,682	17,971	4.0
Collectors, bill and account	25,395	34,229	54,728	76,982	3.8
Statistical clerks	109,956	143,922	265,431	297,939	3.4
File clerks	118,211	152,160	382,578	316,419	3.3
Expediters and production controllers	123,277	151,191	217,107	329,621	3.3
Dispatchers and starters, vehicle	33,746	49,205	63,699	87,622	3.2
Bookkeepers	744,053	973,224	1,633,490	1,804,374	3.0
Ticket, station, and express agents	69,807	76,994	104,285	152,841	2.6
Proofreaders	12,708	17,171	29,940	27,321	2.6
Stock clerks and storekeepers	274,089	384,115	482,259	580,979	2.5
Not specified clerical workers	1,185,906	1,610,020	862,394	1,880,102	1.5
Mail carriers, post office	164,851	203,116	268,612	258,966	1.5
Shipping and receiving clerks	323,785	325,307	400,890	483,183	1.3
Postal clerks	216,164	242,872	321,263	315,111	1.3
Bookkeeping and billing machine operators	26,610	53,914	67,341	37,200	1.1
Enumerators and interviewers	85,013	118,723	68,697	88,712	0.1
Meter readers, utility	40,696	39,712	35,144	41,407	0.1
Calculating machine	19,176	38,903	37,153	17,881	-0.2
Telephone operators	363,472	374,495	433,739	314,674	-0.5
Messengers and office helpers	111,508	61,303	61,050	82,225	-1.0
Weighers	80,915	44,548	41,410	29,717	-3.3
Tabulating machine operator	9,725	26,937	8,685	3,345	-3.5
Telegraph operators	34,811	21,064	13,052	7,604	-4.9
Stenographers	429,424	283,486	136,197	91,593	-5.0

SOURCE: Decennial Census. Data were adjusted for consistency by the authors.

and computing capabilities of modern offices have rendered these jobs less essential than in the past.

With the spectacular exception of the computer operator category, the rapid growth jobs do not show any particular high-technology bent. On the other hand, the declining occupations do seem to offer a technological interpretation, at least in part. Whether this represents a general principle cannot be determined at this time. What is clear is that the bulk of clerical employment occurs in a few very large, very diffuse occupational titles, such as secretary and bookkeeper. This was less true in 1950 than in 1980. It is possible that one impact of office technology over the last 30 years has been to foster more generality in job title and perhaps in duties, but that cannot be conclusively demonstrated with the data that are currently available.[11]

C. CPS Employment from 1972 to 1982

The long-term Census data do not seem to demonstrate a widespread impact of technology on clerical occupations, but it may be more instructive to examine recent annual data for detailed occupations from the Current Population Survey. Due to the benchmarking to Census observations, the only time period for which this can be done with CPS data is the decade from 1972 to 1982.[12] If the microprocessor revolution is going to have catastrophic impacts on clerical employment, it should have become apparent by 1982 when the microcomputer population reached the one million unit level (Computer and Business Equipment Manufacturers Association, 1985: 87).

While this period would seem to be adequate for analysis, it is complicated by the fact that the recession of 1981-82 occurs right at the end of the period. Although the recession would be certain to distort occupational employment numbers for production workers in manufacturing industries, its impact on the employment of clerical workers is less certain.

In addition, the utilization of annual average data from a much smaller household survey such as the CPS will introduce considerable statistical noise into the data. When observations are closely spaced, the inevitable sampling variability becomes all too apparent. Thus, some reservation must be expressed about any particular annual observation. More confidence can be put in trends that emerge over a period of three or four years.

Table 2.3 shows the CPS clerical occupations sorted by the annual rate of change over the 1972-1982 decade. This list is remarkably similar to the

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11. See Hunt and Hunt (1986) chapter 2 for a discussion of the difficulties inherent in measuring employment by occupation.

12. It is frustrating to stop the analysis in 1982. However, the massive reorganization of the occupational classification system introduced to the CPS in 1983 prevents the development of consistent data for all occupations after 1982.

Table 2.3
Employment in Clerical Occupations, 1972 to 1982
Ranked by Relative Change 1972 to 1982

Occupational Title	Employment (in thousands)											Annual Percent change
	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	
Computer and peripheral equipment operators	199	220	251	302	295	311	403	465	535	564	588	11.4
Bank tellers	290	329	356	356	378	416	458	503	542	569	561	6.8
Insurance adjusters, examiners and investigators	109	114	127	153	159	172	173	178	179	191	200	6.3
Teachers' aides, except school monitors	208	232	253	292	325	326	348	357	391	381	373	6.0
Cashiers	998	1,060	1,127	1,200	1,280	1,354	1,434	1,512	1,592	1,660	1,683	5.4
Estimators and investigators, n.e.c.	350	334	374	389	423	459	460	506	545	540	570	5.0
Receptionists	439	450	465	468	511	542	600	614	644	675	672	4.3
Messengers & office helpers	79	85	77	78	83	95	89	95	98	97	115	3.8
Collectors, bill and account	61	59	64	73	66	73	80	77	81	93	87	3.6
Mail handlers, except post office	129	144	148	145	140	149	164	170	168	175	182	3.5
All other clerical workers	1,329	1,331	1,388	1,375	1,444	1,587	1,705	1,818	1,899	1,956	1,871	3.5
Enumerators & interviewers	39	49	53	44	49	55	54	61	87	58	53	3.1
Clerical supervisors, n.e.c.	200	184	231	228	239	229	207	241	245	250	270	3.0
Expediters and production controllers	196	202	201	214	210	219	228	244	238	254	257	2.7
Secretaries	2,964	3,088	3,218	3,281	3,428	3,470	3,646	3,792	3,944	3,917	3,847	2.6
Clerical workers	14,329	14,667	15,199	15,321	15,788	16,372	17,207	17,953	18,473	18,564	18,466	2.6
Keypunch operators	284	255	251	253	279	284	277	279	271	248	364	2.5
Dispatchers & starters, vehicle	86	88	92	93	89	99	99	109	105	115	110	2.5
Bookkeepers	1,592	1,673	1,706	1,709	1,712	1,754	1,861	1,945	1,942	1,961	1,968	2.1
Statistical clerks	301	301	328	331	342	363	384	408	396	370	365	1.9
Payroll & timekeeping clerks	185	200	206	202	211	231	245	241	237	231	224	1.9
Ticket, station, and express agents	130	118	123	138	126	132	131	148	144	148	154	1.7
Counter clerks, except food	331	352	350	331	359	349	383	369	358	360	373	1.2
Shipping & receiving clerks	453	461	469	433	446	474	469	493	515	525	499	1.0
Library attendants and assistants	138	123	135	146	143	144	174	168	155	152	150	0.8
Billing clerks	149	166	158	145	140	157	170	164	165	153	154	0.3
File clerks	274	287	279	268	274	280	279	312	332	315	278	0.1
Mail carriers, post office	271	268	268	254	244	244	258	256	247	242	264	-0.3
Stock clerks & storekeepers	513	478	493	479	499	505	516	539	544	528	497	-0.3
Postal clerks	282	303	295	293	291	271	272	264	291	269	271	-0.4
Typists	1,025	1,040	1,046	1,035	995	1,020	1,060	1,038	1,043	1,031	942	-0.8
Telephone operators	394	390	393	348	343	347	317	333	323	308	283	-3.3
Bookkeeping and billing machine operators	69	57	59	60	49	53	47	59	52	49	42	-4.8
Stenographers	125	107	104	101	101	84	96	78	66	74	66	-6.2

SOURCE: Current Population Survey.

earlier 1950-1980 rate of change listing in Table 2.2. Once again, computer and peripheral equipment operators experienced the most rapid rate of increase of any clerical occupation, although it was only about half the rate shown for the 1950-80 period. Bank tellers and insurance adjusters, examiners and investigators both edged ahead of teachers' aides in growth rates during the more recent decade. This reflects the fall-off in the rate of growth in teachers' aides as employment growth in education as a whole faltered due to funding difficulties and a reduction in the student population.

Other clerical occupations showing relatively rapid growth during the 1972 to 1982 decade include cashiers, estimators and investigators, and receptionists. All three of these occupations involve direct customer contact and probably would fall into the "hard to automate" category. Messengers and office helpers emerge as a relatively rapidly growing clerical occupation in the 70's, which is in contrast with their declining employment from 1950 to 1970. The number of bill collectors increased at 3.6 percent annually during the decade, and non-post office mail handlers increased at 3.5 percent. Once again, there is no particular pattern that emerges from the listing of clerical occupations that grew more rapidly than average during this recent decade.

At the other end of the distribution, the declining occupations, stenographers and telephone operators are joined by bookkeeping and billing machine operators in rather rapid decline for the 1972 to 1982 period. Small annual declines were registered for typists, postal clerks, mail carriers, and stock clerks and storekeepers.

Bookkeeping and billing machine operators are another clerical occupation that may be impacted by the microprocessor revolution. As microcomputers have become more widely distributed, increasing attention has been paid to creating accounting software that will run on the micros. This has undoubtedly impacted the number of bookkeeping machine operators. What is not clear is whether it has reduced the number of people doing the bookkeeping work. Since they are not doing it on a special purpose device, it would no longer be appropriate to call them bookkeeping machine operators, however, and the job titles are very likely changed.

D. Conclusions

The review of employment trends among clerical workers over the last 30 years does not indicate that changes in office technology have been an overwhelming influence on those trends. While some occupations show steep declines in employment levels, it is difficult to argue that in general these declines are really a consequence of changes in office technology. Stenographers are one rare example where a change in process technology (substitution of dictation equipment for human skills) is clearly manifested in a decline in employment. Tabulating machine operators provide an example of a clerical occupation where the change in technology has led to a direct substitution of one occupation (computer operators) for another (tabulating machine operators).

Among rapidly growing clerical occupations, only the computer and peripheral equipment operators show a clear relationship to changes in office

technology. Most other rapidly expanding clerical occupations are distinctly low-tech. Leading examples include teachers' aides, typists, library attendants, bank tellers, receptionists, and cashiers. Of course, at such an aggregated level of analysis, it is difficult to rule out the possibility that the automation of record keeping functions has served to restrain the growth in some clerical occupations, thereby making the growth in others appear more dramatic.

Without more careful study of both inputs and outputs of office production, definitive conclusions about the impacts of office technology cannot be drawn. However, the overall impression of this aggregate analysis is that there are more important determinants of clerical employment trends than changes in office technology. The next section of the paper attempts to identify those determinants.

III. DETERMINANTS OF CLERICAL EMPLOYMENT

The overall trends in occupational employment indicated that some clerical jobs were growing while others were declining. On an aggregate basis, it was seen that clerical jobs as a whole were becoming relatively more important as a proportion of total jobs in the economy, although that growth slowed in the 1970s. It also appeared that the recession of 1980-1982 was unique in that the proportion of clerical jobs did not increase significantly as it has in past recessions. It is not known whether this is a harbinger of the future or an anomaly caused by the worst recession since WWII.

The employment in individual clerical occupations is the focus of this paper, but it is necessary to look beyond the number of workers in a specific occupation to determine what might be causing those movements. This section looks behind the scenes at what might explain the occupational employment movements discussed earlier.

In the broadest terms possible, employment depends upon output and the productivity of the workers which produce that output. National output is generally measured by Gross National Product (GNP), the value of all final goods and services produced in the economy in a year. This simple relationship, although devoid of occupational and industrial content, helps to emphasize two major points relevant to this paper.

First, if one accepts the notion that productivity is more or less fixed in the short run by the technological structure of production, then it should be clear that changes in GNP -- aggregate demand in the economy -- drive any changes in employment. In turn, many socio-economic factors may themselves affect both the level and rate of growth of GNP. There are also totally unforeseen shocks to the economy, such as the energy crises of the 1970s, which at least temporarily disrupt the national economic system. It is also true that business cycles, which may vary tremendously in terms of their length and severity, do periodically recur. The point is that all occupations and industries are adversely affected by the failure of GNP to grow sufficiently. Likewise, all occupations and industries tend to benefit from reasonable economic growth.

The second factor which influences employment is productivity. The concern, of course, is that productivity growth will outpace the growth of GNP. During recessionary periods it is not unusual for the lack of jobs to be blamed on labor-saving technology, which is nothing more than automation in general. However, what must be emphasized here is that productivity growth and GNP growth are actually intertwined. We all have a vital stake in productivity gains because that is what allows the possibility of economic growth.

Historically, technological change has not created permanent unemployment for millions of workers. It instead has raised the living standards of workers. To be sure, there have been winners and losers in this process, both among firms and individuals, but the net result has been real economic growth. No one can guarantee that history will repeat itself with office automation

today but some appear to be too easily persuaded that history will not repeat itself, i.e., office automation and other labor-saving technologies will wipe out millions of jobs. Later in this section we assess the past and current trends in office automation and their impact on clerical workers.

A. Clerical Employment By Industry

The analysis of occupational employment by industry begins with the occupational profile of the nation. If GNP is considered to be the nation's output, then this occupational profile represents the relative importance of each occupation in producing that output. The occupational profile of the U.S. for 1982 using the major occupational groups from the Current Population Survey (CPS) is presented in Table 3.1.[13] Since occupational structures tend to change slowly, the snapshot provided here will provide an adequate overview of the relative importance of the occupations in the nation.

The relative importance of the various industries in the national employment picture is presented in Table 3.2. By far the most important of the individual one-digit industries is the service sector. It accounts for a little over 30 percent of all employment, almost double the size of the next biggest sector retail trade. It is also interesting to note that even though 1982 was a recession year, the durable goods sector holds third place with about 12 percent of total employment.

But how important are the clerical jobs in each of these industries? That question is partially answered in Table 3.3 which presents the summary staffing ratios for all industries. Occupational staffing ratios measure the relative importance of an occupation in an industry. They are obtained by dividing occupational employment in an industry by total industry employment. Thus the staffing ratios of all occupations within an industry must sum to one as reflected in the bottom row of the table. It should be emphasized at the outset that the broad occupational and industrial groupings at the one-digit level actually consist of rather heterogeneous subgroupings and therefore should be interpreted cautiously.

According to Table 3.3, the finance industry shows the highest percentage of clerical workers, nearly 45 percent of all employees in this industry are clerical workers. In fact, there are twice as many clerical workers in finance as any other occupational group employed in that sector. Public administration is also a heavy employer of clerical workers, about 35 percent of all jobs in this industry are clerical. It is followed by utilities and wholesale trade which also utilize heavy proportions (more than 20 percent) of clerical workers to produce their output. However, in neither of these industries are clerical workers as dominant as in finance or public administration.

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13. The year 1982 is chosen because it is the most recent year in the CPS data base for which the historical estimates are consistent.

Table 3.1

U.S. OCCUPATIONAL PROFILE

Occupation	1982 Employment (thousands)	Percent of Total Employment
Professional, Technical, and Related Workers	16,952	17.0
Managers, Officials, and Proprietors	11,494	11.5
Sales Workers	6,580	6.6
Clerical Workers	18,446	18.5
Craft and Related Workers	12,271	12.3
Operatives	12,807	12.9
Laborers, Except Farm	4,517	4.5
Service Workers	13,736	13.8
Total, All Occupations	99,528	100.0

Source: Calculations by the authors based upon data from the Current Population Survey.

Note: Some occupational detail is omitted. Totals and percentages may not add exactly due to omission of some occupational detail and rounding error.

Table 3.2

U.S. INDUSTRY PROFILE

Industry	1982 Employment (thousands)	Percent of Total Employment
Agriculture	3,401	3.4
Mining	1,028	1.0
Construction	5,756	5.8
Durables	11,968	12.0
Nondurables	8,318	8.4
Utilities	6,552	6.6
Wholesale Trade	4,120	4.1
Retail Trade	16,638	16.7
Finance	6,270	6.3
Services	30,259	30.4
Public Administration	5,218	5.2
Total	99,528	100.0

Source: Calculations by the authors based upon data from the Current Population Survey.

Note: Totals and percentages may not add exactly due to rounding.

Table 3.3

OCCUPATIONAL STAFFING RATIOS BY INDUSTRY FOR 1982

Occupation	Construction	Durable Goods	Non-Durable Goods	Utilities	Wholesale Trade	Retail Trade	Finance	Services	Public Administration
Professional & Technical	0.04	0.15	0.10	0.10	0.04	0.02	0.07	0.37	0.20
Managers & Administrators	0.13	0.08	0.08	0.11	0.21	0.19	0.20	D.08	0.13
Sales Workers	0.01	0.01	0.04	0.01	0.24	0.20	D.22	0.01	.00
Clerical Workers	0.08	0.13	0.13	0.22	0.20	0.17	0.44	0.18	0.35
Craft Workers	0.55	0.21	0.17	0.21	0.08	0.07	0.02	0.05	0.06
Operatives	0.04	0.33	0.37	0.02	0.05	0.04	.00	0.03	0.01
Service Workers	0.13	0.04	0.05	0.07	0.06	0.06	0.01	0.02	0.03
Laborers, Non-Farm	0.01	0.02	0.02	0.03	0.01	0.23	0.04	0.26	0.22
TOTAL	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00

Source: Calculations by the authors based upon data from the Current Population Survey.

Note: Some occupational and industrial detail is omitted. Totals and percentages may not add exactly due to omission of some occupational and industrial detail and rounding error.

The service industry and retail trade both show between 15 and 20 percent of their total employment in clerical occupations, although their other occupational needs do not look similar at all. The durable and non-durable manufacturing industries are the home base of the operatives, but both show between 10 and 15 percent of their total employment in clerical occupations. Last is the construction industry which employs relatively few clerical workers, but is the dominant user of skilled craft workers in the economy.

Clearly, different industries use very different mixes of occupations to produce their final output. The occupational staffing ratios are relatively unique to each type of production. It is this variation in the staffing ratios between industries that makes trends in industry employment an important influence on the distribution of occupations throughout the economy.

The absolute number of clerical jobs in each of the major industries is presented in Table 3.4. About 5.5 million clerical workers can be found in the service industry. Just under three million clerical jobs are located in each of two sectors, retail trade and finance. These three sectors combined -- services, retail trade, and finance -- account for over 11 million clerical jobs, almost 60 percent of total clerical employment. Clerical workers may be dispersed broadly throughout the national economy, but these three sectors are especially important to total clerical employment.

B. Industry Employment Trends

The most detailed data on occupational employment by industry are currently collected in the Occupational Employment Statistics (OES) program at BLS. It provides the historical basis for the staffing ratios in the BLS industry-occupation matrix which is subsequently used as the starting point for the BLS occupational employment projections. The BLS occupational employment projections will be discussed later. This section concentrates on gaining a better understanding of the way in which occupational employment is influenced by trends in industry employment.

The 20 most important sectoral employers of clerical workers in 1982 are presented in Table 3.5. The year 1982 is selected because that is the current base year for the OES occupation by industry employment data. The entries in the table are ranked by the number of clerical employees in each industry. The clerical staffing ratios and total industry employment are also included to highlight the importance of these variables in determining occupational employment. Finally, the percent of total clerical jobs accounted for by each of the 20 industries as well as the cumulative total is also reported.

The top 10 industries in terms of clerical employment account for about two-thirds of all clerical employment. The top 20 industries account for over 80 percent of all clerical jobs. While clerical jobs are indeed dispersed throughout the economy, none of the top 10 clerical employment industries are from the goods-producing sectors. Furthermore, it is clear how important the federal and state and local government sectors are to clerical employment. Jointly they account for over 3.6 million clerical jobs or almost 20 percent of the total. We can also see the importance of banking and insurance, the two

Table 3.4

OCCUPATIONAL EMPLOYMENT BY INDUSTRY FOR 1982

Occupation	Construction	Durables	Non-Durables	Utilities	Wholesale Trade	Retail Trade	Finance	Services	Public Administration	Total
Professional & Technical	203	1,795	829	679	176	311	418	11,255	1,021	16,952
Managers & Administrators	740	981	694	721	880	3,126	1,232	2,294	668	11,494
Sales Workers	33	177	335	89	1,009	3,310	1,378	230	4	6,580
Clerical Workers	451	1,513	1,074	1,463	844	2,840	2,750	5,473	1,827	18,446
Craft Workers	3,167	2,513	1,393	1,373	349	1,110	129	1,643	292	12,271
Operatives	407	4,275	3,428	1,577	564	1,046	17	999	111	12,807
Service Workers	33	213	186	199	31	3,898	256	7,750	1,145	13,736
Laborers, Non-Farm	722	501	379	452	266	997	89	614	148	4,517
TOTAL EMPLOYMENT	5,756	11,968	8,318	6,552	4,120	16,638	6,270	30,259	5,218	99,528

Source: Current Population Survey.

Note: Some occupational and industrial detail is omitted. Totals may not add exactly due to omission of some occupational and industrial detail and rounding error.

Table 3.5

BLS CLERICAL EMPLOYMENT BY INDUSTRY, 1982

Industry	Industry Employment (thousands)	Employment Clerical (thousands)	Industry Staffing Ratio (percent)	Percent of Total Clerical Employment	Cumulative Percentage of Total Clerical Employment
State and Local Government and Educational Services	13,068	2,512	19.2	13.4	13.4
Miscellaneous Retail Trade	10,476	2,496	23.8	13.3	26.8
Wholesale Trade	5,294	1,531	28.9	8.2	34.9
Banking	1,650	1,180	71.5	6.3	41.2
Federal Government	2,739	1,138	41.5	6.1	47.3
Insurance	1,700	911	53.6	4.9	52.2
Miscellaneous Business Services	3,139	896	28.5	4.8	57.0
Hospitals	4,166	666	16.0	3.6	60.5
Social Services, Museums, and Membership Organizations	2,755	587	21.3	3.1	63.7
Credit Agencies, Security and Commodity Brokers	1,015	577	56.9	3.1	66.8
Legal and Miscellaneous Services	1,628	560	34.4	3.0	69.7
Telephone and Other Communication	1,174	529	45.1	2.8	72.6
Physician and Dental Offices	1,309	394	30.1	2.1	74.7
Construction	3,913	324	8.3	1.7	76.4
Eating and Drinking Places	4,781	224	4.7	1.2	77.6
Electric Services and Gas Distribution	792	207	26.2	1.1	78.7
Trucking and Warehousing	1,206	199	16.5	1.1	79.8
Miscellaneous Printing and Publishing	846	192	22.8	1.0	80.8
Real Estate	986	188	19.1	1.0	81.8
Miscellaneous Personal Services	1,219	186	15.3	1.0	82.8

Source: Calculations by the authors based upon data tape from the 1982-1995 OES/BLS occupational employment projections.

largest sectors within finance in terms of clerical employment. Finally, clerical jobs are important in a variety of service sector industries from business services to personal services.

Since industry employment is so crucial to occupational employment levels, the trends over the last 27 years in industry employment are presented in Figure 3.A and Table 3.6. Figure 3.A aggregates the employment in the top 10 industries, while the table presents the employment trends for each of the 10 industries. The numbers are reported in index number form to make it easier to compare the growth trends. The average growth in employment for all industries is also reported to facilitate comparisons between the particular industry and the average for all industries.

Figure 3.A demonstrates a number of important features of the top 10 clerical employment industries. First, these industries have been much less susceptible to the vagaries of the business cycle than all industries. The growth rate of the sum of these 10 sectors has remained positive through two of the three recessions during the period. It was only in 1982, during the worst recession since WWII, that the composite growth rate of these 10 sectors turned negative -- and then, barely so.

Second, the average growth rate of these 10 industries has clearly outdistanced the all-industry average for the entire 27-year period. But this is almost entirely due to the fact that employment in these sectors does not ordinarily retreat during recessionary periods, but just keeps expanding. The conclusion appears to be that employment in these 10 important clerical employment industries has grown faster than employment in the overall economy, but that most of this positive growth differential occurs during recessions.

By looking at the employment trends in each of the 10 industries, some of the diversity among the sectors begins to emerge. The most robust growth has clearly occurred in banking, miscellaneous business services, hospitals, and the credit agency, security and commodity broker sector. The growth in employment in miscellaneous business services is particularly striking, more than six times as many workers in this sector in 1984 than there were in 1958. This compares to about a 67 percent growth rate for all employment. This sector provides a myriad of services to business firms from accounting to customized computer software to consulting advice.

The growth rate of employment in hospitals is also striking. This sector tripled in employment over the period 1958 to 1984. Some of the causes of this growth, such as the aging of the population and the increasing availability of medical insurance for retirees and the indigent through government programs, are well known. In any event, the growth of this sector has not been touched by the business cycle and may have even accelerated during the last recessionary period. The real surprise is that hospital employment growth slowed in 1983 and actually turned negative in 1984. Apparently the recent emphasis on cost containment and the shortening of hospital stays is having an impact on employment in that sector.

Figure 3.A

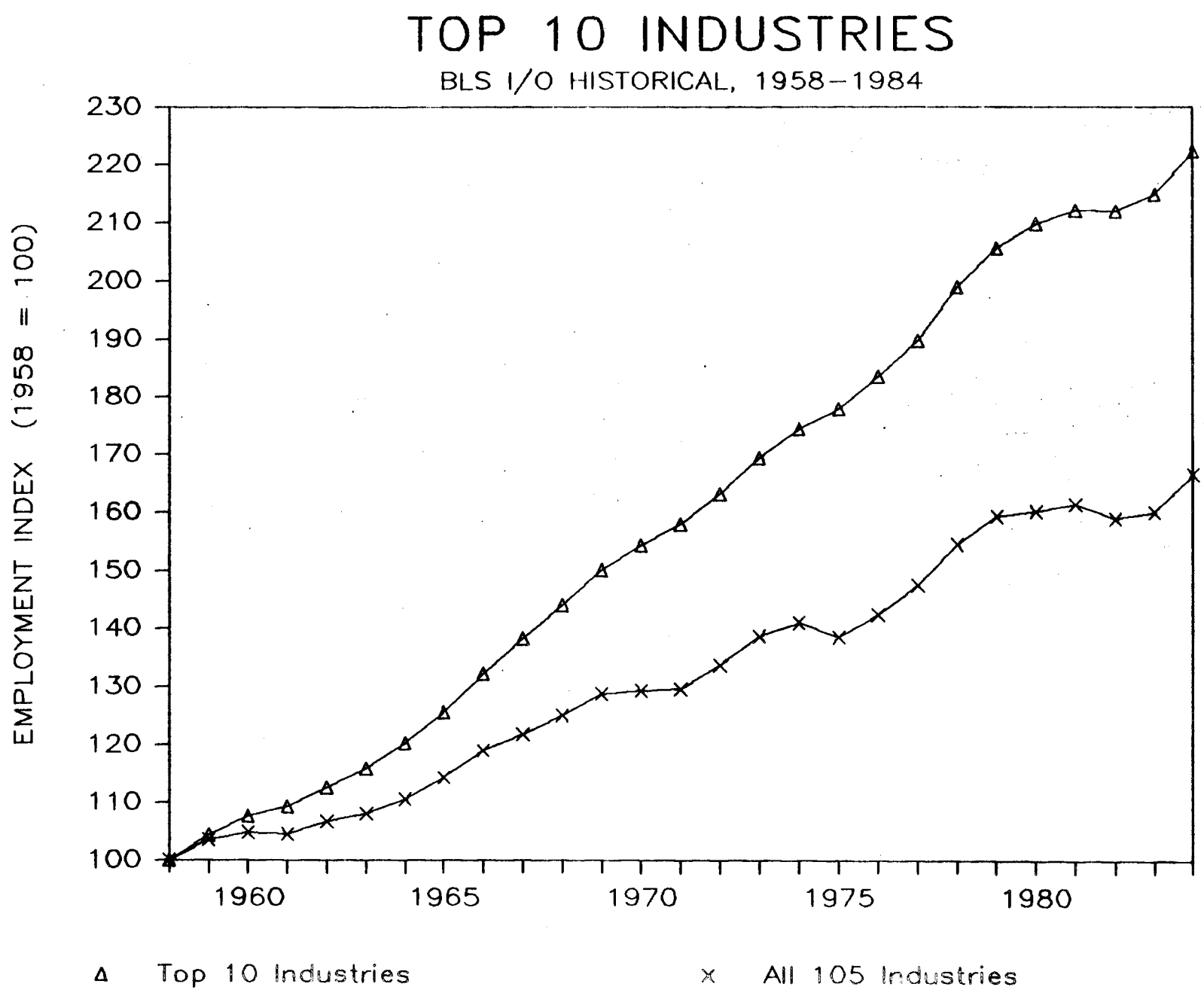
TOP 10 INDUSTRIES
BLS I/O HISTORICAL, 1958–1984
EMPLOYMENT INDEX (1958 = 100)
230
220
210
200
190
180
170
160
150
140
130
120
110
100
1960
1965
1970
1975
1980
Δ Top 10 Industries
× All 105 Industries

Table 3.6

TOTAL INDUSTRY EMPLOYMENT GROWTH OF THOSE SECTORS WITH THE MOST CLERICAL EMPLOYEES

Year	State & Local Government	Misc. Retail Trade	Wholesale Trade	Banking	Federal Government	Insurance	Misc. Business Services	Hospitals	Credit Agencies & Commodity Brokers	Social Services And Museums	Top 10 Industries	All 105 Industries
1958	100	100	100	100	100	100	100	100	100	100	100	100
1959	104	103	103	104	102	101	110	106	109	118	104	104
1960	108	98	105	109	104	103	116	113	116	122	108	105
1961	112	105	105	112	104	105	123	120	124	128	109	105
1962	116	107	107	116	107	106	135	126	129	131	113	107
1963	122	109	109	120	108	109	146	134	132	133	116	108
1964	128	112	112	124	107	111	159	143	138	134	120	111
1965	136	116	116	128	109	112	173	149	142	136	126	114
1966	146	121	121	134	117	114	192	156	149	140	132	119
1967	154	124	124	141	124	119	211	171	156	146	138	122
1968	161	128	127	148	125	122	224	182	171	153	144	125
1969	167	133	131	159	126	125	248	195	186	157	150	129
1970	174	136	134	169	125	129	262	205	182	159	154	129
1971	180	139	134	174	123	131	264	213	184	163	158	130
1972	189	144	138	181	123	133	282	218	194	157	163	134
1973	196	149	144	191	122	135	308	226	202	158	169	139
1974	203	149	149	202	124	139	326	238	202	162	174	141
1975	211	148	148	206	125	140	333	250	202	165	178	139
1976	215	153	153	212	125	142	359	260	210	170	183	142
1977	220	158	158	220	124	148	386	271	222	172	190	148
1978	229	165	167	231	126	154	429	280	238	177	199	155
1979	233	168	175	243	127	160	472	287	256	183	206	159
1980	237	167	177	255	131	164	504	303	268	189	210	160
1981	235	168	180	264	127	167	540	320	284	190	212	161
1982	232	166	177	268	125	168	551	332	291	190	212	159
1983	232	169	176	270	126	169	580	334	317	190	215	160
1984	233	177	185	273	127	172	654	329	343	196	222	167

Source: Calculations by the authors based upon data from the BLS input-output industry series.

It is also clear that the finance sector -- especially banking, credit agencies, security and commodity brokers, and to a lesser extent, insurance -- contributed significantly to clerical job growth during these years. All three of these sectors have staffing ratios for clerical workers in excess of 50 percent, the highest of all industries. Insurance deserves special mention in that its employment growth virtually paralleled that of all industries until about 1974. Then it began to accelerate and outdistanced the national economy in job growth thereafter, except for 1984. The growth of employment in banking, on the other hand, was consistently higher than that for insurance, nearly tripling from 1958 to 1984.

The slowest growth among the 10 industries with heavy clerical employment occurred in the federal government. The employment trend was very flat from 1965 through 1984. The federal government has not been a source of significant employment growth in the last 20 years. It should also be noted that the growth of state and local government while generally above average, actually declined absolutely during the 1980-1982 recession. By the end of 1984, employment in this sector had still not exceeded its peak employment level achieved in 1980. This is significant because it is the first such decline and sluggish recovery in recent history for the largest single employer of clerical workers among the 105 industries in this analysis.

Of course, the gnawing question is: will these industries show rapid employment growth in the future? That question cannot be answered at this point. However, it should be noted that the nation is still experiencing a long run shift from a goods-producing economy to a service-producing economy. This is not to say that the goods-producing sectors such as manufacturing are unimportant, but only that they have not been growing in terms of employment for a long time.

Historically, clerical workers have benefited from this shift since service industries employ much higher proportions of clerical workers. Thus, even if staffing ratios begin to fall for clerical workers (due to office automation or other factors), it is still possible for them to grow at or above the average rate for all jobs because they are concentrated in the nongoods-producing sectors. Clerical workers have a fortunate industry mix in their employment pattern. The next section explores the technological influences on clerical jobs, while the last section measures the contribution of both changing staffing ratios and changing industry mix to the growth of clerical jobs over the last decade.

C. Technological Change and Clerical Employment Growth

One of the goals of office automation is to improve labor productivity. Consequently, actual gains in labor productivity may be the best measure of the degree to which this goal is realized. This approach looks at the results of the implementation of office automation rather than attempting to assess the technological capability or potential of the equipment. It also avoids an assessment of the management plans of firms. Obviously, firms seldom achieve the technological potential that is inherent in capital equipment, but it is

also not unusual for the management plans of firms to be at wide variance with actual operating results.

The major problems in attempting to estimate the true gains from office automation are twofold. First, it is impossible to glean from current data any information whatsoever about the relative importance of office automation spending by firm or industry.[14] Investment data are subdivided only into the two broad subcomponents of machinery and equipment and structures. Second, complete data about clerical jobs are not available over time in any event. So, even if better investment data were available, it would still be impossible to estimate the productivity gains specifically attributable to clerical workers utilizing various types of electronic office technology.

One simple approach to examining the productivity gains from office automation is to study those sectors which are significant employers of clerical workers and which are also believed to be the leaders in office automation. It is well known that the broad industrial sector of finance and insurance is the forerunner and recognized leader in the field of office automation. It is also true that more than one-half of the workers in this sector are clerical workers. Therefore, one indicative approach to studying the productivity gains from office automation is to examine the overall productivity gains in finance and insurance. Of the 105 detailed industries analyzed in this paper, finance and insurance is composed of three sectors, banking, insurance, and credit agencies, security and commodity brokers. These three sectors have clerical staffing ratios of 71.5 percent, 53.6 percent, and 56.9 percent respectively. Thus, if office automation improves productivity, these sectors are logical candidates to demonstrate the effects of such gains.

Figure 3.B reports the productivity gains for banking, insurance, and credit agencies, security and commodity brokers for the period, 1958-1983.[15] The data are reported in index number form to better depict the percent changes in productivity from year to year. The data for all private nonfarm employment are reported as well to facilitate a comparison of these sectors with the aggregate of all private employers, excluding agriculture.

The surprise from Figure 3.B is that there is no discernible trend that can even remotely be attributed to office automation. The productivity gains in banking, insurance, and credit agencies, security and commodity brokers, have

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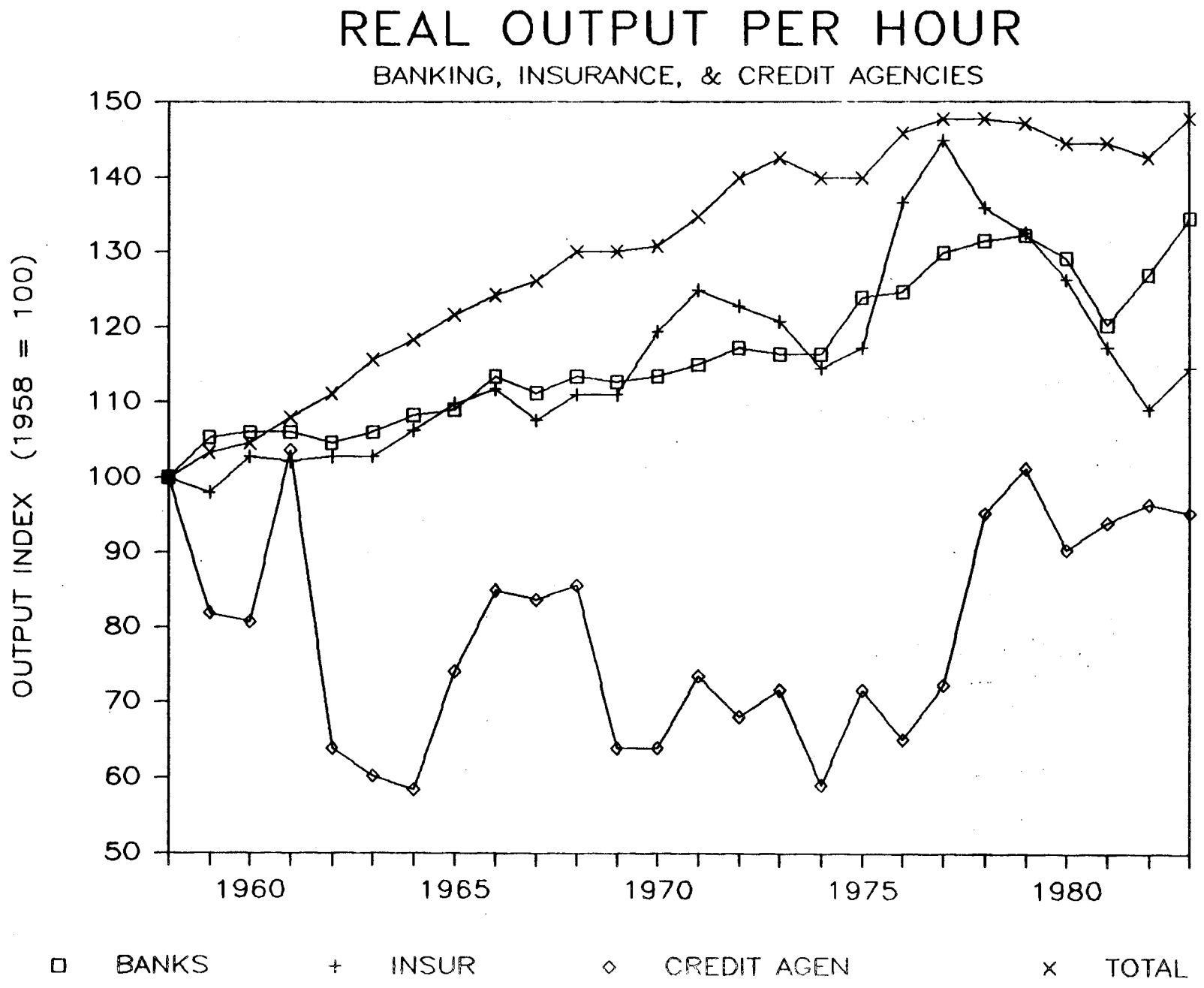
14. See Hunt and Hunt (1985) for an examination of the data bases which are available to study the employment effects of technological change.

15. The gross output in constant dollar terms and employment measures are those defined by the Bureau of Labor Statistics in Bulletin 2018. Time Series Data for Input-Output Industries: Output, Price and Employment (March 1979). The actual data utilized in this paper are from an unpublished update (April, 1985) to the tables in the aforementioned document.

Figure 3.B


REAL OUTPUT PER HOUR
BANKING, INSURANCE, & CREDIT AGENCIES
OUTPUT INDEX (1958 = 100)
150
140
130
120
110
100
90
80
70
60
50
1960
1965
1970
1975
1980
BANKS
INSUR
CREDIT AGEN
TOTAL

all tended historically to lag the average for private nonfarm employment. In fact, productivity for credit agencies, security and commodity brokers was very slightly lower in 1983 than in 1958, and productivity deteriorated absolutely in insurance after 1977. Since 1981, banking productivity has improved relative to all private nonfarm productivity, but it hardly looks like a revolution, especially given that banking productivity declined from 1979 to 1981.

It should be emphasized once again that these are not measures of the productivity gains for clerical workers nor can these gains be attributed to office automation. They are industry-wide measures for output gains due to all employment. However, these industries are predominantly made up of clerical workers and it is popularly believed that these sectors are the leaders in office automation. All that can be fairly concluded is that there is nothing in the aggregate industry data to support the notion that office automation has engendered significant overall productivity gains in these three sectors.

Perhaps these sectors have not been investing in office automation in the way it is popularly believed. Although the investment data do not report office automation expenditures separately, an examination of these data might reveal if there are any new trends in investment in these sectors. Figure 3.C reports in index number form real investment spending per employee by finance and insurance firms, the lowest level of industrial detail for such investment data.[16] Once again, the totals for private nonfarm employment are also shown to provide a reference point for the analysis.

In contrast to the lack of any "take-off" evident in the productivity data for finance and insurance, the investment data in Figure 3.C clearly indicates much higher than average investment trends in finance and insurance after 1966-67. In fact, investment virtually exploded, even after accounting for the significant employment gains in finance and insurance over that time period. Investment per employee in finance and insurance grew a little more than five times the average for all private nonfarm employment after 1966-67.[17]

There is no doubt that finance and insurance is investing heavily in new capital equipment. However, it is less certain that finance and insurance is really investing in office automation. Again, the truth is that we do not know how much of investment in this sector can be truly identified as "office automation spending." What can be concluded is that the dramatic growth in

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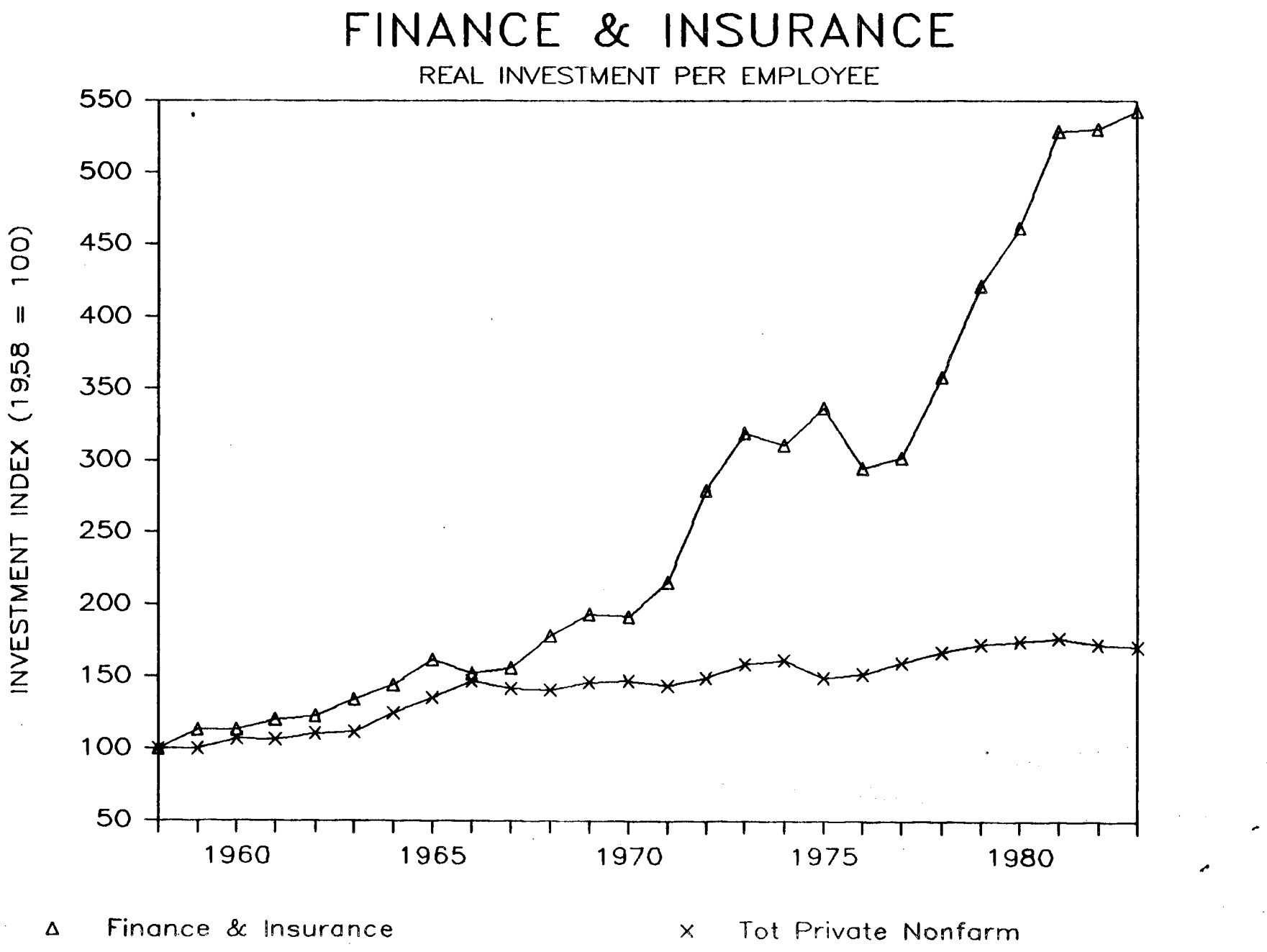
16. The investment data are from the national income and product accounts. See Seskin and Sullivan 1985.

17. The trend in investment per employee is important because it indicates whether something new appears to be happening in that sector, but it is by no means the full story. Historically, absolute investment per employee in finance and insurance has tended to be much less than the average for all nonfarm private industries. That situation reversed itself in the 1970s.

Figure 3.C


FINANCE & INSURANCE
REAL INVESTMENT PER EMPLOYEE
INVESTMENT INDEX (1958 = 100)
550
500
450
400
350
300
250
200
150
100
50
1960
1965
1970
1975
1980
Δ Finance & Insurance
× Tot Private Nonfarm

investment in finance and insurance has not resulted in measurable labor productivity gains to date.

One explanation of this puzzling situation is that the aggregate industry data are flawed. Gross output (or perhaps hours worked) may be measured inaccurately. It may also be that the industry aggregation masks the true changes which are occurring within the individual sectors, or at the firm level. Hunt and Hunt (1985) discussed the many general data problems in exploring the employment impacts of technological change in another paper. Suffice it to say that the investment growth in finance and insurance is so pronounced over such a long period of time, that it is difficult to believe that the productivity data are so flawed that they would not register at least the beginning of a new trend, if one were actually occurring.[18]

Formal case studies of the economic impacts of office automation are generally lacking, but there is fragmentary information which at least casts some doubt on the most wildly optimistic productivity claims of advocates of office automation. First, a number of recent books (Bailey, et. al., 1985; Diebold, 1985; and Katzan, 1982) have been published which are designed to be guides for managers interested in improving productivity through office automation. The surprise is that these books contain so few references to the actual experiences of firms or to the productivity gains which managers can reasonably hope to achieve with office automation. For instance, Katzan includes an entire chapter on word processing, but provides no hint about the likely potential productivity gains. For whatever the reasons, these guides to office automation written for managers are almost totally devoid of specifications of the productivity gains from office automation.

Second, Paul Strassman, an executive and office automation specialist with Xerox, has recently assessed (1985) the technology which he has been associated with for over twenty years. Although Strassman is optimistic about the potential productivity gains from computers and information technology generally, he eschews the current focus on hardware, saying that it is less relevant than the people using that hardware. In fact, he suggests (1985: 151-152) that the growth rates of the early 1980s and the euphoria about this technology are unsustainable unless it produces demonstrable investment returns. Strassman does not find much evidence of such returns currently:

> The preliminary findings of my research raises doubts about the assumptions which managements in the businesses I have sampled so far must have made when they increased their computer-technology budgets in pursuit of improved productivity. (1985: 159)

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18. There are serious concerns about the quality of the aggregate data. But BLS has constructed special productivity indexes in banking measuring output as services rendered and labor input as actual hours worked. The overall result, 1967-1980, is that productivity growth in banking remains very slightly below the national average for all nonfarm businesses. See Brand and Duke (1982).

Strassman thinks the payoff will come when management focuses on strategic goals and the people who will accomplish those goals rather than on the methods to achieve those goals.

Third, it is very interesting to note that International Data Corporation (IDC), which may be the information industry's largest market research and consulting firm, has repeatedly stressed that the labor productivity gains from office automation fall far short of justifying the purchase of the equipment. According to IDC (1984, 1983, 1982), the direct labor savings attributable to an office automation project over a five-year period usually amount to no more than one-half the cost of implementation of the system. IDC states that this rule of thumb does not include the training costs of implementing office automation. However, it also does not include any improvements in the quality of the output of offices. IDC concludes that it is the quality improvements which justify the adoption of office automation.

Perhaps the most eloquent statement of the thesis that the adoption of information technology, which includes office automation, does not lead to dramatic productivity gains has been written by John Leslie King and Kenneth L. Kraemer (1981), who are researchers at the University of Southern California and the University of Arizona respectively. They contend that, while the cost of hardware is falling, the total cost of electronic computing is rising rapidly (1981:101). Furthermore, many of the non-hardware costs tend to be hidden from normal accounting procedures used to justify implementation. So these costs do not necessarily affect the implementation decision itself, although they would adversely impact the firm's actual operating results.

King and Kraemer (1981:102) find that "...software procurement, software maintenance, and data management and computing management, are all becoming increasingly expensive." New positions and even departments are springing up in firms to evaluate software, perform system maintenance, coordinate among different users etc. It is not unusual for firms to find that "off-the-shelf" software is unsatisfactory for their computing needs, necessitating significant investment in software programming. As electronic computing becomes more widespread in firms through the adoption of personal computers, King and Kraemer (1981:101) think that it will become increasingly difficult for management to track these costs. Users at all levels dedicate some portion of their time to routine maintenance tasks. Worse, some may even develop a personal interest in the technology which diverts them from other work.

According to King and Kraemer (1981:101) management seldom knows the ongoing costs of training, normal system maintenance, or unplanned downtime that are in fact incurred because of the firm's utilization of information technologies. They cite (1981:103) a variety of other studies and fragmentary data which appear to indicate that the annual costs for system maintenance run at least 20 percent of the cost of the development of the system itself and may even be much higher. They think the costs due to breakdowns may be

particularly significant in highly integrated systems. According to King and Kraemer (1981:107):

> ...when systems become integrated and units become more interdependent in a real-time sense, problems in one system or unit can literally stop progress in others simply by disruption of the process of interaction. As integration increases, interdependency increases. Together, these two phenomena result in increased costs.

It is just these kinds of changes in manufacturing process technology that lead to the extreme reliability requirements that can impede technological change. King and Kraemer's arguments should not be dismissed lightly.

Finally, it should be mentioned that even some computer vendors are not emphasizing cost savings per se in their attempts to sell office automation. Wang Laboratories makes available to potential customers a booklet about cost justification (1985). It stresses the complexity of the cost justification process for office automation. One of the premises of the booklet (1985: 3) is that information technology systems are fundamentally "...different from other kinds of capital equipment investments and should be treated differently with regard to cost justification." The booklet includes six examples of firms which have successfully cost-justified their systems. The emphasis in all cases is on improvements in quality rather than direct cost savings.

Although there appear to be no documented case studies of the economic impacts of office automation,[19] there is scattered evidence that at least casts some doubt on the most optimistic expectations for office automation. In general, these sources indicate that the costs of installation and continued operation of office automation systems are higher than most people think. If true, these additional costs would obviously translate into reduced productivity gain from office automation. But there are still other reasons why office automation may not have a significant impact on productivity.

First, one of the most obvious reasons that office automation may not have created measurable productivity gains industry wide is that the diffusion of the technology may not have proceeded nearly as far as implied by the popular media. According to a national random survey by Honeywell, Inc. (1983), of 1,264 general office secretaries employed in information-intensive establishments with 100 or more employees, office automation equipment is not yet in widespread use in most offices. Fewer than one-half of the secretaries

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19. Salerno (1985) and Strassman (1985) have reached similar conclusions. There is, however, considerable literature about the sociological impacts of office automation. For a review and introduction to this literature, see Attewell and Rule (1984). From the economists' perspective, these studies are lacking in a systematic treatment of output, capital input, prices of outputs and inputs, and other economic variables.

reported having access to an electronic memory typewriter/word processor/ personal computer in the general office area in which they work, less than one-fourth possessed any of this equipment at their individual workstation (1983: III-5). Given these results, it should not be surprising that almost none of the secretaries reported having direct access to electronic mail, computerized scheduling or computerized filing, while about 15 percent said that such equipment was located somewhere in the office area (1983: III-5).

These results are surprising in part because the sampling frame included only establishments with 100 or more employees, i.e., predominantly larger establishments, in information-intensive industries,[20] exactly where one would expect to find office automation in place. It should also be mentioned that there was a significant positive correlation in the survey between establishment size and the likelihood of having office automation equipment. Thus, this report lends some credence to the undocumented claims reported in the popular media that only one in ten small firms are using personal computers currently.

The second reason that office automation may not be having an impact on productivity is that office automation may not be synonomous with electronic office technology. The reasons for this conclusion are twofold. First, office automation may simply represent additional capital support for office workers rather than capital-substitution for labor. In part, this is a restatement of the quality argument presented earlier. It may also be what firms are referring to when they talk about office automation insuring their competitive survival by providing real time data and feedback. Thus, aside from the question of whether electronic office technology saves labor time directly, there is no doubt that it permits more adequate analytical support for decision-making, timely answers to customer inquiries, more rapid tracking of firm sales data allowing better inventory control, and many other gains in quality.

The second part of the issue is more basic and fundamental. It appears that the adoption of office automation may actually transform the product being produced rather than simply the process which is used to produce that product. Innovative products and services are being designed because electronic office technology is available to deliver those services. This new production and delivery of services creates jobs.

The third reason that office automation may not produce the anticipated productivity gains is closely related to the process of deepening the capital base which supports office workers. Anyone who is acquainted with word processors knows that it is irresistible to make that one last revision when the marginal cost is so low. Those who have utilized electronic spreadsheet software know that it results in a whole new world of opportunities for tabular and graphical analyses. The problem is that the output of most offices cannot

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20. The report does not specify the definition of information-intensive industries.

be measured simply and unequivocally so it is extremely difficult to know how much the new technologies have added to the bottom line of the firm.

The expansion of existing work due to the friendliness of the technology in accomplishing that work cannot be dismissed as simply the failure of management to properly control the technology. What manager is satisfied with the information which he or she has available for decision-making? The installation of personal computers taps hidden computing needs that executives always wanted to do, but there was not the manpower or the time available to do it on the firm's mainframe computer. The diffusion of the newer and smaller microelectronics based computer systems beyond the formally designated computer centers eliminates this roadblock. Suffice it to say that we think that even the best managers and the best managed offices take advantage of the lower marginal cost of computing by utilizing it in new and different ways. This result is compounded by our inability to adequately measure the output from an office in the first place.

The fourth reason that office automation may not be producing the promised productivity gains is that there may indeed be technical constraints inherent in the current technology which reduces its effectiveness. Word processors may not really be that much different than their earlier nonelectronic predecessors. Both are appendages used to accomplish standard office functions. Until more advanced devices and appropriate methods are in routine operation, the changes may be limited.

There also appear to be severe hardware and software compatibility problems across computer systems. Complaints from firms abound concerning the current limitations of electronic mail, for example. It is undoubtedly true that many firms discover the hard way that it doesn't work in the real world quite the way it did in the sales demonstration. This is a characteristic of new technology. It is not totally predictable until it is old established technology.

The conclusion appears to be that even when direct communications systems are installed, say in the form of a local area network, it will likely still be a relatively primitive system. It may not be possible to use the LAN to access the large data bases on the firm's mainframe computer. It may not be possible to transmit a graph via the network. While it may be possible to access a user who is not on the local area network, the procedure may be too tedious and cumbersome to be truly useful in the transmission of serious business messages. In short, the allowable traffic on the local area network may be very structured and severely limited by the available hardware and software. The office with instantaneous access to any data base around the world and total communications flexibility still lies somewhere in the future.

Many writers have compared this stage in the evolution of computers to that of autos in the 1920s. The technology for autos had already been firmly established by that date. What was needed, however, were the highways which would make it possible to effectively utilize the technology. According to this analogy, computers now need "pathways" to effectively communicate across

dissimilar hardware and software systems before it is possible to realize their full potential.

Finally, we cannot ignore the fact that the entire computer industry is currently experiencing unexpectedly slow growth in sales. Firms such as Wang, which have specialized in the office automation market, have actually furloughed workers for the first time in corporate history. What is surprising about this slowdown is that it is occurring during a relatively robust recovery from the 1980-82 recession. It is happening exactly when most computer industry officials had expected an explosion in computer and office automation sales. Apparently the office automation revolution is being delayed somewhat by the unwillingness of individuals and firms to enthusiastically embrace the technology. That is not meant to deny the healthy growth that occurred in earlier years. What it does imply, however, is that for whatever the reason it does not appear that the marketplace is currently supporting the most optimistic claims of the proponents of office automation. It remains to be seen, of course, how long the current slowdown will last.

In summary, this review of the technological influences on clerical employment has been relatively unsatisfying. There are no general time series data about office automation spending by industry or about the application of devices by individual occupations. The analysis of overall productivity gains in finance and insurance did not provide any evidence that office automation is producing significant productivity gains in that sector despite the fact that real investment spending in finance and insurance has skyrocketed since the late 1960s.

There appear to be many possible explanations for the apparent lack of productivity gains from office automation to date. The data may be flawed. The diffusion of office automation may not have proceeded as far as many have thought. The equipment may be technically limited, more expensive and less productive than many think. It is also possible that much of what we term office automation is not being purchased as labor-saving process technology at all. There may simply be a deepening of capital occurring as products and services become more information-intensive.

D. Decomposition of Occupational Employment Changes

In earlier sections the focus was on the overall trends in occupational employment, whereas in this section it has been on those factors which might explain occupational employment, namely (1) general economic conditions, (2) the sectoral composition of the economy, and (3) the relative importance of the occupations within those sectors. What is needed is an analytical device to summarize the effects of these influences on occupational employment. Otherwise, it is all too easy to become lost in a morass of details.

The analytical tool which will be used to summarize the detailed occupation-industry data is presented in this section of the paper. It is an artificial separation, or decomposition, of occupational employment changes into the components due to overall economic growth, differences in the rates of

growth of industries, and changes in the staffing ratios within industries.[21] This tool is then applied to the occupational employment changes which have occurred from 1972 to 1982, using the one-digit industries and occupations from the CPS data.

The trend in occupational employment can be thought of as arising from three factors. First, the overall health of the economy, as indicated by total employment, exerts a strong influence on occupational employment. Without sufficient aggregate demand, employment in most occupations will surely fall. The second influence on occupational employment is the relative importance of the different industries in the total economy. Earlier it was demonstrated that there are very wide differences in the proportions of clerical employment in different industries. For example, clerical workers are particularly concentrated in finance and public administration. So clerical jobs will grow faster than the average for all jobs if these industries grow faster than the average for all industries (even without any changes in staffing ratios). Finally, the third influence on occupational employment trends is the set of staffing ratios that characterize the different industries.

If the net effect of office automation is the displacement of clerical jobs, over time clerical staffing ratios will fall. Thus, the decomposition methodology provides an opportunity to assess the technological influence of office automation on clerical jobs. This attempt is sorely needed since the analysis in the previous section proved to be so inconclusive about the productivity gains from office automation.

In general, changing staffing ratios are probably the most visible manifestation of the specific effects of technological change on occupational employment. For example, the staffing ratios for computer-related occupations have risen in many industries over time due to the dramatic increases in the use of computers. On the other hand, the staffing ratios for stenographers have been falling over a long period of time due to the adoption of dictation equipment, a technological change which reduces the need for stenographers.

However, it should be emphasized that staffing ratios may change for other reasons, such as organizational change, job title change with no change in job content, or others. In particular it should be understood that any time an individual occupational staffing ratio changes, all of the remaining staffing ratios in that industry will change as well. This occurs because the sum of the staffing ratios in an industry must equal one (recall that staffing ratios are obtained by dividing each occupation's employment in that industry by total employment in the industry). Thus, if a particular industry was very successful in automating production worker jobs, perhaps by using robots, then the relative importance of other jobs such as clericals, professionals, etc.

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21. A more technical description of the decomposition is provided in Hunt and Hunt (1986), chapter 4.

will increase. This demonstrates that changes in staffing ratios should not be considered in isolation; other changes may be taking place as well.

The mathematical decomposition of occupational employment growth is not an explanation of cause and effect; many complex economic and noneconomic forces lie hidden behind the numbers. It is really the simultaneous interaction of all three factors which determine employment trends in any particular occupation.

The three-way decomposition of occupational employment growth into changes due to (1) constant employment shares (economic growth), (2) differential rates of industry growth, and (3) staffing ratios changes is applied to historical data for 1972 to 1982 from the Current Population Survey (CPS). It should be mentioned that the other obvious candidate for such a decomposition, the Census of Population data, cannot be used. As discussed earlier, it is a major task to redefine census occupations so that they are consistent over time. It is impossible to do it for occupations within industries without a special dual classification study.

One-digit industries and occupations are used in the analysis because the CPS sample is far too small to provide both industrial and occupational detail below that level. Thus, this aggregate analysis may mask the changes which are occurring at more disaggregated levels. The time period for the analysis, 1972-1982, is selected because that is the only recent time span for which consistent data are available. However, 1982 was a recession year so there may be some distortions in the data. Nonetheless, having duly noted the qualifications and cautions, the highly aggregative one-digit CPS data will at least provide an important overall perspective on trends in U.S. occupational employment growth.

The results of the decomposition for the major occupational groupings are presented in Table 3.7 and summarized in Figure 3.D. From 1972 to 1982 the number of clerical jobs increased by just over 4 million for a 28.8 percent gain over 1972 employment levels. During that same time span total employment increased by 21.1 percent. So clerical jobs grew faster than the average for all jobs, which also means that clerical jobs were becoming relatively more important in the national economy.

Turning to the occupational decomposition, it is possible to examine the factors which contributed to that clerical job growth. The bulk of all new clerical jobs, a little over three million, were added as a consequence of the overall growth of the economy, identified as constant employment shares in the table. Another 625,000 clerical jobs were added because clerical workers were more prevalent in industries that were growing faster than the average for all industries. This factor is labeled differential rates of industry growth in the table. Finally, 466,000 clerical jobs were added due to increasing staffing ratios for clerical jobs; that amounts to 3.3 percent of the 1972 employment level for clerical workers. This does not mean that staffing ratios in all industries were increasing for clerical occupations, but rather that the net effect across all industries was positive.

Table 3.7

U.S. OCCUPATIONAL EMPLOYMENT GROWTH, 1972-1982

Occupation	Employment Changes				Decomposition of Employment Changes, 1972-1982					
					Absolute Changes			Percent of 1972 Occupational Employment		
	1972 Employment (thousands)	1982 Employment (thousands)	Change in Employment 1972-1982 (thousands)	Change in Employment 1972-1982 (percent)	Constant Employment Shares (thousands)	Differential Rates of Industry Growth (thousands)	Staffing Ratios (thousands)	Constant Employment Shares	Differential Rates of Industry Growth	Staffing Ratios
Professional, technical	11,536	16,952	5,416	46.9	2,439	922	2,055	21.1	8.0	17.8
Managers, administrators	8,082	11,494	3,412	42.2	1,709	246	1,457	21.1	3.0	18.0
Sales workers	5,383	6,580	1,197	22.2	1,138	281	-222	21.1	5.2	-4.1
Clerical workers	14,326	18,446	4,120	28.8	3,029	625	466	21.1	4.4	3.3
Craft and kindred workers	10,867	12,271	1,404	12.9	2,298	-790	-104	21.1	-7.3	-1.0
Operatives	13,612	12,807	-805	-5.9	2,878	-1,457	-2,226	21.1	-10.7	-16.4
Laborers, nonfarm	4,241	4,517	276	6.5	897	-203	-418	21.1	-4.8	-9.9
Service	11,024	13,736	2,712	24.6	2,331	1,102	-721	21.1	10.0	-6.5
Total	82,155	99,528	17,373	21.1						

Source: Calculations by the authors based upon data from the Current Population Survey.

Note: Some occupational detail is omitted. Totals and percentages may not add exactly due to omission of some occupational detail and rounding error. The decomposition was accomplished using 1-digit SIC code industries.

Figure 3.D

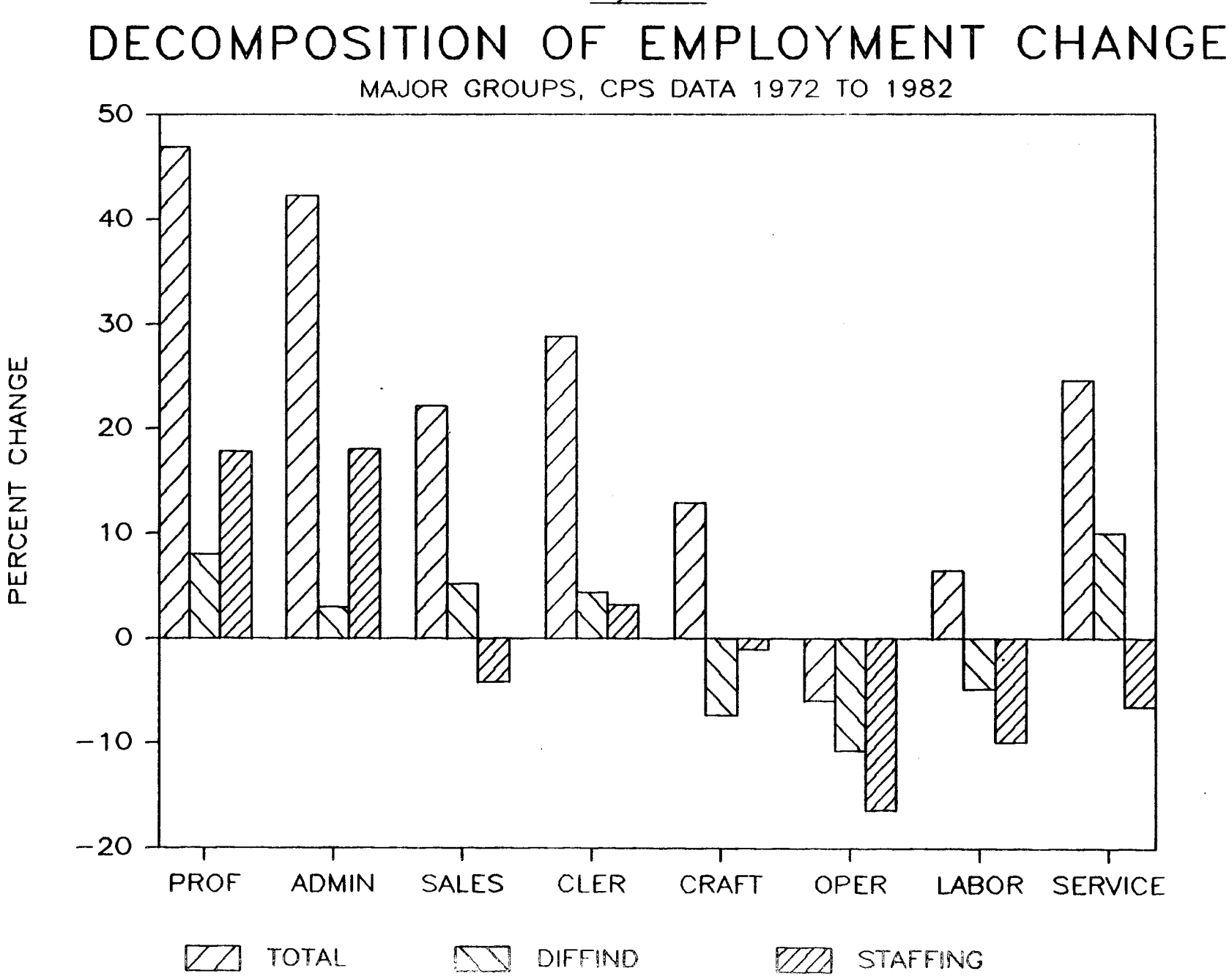

DECOMPOSITION OF EMPLOYMENT CHANGE
MAJOR GROUPS, CPS DATA 1972 TO 1982
PERCENT CHANGE
50
40
30
20
10
0
-10
-20
PROF
ADMIN
SALES
CLER
CRAFT
OPER
LABOR
SERVICE
TOTAL
DIFFIND
STAFFING

Table 3.7 demonstrates very rapid growth in the professional and technical group and in the management and administrative field, more than double the average growth for all jobs. It is also very interesting to note that a significant proportion of the growth in these fields can be attributed to increasing staffing ratios for those jobs. In contrast, the impacts of changing staffing ratios for such occupations as craft and kindred workers, operatives, and laborers were all negative, undoubtedly influenced in part by the recession.

It cannot be ruled out that the reported increase in staffing ratios for clerical jobs was influenced to some degree by the declining staffing ratios for jobs that are traditionally more susceptible to layoffs during recessions. What can be said is that neither changing staffing ratios nor differential rates of industry growth were major contributors to clerical employment growth in the 10 years from 1972 to 1982, although both factors were modestly positive during the period. The more intensive utilization of clericals improved total clerical employment levels by 3.3 percent and the differential rates of industry growth added 4.4 percent to clerical employment totals.

Since total employment growth for each occupation is merely the sum of the effects across all industries, it is also possible to look at the details of the decomposition for a particular occupation in each industry. The results of the decomposition of the growth in clerical jobs for each of the one-digit industries is presented in Table 3.8 and Figure 3.E.

What is particularly striking in this second set of figures is that staffing ratios for clerical jobs are <u>falling</u> in a number of sectors. Most interesting are the results for the finance sector, probably the biggest user of office automation to date. The finance sector has been a rapidly growing sector as indicated by the 37 percent overall growth rate of clerical jobs in that sector versus the 28.8 percent growth rate for all clerical jobs. Thus, the effects of falling staffing ratios, which would have reduced jobs in this sector by 6.9 percent from 1972 employment levels, were more than made up by the fast growth of the industry itself. However, if the industry had not expanded so rapidly, there would have been actual reductions in employment of clerical workers in the finance sector.

Staffing ratios for clerical jobs have also been falling in three other important industries -- utilities, wholesale trade, and public administration. The decline in public administration is difficult to explain. No one maintains that government has been in the forefront in adopting office automation. On the other hand, the postal service has automated many clerical jobs in the mail sorting operation. It is also true that government was one of the slowest growing sectors during this time period. So it is possible that government administrators, when faced with tight budgets and rising demands for services, economized more on clerical jobs than other positions. It is not possible to provide an adequate explanation of the fall in staffing ratios for public administration or the other industries. Clearly, more study of these trends is called for.

Table 3.8

U.S. CLERICAL EMPLOYMENT GROWTH BY INDUSTRY, 1972-1982

Industry	Employment Changes				Decomposition of Clerical Employment Changes, 1972-1982					
					Absolute Changes			Percent of 1972 Employment		
	1972 Employment (thousands)	1982 Employment (thousands)	Change in Employment 1972-1982 (thousands)	Change in Employment 1972-1982 (percent)	Constant Employment Shares (thousands)	Differential Rates of Industry Growth (thousands)	Staffing Ratios (thousands)	Constant Employment Shares	Differential Rates of Industry Growth	Staffing Ratios
Agriculture	48	83	35	72.9	10	-11	36	21.1	-22.9	75.0
Mining	59	128	69	116.9	12	29	28	21.1	49.1	47.5
Construction	362	451	89	24.6	77	-44	56	21.1	-12.1	15.5
Durables	1,352	1,513	161	11.9	286	-244	119	21.1	-18.0	8.8
Nondurables	1,040	1,074	34	3.3	220	-222	36	21.1	-21.3	3.5
Utilities	1,307	1,463	156	11.9	276	-23	-97	21.1	-1.8	-7.4
Wholesale Trade	684	844	160	23.4	145	86	-71	21.1	12.6	-10.4
Retail Trade	2,099	2,840	741	35.3	444	45	252	21.1	2.1	12.0
Finance	2,007	2,750	743	37.0	424	457	-138	21.1	22.8	-6.9
Services	3,691	5,473	1,782	48.3	781	605	396	21.1	16.4	10.7
Public Administration	1,678	1,827	149	8.9	355	-53	-153	21.1	-3.2	-9.1
Total	14,326	18,446	4,120	28.8	3,029	625	466	21.1	4.4	3.2

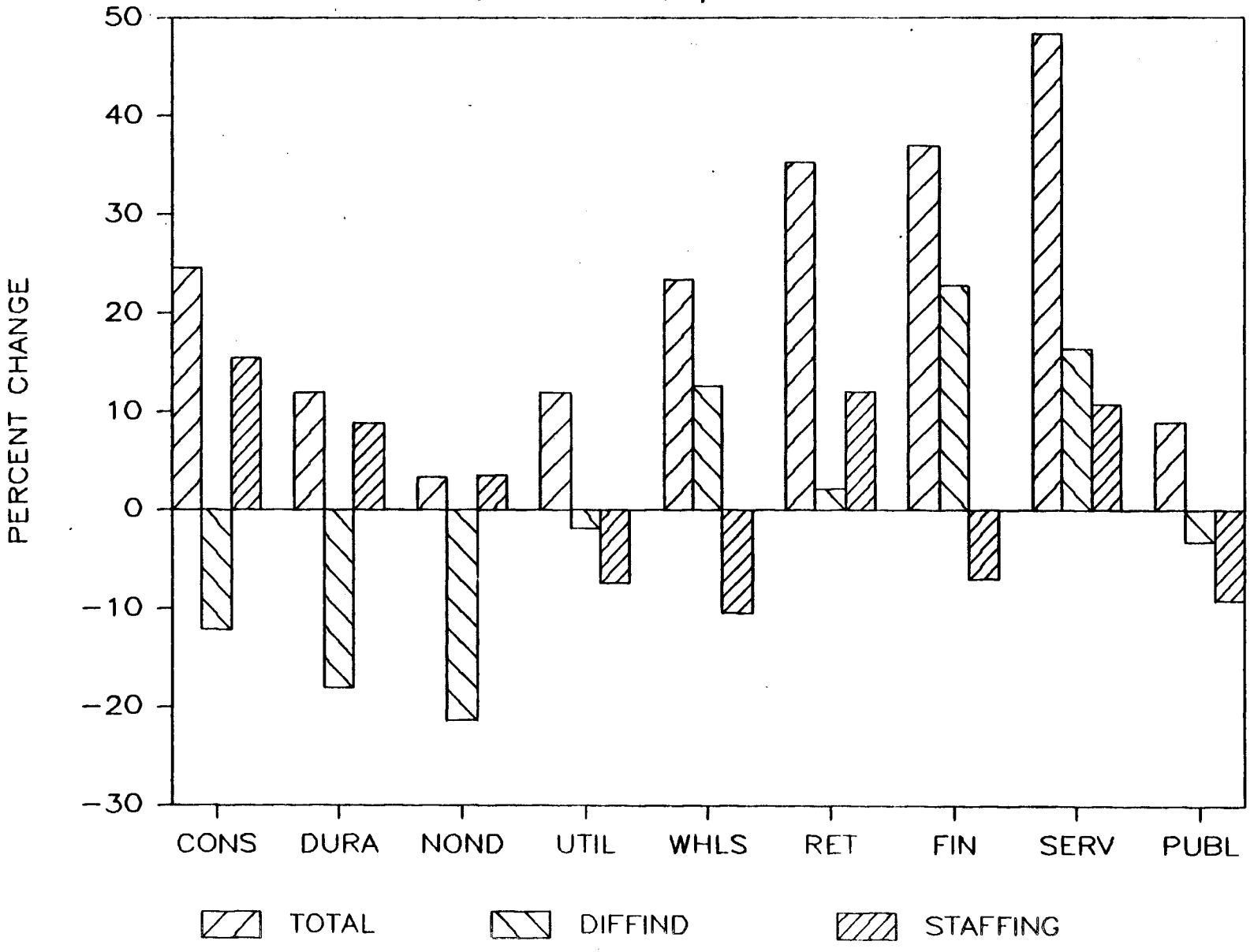
Source: Calculations by the authors based upon data from the Current Population Survey.

Note: Totals and percentages may not add exactly due to rounding.

Figure 3.E

DECOMPOSITION OF EMPLOYMENT CHANGE

CLERICAL EMPLOYMENT, CPS DATA 1972–1982



In summary, the occupational decomposition using the CPS data indicates that clerical jobs have more than maintained their relative importance in the economy from 1972 to 1982. In fact, both the effects of differential rates of industry growth and change in staffing ratios were moderately positive. Thus, clerical jobs were actually slightly more important at the end of the period than at the beginning of the period. This confirms the results in Section 1 on the overview of clerical employment. However, 1982 was a recession year so these results should be interpreted with caution. It is also true that some of the major employers of clerical workers demonstrated negative staffing ratio trends over this period. Finance, generally acknowledged to be the biggest user of office automation today, experienced declining staffing ratios for clericals during this time period. So it is possible that office automation is negatively impacting clerical jobs in selected sectors.

E. Conclusions

Since it appears to be impossible to directly link office automation to the productivity gains of clerical workers, the decomposition methodology looks at the changes in staffing patterns across industries as an indicator of the net impact of technology and other factors on clerical employment over the time period being examined. The net effect of changing staffing ratios on clerical employment has been moderately positive in the last decade or so. Economy-wide there appears to be little evidence that office automation has negatively impacted clerical jobs in the past. However, it does appear that staffing ratios for clerical workers are declining slightly in some sectors such as finance. So, it is at least possible that office automation is raising the productivity of clerical workers and thereby contributing to the falling staffing ratios in those sectors.

The decomposition methodology also puts into proper perspective the important roles that economic growth and the changing composition of industries play in determining clerical employment. According to this analysis, clerical job growth is significantly related to overall economic growth. This conclusion should not be surprising, but many people find it all too easy to discover other reasons which purportedly explain employment changes. In fact, not only is economic growth by far the most important factor in determining clerical employment, but it appears that the correlation may be growing stronger. If the last recession is a precursor of the future, clerical jobs are becoming more like other jobs in their sensitivity to general economic conditions.

It is well-known that the changing composition of industries has tended to favor clerical jobs. But the influence of industry mix was only moderately positive during the 1970s, and some sectors which are heavy employers of clericals have recently begun to experience much slower growth or even absolute declines in total employment. This is particularly true for hospitals and state and local government, the latter of which is the largest single employer of clericals. So, even though other sectors, notably services, will likely continue to be fast growing, there is no strong reason to think that industry mix will play a more significant role in the future employment outlook for clerical workers.

It is puzzling that the aggregate productivity data for finance and insurance showed below average productivity growth for the sector as a whole, yet the decomposition analysis showed declining staffing ratios for clerical jobs within finance and insurance. Since clerical jobs are so important in this sector, it is logical to think that falling staffing ratios for these jobs might also be associated with realized productivity gains. But it should be recalled that the aggregate productivity data may be seriously flawed, the loss of jobs in this sector due to falling staffing ratios was relatively modest, and there could have been offsetting employment gains elsewhere in the sector. If nothing else, this review has demonstrated that there are many unanswered questions about employment trends for clericals in some sectors such as finance and insurance.

The examination of the historical evidence on clerical jobs has been a sobering experience. Clerical employment has grown rapidly in the last 40 years or so. But many factors appear to confirm that the growth of clerical jobs has slowed in the last decade. Based upon the review in this chapter, it is difficult to see how anyone could expect much more than average growth for clerical jobs in the future.

IV. FORECASTS OF THE CLERICAL EMPLOYMENT IMPLICATIONS OF TECHNOLOGICAL CHANGE

This paper heretofore has dealt exclusively with historical data. The purpose of this section is to review the existing forecasts of the future prospects for clerical jobs. The BLS occupational projections are the major effort of the U.S. government to anticipate the needs for specific occupations. As will be seen shortly, the BLS methodology is based on a modeling framework that accounts for many economic variables. The resulting occupational projections are not necessarily superior to others but they do have the advantage of being produced in a comprehensive and reasonably consistent manner.

Other forecasts that are much less comprehensive than the BLS efforts but potentially useful are also reviewed. First, Wassily Leontief and Faye Duchin of New York University have produced an analysis of the impacts of automation on employment, 1963-2000. Second, the work of Matthew P. Drennan of Columbia University is examined. He focuses on clerical jobs in six office industries, primarily within the finance sector. Finally, the recent work of J. David Roessner, Georgia Institute of Technology, is reviewed. Like Drennan, he examines clerical jobs within the finance sector, but he focuses on only two industries, banking and insurance.

A. BLS Occupational Employment Projections

The BLS forecasting system is actually a group of separate projections which are linked to each other for consistency. Aggregate economy-wide activity is forecast first. This includes labor force projections by age, race and sex, and aggregate output decomposed into its major components, among other variables. Due to BLS budget constraints and the large amount of staff time necessary to maintain an aggregate econometric model, the most recent aggregate forecasts were made using the existing model at Chase Econometrics, Inc. BLS produced the forecasts using their own assumptions but accepted the economic interrelations implicit in the Chase model.

The second step in the BLS forecasting system is to develop industry output projections that are consistent with the aggregate output projections of step one. The 156-sector input-output model, prepared by the Bureau of Economic Analysis, U.S. Department of Commerce, is used as a base for these projections. Given a set of industry demand figures, an input-output model can calculate the total industrial production required to meet those demands. The BLS input-output system utilizes "bridge tables" to update the historical input-output coefficients and to allow for anticipated shifts in demand for inputs and/or outputs over the period of the projection.

Once the industry output projections are determined, then productivity levels are forecast to arrive at total industry employment requirements. The productivity gains are estimated separately for each industry utilizing an econometric equation. Worker-hours are estimated as a function of the industry's output, capacity utilization, relative price of labor, and (as a

proxy for technology) the output/capital ratio. The implication of the technology proxy is that more capital per unit of output implies the need for less worker-hours. Finally, the estimates of total worker-hours are combined with other estimates of average annual hours per person to arrive at the industry employment levels.

The last step in the BLS projections system is to forecast occupational employment within these industry total employment levels. The basis for these projections are the occupational staffing patterns from the latest Occupational Employment Statistics (OES) surveys. The individual occupational coefficients are adjusted on a judgmental basis to account for the changes in occupational demand anticipated as a result of technological change or other reasons. For example, computer-related occupations will likely become relatively more important in many industries as computers are more widely applied in those industries. So the coefficients for these occupations are increased correspondingly. These revised staffing coefficients are then applied to the previously forecast level of industry total employment. The sum of the employment across all industries for a given OES occupation then becomes the new occupational employment projection of BLS.

Several features of the BLS system should be noted, particularly those that relate to technological change. Technological change actually enters the system in at least three places. First, the industry output projections should account for anticipated changes in demand induced by technological change. Secondly, the estimated productivity gains forecast for each industry should be influenced by technological change. Finally, the staffing patterns themselves are altered directly to account for technological change. In other words, technological change will have specific effects on some occupations, it will have an overall impact on the productivity of workers, and it will affect the demand for goods and services generally.

It is worthy of note that this system involves a considerable amount of judgment, especially in anticipating the effects of technological change. There are no simple equations that predict changes in staffing ratios within an industry. In fact, the BLS staff has found that trends in industry employment levels can be predicted more accurately than the changes in occupational employment (Kutscher, 1982: 8, and Office of Economic Growth and Employment Projections, 1981). This is due in large part to the difficulty of projecting specific occupational impacts of technological change.

One of the primary motivations in developing the occupational decomposition as an analytical tool earlier is its usefulness in evaluating the BLS occupational projections. Note that the last step in the BLS methodology is to change the staffing ratios in the industry occupation matrix to account for technological change and other factors. In other words, BLS takes the best industrial demand and productivity forecast that it can muster and converts that into projections of total employment by industry. Then it considers changing the staffing ratios from their historical levels. Thus, by using the historical staffing ratios from the base period of the BLS projections, the occupational decomposition will measure the extent to which BLS <u>expects</u> staffing ratios to change over the course of the projection.

In Section III the historical employment trends for the 10 BLS input-output industries which account for the largest number of clerical jobs were reviewed. Those 10 industries employed about two-thirds of all clerical workers in 1982. Thus it should be clear that the fortunes of these industries will have a major impact on the employment of clerical workers in the years ahead. In this section we review the BLS projections of employment for these industries. It provides an opportunity to evaluate the industry forecasts independent of their occupational content. Since the occupational decomposition summarizes the effects of differences in the rates of growth of all industries, the focus here is limited to the 10 industries responsible for the most clerical jobs.

The combined employment trends for the top 10 industries in terms of clerical employment are presented in Figure 4.A, while the employment trends for each of those 10 industries follows in Table 4.1. The figure depicts the historical growth trends, 1967-1982, as well as the projected growth trends, 1983-1995. The data are reported in index number form to emphasize the relative growth of the industries. The total employment trend for all 105 industries is also presented to facilitate the comparison of the growth of each industry to the overall growth of employment.

In the past the industries with the most clerical jobs have been much faster growing than the average for all industries. But the magnitude of that positive differential was reduced sharply in the 1970s and BLS does not expect it to reappear by 1995. If these projections are correct, the 10 industries which account for about two-thirds of all clerical jobs will grow at roughly the same rate as all jobs over the period of the projection.

It is natural for the combined growth trend of all 10 industries to mask some important differences among the industries. The figures for the individual industries reveal that the laggards in terms of industry growth are state and local government and the federal government. Employment by the federal government is not expected to increase at all, while state and local government are expected to reverse the declines suffered in the 1980-82 recession and grow once again, albeit significantly more slowly than average.

The fastest growing industries among the top 10 employers of clerical workers are credit agencies and commodity brokers, hospitals, miscellaneous business services, and banking. Of these, one of the more surprising projections is the growth anticipated for banking, which outgrows the overall economy throughout the period of the projection. Considerable attention has been focused on banking employment in the last couple of years, and it does appear that the industry is experiencing significant structural change due to deregulation, among other factors. The closing of branch or satellite banks, especially in such states as California, and employment declines in a few of the largest banks in the nation, has contributed to speculation that the growth of banking employment may slow. There is also the question of the impacts of office automation equipment such as automatic teller machines. In contrast, deregulation has also increased the number of financial services banks provide, so it is possible to argue that banking employment will continue to grow. We

Figure 4.A

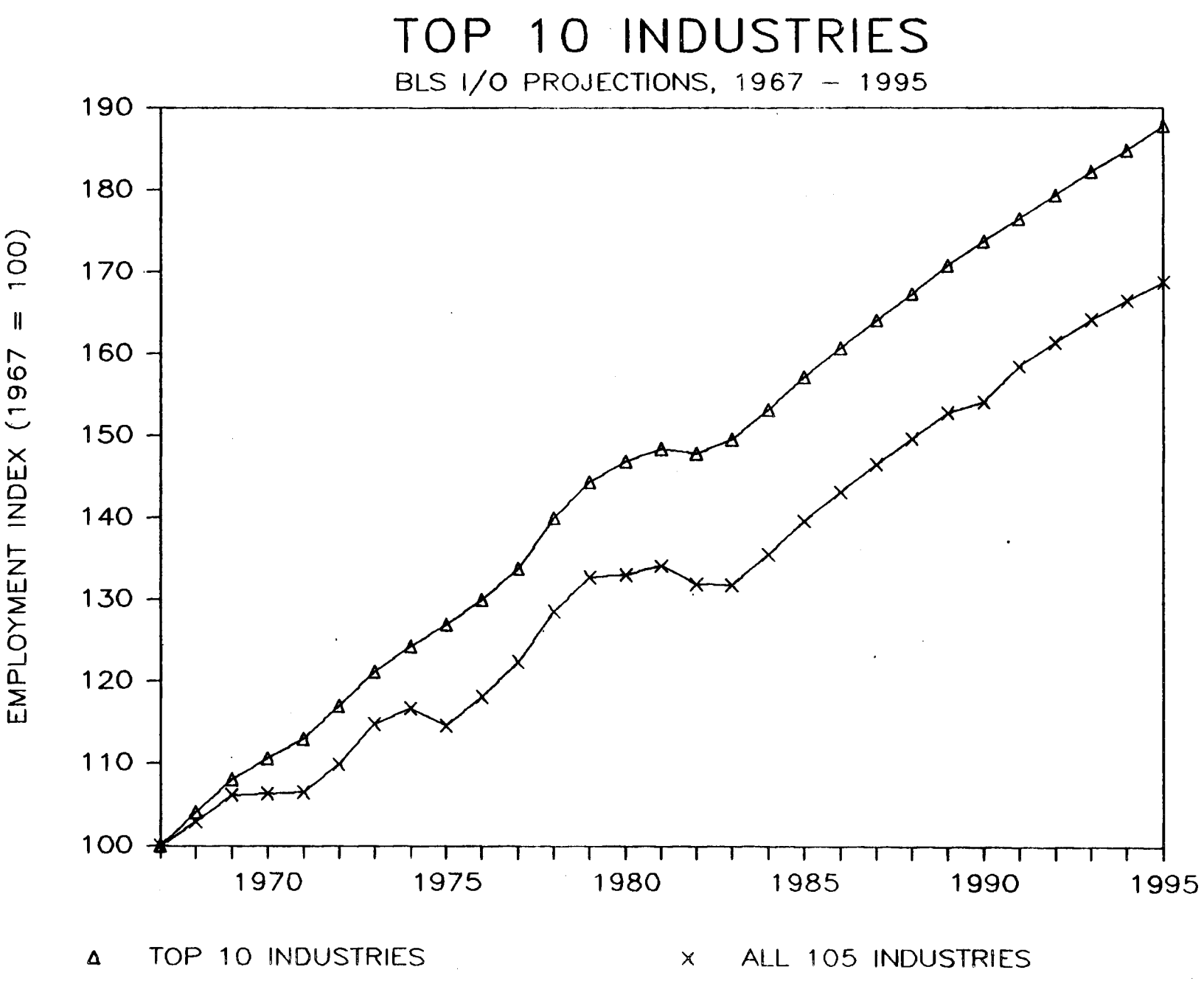

TOP 10 INDUSTRIES
BLS I/O PROJECTIONS, 1967 – 1995
EMPLOYMENT INDEX (1967 = 100)
190
180
170
160
150
140
130
120
110
100
1970
1975
1980
1985
1990
1995
Δ TOP 10 INDUSTRIES
x ALL 105 INDUSTRIES

Table 4.1

TOTAL INDUSTRY EMPLOYMENT GROWTH OF THOSE SECTORS WITH THE MOST CLERICAL EMPLOYEES

Year	State & Local Government	Misc. Retail Trade	Wholesale Trade	Banking	Federal Government	Insurance	Misc. Business Services	Hospitals	Social Services & Museums	Credit Agencies & Commodity Brokers	Total Top 10 Industries	Total All 105 Industries
1967	100	100	100	100	100	100	100	100	100	100	100	100
1968	105	104	102	106	101	103	107	106	105	109	104	103
1969	109	108	106	114	102	104	118	113	103	118	108	106
1970	113	110	108	121	99	108	122	118	103	116	111	106
1971	117	112	109	124	98	108	122	126	110	116	113	107
1972	122	115	112	129	97	110	131	137	114	122	117	110
1973	127	118	117	136	96	113	145	143	114	126	121	115
1974	131	119	120	144	98	117	153	151	116	127	124	117
1975	137	115	126	147	98	119	157	158	125	128	127	115
1976	139	119	130	151	98	121	168	164	128	132	130	118
1977	142	123	135	156	97	127	183	170	130	140	134	122
1978	148	128	142	164	97	133	204	177	134	151	140	129
1979	151	130	149	173	98	139	225	183	137	161	144	133
1980	154	129	150	181	99	143	239	192	139	168	147	133
1981	153	130	153	188	97	145	253	203	139	179	148	134
1982	151	129	151	191	97	147	256	210	139	184	148	132
1983	148	130	155	190	97	145	278	227	137	204	150	132
1984	150	136	160	194	96	149	286	230	141	204	153	136
1985	152	141	163	201	97	154	302	239	145	212	157	140
1986	153	145	166	207	96	158	319	248	149	220	161	143
1987	155	149	169	211	96	162	333	256	152	225	164	146
1988	158	152	171	216	96	166	344	262	155	230	167	150
1989	161	156	172	221	97	171	355	269	158	236	171	153
1990	164	159	172	225	98	174	368	276	160	243	174	154
1991	167	164	174	228	99	177	366	276	162	240	176	158
1992	168	168	178	234	99	180	374	281	164	143	179	161
1993	169	170	181	238	99	183	389	288	165	249	182	164
1994	171	172	184	241	99	184	410	297	166	258	185	166
1995	172	172	185	244	99	184	445	312	166	274	188	169

Source: Calculations by the authors based upon data from BLS.

think that BLS will moderate the anticipated growth trend for banking in the next round of forecasts.

The decomposition of the BLS occupational employment projections at the major group level are presented in Table 4.2 and summarized graphically in Figure 4.B. In general, it is clear that BLS anticipates strong occupational employment growth for most occupations over the course of the projection.[22] In fact, at this level of aggregation, only three of the eight occupations are slower growing than the average for all occupations, namely operatives, laborers, and clerical workers. However, the range of the growth rates for the occupations around the average growth rate of all jobs is relatively narrow, from 19.1 percent to 38.5 percent. Compare that to the range from the CPS data, 1972 to 1982 of -5.9 percent to 46.9 percent, or 1972 to 1979 (to avoid the distortions in the data due to the recession) of 8.5 percent to 35.4 percent. Apparently BLS anticipates less relative change in the importance of occupations over the 13 years of their projection than actually occurred during the seven years from 1972 to 1979.

Given these overall results, it is not surprising that the occupational decomposition indicates that the relative impacts of changing staffing ratios and differential rates of industry growth are modest for all occupations. The surprise in the decomposition is that the impact of staffing ratios on forecast clerical employment is actually negative. In fact, this is the only turnaround projected by BLS from the existing trends in the historical data. It appears to be an indication that BLS expects office automation to retard the growth of clerical jobs in the future.

It is possible to compare the historical CPS data with the projections of BLS at the major occupational group level, but one of the difficulties with such a comparison is that the time spans covered are of such unequal length. Figures 4.C and 4.D attempt to remedy this problem by stating the staffing ratio changes and the effects of differential rates of industry growth for the major occupational groups in terms of average annual rates of change. The comparisons are done over two historical time periods, 1972-1979 and 1972-1982 to ameliorate as much as possible distortions in the data due to the recession. It should be noted that the unemployment rate in 1979 was just under 6 percent, virtually the same unemployment rate built into the BLS projections. Overall this approach facilitates a more direct comparison of the BLS projections with the historical data using a consistent unit of measurement.

The results depicted in Figures 4.C and 4.D indicate unequivocally that BLS anticipates far less impact in the years ahead from staffing ratio changes and

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22. The BLS does not actually forecast occupational employment growth at the major group level, but it is still helpful to analyze the projections at this level of aggregation to provide an overview of the system. It also enables us to compare those projections to the historical CPS data reviewed in Section 3.

Table 4.2

BLS PROJECTED OCCUPATIONAL EMPLOYMENT GROWTH, 1982-1995

Occupation	Employment Changes				Decomposition of Employment Changes, 1982-1995					
					Absolute Changes			Percent of 1982 Occupational Employment		
	1982 Employment (thousands)	1995 Employment (thousands)	Change in Employment 1982-1995 (thousands)	Change in Employment 1982-1995 (percent)	Constant Employment Shares (thousands)	Differential Rates of Industry Growth (thousands)	Staffing Ratios (thousands)	Constant Employment Shares	Differential Rates of Industry Growth	Staffing Ratios
Professional, technical	15,071	20,177	5,106	33.9	4,228	-99	977	28.1	-0.7	6.5
Managers, officials	7,696	10,659	2,963	38.5	2,159	162	642	28.1	2.1	8.3
Sales workers	5,906	7,704	1,798	30.4	1,657	141	0	28.1	2.4	0.0
Clerical workers	18,717	23,673	4,957	26.5	5,251	295	-588	28.1	1.6	-3.1
Craft and Related Workers	10,133	13,223	3,089	30.5	2,843	36	211	28.1	0.4	2.1
Operatives	12,504	14,896	2,392	19.1	3,508	-566	-550	28.1	-4.5	-4.4
Laborers, nonfarm	5,572	6,794	1,222	21.9	1,563	-203	-139	28.1	-3.6	-2.5
Service workers	15,318	19,727	4,408	28.8	4,297	580	-469	28.1	3.8	-3.1
Total	91,950	117,745	25,795	28.1						

Source: Calculations by the authors based upon data tape from the 1982-1995 OES/BLS occupational employment projections.

Note: Some occupational detail is omitted. Totals and percentages may not add exactly due to omission of some occupational detail and rounding error. The 378 OES industries were first aggregated to 105 industries before accomplishing the decomposition. The OES data tape includes wage and salary employment only.

Figure 4.B

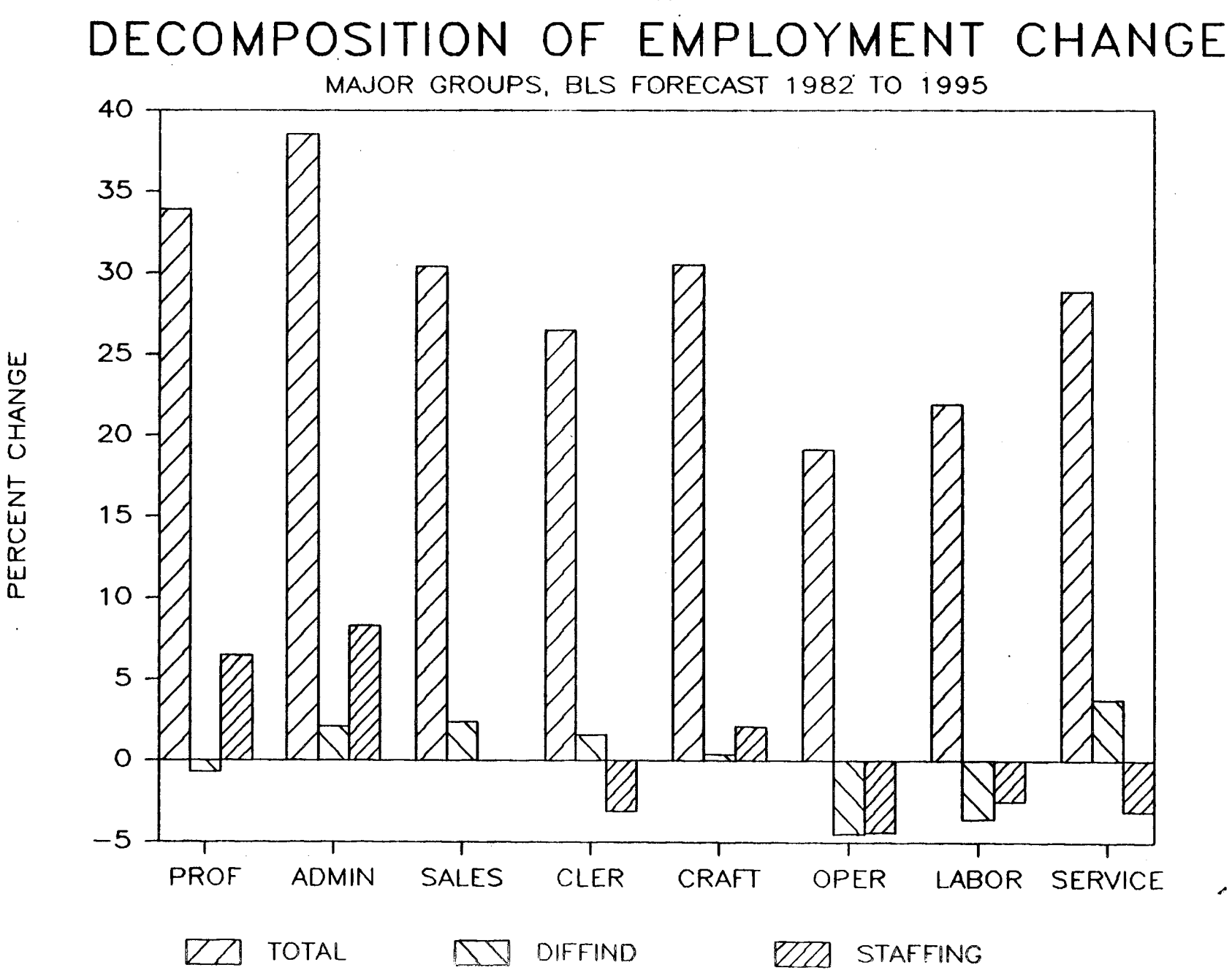

DECOMPOSITION OF EMPLOYMENT CHANGE
MAJOR GROUPS, BLS FORECAST 1982 TO 1995
PERCENT CHANGE
40
35
30
25
20
15
10
5
0
-5
PROF
ADMIN
SALES
CLER
CRAFT
OPER
LABOR
SERVICE
TOTAL
DIFFIND
STAFFING

Figure 4.C

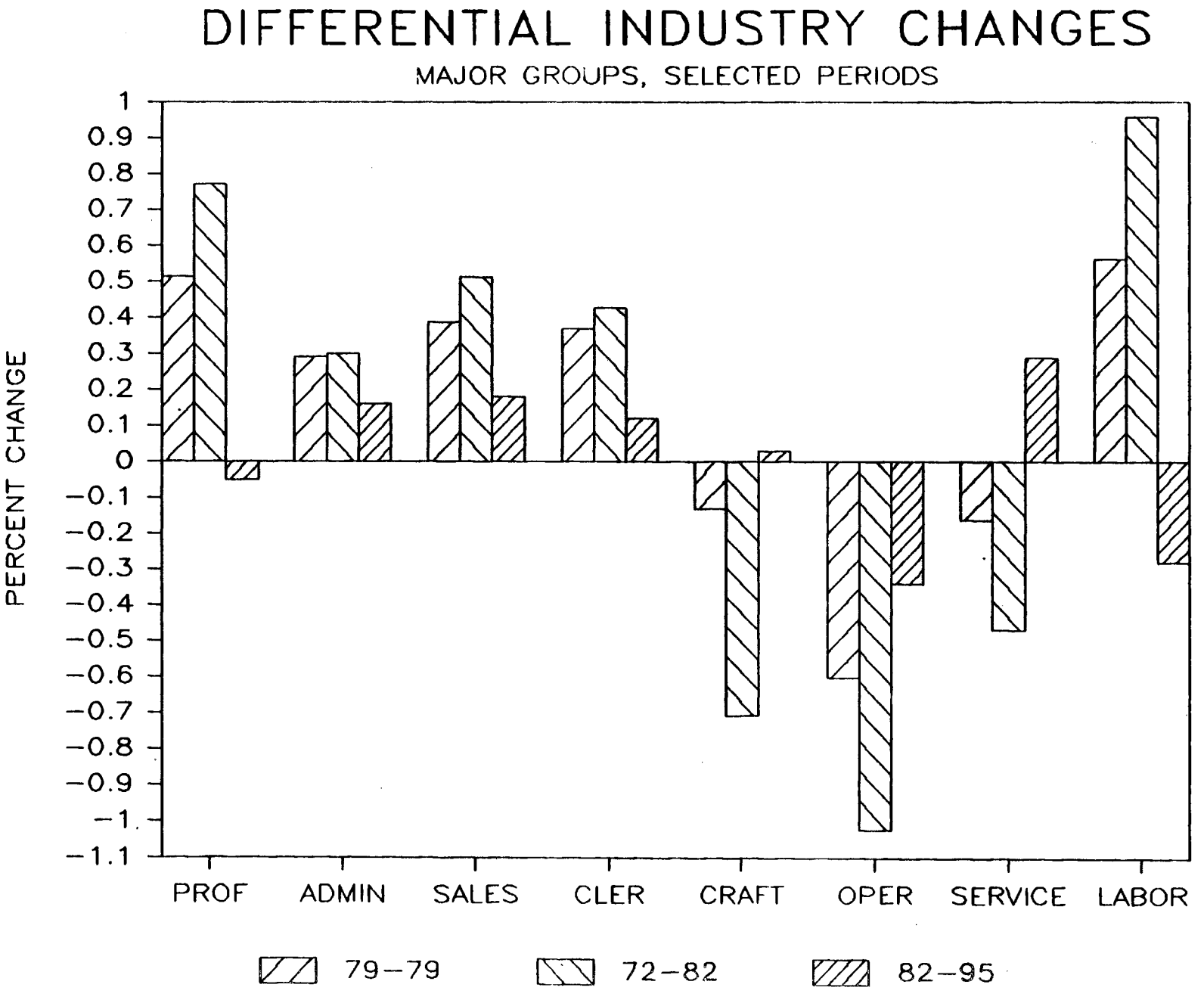
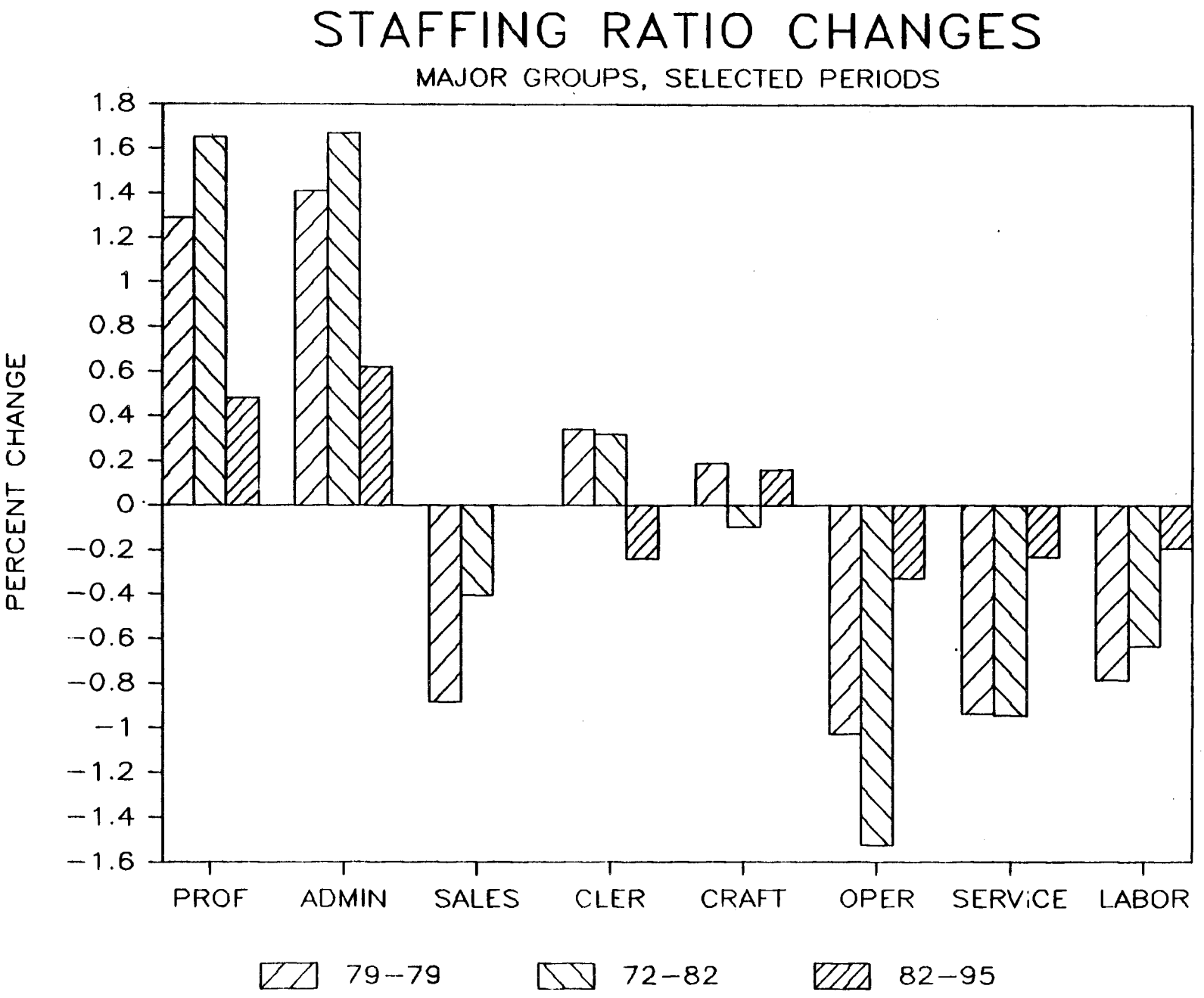

DIFFERENTIAL INDUSTRY CHANGES
MAJOR GROUPS, SELECTED PERIODS
PERCENT CHANGE
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
-0.1
-0.2
-0.3
-0.4
-0.5
-0.6
-0.7
-0.8
-0.9
-1
-1.1
PROF
ADMIN
SALES
CLER
CRAFT
OPER
SERVICE
LABOR
79-79
72-82
82-95

Figure 4.D


STAFFING RATIO CHANGES
MAJOR GROUPS, SELECTED PERIODS
PERCENT CHANGE
1.8
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
-0.2
-0.4
-0.6
-0.8
-1
-1.2
-1.4
-1.6
PROF
ADMIN
SALES
CLER
CRAFT
OPER
SERVICE
LABOR
79-79
72-82
82-95

differential rates of industry growth than have occurred in the last decade. For most of the major occupational groups, the average annual rate of change during the projection period tends to be less than one-half the average annual rate of change during either of the historical periods, 1972-1979 or 1972-1982. Again, the most important exception is probably the turnaround in the effects of staffing ratios on clerical employment. But it should be mentioned that the impacts of changing staffing ratios on clerical employment have been modest historically as well. Nonetheless it is interesting that staffing ratio changes for clerical workers are predicted to change from slightly positive historically to slightly negative during the projection period.

There are 673 occupations with 5,000 or more employees in the detailed occupation-industry matrix of the BLS. Of those, there are 95 occupations that fall within the major occupational group of clerical workers. The BLS projected occupational employment growth for all 95 of these occupations is reported in Table 4.3. The decomposition of the projected occupational employment growth into the portions due to overall employment expansion, differential industry growth, and staffing ratio changes is also reported in the table.

The message of this analysis is that the detailed clerical occupations differ widely in terms of their growth rates and staffing ratio changes. The range in the overall forecast growth rate of the 95 detailed clerical occupations is from a positive 76.1 percent to minus 20 percent. The range in the staffing ratio changes is from plus 38.4 percent to minus 55.6 percent. The diversity in the results indicates that BLS is attempting to capture a variety of influences on the level of occupational demand. It is clearly erroneous to think that BLS is unwilling to alter staffing ratios from their historical levels. It is hoped that BLS will be more open in the future about explaining the judgments which were made in adjusting staffing ratios, however.

The analysis of specific occupations is difficult because of the sheer number of those occupations. The discussion here is limited to the largest, the fastest growing, and the declining occupations. The three largest occupations are general office clerks, secretaries, and cashiers. There are no discernible technological impacts on employment trends in these occupations. However, it is noteworthy that the staffing ratios for cashiers is expected to increase significantly contributing to the overall 48.2 percent growth forecast for that occupation. The growth of the other two occupations is much closer to the average for all clerical workers.

It is also interesting that the effects of staffing ratio changes for secretaries are expected to be slightly negative. Looking at the effects of staffing ratios alone, the occupational decomposition indicates a projected decline in employment from 1982 levels of 2.3 percent, but the effects of differential rates of industry growth more than make up for this loss. The net result is that secretaries are expected to grow slightly faster than all occupations.

Table 4.3

BLS Projected Occupational Employment Growth, 1982-1995
All Clerical Occupations

Occupation	Employment changes				Decomposition of employment changes, 1982-1995					
					Absolute changes			Percent of 1982 occupational employment		
	1982 employment (000s)	1995 employment (000s)	Change in employment 1982-1995 (000s)	Change in employment 1982-1995 (percent)	Constant employment shares (000s)	Differential rates of industry growth (000s)	Staffing ratios (000s)	Constant employment shares	Differential rates of industry growth	Staffing ratios
Clerical workers	**18,716.6**	**23,673.5**	**4,956.9**	**26.5**	**5,250.6**	**294.8**	**(588.4)**	**28.1**	**1.6**	**-3.1**
Adjustment clerks	33.8	47.4	13.6	40.1	9.5	0.3	3.8	28.1	0.9	11.2
Admissions evaluators	10.5	12.1	1.6	15.4	2.9	(1.8)	0.5	28.1	-17.3	4.7
Bank tellers	538.8	693.0	154.2	28.6	151.1	24.1	(21.0)	28.1	4.5	-3.9
New accounts tellers	67.3	79.9	12.6	18.8	18.9	4.1	(10.3)	28.1	6.0	-15.3
Tellers	471.5	613.1	141.6	30.0	132.3	20.1	(10.7)	28.1	4.3	-2.3
Bookkeepers & accounting clerks	1,613.5	1,892.5	279.1	17.3	452.6	46.7	(220.2)	28.1	2.9	-13.6
Accounting clerks	728.7	850.0	121.3	16.7	204.4	6.2	(89.3)	28.1	0.9	-12.3
Bookkeepers, hand	884.8	1,042.5	157.7	17.8	248.2	40.4	(130.9)	28.1	4.6	-14.8
Brokerage clerks	16.5	20.3	3.8	23.0	4.6	3.1	(3.9)	28.1	18.5	-23.5
Car rental clerks	16.2	21.6	5.4	33.3	4.6	2.5	(1.6)	28.1	15.1	-9.9
Cashiers	1,532.4	2,270.5	738.1	48.2	429.9	56.6	251.6	28.1	3.7	16.4
Checking clerks	18.0	22.7	4.7	26.2	5.0	0.5	(0.8)	28.1	2.7	-4.5
Circulation clerks	9.5	11.8	2.3	23.8	2.7	(0.8)	0.4	28.1	-8.4	4.2
Claims adjusters	65.4	97.6	32.1	49.1	18.4	(4.0)	17.8	28.1	-6.2	27.3
Claims clerks	63.0	89.8	26.8	42.5	17.7	(4.2)	13.3	28.1	-6.7	21.1
Claims examiner, insurance	47.3	62.1	14.9	31.5	13.3	(0.9)	2.6	28.1	-2.0	5.4
Clerical supervisors	466.1	627.4	161.3	34.6	130.7	13.4	17.2	28.1	2.9	3.7
Coin machine operators and currency sorters	5.0	6.0	0.9	18.2	1.4	.0	(0.5)	28.1	0.4	-10.3
Collectors, bill & account	90.9	130.9	40.0	44.0	25.5	16.5	(2.0)	28.1	18.1	-2.2
Court clerks	27.3	29.4	2.2	7.9	7.7	(4.7)	(0.8)	28.1	-17.3	-2.9
Credit authorizers	20.2	30.5	10.3	51.2	5.7	0.6	4.0	28.1	3.1	20.0
Credit clerks, banking and insurance	49.6	76.4	26.8	54.0	13.9	5.5	7.4	28.1	11.1	14.9
Credit reporters	15.3	20.5	5.2	34.4	4.3	4.7	(3.7)	28.1	30.8	-24.5
Customer service representatives	88.9	123.8	34.8	39.2	25.0	3.4	6.5	28.1	3.8	7.3
Customer service reps., print. and publish.	8.4	10.3	1.9	22.2	2.4	(0.5)	(.0)	28.1	-5.4	-0.5
Desk clerks, bowling floor	15.4	17.8	2.4	15.4	4.3	1.1	(3.0)	28.1	7.0	-19.7
Desk clerks, ex. bowling floor	85.3	104.3	19.0	22.3	23.9	5.0	(9.9)	28.1	5.8	-11.6
Dispatchers, police, fire and ambulance	47.8	53.4	5.5	11.6	13.4	(7.9)	(.0)	28.1	-16.5	.0
Dispatchers, vehicle serv. or work	86.9	109.7	22.8	26.3	24.4	0.1	(1.7)	28.1	0.2	-2.0
Eligibility workers, welfare	31.5	32.1	0.6	2.0	8.8	(5.4)	(2.8)	28.1	-17.1	-9.0
File clerks	293.0	319.5	26.5	9.1	82.2	21.3	(77.0)	28.1	7.3	-26.3
General clerks, office	2,342.0	3,037.4	695.5	29.7	657.0	20.6	17.8	28.1	0.9	0.8
In-file operators	5.0	6.9	1.9	38.8	1.4	2.8	(2.2)	28.1	55.6	-44.9
Insurance checkers	14.9	22.4	7.4	49.8	4.2	(0.3)	3.5	28.1	-2.0	23.7
Insurance clerks, except medical	10.6	14.6	4.0	37.6	3.0	0.6	0.4	28.1	5.7	3.9
Insurance clerks, medical	85.7	139.1	53.4	62.2	24.1	15.9	13.4	28.1	18.5	15.7
Library assistants	80.2	94.6	14.4	18.0	22.5	(10.8)	2.7	28.1	-13.4	3.4
License clerks	5.7	5.5	(0.2)	-4.0	1.6	(1.0)	(0.8)	28.1	-17.3	-14.7
Loan closers	45.3	64.0	18.8	41.5	12.7	4.2	1.9	28.1	9.2	4.2
Mail carriers & postal clerks	540.6	474.4	(66.2)	-12.2	151.7	(108.1)	(109.7)	28.1	-20.0	-20.3
Postal mail carriers	234.1	222.7	(11.4)	-4.9	65.7	(46.8)	(30.3)	28.1	-20.0	-12.9
Postal service clerks	306.5	251.8	(54.8)	-17.9	86.0	(61.3)	(79.5)	28.1	-20.0	-25.9
Mail clerks	98.7	129.7	31.0	31.4	27.7	1.2	2.2	28.1	1.2	2.2
Messengers	49.7	65.4	15.8	31.8	13.9	4.6	(2.7)	28.1	9.2	-5.5
Meter readers, utilities	30.5	37.9	7.3	24.0	8.6	(1.5)	0.3	28.1	-4.9	0.9
Mortgage closing clerks	15.3	22.6	7.2	47.2	4.3	1.7	1.3	28.1	10.8	8.4
Office machine operators	933.6	1,194.6	260.9	27.9	261.9	73.7	(74.7)	28.1	7.9	-8.0
Bookkeeping & billing operators	226.1	289.9	63.8	28.2	63.4	3.7	(3.4)	28.1	1.7	-1.5
Bookkeeping, billing machine operators	171.5	221.7	50.2	29.3	48.1	3.4	(1.3)	28.1	2.0	-0.8
Proof machine operators	47.4	59.4	11.9	25.2	13.3	0.3	(1.6)	28.1	0.6	-3.4
Transit clerks	7.3	8.9	1.6	22.6	2.0	0.1	(0.5)	28.1	0.9	-6.4

Table 4.3 (cont.)

Occupation	Employment changes				Decomposition of employment changes, 1982-1995					
					Absolute changes			Percent of 1982 occupational employment		
	1982 employment (000s)	1995 employment (000s)	Change in employment 1982-1995 (000s)	Change in employment 1982-1995 (percent)	Constant employment shares (000s)	Differential rates of industry growth (000s)	Staffing ratios (000s)	Constant employment shares	Differential rates of industry growth	Staffing ratios
Computer operating personnel ..	578.7	735.9	157.2	27.2	162.3	57.3	(62.5)	28.1	9.9	-10.8
Computer operators	210.0	369.7	159.7	76.1	58.9	20.1	80.7	28.1	9.6	38.4
Data entry operators	318.7	284.6	(34.1)	-10.7	89.4	30.6	(154.1)	28.1	9.6	-48.4
Peripheral EDP equipment operators	47.7	78.6	30.8	64.6	13.4	6.6	10.9	28.1	13.7	22.8
Duplicating machine operators ..	36.1	42.3	6.2	17.1	10.1	3.8	(7.8)	28.1	10.6	-21.5
All other office machine oprs.	89.0	121.8	32.8	36.8	25.0	8.8	(1.0)	28.1	9.9	-1.1
Order clerks	257.0	325.4	68.4	26.6	72.1	(3.0)	(0.7)	28.1	-1.2	-0.3
Payroll & timekeeping clerks	201.2	268.8	67.6	33.6	56.4	6.6	4.5	28.1	3.3	2.2
Personnel clerks.....	102.3	131.0	28.7	28.0	28.7	(3.3)	3.3	28.1	-3.3	3.2
Policy change clerks	27.6	30.5	2.9	10.5	7.7	(0.6)	(4.3)	28.1	-2.0	-15.6
Procurement clerks	46.9	59.0	12.2	25.9	13.2	(1.9)	(0.9)	28.1	-4.1	2.0
Production clerks	199.8	260.0	60.2	30.1	56.0	1.9	2.2	28.1	1.0	1.1
Proofreaders	16.2	20.6	4.3	26.8	4.5	(0.4)	0.2	28.1	-2.6	1.3
Protective signal operators.....	6.9	11.7	4.8	69.4	1.9	3.8	(1.0)	28.1	55.6	-14.3
Purchase & sales clerks, security ..	5.2	4.9	(0.3)	-5.5	1.5	1.0	(2.7)	28.1	18.5	-52.0
Rate clerks, freight	10.2	12.5	2.3	22.6	2.9	(0.7)	0.2	28.1	-7.2	1.8
Raters	52.6	69.0	16.4	31.1	14.8	(1.1)	2.7	28.1	-2.0	5.0
Real estate clerks	16.6	23.5	6.9	41.8	4.7	1.0	1.2	28.1	6.2	7.5
Receptionists	381.1	569.7	188.6	49.5	106.9	54.2	27.5	28.1	14.2	7.2
Reservation agents and transport. tick. clerks	107.5	109.6	2.1	1.9	30.2	(8.5)	(19.5)	28.1	-7.9	-18.2
Reservation agents	52.9	54.9	2.0	3.7	14.8	(3.0)	(9.9)	28.1	-5.7	-18.6
Ticket Agents.....	49.3	48.9	(0.4)	-0.7	13.8	(5.2)	(8.9)	28.1	-10.6	-18.2
Travel counselors, auto club	5.4	5.9	0.5	9.1	1.5	(0.3)	(0.8)	28.1	-5.1	-13.9
Safe deposit clerks.....	13.9	18.1	4.2	30.5	3.9	0.3	.0	28.1	2.4	.0
Secretaries and stenographers	2,634.8	3,337.3	702.5	26.7	739.1	97.3	(133.9)	28.1	3.7	-5.1
Secretaries	2,298.7	2,988.5	689.8	30.0	644.8	98.3	(53.3)	28.1	4.3	-2.3
Stenographers	265.6	244.9	(20.7)	-7.8	74.5	(7.8)	(87.4)	28.1	-2.9	-32.9
Typists	974.9	1,128.8	153.9	15.8	273.5	2.0	(121.6)	28.1	0.2	-12.5
Service clerks	23.6	34.9	11.3	48.1	6.6	0.8	4.0	28.1	3.2	16.9
Shipping and receiving clerks.....	364.3	430.4	66.1	18.2	102.2	(7.4)	(28.7)	28.1	-2.0	-7.9
Shipping packers.....	339.0	402.1	63.1	18.6	95.1	(15.2)	(16.8)	28.1	-4.5	-5.0
Sorting clerks, banking.....	7.4	9.3	1.9	25.5	2.1	0.1	(0.3)	28.1	1.5	-4.1
Statement clerks	33.6	44.2	10.7	31.7	9.4	0.8	0.4	28.1	2.3	1.3
Statistical clerks.....	96.1	110.8	14.7	15.3	27.0	5.7	(18.0)	28.1	5.9	-18.7
Stock clerks, stockroom and warehouse.....	827.3	983.5	156.3	18.9	232.1	0.9	(76.7)	28.1	0.1	-9.3
Survey workers	51.4	76.1	24.8	48.2	14.4	21.7	(11.4)	28.1	42.3	-22.1
Switchboard oper./receptionists ..	203.8	281.6	77.9	38.2	57.2	18.5	2.2	28.1	9.1	1.1
Teachers' aides	462.7	593.1	130.3	28.2	129.8	(69.4)	70.0	28.1	-15.0	15.1
Telephone ad takers, newspapers .	10.4	14.5	4.2	40.5	2.9	(0.9)	2.2	28.1	-8.8	21.2
Telegraph operators	4.4	6.4	2.0	46.1	1.2	0.3	0.5	28.1	7.5	10.6
Telephone operators	315.8	341.4	25.5	8.1	88.6	36.6	(99.7)	28.1	11.6	-31.6
Switchboard operators	169.6	211.3	41.7	24.6	47.6	25.7	(31.6)	28.1	15.1	-18.6
Central office operators	108.7	86.9	(21.8)	-20.0	30.5	8.1	(60.4)	28.1	7.5	-55.6
Directory assistance operators...	37.5	43.1	5.6	14.9	10.5	2.8	(7.7)	28.1	7.5	-20.6
Title searchers	5.1	7.1	2.0	38.5	1.4	0.4	0.2	28.1	7.4	3.1
Town clerks	26.0	29.1	3.1	11.7	7.3	(4.5)	0.3	28.1	-17.3	1.0
Traffic agents.....	17.8	22.3	4.5	25.1	5.0	(0.6)	0.1	28.1	-3.3	0.4
Traffic clerks	7.1	10.5	3.3	47.0	2.0	2.5	(1.2)	28.1	35.8	-16.9
Transportation agents.....	20.6	28.1	7.5	36.3	5.8	(0.1)	1.8	28.1	-0.6	8.9
Weighers.....	24.3	28.7	4.3	17.8	6.8	(2.6)	0.1	28.1	-10.5	0.3
Welfare investigators	11.8	12.3	0.5	4.0	3.3	(2.0)	(0.8)	28.1	-17.1	-7.0
Worksheet clerks.....	10.6	15.3	4.7	44.1	3.0	(0.2)	1.9	28.1	-2.0	18.1
All other clerical workers	1,220.5	1,542.0	321.6	26.3	342.4	(14.0)	(6.8)	28.1	-1.1	-0.6

SOURCE: Calculations by the authors based upon data tape from the 1982-1995 OES/BLS occupational employment projections.

NOTE: Some occupational detail is omitted. Totals and percentages may not add exactly due to omission of some occupational detail and rounding error. The 378 OES industries were first aggregated to 105 industries before accomplishing the decomposition. The OES data tape includes wage and salary employment only.

The fastest growing clerical jobs are expected to be computer operators, claims adjusters, insurance checkers, peripheral EDP equipment operators, telephone ad takers, claims clerks, and credit authorizers. All are expected to have staffing ratio impacts equivalent to increases in employment levels of 20 percent or more. Besides the obvious technological impacts of computers on this list, it may be important to note that many of these occupations require the worker to interact in some way with the customer that is being served. That may provide a clue as to why BLS thinks secretaries will not decline in importance, or perhaps why cashiers are the 10th fastest growing occupation. Again a world of both high-tech and high-touch is anticipated.

Turning to the clerical occupations which are declining the most in terms of their staffing ratios, the single greatest decline is projected for central office telephone operators. This is followed by security purchase and sales clerks, data entry operators, in-file operators, stenographers, file clerks, and postal service clerks. All are projected to have a staffing ratio impact equivalent to reductions in employment of 25 percent or more. Most of these occupations have been declining historically as well, so there are not really many surprises. BLS thinks that the decline in the relative importance of file clerks will continue in the years ahead, thus continuing the trend established in the 1970s. But this occupation is expected to grow slowly on an absolute basis. In general, it is worth reiterating once again that it is easier to provide a technological explanation for the declining occupations than for many of the growing occupations.

B. Leontief and Duchin Study

Wassily Leontief and Faye Duchin have attempted to isolate the impact of computer-based technologies on employment by industry and occupation in The Impacts of Automation on Employment, 1963-2000 (1984). They utilize a comprehensive input-output framework with four separate but interrelated matrices. The model is dynamic in that investment is a function of output changes in the individual producing sectors. The Leontief-Duchin study begins with the various BEA input/output tables and the census-based employment data by occupation. The key forecasting task is to alter the individual technical coefficients to account for the new computer-based automation.

The technological assessment is limited to computer-based technologies, specifically robots, computers, CNC machine tools, electronic office equipment, electronic education devices, and the industries which will use the aforementioned equipment. The technological forecasting is open in that the assumptions are clearly stated and based primarily upon the expert judgment of the researchers. The overall model is then driven by the same final demand forecast used by the Bureau of Labor Statistics in the OES occupational projection effort, except for allowing greater investment in computer-based technologies where the authors deem appropriate.

It is important to emphasize at the outset that one of the assumptions in the Leontief-Duchin study is that no technical change outside computer-based technologies is allowed to affect future employment levels. This leads to dramatic gains in employment for occupations that are largely unaffected by

these technologies such as farmers, bakers, truckers, etc. While this assumption isolates the pure impact of computers in a modeling sense, the Leontief-Duchin approach seriously limits the usefulness of the occupational employment projections. Since balanced sectoral expansion is also assumed, obviously the growth of output in non-automated sectors requires massive infusions of labor to produce that output.

One of the most dramatic illustrations of the impacts of this assumption occurs for IEA occupational group #53, Farmers and Farm Workers. According to the Leontief-Duchin presentation, one might be led to expect that the long secular decline in job opportunities for farm workers has ended, as shown in Figure 4.E. In fact, it appears that this will be a significant growth occupation in the future. Of course, no one really predicts such a result. It occurs because of the construction of the Leontief-Duchin model.

Specifically, in the case of agricultural workers, the expansion of final demand for foodstuffs along with other goods and services (balanced sectoral expansion) combined with no increases in labor productivity leads to substantial increases in the demand for farm workers. Labor productivity gains for farm workers are zero because most farm work is presumably not amenable to the utilization of computer-based technologies, the only source of productivity growth allowed for in the Leontief-Duchin framework. Clearly, this is purely an artifact of the model and should not be regarded as a projected occupational trend. In fact, nearly everyone assumes that the phenomenal increases in productivity in agricultural production will continue so that future food supplies will be generated without substantial increases in human resource inputs. To repeat, Leontief-Duchin assume no productivity increases in the economic system other than those induced by computer-based technologies.

The Leontief-Duchin employment projections utilize four different scenarios which differ in their technological assumptions. Scenario S1 is the baseline scenario; it assumes no further automation or any other technological change after 1980. Scenarios S2 and S3 are identical to S1 through 1980 but S3 assumes more rapid adoption of computer-based technologies than S2 thereafter. Since the BLS estimates of demand drive the model, Scenario S1, with no productivity gains, generates employment estimates that are far beyond reasonable projections of the labor force available. It turns out that both S2 and S3 do so as well (i.e., there are more jobs anticipated than people to fill those jobs) although S3 is closer to realistic projections of the labor force than S2. The fourth and final scenario in the Leontief-Duchin study, S4, adjusts the level of demand for labor downward (using the composition of demand from S3) until it is just consistent with the labor supply which will likely be available to produce that output (i.e., full employment). The employment estimates from S4 are used here in reviewing the Leontief-Duchin study.

The Leontief-Duchin projections for employment in the major occupational groups are presented in Table 4.4. The time period selected is for 1982-1995 to facilitate comparison with the BLS projections. The occupational decomposition in the table is limited to the constant employment shares and all other structural change, thus combining the effects of staffing ratios and differential rates of industry growth. However, this is not likely to be a

Figure 4.E

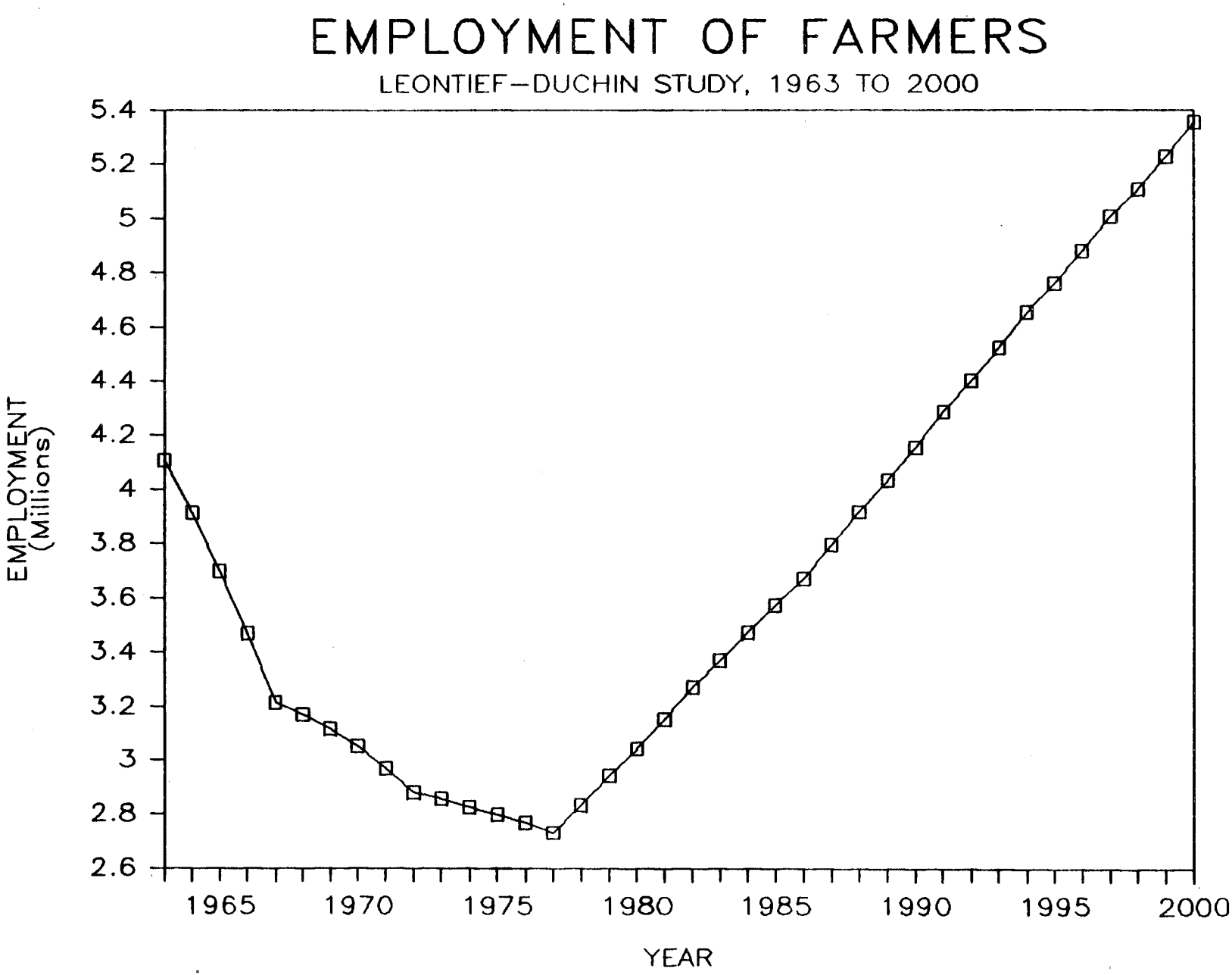

EMPLOYMENT OF FARMERS
LEONTIEF–DUCHIN STUDY, 1963 TO 2000
EMPLOYMENT (Millions)
5.4
5.2
5
4.8
4.6
4.4
4.2
4
3.8
3.6
3.4
3.2
3
2.8
2.6
1965
1970
1975
1980
1985
1990
1995
2000
YEAR

Table 4.4

LEONTIEF-DUCHIN PROJECTED OCCUPATIONAL GROWTH, 1982-1995

MAJOR OCCUPATIONAL GROUPS

Occupation	Employment Changes				Decomposition of Clerical Employment Changes, 1982-1995			
					Absolute Changes		Percent of 1982 Employment	
	1982 Employment (thousands)	1995 Employment (thousands)	Change in Employment 1982-1995 (thousands)	Change in Employment 1982-1995 (percent)	Constant Employment Shares (thousands)	Other Structural Change* (thousands)	Constant Employment Shares	Other Structural Change*
Professionals	16,292	25,858	9,566	58.7	5,538	4,028	34.0	24.7
Managers	11,218	12,484	1,266	11.3	3,813	(2,548)	34.0	-22.7
Sales	6,861	9,328	2,466	36.0	2,332	134	34.0	2.0
Clerical	18,032	17,786	(246)	-1.4	6,129	(6,375)	34.0	-35.4
Craftsmen	15,314	21,554	6,240	40.7	5,206	1,034	34.0	6.7
Operatives	17,852	23,945	6,093	34.1	6,069	24	34.0	0.1
Service	12,909	20,023	7,114	55.1	4,388	2,725	34.0	21.1
Laborers	5,535	8,015	2,480	44.8	1,882	598	34.0	10.8
Farmers	3,270	4,761	1,491	45.6	1,112	379	34.0	11.6
Total	107,284	143,753	36,469	34.0				

Source: Calculations by the authors based upon data kindly provided by Faye Duchin.

Note: Totals and percentages may not add exactly due to omission of some occupational detail and rounding error.

*Other structural change includes the combined effects of changes in staffing ratios and differential rates of industry growth.

serious problem since Leontief-Duchin use the final demand forecast of BLS, for which it has already been shown that the impacts of differences in the rates of growth of industries is relatively modest. The real differences between the BLS and the Leontief-Duchin projections arise from the assumed changes in the staffing ratios as well as the assumption of no productivity growth other than that connected with computer-based technologies.

An examination of the employment projections for the major occupational groups in Table 4.4 clearly illustrates the impacts of assuming no general productivity gains. The employment growth rate for farmers is nearly 46 percent, about one-third higher than the growth of all jobs. Service workers also show fantastic increases. This latter result may appear less unreasonable since it is part of conventional wisdom that service sector jobs have been the major growth sector for the last 20 years or more. However, the estimates in the Leontief-Duchin study result from the same assumptions as in the case of the farm workers.

What is most significant from the standpoint of this study is that Leontief-Duchin project an absolute decline in the employment of clerical workers as well as very slow growth in managers. Regardless of the problems in interpreting the projections that emanate from this model, if Leontief-Duchin are at all correct, it could mean not only displacement for large numbers of clerical workers but also portend difficulties for those workers seeking higher level positions in the office.

The Leontief-Duchin study disaggregates total clerical jobs into five specific clerical occupations, namely secretaries, office machine operators, bank tellers, phone operators, and cashiers, plus a sixth category for all other clericals. The projections for these jobs are shown in Table 4.5 using the same format as shown for the major occupational groups. Secretaries, office machine operators, bank tellers, and phone operators are all expected to experience absolute declines in employment. Only cashiers are growing faster than the average for all occupations. The inference is that Leontief-Duchin think that cashiers will be relatively unaffected by computer technology, while the other clerical occupations will experience significant displacement.

Unlike the BLS model, Leontief-Duchin openly state their assumptions about technological change and the subsequent impact that has on the staffing ratios of the occupations. Therefore, it is possible to evaluate those assumptions independently of the overall reasonableness of the projections. Given the much slower than average growth for most of the clerical fields, at least some of the staffing ratios for those jobs must be expected to fall rapidly. Thus, the selected analysis of some of those assumptions is critical for this study.

The technological assumptions for secretaries and typists will be examined in detail to illustrate the approach of Leontief and Duchin. According to Leontief-Duchin (1984: 5.21), the direct impact of office automation on particular occupations is based on the findings of case studies wherever possible. In general they find that word processing equipment "produces remarkable gains in productivity when it is properly selected and used." (1984: 5.29) They reference an article in Administrative Management (no author, 1978:

Table 4.5

LEONTIEF-DUCHIN PROJECTED OCCUPATIONAL GROWTH, 1982-1995

DETAILED CLERICAL OCCUPATIONS

Occupation	Employment Changes				Decomposition of Clerical Employment Changes, 1982-1995			
					Absolute Changes		Percent of 1982 Employment	
	1982 Employment (thousands)	1995 Employment (thousands)	Change in Employment 1982-1995 (thousands)	Change in Employment 1982-1995 (percent)	Constant Employment Shares (thousands)	Other Structural Change* (thousands)	Constant Employment Shares	Other Structural Change
Clerical	18,032	17,786	(246)	-1.4	6,129	(6,375)	34.0	-35.4
Secretaries	4,951	4,592	(359)	-7.2	1,683	(2,042)	34.0	-41.2
Office Machine Operators	811	224	(587)	-72.4	276	(863)	34.0	-106.4
Bank Tellers	494	404	(90)	-18.2	168	(258)	34.0	-52.1
Phone Operators	355	356	1	0.3	121	(119)	34.0	-33.7
Cashiers	1,568	2,186	618	39.4	533	85	34.0	5.4
Other Clerical	9,853	10,024	171	1.74	3,349	(3,178)	34.0	-32.3
Total Employment	107,284	143,753	36,469	34.0				

Source: Calculations by the author based on data kindly provided by Faye Duchin.

Note: Totals and percentages may not add exactly due to omission of some occupational detail and some sounding error.

*Other structural change includes the combined effects of changes in staffing ratios and differential rates of industry growth.

70-71) which concludes that word processing can increase output from 500 to 1,000 percent. They also suggest that several other studies support labor savings of up to 50 percent -- Murphree (1981) in a Wall Street Legal firm and Downing (1980). Finally, they cite Karon (1982) as concluding that word processing equipment in one research organization reduced labor requirements by 20 percent.

Leontief and Duchin assume that 100 percent of a typist's time will be affected by word processing and that word processing technology will produce labor savings of 80 percent. That amounts to a whopping 500 percent gain in productivity for typists who use word processing equipment. Furthermore, Leontief and Duchin assume that word processing equipment produces only a temporary increase in the amount of work that originators will request, which can be eliminated through a properly managed installation. Thus, word processing creates no "new" work such as more revisions or more perfect copies. All the assumed productivity gain adds "directly or indirectly to the total output of the firm." (1984: 5.30)

But, the capabilities of the microprocessor are ideally suited to redrafts, more form letters, updated statistical reports, etc. Word processing is not adopted simply to save labor time, i.e., to accomplish the same old work with fewer workers, but because there is additional work that needs to be done. Thus the production in the firm becomes more intensive in information content, a trend which has been ongoing for many years.

The technological capability of word processing to save the time that a secretary or typist would have spent doing the same work on a typewriter is only one of the links in estimating the expected changes in staffing ratios. A separate question is that of how many such workers will have word processors, in other words the diffusion of the technology. A 500 percent gain in labor productivity by a small percentage of the workers will have little impact at the aggregate level.

Leontief and Duchin assume that the 500 percent gain in labor productivity from using word processing affects 100 percent of the tasks of typists and that 70 percent of all typists will have word processing by 1990. (1984: 5.31-32) The assumptions are the same for secretaries except that only 24 percent of them type full-time, while the remainder type 20 percent of the time. It should be mentioned that there are separate assumptions about the adoption of integrated office systems that link various devices together. These networks will also decrease overall requirements for secretaries.

In the Leontief-Duchin study, the diffusion rates for word processing equipment are not influenced by industrial sector or by size of firm, i.e., the technology is assumed to diffuse steadily with the same impacts regardless of industry or size of firm. In reality these assumptions may not be accurate. For example, certain sectors such as insurance and banking are already significant users of electronic office technology. Thus some proportion of secretaries and typists may already be using this equipment (before the base period of the research study). Obviously they cannot benefit a second time from its introduction. Along a similar vein, it is possible that the work in

particular sectors is more amenable to electronic office technology. Examples may be law offices where some types of legal briefs are repetitive except for a few sections; and where a high premium is assigned to the correctness of language used in each brief. In these sectors, just as in banking and insurance, the new office technologies may be more productive and hence spread rapidly. On the other hand, the situation may be more clouded in other sectors, where the work tends to be more unique and less repetitive. It seems logical that the productivity gains will vary widely depending on the precise nature of the output of the office.

Finally, it is also possible that the size of firm is a crucial variable in determining the impacts of electronic office technology. The most obvious example is the one-secretary office where the labor savings may free the secretary to do other tasks but the firm has no intention of eliminating this job. Thus the hypothetical productivity gains do not reduce the actual number of secretaries in such an environment. Ideally these positions would be excluded from the calculations developed by Leontief and Duchin.

Although size of firm and industry are not specifically accounted for by Leontief and Duchin, it can be argued that their estimates represent average gains over a very long period of time. However, our judgment is that at best the productivity gains anticipated by Leontief and Duchin are only possible for tasks that are very repetitive and which therefore require little individual attention.

In general, the Leontief-Duchin model produces three different types of projected occupational impacts. The first type (direct impacts) results from stated assumptions about the spread of computer-based technologies and the labor displacement potential of those technologies. The second type (indirect impacts) results from the workings of the input-output model itself. They represent the secondary impacts from the changes in investment and labor demand associated with the direct impacts. The third type (unintentional impacts) represent the forced growth of occupational demand in areas not substantially affected by computer-based technologies.

We feel very strongly that to make the projections of the occupational impact of computer-based technologies most useful for policy decisions, the projections should be compared to an alternative state of the world that represents a realistic baseline. Even a simple linear extrapolation of historical employment trends by sector or occupation would provide a more realistic baseline than the counterfactual assumption of no productivity gains except those due to computer-based technologies.

While the Leontief-Duchin configuration may be useful as a modeling device, it obscures the true policy implications of the model. In fact, we think that comparisons based on it may be seriously misleading to policymakers. For policy purposes it is more important to focus on the marginal changes that will result from a specific change or treatment than to focus on the aggregate change from an alternative state of the world that could never happen.

It is important that the global scope of the results presented in the Leontief-Duchin study not conceal the fact that the actual assumptions about the spread of computer-based technologies and the labor displacing impacts are judgmental. This is not meant as a criticism in any way of the Leontief-Duchin effort, but the elegance of the final presentation can mislead the unwary into the mistaken impression that the model is responsible for the predictions. In fact, the model is simply a tool to project the implications of the stated assumptions about the technology. We feel that some of the assumptions about the spread of computer-based technologies are reasonable and some are not. It is natural that people will differ in these judgments; what is important is that it be clear that it is the assumptions that drive the model, not vice versa.

In addition, we think that the changes they studied are not the only changes that will take place, nor are they necessarily the most important ones. The model does not address substitution among inputs based upon price changes, or changes in final demand induced by price effects resulting from use of the new technologies. Nor does it include scale economies and agglomeration economies, both of which may be influenced directly by technological change. This latter point may be particularly important since some experts expect computer-based technologies to transform the traditional manufacturing environment.

There is also an important question about the degree of substitution among different kinds of capital goods. It is not necessarily true that because an industry adopts some form of automation that it will achieve better than average gains in productivity. The reason is that it may at the same time reduce investments in other productivity-enhancing areas. In other words, the new investment may simply be the current manifestation of labor-saving technology that will help these firms to achieve productivity gains at the historic average. Resolution of this issue is of major importance in assessing the effects of computer-based technologies.

The Leontief-Duchin study represents a significant advance in modeling that holds considerable promise for studying the employment implications of technological change. It moves the field one step closer to a general equilibrium model that could incorporate all direct and indirect influences on employment that emanate from technological change or other structural change in the economy. However, the true contribution of the Leontief-Duchin model to understanding future occupational trends cannot yet be determined. The model needs a more realistic baseline scenario, including trend values of productivity increase by sector, to determine the marginal employment impacts of computer-based technology.

C. Drennan Study

Matthew P. Drennan (1983) has explored the impacts of office automation on clerical employment in six industries in "Implications of Computer and Communications Technology for Less Skilled Service Employment Opportunities." The industries examined were banking, credit agencies, securities, insurance, business services, and miscellaneous services. The analysis of clerical

employment uses the job classification system from the 1970 Census of Population.

The Drennan study is both quantitative and qualitative. The quantitative portion of the study utilizes a variety of data sources, while the qualitative portion is based on the author's interviews with a selected number of producers and users of office automation. The review here is limited to the projections methodology used by Drennan and the important judgments and assumptions which drive those projections.

The Drennan methodology utilizes simple extrapolation to forecast industry-occupation employment to 1990. First, industry employment in the six industries from 1983 onward is assumed to grow at the historical average rate experienced from 1969-1979. The assumption is that following the 1980-1982 recessionary period these industries will return to pre-recessionary growth patterns. In addition, Drennan also includes an alternative 1990 forecast which assumes a productivity growth rate that is .5 percentage points higher per year in each industry than the historical average for those industries. This allows for increased employment impacts of office automation in future years.

Once the estimates for 1990 industry employment are obtained, then employment by occupation in those industries is estimated by assuming that the change in occupational staffing patterns from 1970 to 1978 will continue to 1990, what Drennan (1983: 88) calls a continuation of "more of the same." The occupational staffing patterns were obtained from the National Industry-Occupation Employment Matrix, 1970, 1978, and Projected 1990 (Bureau of Labor Statistics, 1981). In brief, the occupational employment estimates for these six industries are derived from past changes in occupational staffing patterns and past industry growth trends.

A brief summary of Drennan's overall projections are presented in Table 4.6. Since staffing ratios for clerical employment fell in these six industries by nearly 3 percent from 1970 to 1978, the extrapolation indicates a similar decline from 1978 to 1990. Total employment in these industries grew 70 percent from 1970 to 1978, but it is only expected to grow 44 percent from 1978 to 1990. This slower growth is presumably due to the interruption of growth in these industries during the 1980-1982 recession. Since staffing ratios are falling for clerical workers, clerical employment growth is much slower than total employment growth in these industries. Drennan concludes (1983: 90):

> The expectation of markedly slower employment growth in clerical jobs in those industries is firmly based and is difficult to contest. The chief implication for the labor force is the same as it was a decade ago: education beyond secondary school is the key passport to job security in the 1990s.

Table 4.6

DRENNAN: PROJECTED EMPLOYMENT BY OCCUPATION IN SIX OFFICE INDUSTRIES

(thousands)

Occupation	1970 Employment*	1978 Employment*	1990 Employment	Alternative 1990 Employment
Professionals	1,005	1,595	2,611	2,458
Managers	814	1,176	1,755	1,637
Sales	577	770	1,015	950
Clericals	2,325	3,092	4,153	3,867
Other	705	1,081	1,620	1,611
Total	5,426	7,714	11,156	10,525

*Bureau of Labor Statistics, U.S. Department of Labor, The National Industry-Occupation Employment Matrix, 1970-1978 and Projected 1990, Bulletin 2086, April 1981.

The strength of Drennan's simple extrapolation technique is that since these industries have been the leaders in office automation, the assumed scenario is plausible if one thinks the past impacts of office automation will continue in the future. The implication is that if the past is any guide to the future for these industries, then clerical jobs will continue to grow, but much slower than the average of all jobs in these industries. On the other hand, it is easy to dismiss any extrapolation technique as too simplistic. But, besides the rather obvious questions that can be directed at any extrapolation methodology, there are a number of other concerns about Drennan's projections.

First, it is clear that the alternative 1990 industry employment estimates, which assume an additional .5 percent productivity growth, are not logically related to any of the other data in the extrapolations. But it is inconceivable that the extra productivity growth (which ranges from just under 20 percent to in excess of 100 percent depending on the industry) would not lead to price declines which in turn would positively affect industry sales. Our judgment is that it is not meaningful to fix demand and then vary productivity to show that less labor would be needed if the existing workers would only produce more. The arithmetic in these calculations is easy to do, but in reality the growth in demand for these service industries has been robust over the last decade or so. The strong implication is that price declines would be accompanied by at least some increase in demand for the products produced by those sectors.

Second, the assumption of the continuation of past trends in staffing ratios appear to be contradicted to some extent by Drennan's own qualitative analysis. According to him (1983: 69), managers employment will "experience a marked curtailment of growth" in the years ahead. This slowdown will be due to the diffusion of integrated office systems, where executives will be able to communicate with each other electronically, access data bases and all other software using desktop computers. Although Drennan points to several reasons why these systems will not diffuse as rapidly as perhaps some experts think, it is clear that he includes the alternative 1990 industry projections to incorporate the possibility of faster diffusion. But, even in the alternative scenario, the productivity gains are spread out evenly over all occupations.

In summary, Drennan has forecast clerical jobs to 1990 in six industries. He uses a simple extrapolation technique, after accounting for the lack of growth during the 1980-1982 recession. There may be some problems in the data used for the extrapolations, questions about the alternative employment growth scenario, and some questions about the logical relationship between the qualitative analysis and the quantitative extrapolations. Nonetheless, to the extent that the past decade is a guide to the future for these industries, the projections deserve serious consideration.

D. Roessner Study

J. David Roessner and his colleagues at Georgia Tech have examined the impact of office automation on clerical employment in two industries, banking and insurance, in Impact of Office Automation on Office Workers (1984).

Roessner stresses the need to extend current employment forecasts such as those by BLS beyond 10 years. He (II, 1984: 2) also concludes that there are weaknesses in existing employment forecasts, especially in the way in which jobs are defined and the incorporation of technological change in the projections methodology. The forecast horizon in the Roessner study extends to the year 2000.

The Roessner study focuses on an explicit and systematic technology assessment and forecast and the relationship of that forecast to occupational employment. He describes his method as more of an engineering approach but one that also takes account of economic considerations. (III, 1984: 4-5). He stresses the importance of making the process as open and transparent as possible to facilitate its use by others and to encourage improvements in the methodology.

The Roessner study team (10 people) first internally developed a time-phased technology forecast for office automation in banking and insurance. This initial forecast was then distributed to officials from these two industries who were asked to participate in a Delphi exercise designed to confirm/modify the original forecast. The Delphi methodology attempts to develop a consensus forecast from iterative and independent polling of experts in a given field. Roessner (III, 1984: 96-97) conducted two rounds of polling of eight experts each in banking and insurance.

Space limitations prohibit reporting the full technology forecast, or technology "morphology" as Roessner calls it (III, 1984: 46-55). However, the emphasis was on the identification of breakthrough technologies that might have a significant impact on clerical employment. According to Roessner's projections, there are two breakthrough technologies on the horizon that will likely impact clerical employment in the 1990s, namely optical scan and voice recognition systems and artificial intelligence (AI). The market for the former devices, which will eliminate the human keying of data and text, will be about $4 billion by 1992, and these systems will be in widespread use by that year. The market for various types of AI systems will lag that of voice recognition; but by 1998 Roessner forecasts we will have "self-generating" software (II, 1984: 8). As will be seen later, these two breakthrough technologies will indeed have a significant impact on Roessner's projections of clerical employment in the 1990s.

The second step in the Roessner methodology was to develop a task characteristic/function matrix for each detailed clerical job using the job classification system of BLS. For instance, the tasks of typing and data entry might both be classified simply as the input function. The six functions identified by Roessner were: input, processing, output, data base, communications, and monitoring. According to him the advantage of the functional terms is that they are independent of technologies currently in use.

The identification of the task/function matrices were essentially judgmental (III, 1984: 73). The detailed BLS jobs were then grouped into clerical job clusters by the similarity of their functions. Roessner used

secondary sources supplemented by a small number of interviews and survey questionnaires to determine the time clericals spend in each task/function.

The third step of the Roessner methodology was to conduct an industry Delphi forecast to provide estimates of the impacts of office automation on the structure of work. These estimates were not nearly as detailed as the task characteristic/function matrix but were designed to identify in broad terms different organizational structures and employment mixes that might prevail in the future. They provide an input to the next step of the process, which develops the estimated labor savings, plus they provide an independent means of verifying or validating the final employment forecast itself.

The fourth step of the Roessner methodology was to actually estimate the impact of office automation on the clerical job clusters using the functions of those jobs developed earlier. It amounts to producing time-phased estimates of labor savings due to the new technology. This was done internally by the study team using a modified Delphi process which Roessner (III, 1984: 122) calls "estimate-talk-estimate." The goal of the method was to gain consensus among the study team about the various judgments which had to be made to quantitatively estimate the labor savings for each job cluster.

The fifth step of the Roessner methodology was to generate the employment forecasts for each of the clerical job clusters. These estimates used a base year of 1980 and provided forecasts at five-year intervals to the year 2000. Demand for the output of these industries, what Roessner calls "workload", is a straight line extrapolation of value added in banking and insurance plus a special output index in banking which was constructed from various deposit transactions (II, 1984: 22).

The final step of the Roessner methodology is to conduct a sensitivity analysis of the results and to validate those results. The primary validation is to return to the industry Delphi forecast which identifies the general job mixes and compare those with the more detailed approach. According to Roessner, the two methods provide remarkably consistent employment estimates (II, 1984: 27). For the sake of brevity, only the standard or most likely estimates from the Roessner study are presented in this review.[23]

One of the most important set of summary estimates in the Roessner study are those that pertain to the labor savings which are most likely to be realized by the installation of office automation in banking and insurance. These estimates are actually the heart of the study; they summarize the interaction of the technology forecast with the task/function matrix which describes the job activities of clerical workers. Recall also that demand is a simple extrapolation of past trends in these industries, so it is truly the labor savings estimates which are novel and which drive the employment projections.

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23. This brief summary of the Roessner methodology does not do justice to its complexity; there are actually many parts to each of the major steps.

The labor savings or productivity gains attributable to office automation for each of the occupational clusters developed by Roessner are presented in Table 4.7. Roessner states these in index number form as the percent of the 1980 base time required. Thus a falling index number indicates that the same amount of work in the specified future year can be accomplished in less time than in the base year, 1980. These labor savings estimates are quite similar across the job clusters and even across the two industries. Thus the productivity gain for Filing Data Entry Clerks is almost the same as that for Receptionists/Telephone Operators.

The strong implication is that individual clerical occupations will not change much in relative importance from 1980 to 2000. Roessner (IV, 1984: 145) acknowledges that some readers might be surprised at the homogeneity of the results across occupations. But he suggests one interpretation of the findings:

> One possibility is that this surprisingly even, across-the-board projected reduction in clerical time per work function will prove accurate because market forces will act to stimulate new technological development to improve productivity evenly across clerical activities. For instance, while automation of structured input is commencing earlier than automation of unstructured input, that very gap may accentuate efforts to bring technologies such as voice recognition to market. There appear to be relatively few work functions that are "safe" from a substantial degree of automation.

Again, if Roessner's projections are correct, all clerical jobs will be impacted similarly by office automation, <u>in the short run as well as the long run</u>.

A summary of Roessner's employment forecast for banking and insurance is presented in Table 4.8. The overall demand or workload forecast is presented first; it is the linear extrapolation of demand referred to earlier, stated as the number of workers required assuming no productivity gains (1980 base). That is followed by the presentation of the overall productivity gains for clerical workers, what Roessner calls the percent reduction due to technology. Third, the estimated clerical workforce required to accomplish the projected workload is derived, i.e., the employment projections. Finally, for purposes of explanation, the annual average productivity gains for each five-year period are presented.

The data in Table 4.8 illustrate the major conclusions of the Roessner study. He expects a drastic curtailment of the growth of clerical jobs in banking and insurance, which will tend to accelerate in the 1990s. By the year 2000 there will be fewer clerical workers in banking and insurance than there were in 1980. Although only the results from the most likely scenario are presented in this review, employment declines are projected by Roessner even for the most conservative technological assumptions (III, 1984: 149). It

Table 4.7

ROESSNER: PERCENT OF 1980-BASE TIME REQUIRED BY OCCUPATIONAL CLUSTER, MOST LIKELY SCENARIO FOR BANKING AND INSURANCE

Occupational Cluster	1980	1985	1990	1995	2000
Banking					
Computation/Bookkeeping Clerks	100.00	92.75	81.73	63.36	42.10
General Office Clerks	100.00	92.75	81.56	63.36	42.03
Typists/Word Processor Operators	100.00	94.00	83.29	66.25	45.86
Secretary/Administrative Assistants	100.00	93.62	82.15	65.61	46.01
Filing/Data Entry Clerks	100.00	92.44	80.82	61.42	39.07
Information Retrieval/ Communications Clerks	100.00	92.35	80.33	61.37	40.06
Mail Handlers	100.00	92.71	80.76	63.64	42.25
Clerical Supervisors	100.00	93.39	82.46	65.75	46.71
Receptionists/Telephone Operators	100.00	92.23	79.40	60.94	39.30
Computer/Office Equipment Operators	100.00	91.69	80.47	61.58	39.42
Tellers	100.00	92.22	60.92	61.79	38.80
Information Maintenance Clerks	100.00	92.96	81.45	63.24	41.60
Insurance					
Computation/Bookkeeping Clerks	100.00	92.52	81.57	62.89	42.00
General Office Clerks	100.00	92.76	81.37	63.28	42.31
Typists/Word Processor Operators	100.00	94.10	83.42	67.02	47.37
Secretary/Administrative Assistants	100.00	93.38	82.15	64.93	44.71
Filing/Data Entry Clerks	100.00	92.55	81.21	61.77	40.12
Information Retrieval/ Communications Clerks	100.00	92.66	80.38	61.27	38.96
Mail Handlers	100.00	92.61	80.88	63.49	41.51
Clerical Supervisors	100.00	93.76	82.81	65.96	46.47
Receptionists/Telephone Operators	100.00	92.10	79.39	60.34	39.29
Computer/Office Equipment Operators	100.00	92.02	80.99	61.89	39.43

Source: J. David Roessner, Impact of Office Automation on Office Workers, Volume IV, Appendices, prepared for the Employment and Training Administration, U.S. Department of Labor, April 1984, Appendix P, Runs #1 and #51.

Table 4.8

ROESSNER: SUMMARY EMPLOYMENT PROJECTIONS
FOR BANKING AND INSURANCE, MOST LIKELY SCENARIO

Item	1980	1985	1990	1995	2000
Banking					
Clerical Workload Forecast (employees x 1,000)	1,100	1,326	1,551	1,781	2,001
Percent Reduction Due to Technology	0.0	7.37	18.67	37.05	58.81
Clerical Workforce Required (employees x 1,000)	1,100	1,228	1,261	1,121	824
Average Annual Productivity Gain for Each Five-Year Period	---	1.474	2.260	3.676	4.352
Insurance					
Clerical Workload Forecast (employees x 1,000)	924	1,024	1,124	1,225	1,324
Percent Reduction Due to Technology	0.0	7.07	18.28	36.30	57.09
Clerical Workforce Required (employees x 1,000)	924	952	919	780	568
Average Annual Productivity Gain for Each Five-Year Period	---	1.414	2.242	3.604	4.158

Source: J. David Roessner, Impact of Office Automation on Office Workers, Volume IV, Appendices, prepared for the Employment and Training Administration, U.S. Department of Labor, April 1984, Appendix P, Runs #1 and #51.

should be clear that if demand increases linearly, while the productivity gains from office automation accelerate over the 20 years of the projection period in an exponential fashion, then the logical result must be an accelerating decline in clerical employment.

But the truth is that the Roessner projections may not be any more usable by policymakers than those by Leontief-Duchin. Whatever the merits of the Roessner methodology, the results do not appear to describe real world events. This conclusion is demonstrated by Table 4.9 which presents the actual BLS staffing ratios for selected clerical occupations for 1970 and 1978 in the banking industry. In so far as possible Roessner's occupational clusters have been related to the BLS system. The match is at least roughly consistent for 8 of the 12 occupational clusters. Actually, the match is not nearly as important as simply noting how dramatic the actual changes in staffing ratios were. From 1970 to 1978 the changes in staffing ratios for the selected clerical occupations presented in Table 4.9 ranged from -60 percent to +115 percent.

Yet Roessner asserts that the relative importance of individual clerical jobs will not change much in the future. Back-office jobs such as file clerks have been declining in relative importance for a long time, while computer-related positions have been increasing dramatically in relative importance. Absent a complete break with history, clerical occupations can be expected to continue to rise and fall at differential rates.

There appear to be three major problem areas in the Roessner study which have contributed to the counter-intuitive conclusions about the likely relative importance of clerical jobs in banking and insurance in the future. These same problems may also have contributed to Roessner's overall pessimistic outlook for clerical jobs in these two industries. Each problem area is discussed briefly in turn.

First, there is no consideration of a whole host of investment questions or the possibility that the information content of output will increase. Like Drennan, it is presumed that the epoch making gains in productivity attributable to office automation will not alter the linear increase in demand for the output of banking or insurance. Such an assumption may be acceptable for a sector like agriculture when we already have enough foodstuffs to eat. But it is not appropriate to apply that assumption to services. Again, a more reasonable position is that productivity gains of the magnitude expected by Roessner would lead to price declines which in turn would surely expand the markets for those services.

It should also be mentioned that the changes envisioned by Roessner may not only save labor but they may also be the catalyst for the development of entirely new products within banking and insurance. Although it appears to be impossible to identify those new products in advance, banking and insurance have offered innovative services in the past and will likely continue to do so in the future. To the extent that new products and services are developed, they will tend to mitigate any employment declines from office automation.

Table 4.9

STAFFING RATIOS FOR SELECTED CLERICAL POSITIONS IN BANKING BASED UPON THE NATIONAL INDUSTRY-OCCUPATION EMPLOYMENT MATRIX, 1970 AND 1978, GROUPED BY ROESSNER'S OCCUPATIONAL CLUSTERS

Occupation (Roessner/BLS)	1970	1978	Percent Change in Staffing Ratios, 1970-1978
Typists/Word Processor Operators			
Typists	2.94	2.24	- 23.8
Secretaries/Administrative Assistants			
Secretaries	6.93	6.28	- 9.4
Filing/Data Entry Clerks			
File Clerks	1.27	.96	- 24.4
Keypunch Operators	1.78	1.27	- 28.7
Mail Handlers			
Mail Handlers	.62	.57	- 8.1
Messengers	.63	.46	- 27.0
Clerical Supervisors			
Clerical Supervisors	.73	.80	+ 9.6
Receptionists/Telephone Operators			
Receptionists	.60	.56	- 6.7
Telephone Operators	.45	.18	- 60.0
Computer/Office Equipment Operators			
Computer Operators	1.26	2.72	+115.9
Duplicating Machine Operators	.03	.03	0.0
Banking			
Tellers			
Tellers	26.27	30.28	+ 15.3
Total Clerical	64.77	64.50	- 0.3

Source: Bureau of Labor Statistics, U.S. Department of Labor, The National Industry-Occupation Employment Matrix, 1970, 1978, and Projected 1990, Volume I, 1981, p. 289.

It is also bothersome that Roessner appears to allow for no slack or slippage of any kind in calculating the productivity gains. Organizations and the technologies which they use do not fit together perfectly; there tend to be bottlenecks and downtime. Most important of all, it is well-known that the potential labor savings of any technology may not actually be realized in fact. It is unknown if Roessner implicitly accounted for these factors, but his estimates appear so optimistic that he may not have accounted for them sufficiently.

The second major problem area in the Roessner study is in the task/function matrix. Economists have been looking for an objective way to define jobs for a long time. But job content tends to be very amorphous. That is one of the reasons why the OES system now in use at BLS concentrates on job titles. The definition of jobs, whether by task characteristics, or Roessner's functions, or by any other means, tends to be a moving target which is impossible to hit squarely. The functions identified by Roessner may be so general (input, data processing, etc.) that they do not truly describe job activities in a meaningful way. In short, there is a possibility that Roessner's task/function matrix may have introduced a homogeneity across jobs that does not exist in reality. This problem was then compounded by the aggregation of those occupations into job clusters.

The final problem area in the Roessner study may be in the technology forecast itself. Roessner concludes that it is important to extend these forecasts beyond 10 years, "...to anticipate major changes in time for policy machinery to move and related institutions to adjust." (II, 1984: 34). However desirable Roessner's goal may be, it probably cannot be achieved.

History is littered with technological forecasts which turned out to be false or at best only partially true, while other radical changes were not foreseen at all. Artificial intelligence is not a new technology; there were high hopes for it in the early 1960s (Winston, 1985: 75-78). Many experts also thought that various types of electronic funds transfer would replace paper transactions by the early 1980s. Indeed, a recent study of the financial services sector by the Office of Technology Assessment, Congress of the United States, begins by acknowledging that past technology forecasts for this sector have not been particularly accurate (1984: 7).

Our judgment is that the state of the art in technology forecasting is not sufficiently advanced to permit the kind of long-run analysis performed by Roessner; even 10-year forecasts of occupational employment stretch our current forecasting abilities. Indeed, Roessner's attempt to identify so-called "breakthrough" technologies vividly demonstrates the problems of extending the forecast horizon beyond 10 years. Our knowledge becomes so limited that it is easy to imagine greater and greater change. Extending the forecast horizon removes all of the constraints that logically hinder the development and diffusion of new technologies. All the rigors of the marketplace such as competing products and other investment goals evaporate. Problems that inevitably arise with new technology but are not known until it is implemented, simply do not exist in these long-run projections. Uncooperative consumers who

do not wish to use the new technologies are ignored. What remains is the euphoria about what tomorrow's technologies will be able to accomplish.

Stated differently, employment projections beyond 10 years require knowledge about technological breakthroughs, the amount of time it will take to bring the new systems to the marketplace, the rate at which the technology will diffuse or be adopted by firms, the organizational structure and the structure of jobs in those firms, and the specific jobs which will be affected by those new technologies. All this presumes that the products being produced with the new technologies will be deemed desirable by consumers and that it is known which of these goods will be purchased through import markets. Furthermore, all of this knowledge of the future must be precisely time-phased to properly estimate the occupational impacts.

Roessner says that new public policy initiatives should not be taken on the basis of only one study. But, his emphasis on breakthrough technologies coupled to his long-run projections horizon raise some fundamental questions about forecasting and its relation to policymaking. Are we willing to commit public funds to correct for problems which have not yet actually arisen? How many tax dollars do we spend retraining clerical workers in banking and insurance because some day in the future voice recognition and artificial intelligence may eliminate their jobs? What jobs do we train these workers for? Do we train real people for jobs that don't yet exist, but may exist after the technological breakthroughs occur? What do we do with them in the meantime? How many problems that <u>might</u> develop in the future can we as a society afford to solve now?

Roessner's long-run employment projections cannot be taken seriously as a practical guide for policymaking. In the short run the projections appear to contradict the best current evidence available about the uneven impacts of new technologies on occupations. In the long run (beyond 10 years) virtually any technological event is possible, so it is unwise to seriously shape public policy now for events which may or may not occur. There will be "technological surprises" in the years ahead just as there have been in the past. No one (or group) has the immense amount of insight necessary to predict detailed occupational employment in the long run sufficiently precisely that it is possible to develop a consensus view of what public policy should be today.

E. Summary

In this section the major existing forecasts of the impacts of office automation on clerical employment have been reviewed. Although there appear to be great disparities between the forecasts of BLS, Leontief-Duchin, Drennan, and Roessner, there is broad agreement that clerical jobs will not continue their rapid growth of the past few decades.

Except for Roessner, there is also broad agreement that the so-called back office jobs will continue to be automated first, slowing their growth dramatically. These jobs appear to be more structured and repetitive, therefore more subject to automation. This represents the continuation of a long historical trend that has its roots in the manufacturing sector but will

apply to computer and office electronic technology as well. Computer technology is still not ready to tackle the unstructured situations where humans excel, however.

On a more positive note, there will likely continue to be strong growth in relative terms for computer-related clerical positions for the foreseeable future and more or less average growth for clerical positions that directly interface with customers or other co-workers. Many of these latter positions, though not all, are more generalist in nature. Roessner notwithstanding, a variety of skills probably helps to insure that the automation of any one of those skills leaves the job intact. It also implies that a worker can in effect purchase job insurance by possessing numerous skills.

The methodologies of these studies are very different, but they share one important characteristic which should not be overlooked. Regardless of the modeling used, it is the technology forecast, its presumed relationship to specific occupations, and the demand outlook that drives any employment impacts. Too often it appears that somehow the model itself produced the results, whereas in reality it is the assumptions which determine the results.

In this regard it is important to applaud the openness of the work of Leontief-Duchin, Drennan, and Roessner. An evaluation of their studies would be virtually impossible without the explicit reporting of their technological assumptions. BLS is currently much less open about their handling of technological change. The mathematical decomposition was used to estimate the quantitative change in the staffing ratios in the industry-occupation matrix. These are the most visible sign of the specific occupational impacts of technological change in the BLS system. The results showed that BLS is indeed changing the staffing ratios, but they do not report the basis of their judgments which guide the process.

Doubts have been expressed about the long-run technology forecasts of Leontief-Duchin and Roessner, especially in regards to determining the occupational impacts thereof. It is not necessary to repeat the details of these arguments. Suffice it to say that it is far easier to calculate simple labor-savings based on engineering concepts than to specify and quantify the new jobs which will be created by a growing, dynamic economy. Furthermore, if history is any guide, our abilities to calculate theoretical labor-savings exceed our ability to actually achieve those savings in practice. Bela Gold, an economist who has studied technological change for over 25 years, concludes (1981: 91) that even major technological changes have "fallen far short of their expected effects."

Absolute declines in total clerical employment for the foreseeable future are extremely unlikely. Even more significantly, shaping public policy today because of the chance that clerical jobs may decline in the future is sheer folly. The most likely scenario for the future is that clerical jobs will continue to grow, but more slowly than the average for all jobs.

V. CONCLUSIONS

The focus of this paper has been (1) to review the trends in clerical employment over the last 30 years and (2) to assess the existing forecasts for clerical jobs. Of particular concern has been the potential impact of office automation on these jobs. Although it is impossible to develop a new forecast for clerical jobs based on this review, we have tried to be forthright with our own judgments along the way. Now it is time to bring together the various themes of the paper.

A. The Data Problems

The most obvious problem is that there is a scarcity of data on which to base the assessment of clerical jobs and office automation. Time series data are not available on office automation spending by industry or even detailed clerical employment by industry. Hunt and Hunt (1985) recommended in another paper, which critically assessed the data available to study the employment effects of technological change, that highest priority should be given to the establishment of a new, integrated data base capable of dealing simultaneously with the employment and technology issues.

We have tried to openly state the data problems in this paper. Some may think we have gone too far in this. But it is important to remember how easy it is to utilize data which look similar on the surface, and end up drawing inferences which reflect nothing more than differences in measurement. The existing data are so fragmentary and so uneven that conclusions drawn from them may always be tenuous.

We have done our best to insure that the data reported in this paper are reasonably consistent. Undoubtedly, some will object that time series data were not developed for all clerical occupations or that the analysis halts abruptly in 1982 in some cases. Suffice it to say that we endeavored to avoid reporting results which might be misleading, but yet to get as much from existing data sources as possible.

Another problem encountered in this effort was that a number of separate influences occurred simultaneously in 1982 which make it extremely difficult to interpret recent occupational employment trends. First, the bottom of the worst recession since World War II occurred in 1982. This distorted the employment figures in a number of ways. Second, at about this same time there appeared to be some real changes occurring in the patterns of growth across different industries. This is particularly evident for state and local government and perhaps hospitals. Third, it is possible that office automation had diffused sufficiently to make some real impact by 1982. Finally, among the data problems alluded to earlier, it turns out that 1982 was the last year in which the CPS used the 1970 census classification system for occupations. Since the data from 1983 and 1984 utilize such a different occupational structure, even at the major group level, it is extremely difficult to conduct meaningful analyses across this time span.

Of course, the problem is that the confluence of these events, some real and some artifacts of the data, make it very difficult to determine what the recent trends have been. The employment of secretaries fell slightly in 1981 and 1982. That is very unusual, even during a recession. Did office automation cause the decline? Was it simply that this recession was the worst since World War II? Or did some other factor such as changing utilization of job titles or some technical problem with the survey cause the fall? These questions cannot be answered with confidence, but the growth of secretarial employment resumed in 1983 and 1984. This argues that the decline was probably due to the recession. The point is that it may be all too easy to draw false inferences about the last few years.

B. Trends in Clerical Employment

The data problems notwithstanding, the aggregate analysis of all clerical jobs clearly showed that the growth of this major occupational group has slowed relative to the growth of all jobs. In particular, it appears that the proportion of clerical jobs in total employment did not increase during the 1980-82 recession as it has in other recessions.

The decomposition analysis put clerical occupational growth into a larger perspective. It emphasized the role of economic growth in determining the fortunes of individual occupations. It was also seen that the growth of particular industries (the changing sectoral composition of output) can have a significant impact on occupational employment. In the long run there is no doubt that the evolution of the service economy has been a favorable influence on clerical employment levels.

The occupational decomposition also showed how changing staffing ratios can influence occupational employment. Not only has industry mix been positive for clericals, but it seems that goods and services have been growing more information-intensive per unit of output. This has also boosted clerical employment. In addition, by showing how different the staffing ratios really are across industries, the analysis reinforced the notion that industry structure cannot be ignored in studying occupational employment.

Of course, it is the changes in staffing ratios that best summarize the impacts of technological change on occupations. It was found that from 1972 to 1982 the net effect on clerical employment of changing staffing ratios was modestly positive across all industries, but there were a few sectors, notably finance, where the effect was negative. This is taken as evidence of the adverse impact of technological change on clerical employment. Even in finance, however, the strong industry mix effect and overall economic growth overwhelmed the displacement effect of falling staffing ratios. So employment of clericals continued to rise significantly despite the impact of automation.

In general, the results of the analysis for individual occupations were disappointing. The amazing variety of clerical jobs was depicted, and the diversity in their employment trends clearly emerged from the analysis. But the trends in employment proved to be very difficult to tie conclusively to technological change or any other single cause. The general conclusion was

that this aggregate analysis of occupational employment data was not sufficient to reveal the causes behind the trends.

The attempt to find empirical evidence on the productivity gains from office automation was also relatively unsatisfying. What is available consists of mostly undocumented trade journal articles which are hard to take seriously. It was shown that the measured productivity gains in finance and insurance did not support the thesis that office automation was having a significant impact. Yet it is true that investment in this sector has been dramatically higher than the historical average for that sector for the last 15 years. In addition, clerical staffing ratios have declined in finance, so this lack of measured productivity results remains a puzzle. In general, our judgment is that there does not appear to be much empirical evidence of dramatic productivity gains due to office automation at this time. Some possible explanations for these results are offered later.

C. The Forecasts of Clerical Employment

The most obvious question in looking at forecasts of clerical employment growth is whether or not the recent slowdown in the growth of clerical jobs will continue in the years ahead. In this regard, all four of the forecasts reviewed in this paper concur that the slowdown is permanent.

BLS anticipates average growth for clerical jobs through 1995, with modestly declining staffing ratios just about offset by the favorable industry mix of these jobs. The projections offered by Leontief-Duchin, Roessner, and Drennan all foresee that office automation will have more negative impacts on clerical workers than those expected by BLS. Leontief-Duchin and Roessner expect an absolute decline in the need for clericals in the next decade or so. Our judgment, however, is that these two studies are too pessimistic about the outlook for clerical jobs.

Before proceeding to a critical discussion of these forecasts, it is important to emphasize the value of this research. First, all three of these studies carefully state their assumptions about technological change. In this regard their approach is completely open and subject to scrutiny by others. BLS, on the other hand, has been much less open about the technological assumptions implicit in its methodology. That is one of the reasons that the decomposition analysis was applied to the projections of BLS. That analysis showed clearly that BLS substantially alters some of the staffing ratios in making its forecasts, but currently it is virtually impossible to determine why those changes were made. In our opinion it is important for BLS to provide more information about the basis for their judgments.

Second, there is a clear need to explore alternatives and supplements to the BLS methodology. Roessner, for example, recognizes that his method is far too complex and expensive to apply economy-wide. He suggests the in-depth study of selected industries, where it is expected that technological change will have the greatest impact. In any event, there is no doubt that we need to explore new ways of forecasting the jobs of the future.

There are a variety of reasons that support our contention that Leontief-Duchin and Roessner are too pessimistic in their outlook for clerical employment. First, it is important to note that Leontief-Duchin actually use the BLS demand forecast in their research, whereas both Drennan and Roessner use simple extrapolation methods to obtain estimates of demand for their studies. What this means is that demand is expected to grow as it has in the past, but the impacts of technological change (i.e., office automation) will be much different than they were previously. The revolution in office automation will leave the demand side of the marketplace unchanged.

But that is not the way a complex, dynamic market economy operates. If office automation were adopted rapidly, it should reduce the relative costs of production for those goods and services which are intensive users of office automation. Those lower production costs will in turn tend to lead to lower prices. But, there is every reason to think that lower prices will generate additional demand for the goods and services in question. This will tend to increase employment levels as well.

This scenario is even more plausible when one realizes that the product markets are not static. So the new electronic office technologies may themselves provide the impetus for the development of entirely new goods and services. Industry interrelationships may change or scale economies may be so significant that they fuel the development of a mass market that heretofore was undreamed of. In our opinion it is inappropriate to fix demand or the growth of demand and then assume a revolutionary change on the supply side of the market. Obviously, such a partial analysis can create false impressions about the true impacts of office automation.

Second, it appears that none of these other studies account for the tendency of output to become more information-intensive over time. Yet this is a process which has been occurring for a long time. The production recipes for many different goods and services today require more information processing than yesterday. This is not simply a function of the changing composition of demand, but relates to the composition of a standard unit of output. To the extent that this trend continues in the future, it implies that office automation may have less impact on clerical employment levels than anticipated by some researchers.

It should also be mentioned once again that office automation is likely to lower the marginal cost of some new types of work so much that the required labor input rises by more than the impact of the new techniques themselves. The common example is redrafts of documents with word processing. The probability that this will occur may be enhanced by our inability to measure output from offices in the first place. This type of new work or rework is explicitly rejected by Leontief-Duchin, and perhaps implicitly by Roessner.

Third, these studies do not account for the fact that the new technologies must be cost-effective and relatively reliable for widespread application. The technologies may appear to be costless, producing quantum leaps in productivity for the users. Yet there are both installation costs and ongoing costs that must be accounted for in addition to the purchase price. The ongoing costs

include system maintenance, software development, personnel training, and others. There is also the cost of unscheduled downtime, which may become even more significant with integrated systems.

Leontief-Duchin and Roessner appear to us to be truly overoptimistic technologically, both in terms of office automation equipment capabilities and in the speed of diffusion of that equipment. Leontief-Duchin assume that word processors alone will produce productivity gains for typists and secretaries of 500 percent. Yet this assumption is based upon a short trade journal article which is five times more optimistic than the other articles which Leontief-Duchin reference. Roessner, on the other hand, emphasized the potential for two breakthrough technologies, voice input and artificial intelligence. He assumes that innovations will occur in these technologies in the years ahead, they will be successfully marketed, and they will dramatically reduce clerical employment in banking and insurance during the 1990s.

Our major complaint with the technological assumptions of both Leontief-Duchin and Roessner is not just that they may be technically wrong, although there is ample reason to question them, but that the level of uncertainty about the technical forecast is so great that interpretation of the occupational employment forecasts which are derived from them becomes little more than an academic exercise. Does anyone seriously wish to base policy decisions on a forecast of the capabilities of artificial intelligence, a technology which has been kicking around research labs since the 1950s? Perhaps we will always be optimistic about new technologies; it seems to be part of the human condition. But that is no justification to shape public policy based on our dreams of the future.

Suffice it to say that we are unconvinced that technology will evolve as far or as fast as Leontief-Duchin and Roessner predict. But even if it does, the derivative employment impacts foreseen by these researchers may still be very far off the mark. The overgeneralization to broad employment impacts based on assumptions about labor productivity at the task or firm level is very dangerous. This is the kind of analysis that leads to the fear that we will experience massive technological unemployment at some point in the future. Various analysts have been predicting such an event at least since the dawn of the industrial age. Somehow the employment apocalypse is always just ahead, yet thankfully we never quite reach it. In any event, when evaluating these studies it is important to remember that the model simply processes the technological assumptions about the economy. It is the technological assumptions that drive the employment impacts in these studies.

Because of the uncertainties about future demand and the capabilities of future technologies, we would encourage a focus on shorter range occupational forecasting, exactly the opposite approach being suggested by Leontief-Duchin and Roessner. Roessner says that public policymakers need a longer time period for planning. But, if technological change is occurring faster today, then it is becoming even more impossible to develop long-run employment forecasts. Surely it is folly to think that we can peer 15 to 20 years into the future and see the detailed occupational and industrial structure of this nation. In

fact, we think that the current BLS efforts, which produce about a 10-year planning horizon, tax existing forecasting abilities to the limit.

D. The Outlook for Clerical Employment

What has this review shown for the future of clerical jobs? First, we think the pessimists are wrong who claim that these jobs will either stop growing absolutely or actually decline. The forces of economic growth, the shift toward services, the current limitations of office automation technologies, all argue strongly against this scenario.

However, it is clear that the historical rate of growth of clerical jobs has slowed. Clericals did not benefit from the last recession as they have in earlier recessions, nor are some of the sectors that are important employers of clericals growing as fast as they once were. Finally, although office automation may not be producing a revolution, it should at least contribute to the slowing of employment growth in these occupations in the future. We think that the overall growth of clerical jobs in the future will be average to slightly below average.

The common wisdom today is that the back office jobs will go away. We think this is a glittering generality, but there is an analogy to manufacturing which may be useful. Automation has not caused the total elimination of production workers in manufacturing, but these jobs have not been increasing in absolute terms for 40 years either. We think the so-called back office jobs, to the extent that you can truly identify them, are more threatened by automation than other positions. They share with production workers a routinization of tasks which tends to support automation. This will not necessarily lead to their demise, but their growth will probably be well below average.

As mentioned earlier in this paper, it is definitely much easier to provide a technological explanation for declining occupations than growing occupations. There is an important message here. It is far easier to identify the impacts of labor-saving technology than the new jobs which are created by a growing, dynamic economy. Technology is only one aspect of economic growth, whereas the examination of the potential job losses is much more narrow and focused.

Many people today are ready to add bank tellers to the list of declining occupations. Unfortunately tellers are one of the occupations for which the time series data are especially poor, but it does appear that the growth of this occupation has slowed in recent years. It also appears that to some extent the future growth prospects for bank tellers is directly tied to the public's acceptance of automatic teller machines. But these machines today are being used mostly for withdrawals and most customers do not think of them as a substitute for a fully staffed bank. Furthermore, it is difficult to know if and when the public will be willing to break the human link in making banking transactions. As a result, the future for bank tellers is extremely cloudy.

Roessner notwithstanding, we think that the growth of technology related positions will continue to be rapid, particularly clerical computer positions. Office automation is not sufficiently advanced at this point to slow the growth of these jobs. It remains to be seen if that will ever occur. We also think that those clerical positions which require the worker to interface with customers will likely experience average growth or better. The office of the future will require both "high-tech" and "high-touch". Except possibly for bank tellers, there appears to be more emphasis on customer service and the quality of that service.

Secretaries fall somewhere between the back-office jobs and those positions which involve considerable customer interface. Therefore, secretarial employment growth may slow but these jobs will not go away. It is also true that many of these positions are generalist in nature and more difficult to threaten with automation. It seems clear that the secretaries of the future will require a greater variety of skills and will utilize much more capital equipment. We think that the growth of secretarial jobs will be average to slightly below average, but the absolute number of these jobs will definitely increase.

In summary, there is no persuasive evidence today that there will be a significant decline in clerical jobs in the future. The forecasts of declining clerical employment are based on overoptimistic expectations of technological improvements or exaggerated productivity claims on behalf of existing technology. In our opinion, current office technology offers significant improvements in product quality and modest improvements in productivity. There is as yet no empirical evidence of an office productivity revolution that will displace significant numbers of clerical workers.

On the contrary, we think there are many factors which will contribute to the job growth of clericals in the future. Chief among these is the simple fact that clericals are so diffused in the national economy. Moreover, to the extent that clerical jobs are concentrated in particular industries, it has been in sectors growing faster than average. Therefore, even allowing for negative employment impacts from office automation, it is extremely difficult to believe that the growth of this large, diverse, and diffused major occupational group could be much below the average growth for all occupations for the next decade.

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