OFFSHORE ASSEMBLY BY U.S. COMPUTER FIRMS:
EMPLOYMENT AND INCOME EFFECTS

by

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In recent years employment growth in the U.S. has been more rapid in nonmanufacturing sectors than in manufacturing, and this trend is often attributed in the business press to an alleged decline in the international competitiveness of U.S. industry. A number of good criticisms can and have been made of this popular theory. Manufacturing *output* as a share of GNP has been quite stable (at around 21 percent) since 1947. Furthermore, the trend in manufacturing employment relative to total civilian employment (which is declining) has been fairly stable since the early 1950s.[1] Hence it is difficult to argue that the U.S. *manufacturing sector* is in decline as a result of international competition (though of course there may be individual industries that are having difficulties on this account).

What is lost in this debate, however, is the fact that manufacturing production workers have been having a very different experience in recent years from that of white-collar employees in manufacturing. The share of production workers in manufacturing employment has been declining rapidly since the late 1970s, as indicated in Figure 1. The recent trend is very different from the slow decline of this share in the 1960s.

There are a number of possible explanations for this trend, which have different implications for production worker employment and earnings *at the industry level*. In this study I investigate trends in employment and earnings in one important manufacturing industry--the industry that produces electronic computing equipment. The key finding is that, after controlling for changes in the quality of the labor force, real wages for semi-skilled production workers in this industry are estimated to have dropped 19 percent between 1967 and 1984. Real wages for other, mostly white-collar occupations, have not changed significantly over that period, again after adjustment for changes in the quality of the workforce. Hence there has been a significant decline in the relative earnings of production workers.

At the same time, employment of production workers has declined relative to employment of other kinds of labor. In particular, the share of scientists and engineers in the industry's employment increased from 6.0 percent to 14.9 percent during the 17 years covered by the study, while the share of production workers declined from 38.2 to 32.1 percent.

These findings are consistent with the hypothesis that offshore production by U.S. firms is having a significant impact on the employment and earnings of different kinds of labor in this and other U.S. manufacturing industries--reducing the demand for production workers and increasing the demand for professional-technical labor.

1. Offshore Assembly and the Demand for Production Workers

One explanation for the declining relative use of U.S. production workers is the rapid growth in offshore production by U.S. manufacturing firms that has taken place in the past two decades. As U.S. manufacturing firms become increasingly international, more and more of their production workers are employed overseas; white-collar jobs, however, tend to remain concentrated in the home country.

The expansion of multinational activity in a wide range of U.S. manufacturing industries could plausibly change the general trade equilibrium for the U.S. and lead to changes in relative factor prices. One of the key characteristics of the multinational enterprise (MNE) is that it is a vehicle through which the U.S. can directly export the services of professional-managerial labor, which tends to increase demand for that factor. Often, MNEs are also directly involved in importing physical goods whose primary foreign value-added comes from semi-skilled labor, reducing the demand for such labor in the U.S.

In terms of trade in products, what we see as offshore production expands is increased imports of manufactured *merchandise* balanced by increased exports of *services*. In terms of factors, typically what is being exported is the labor of scientists, engineers, managers, and other white-collar occupations. This process is well documented in the literature on multinationals: scientists and engineers create the technology that MNEs exploit internationally. And managing the multinational network from the U.S. leads to a stream of service exports arising from the activity of managers and related occupations.[2]

This hypothesis then suggests that the growth of MNEs generates a decline in the demand for blue-collar employees and an increase in demand for white-collar employees. The former tends to be more visible than the latter because the declining demand for production workers is connected to imports of tangible merchandise, whereas the growing demand for white-collar labor results from exports of invisibles.

Ideally, one would like to go directly to the trade statistics to measure the importance of these service exports. There are several reasons, however, why these service exports are not accurately recorded in the balance of payments statistics. Most importantly, many of these invisibles are difficult to measure and price, which is one of the reasons that they are exported through an integrated network rather than at arm's length. When invisibles are exported to a subsidiary, there is no strong incentive to price them accurately. In addition, the controls that many nations impose on service imports provide a definite incentive not to record this intrafirm trade explicitly. Finally, there may be tax advantages to not pricing services exported within the firm, since this practice will inflate the accounting profits of foreign subsidiaries and reduce the accounting profits of the U.S. parent.[3]

The earnings from these service exports do show up somewhere, namely in "investment income," as noted by Caves (1971), Vernon (1972), and others. This suggests erroneously that the earnings are a return to capital rather than to professional-managerial labor. For these reasons the balance of payments data do not give a good picture of the extent of these invisible exports, and it is necessary to look elsewhere for indirect evidence of their growing importance.

2. Explaining the Growth of MNEs

Before proceeding it should also be noted that there is the deeper question of what accounts for the rapid growth of offshore production by U.S. manufacturing firms. Certainly one part of the answer to this question is changes in factor supplies in the rest of the world.[4] The rapid increase in the semi-skilled labor force in the Newly Industrializing Countries (NICs), for instance, has clearly been a powerful pull to U.S. MNEs. Such an explanation remains within the framework of standard neoclassical trade theory: the implicit factor trade is driven by differences in relative factor endowments, and the MNE is merely a *vehicle* that facilitates that trade.

It is also clear that there have been dramatic advances in communications and transportation in recent decades that make globally integrated production possible for the first time in economic history. It is possible that the manufacturing MNE, developing in response to changes in global infrastructure, permits factor trade at a far greater level than would be possible merely through trade in goods.

The MNE also appears to play an important role in technology diffusion and the product cycle.[5] MNEs are an avenue through which new technology is transferred to the NICs, and in this way as well they may affect implicit factor trade. In this case the MNE is itself important as an *institution*.

It is not the purpose of this paper to attempt to weigh the relative merits of these different theories, though obviously that is an important task. What the theories have in common is that the growth of MNE activity is the *proximate cause* of an important shift in the pattern of U.S. factor trade, which in turn affects the relative demand for different kinds of labor in the U.S. The specific hypothesis is that the growth of MNEs has led to declining relative demand for production workers in manufacturing, which is reflected in this factor's relative earnings. The relative demand for scientists, engineers, and managers, on the other hand, is increasing within manufacturing industries.

This hypothesis predicts that within individual industries in the U.S. we will find declining relative employment of production workers accompanied by declining relative earnings.

3. The Computer Industry as a Case Study

This paper uses the industry that manufactures computing equipment as a case study to investigate whether there is any empirical support for the hypothesis that offshore assembly is reducing the U.S. demand for production workers relative to demand for professional labor. The advantage of an industry case study is that it enables us to concentrate on outputs and inputs at a highly disaggregated level; on the other hand, there is the obvious drawback that it is risky to generalize on the basis of one industry's experience.

Electronic Computing Equipment (SIC 3573) is an industry in which output and employment have expanded very rapidly over the past 20 years. It is the epitome of "hi-tech" manufacturing, an area in which the U.S. is often alleged to have comparative advantage.

The U.S. experience with production and trade in this industry actually follows a classic product-cycle pattern. The value of shipments for the U.S. computer industry (in constant 1967 dollars) is plotted in Figure 2 for the period 1967-87. Real output increased rapidly during the period, rising more than fourfold between 1967 and 1984; since 1984 there has been a small decline in real output.

Merchandise exports increased more rapidly than output throughout this period, and the U.S. had a growing merchandise surplus in this industry up through 1980. This is a typical pattern for a "new" product, first developed by U.S. firms, for which worldwide demand is rapidly growing.

At the same time, however, imports of computers have been increasing at a rapid and accelerating rate: imports in constant dollars increased at average annual rates of 15.3 percent in the 1967-77 period and 26.0 percent in the following decade. As a result the merchandise balance for this industry (plotted in constant dollars in Figure 3) peaked in 1980 and since then has dropped sharply; the Commerce Department estimates that for 1987 merchandise trade in this industry will be virtually balanced. This erosion of the industry trade position as the technology of production diffuses internationally is also typical of the product cycle.

Today, the product cycle occurs very rapidly, in part because of the role of MNEs.[6] Already in the late 1960s and early 1970s, for example, U.S. firms in the computer industry were moving some parts production offshore, to take advantage of low wages. In 1977 two-thirds of the computer imports into the U.S. were parts; and much of this trade in parts occurred between affiliates of U.S. corporations.[7]

It seems probable that this offshore production of parts accelerates the process by which foreign firms learn to imitate technology developed by U.S. firms. The recent development of "IBM PC clones" by firms in East Asia, for instance, was clearly aided by the fact that plants in these countries were already producing parts for

IBM. The diffusion of technology to foreign firms, in turn, puts pressure on the U.S. manufacturers to shift even more production overseas in order to cut costs.

It is difficult to obtain hard data on how offshore production by U.S. firms has affected U.S. imports and exports of computers, but there is some indirect evidence. First, offshore production has clearly been increasing steadily; for the machinery industries as a group (SIC 35 plus SIC 36) the direct foreign investment position of U.S. firms increased at an average annual rate of 12.3 percent in the period 1959-79, which suggests that a growing share of the capital stock managed by U.S. firms in these industries is overseas.[8]

The Commerce Department's 1987 report on the computer equipment industry recognizes the influence of offshore production on the trade position of the industry: "An important percentage of U.S. production has moved to offshore sites as U.S. manufacturers have sought to remain price competitive. The result has been a reduction in U.S. employment in the industry and a shrinking trade surplus in computer equipment."[9]

As assembly operations are shifted overseas the big employment effect concerns *production workers*. Many U.S. firms remain competitive in producing computing equipment and have large U.S. labor forces, but the U.S.-based jobs are increasingly concentrated in the white-collar occupations, as detailed in the next section.

4. *Declining Share of Production Workers in the Computer Industry*

U.S. employment in the computer industry has expanded rapidly in the post-war period. Unfortunately, data on employment and earnings in SIC 3573 are poor before 1972, so that data from Office and Computing Machines (SIC 357) had to be used for this study. (For simplicity I will refer to this industry as the "computer industry.") The industry currently employs about half a million workers. In BLS statistics, Electronic Computing Equipment (SIC 3573) is broken out of 357 beginning in 1967; at that time it represented 60 percent of the employment in 357; today its employment share of 357 is more than 85 percent. Employment trends for 357 and 3573 are depicted in Figure 4.

The share of production workers in the computer industry is plotted in Figure 5. This share has declined sharply since 1958, with the steepest decline occurring in the late 1960s and early 1970s. Today only about one-third of employees in this industry are production workers; in 1958 production workers represented two-thirds of employment.[10]

It is possible to use the *Current Population Survey* to obtain more detailed information about changes in the occupational structure of the labor force in the computer industry. The March 1985 *CPS* yielded a sample of 547 full-time employees of firms in the computer industry. The March 1968 *CPS* provided a sample of 249 full-time employees. The survey contains detailed information about occupation, and the shares of different occupational groups in the two samples are presented in Table 1. The number of employees in each occupational group was estimated by applying the sample share to the BLS figure for total employment in the industry.

Total employment in the computer industry roughly doubled between 1968 and 1985. The occupational group experiencing the largest increase is engineers and scientists, whose estimated number grows by over 400 percent and whose share of employment grows two and one-half times, from 6.0 percent to 14.9 percent. Also experiencing increases in employment shares are the managerial occupations.[11]

A significant decline in employment share is registered by production workers, with decreases both for skilled and semi-skilled occupations. In the 1968 sample there are 6.4 production workers for each engineer or scientist; by 1985 this ratio had dropped to 2.1. This is a very large change in relative factor proportions.

5. Occupational Earnings in the Computer Industry

The employment share of production workers in the U.S. computer industry has clearly been declining. It remains to investigate what has been happening to the relative earnings of this occupational group. According to BLS data, real average hourly earnings of production workers in SIC 357 declined over the period spanned by the two *CPS* samples. Figure 6 plots an index of average real earnings: the index rises steadily throughout the 1960s and peaks in 1969; during the 1970s it declines by 17 percent; since 1980 there has been an increase back to the level of 1961. The BLS data, however, represent an average wage that can be affected by changes in the composition of the labor force as well as by changes in real wages.

The *CPS* provides more detailed information about earnings, as well as information on characteristics of the labor force. Using the samples from the 1968 and 1985 *CPS* it is possible to estimate earnings for different occupations. (Note that the earnings information from the 1968 and 1985 *CPS* samples is for 1967 and 1984, respectively.) Table 2 provides estimates of average earnings for different occupational groups in the computer industry in 1967 and 1984.

The *CPS* can also be used to control for changes in characteristics of the labor force within each occupational group. In order to do this an earnings equation for each occupational group was fitted to the 1985 sample. The explanatory variables in the earnings equations are level of education, years in the labor market, sex, race, marital status, and dummies for urban/rural and South/non-South location. All of the earnings equations yielded reasonably good fits with R^2s around .4; in all cases the variables with the most explanatory power were education and experience.

The regression coefficients generated from the 1985 sample were then used to estimate what the individuals in the 1968 sample would have earned in 1984 (given their education, experience, etc.). These average earnings of the 1968 sample calculated at 1984 factor prices are given in Table 2. Percent changes in average earnings for each group are provided in Table 3. Table 4 shows the important changes in characteristics of the labor force.

Tables 2 and 3 should be interpreted in the following way: the scientists, engineers, and managers in the 1985 sample, for instance, actually earned 7 percent more in real terms than this occupational group in the 1968 sample. This increase, however, can be completely explained by an upgrading of the labor force; the 1968 sample evaluated with the regression coefficients from the 1985 earnings equation actually earns slightly less than it did in 1967. Thus this group evidences no significant change in real wages, properly defined.

That the actual earnings of the 1985 sample are greater than the earnings of the 1968 sample estimated using coefficients derived from the 1985 earnings equation is an indication that the average quality of labor has improved in this occupational group. Table 4 shows why: average education and years of experience for scientists, engineers, and managers both increase between 1968 and 1985.

For the next two occupational groups listed in Table 2 there is also no large change in average earnings, after controlling for changed characteristics of the labor force. One interesting result here is that the quality of labor in other professional and administrative occupations has been downgraded, while the quality of clerical workers has been upgraded, making these two groups more similar in terms of characteristics and earnings. A striking element of this convergence is that the female share of the Other Professional category rises from 4 percent in the 1968 sample to 50 percent in the 1985 sample.[12] (The female share of clerical employment is relatively stable at 75-80 percent.)

Note that average quality and earnings for the top professional/managerial jobs have increased while average quality and earnings for the other professional/administrative jobs have gone down.

Turning now to production jobs, we find that skilled production workers on average are making more in real terms in 1984 than in 1967. However, the quality of this labor force has risen (average level of education is up by a full year); and real wages are estimated to have declined a slight 4 percent after adjusting for these changes in quality.

The most striking result in Table 2 is that average earnings for semi-skilled production workers declined by 15 percent between 1967 and 1984. Furthermore, average education increased by a full year for this group and average experience increased as well, so that the quality of the labor force has improved. After adjusting for these improvements in quality, real wages for this occupational group are estimated to have dropped 19 percent between 1967 and 1984.[13]

Thus earnings of semi-skilled production workers in this industry have declined relative to all other occupational groups, while at the same time employment of these production workers has also declined relative to employment of other kinds of labor. The sharpest contrast is with the experience of engineers, scientists, and managers: employment of the latter group relative to semi-skilled production workers increases more than 300 percent, while the adjusted earnings of these top professionals rise 20 percent relative to earnings of semi-skilled production workers. (Note in Table 2 that the unadjusted increase is 25 percent.)

6. *Alternative Explanations*

The empirical results of this study are consistent with the hypothesis that growth of offshore assembly by U.S. computer firms has reduced demand for production workers relative to other types of labor in the U.S. It remains to consider other possible theories that might explain these findings.

In principle, the observed decline in the production worker share of employment could be a supply-side phenomenon: that is, it could be the result of the *supply* of white-collar employees relative to production workers increasing over time in the U.S. One would expect this to be accompanied, ceteris paribus, by an increase in the earnings of production workers relative to white-collar labor, and by a decrease in the employment share of production workers within each industry (owing to substitution away from the factor whose relative price is rising). The finding that the real wage of production workers has dropped relative to earnings of all white-collar occupations obviously contradicts this hypothesis.

A second hypothesis is that the important change in relative factor supplies has been *in the rest of the world*, not in the U.S., and that these changes are affecting U.S. labor markets through trade in goods. In this scenario, the changing pattern of merchandise trade (caused by changes in factor supplies in the rest of the world) is reducing the demand for production workers in the U.S., while increasing the demand for other factors such as white-collar labor. Consistent with this explanation would be a downward trend in the earnings of production workers relative to white-collar employees.

Now an interesting implication of what we can call the "trade in goods" hypothesis is that *at the industry level* employment of production workers relative to white-collar employees should then be rising. In order to see this, it is useful to conceive of a typical industry production function, which for convenience could be Cobb-Douglas:

$$(1) \quad LnY = \delta + \sum_{i}^{n} \gamma_i LnL_i + \sum_{j}^{m} \rho_j LnX_j, \qquad \Sigma\gamma_i + \Sigma\rho_j = 1,$$

where Y is output, the L_i are n different kinds of labor, and the X_j are m other factors of production (physical capital, natural resources, etc.). (The coefficients of course would be different in each industry.) If this technology is stable over time, then employment of L_i relative to L_h will rise and fall with the price of L_h relative to that of L_i.

According to this scenario, the declining share of production workers in manufacturing employment is not caused by substitution away from this factor at the industry level, but rather results from a shift in the output mix toward industries employing relatively few production workers. The shift in the U.S. output mix in turn is the response to an altered pattern of merchandise trade, driven by changes in factor supplies in the rest of the world.

This theory too is inconsistent with the data presented in this paper, because it cannot account for declining relative earnings of production workers accompanied by declining relative use of this factor *at the industry level*.

A third potential explanation for the declining employment share of production workers is technological change. *Neutral* technical change [a shift in δ in the production function in equation (1)] would leave factor proportions unaltered at any set of factor prices; so that to account for declining relative employment of production workers at the industry level accompanied by declining relative earnings requires technical change *biased* against production workers (a decline in the γ for that factor in the production function).

Biased technical change occurring in several manufacturing industries could substantially reduce the overall demand for production workers, lowering their relative earnings. This theory is consistent with declining relative earnings of production workers in the U.S. accompanied by declining relative employment in the industries in which the technical change is taking place.

To distinguish between the biased technical change hypothesis and the offshore assembly hypothesis requires worldwide data from U.S. computer firms: biased technical change implies a declining production worker share in the worldwide employment of this industry, whereas the offshore assembly hypothesis suggests that there will be different trends in different countries.

More data will have to be accumulated before the question can be settled definitively; but casual support for the offshore assembly hypothesis is provided by the observation that in South Korea the production worker share of employment in the computing equipment industry is 83 percent (compared to 35 percent in the U.S. today)!

7. Conclusions

This study provides strong evidence that in the U.S. computing equipment industry there has been a decline in demand for production workers relative to demand for white-collar employees, particularly scientists, engineers, and managers. To the extent that labor markets in different manufacturing industries are closely connected, this evidence also suggests that within the whole manufacturing sector there may be declining demand for production workers and increasing demand for the professional/technical occupations.

The empirical findings are consistent with the hypothesis that growing offshore production by U.S. manufacturing firms is having a significant impact on the demand for different kinds of labor in the U.S. This hypothesis can account for declining relative earnings and declining relative employment of production workers *at the industry level*. The only other hypothesis that can explain this empirical finding is technical change biased against production workers, and for the moment offshore production appears to be a more plausible explanation for the observed changes in the occupational structure of manufacturing employment.

These results support the notion that the U.S. manufacturing sector is *not* in decline. But in an increasingly integrated world economy with rapid international diffusion of new technology, U.S. manufacturing firms remain competitive in many industries by shifting assembly operations requiring semi-skilled labor to low-wage locations offshore. The ensuing pattern of trade is one in which the U.S. exports a lot of services--often through multinational enterprises and in a way that is not easily captured in the trade statistics--and imports merchandise.

An important implication of this theory is that, when discussing trade and employment in the U.S., it is inappropriate to consider only merchandise trade, as is commonly done in the political debate about trade and in the protectionist legislation pending in Congress. The export of services, even when recorded as "overseas investment income," is connected to jobs, especially to the white-collar occupations that increasingly predominate in U.S. manufacturing.

If there is a long-run "trade problem" for the U.S., it is not an employment (or unemployment) problem.[14] Rather it is an income problem, or more properly, a problem with the changing distribution of income. For the changes in earnings of different occupations documented in this study are making the distribution of income increasingly skewed. This is very clear in the computer industry: Table 5 shows the distribution of income among employees of this industry in the samples drawn from the 1968 and 1985 *CPS*. Between 1967 and 1984 the share of total labor income earned by the highest-paid fifth of employees increased from 35.9 percent to 39.9 percent; and this increase came at the expense of the lowest-paid workers. The share of labor income accruing to the bottom forty percent fell from 23.0 percent to 18.8 percent.

Table 6 shows the average earnings of the top ten percent relative to the earnings of the bottom ten percent: the earnings differential increases from 6.6 in 1967 to 10.5 in 1984. Perhaps more startling is the fact that the real earnings of the bottom ten percent of full-time employees in the computer industry fell by 28 percent over this 17-year period.

In general, the occupational groups in the U.S. that are benefiting from changes in the international economy are those that already have relatively high pay, while the groups that are being hurt are at the low end of the earnings spectrum. This fact is one of the reasons for the current controversy about trade in the U.S.

NOTES

1. See Tatom (1986).

2. See, for instance, Caves (1982).

3. These arguments about the difficulty of measuring the invisible exports of U.S. MNEs are developed at greater length in Dollar (1987).

4. Note that in principle changes in factor supplies within the U.S. could also fuel the growth of MNEs, if the supply of professional-managerial labor were increasing relative to production workers. This "supply-side" explanation suggests that the relative earnings of professional-managerial labor should be decreasing.

5. On the product cycle, see Vernon (1966). Krugman (1979) and Dollar (1986) present formal models of the product cycle that demonstrate how more rapid diffusion of technology internationally may adversely affect earnings of manufacturing workers in the U.S.

6. Vernon (1979) presents empirical evidence that the product cycle has accelerated in recent years.

7. *U.S. Industrial Outlook 1969*, p. 261.

8. *Survey of Current Business*.

9. *U.S. Industrial Outlook 1987*, p. 28-1.

10. The employment share of production workers is lower in SIC 3573 than in the rest of SIC 357. The downward trend in this share, however, occurs both in 3573 and in the rest of 357; so that the trend depicted in Figure 5 cannot be explained by the more rapid growth of employment in 3573 than in the rest of 357.

11. The empirical exercise being carried out here is similar in spirit to earlier empirical work by Baldwin (1971) and Keesing (1966). Those

authors demonstrated that in the 1960s U.S. net exports of *goods* were relatively intensive in the employment of scientists and engineers. This paper is attempting to demonstrate that the U.S. is still a net exporter of the services of these factors, but that today the exports are more likely to occur directly through MNEs rather than implicitly through merchandise trade.

12. This is the one occupational group where the sex dummy plays an important role in the results. In the earnings regression, the coefficient on the female dummy is significantly negative. Both average education and average experience increase between 1968 and 1985 for this occupational group, and yet the empirical results indicate that the average quality of the labor force declined. This results from the increase in the female share of employment.

13. It should be noted that the female share of employment for this group increased substantially, from 29 percent to 55 percent. However, the female dummy in the earnings regression for semi-skilled production workers has a very small (negative) coefficient, so this change does not overshadow the improvement in education and experience.

14. In the short run there could of course be a substantial unemployment problem owing to the difficulty of shifting labor from factory occupations to service and information-related occupations.

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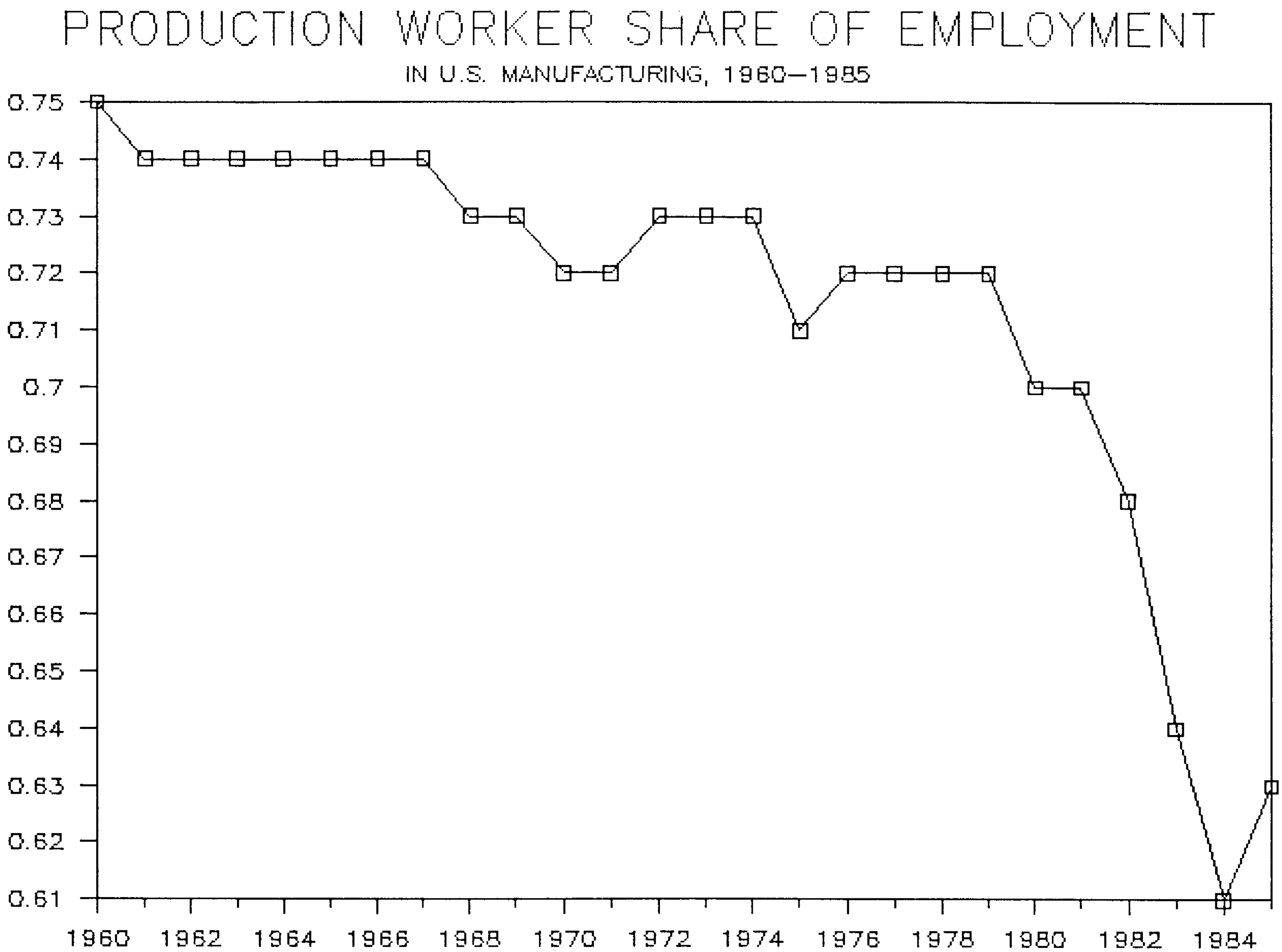

FIGURE 1

Source: Bureau of Labor Statistics, <u>Employment and Earnings</u>.

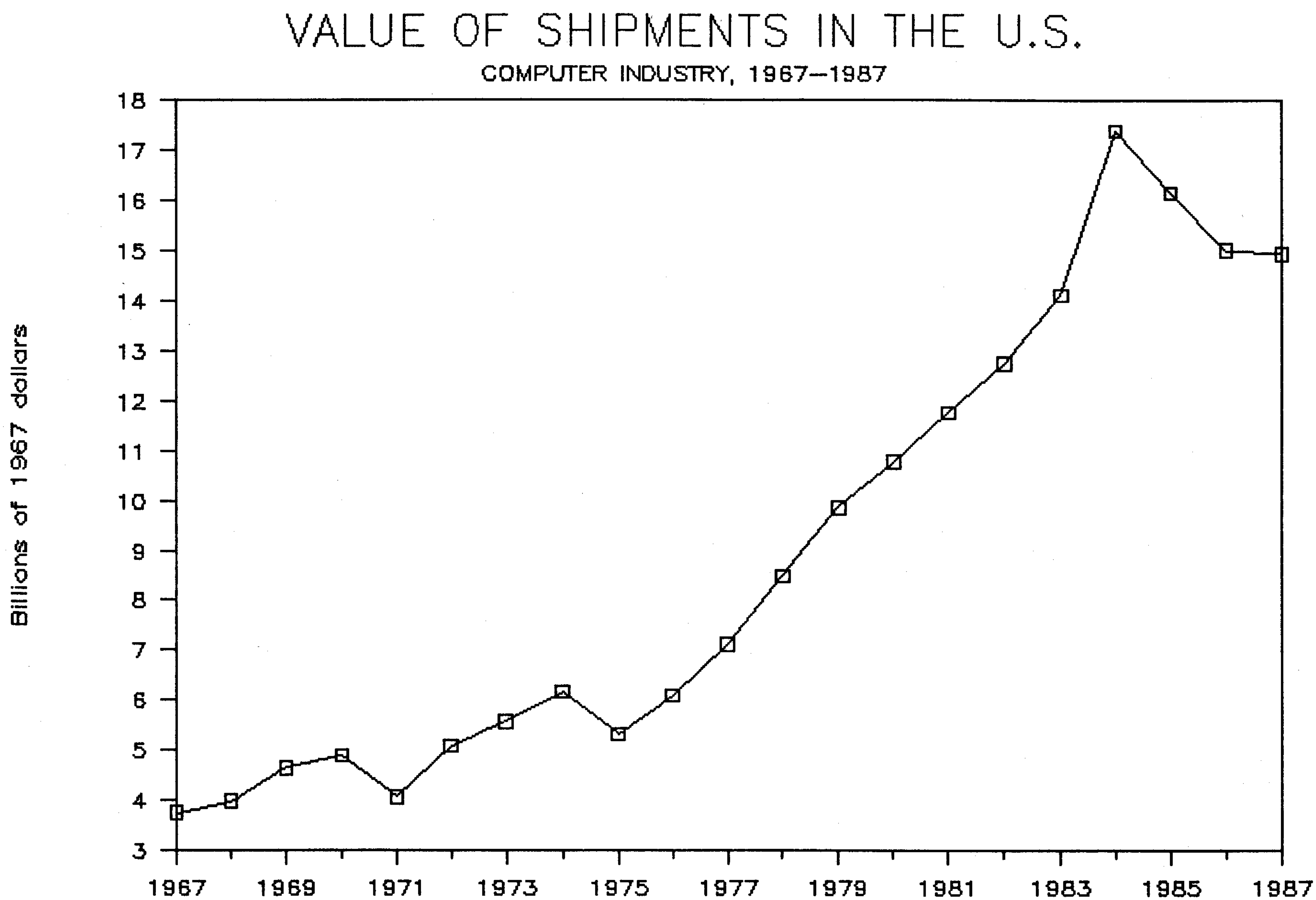

FIGURE 2

Source: <u>U.S. Industrial Outlook</u>.

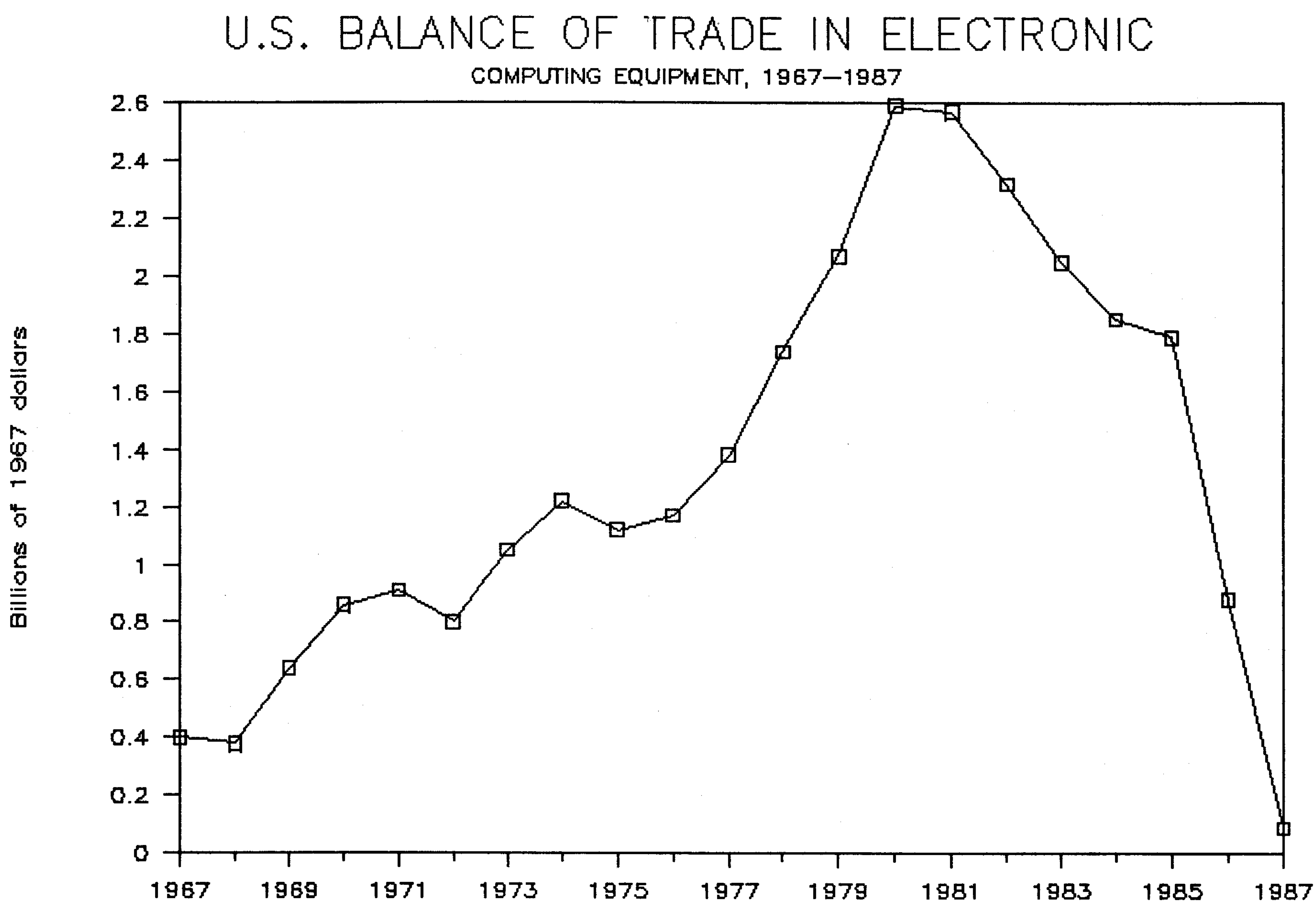

FIGURE 3

Source: U.S. Industrial Outlook.

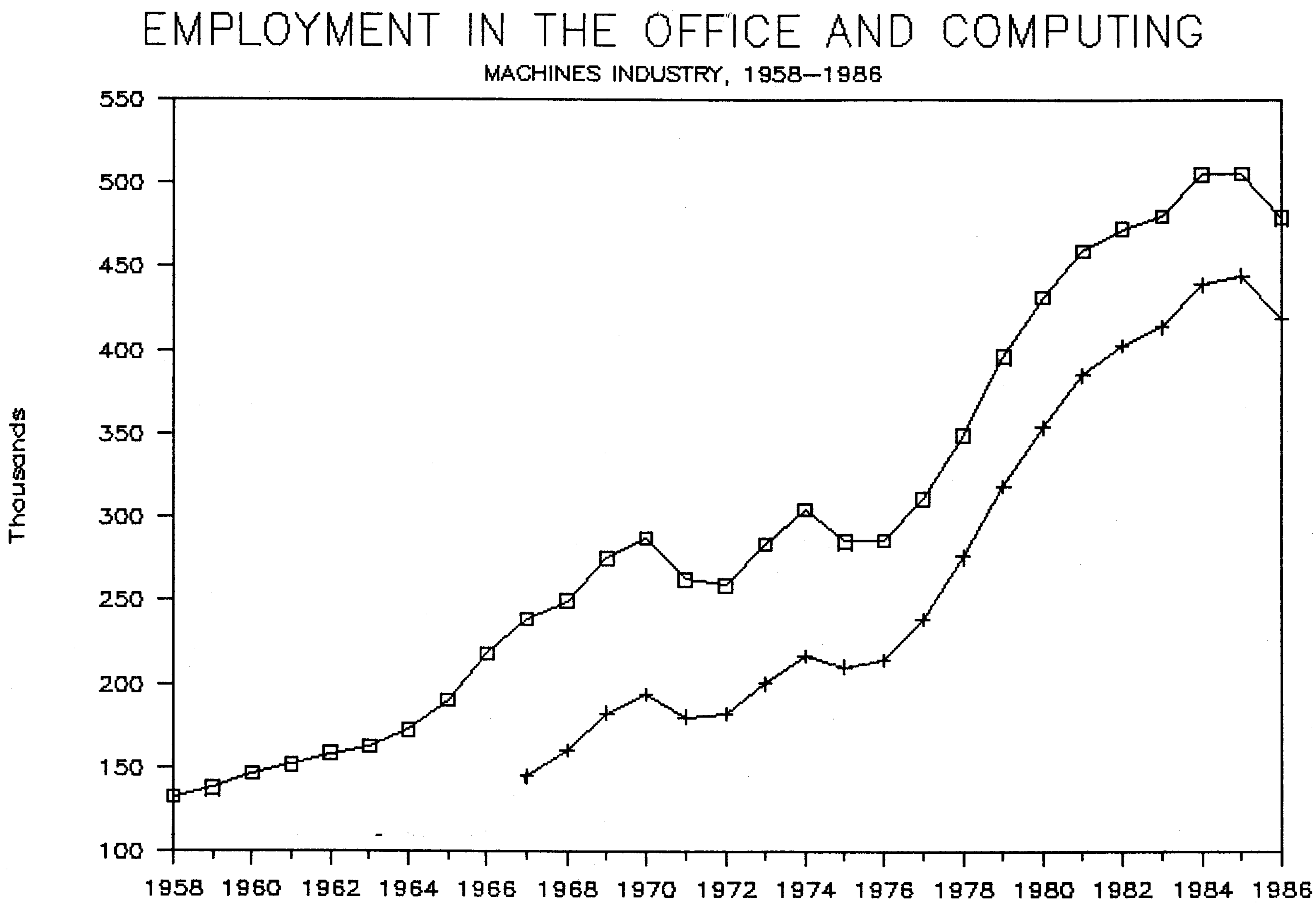

FIGURE 4

Source: Bureau of Labor Statistics, Employment and Earnings.

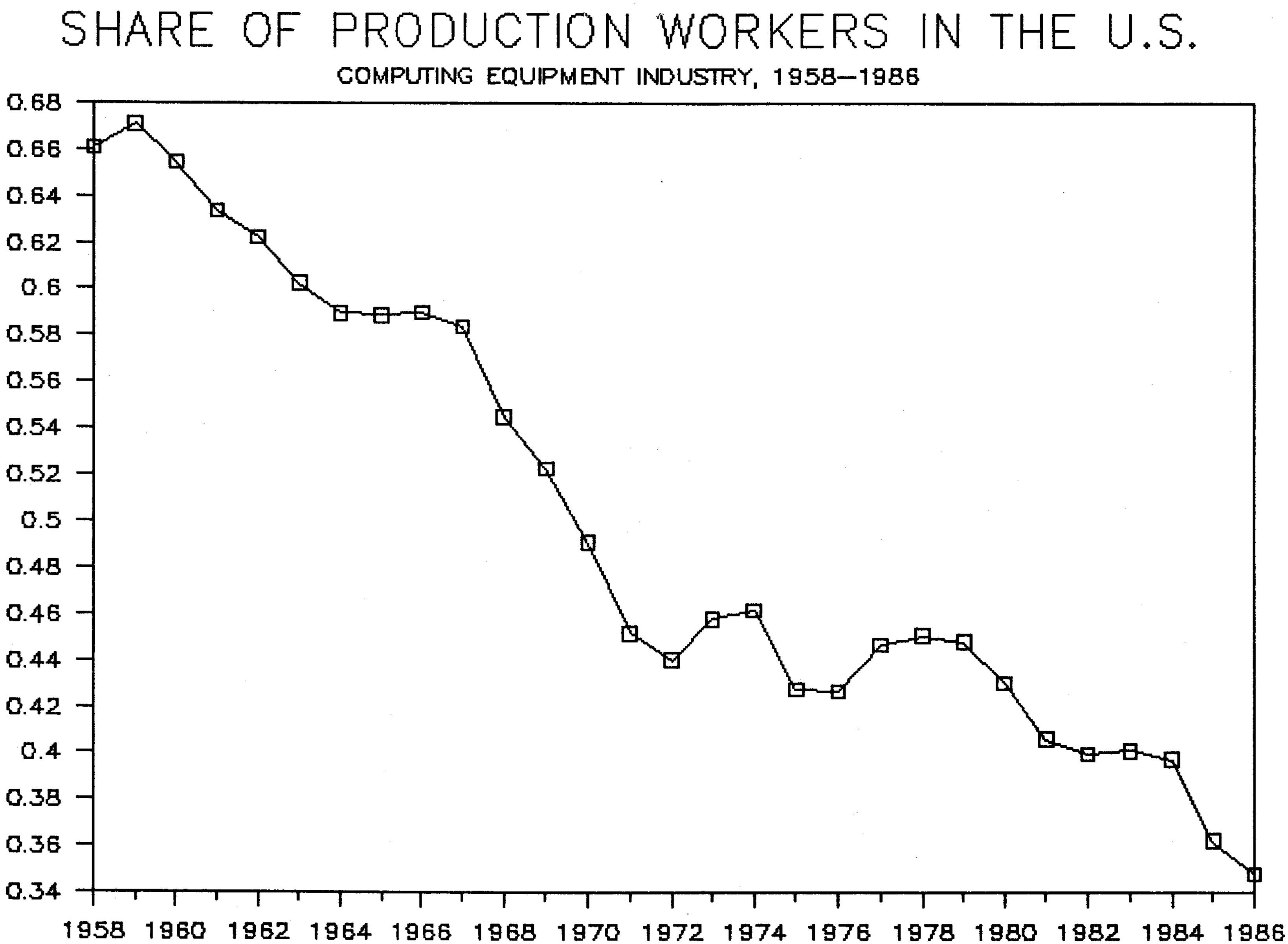

FIGURE 5

Source: Bureau of Labor Statistics, <u>Employment and Earnings</u>.

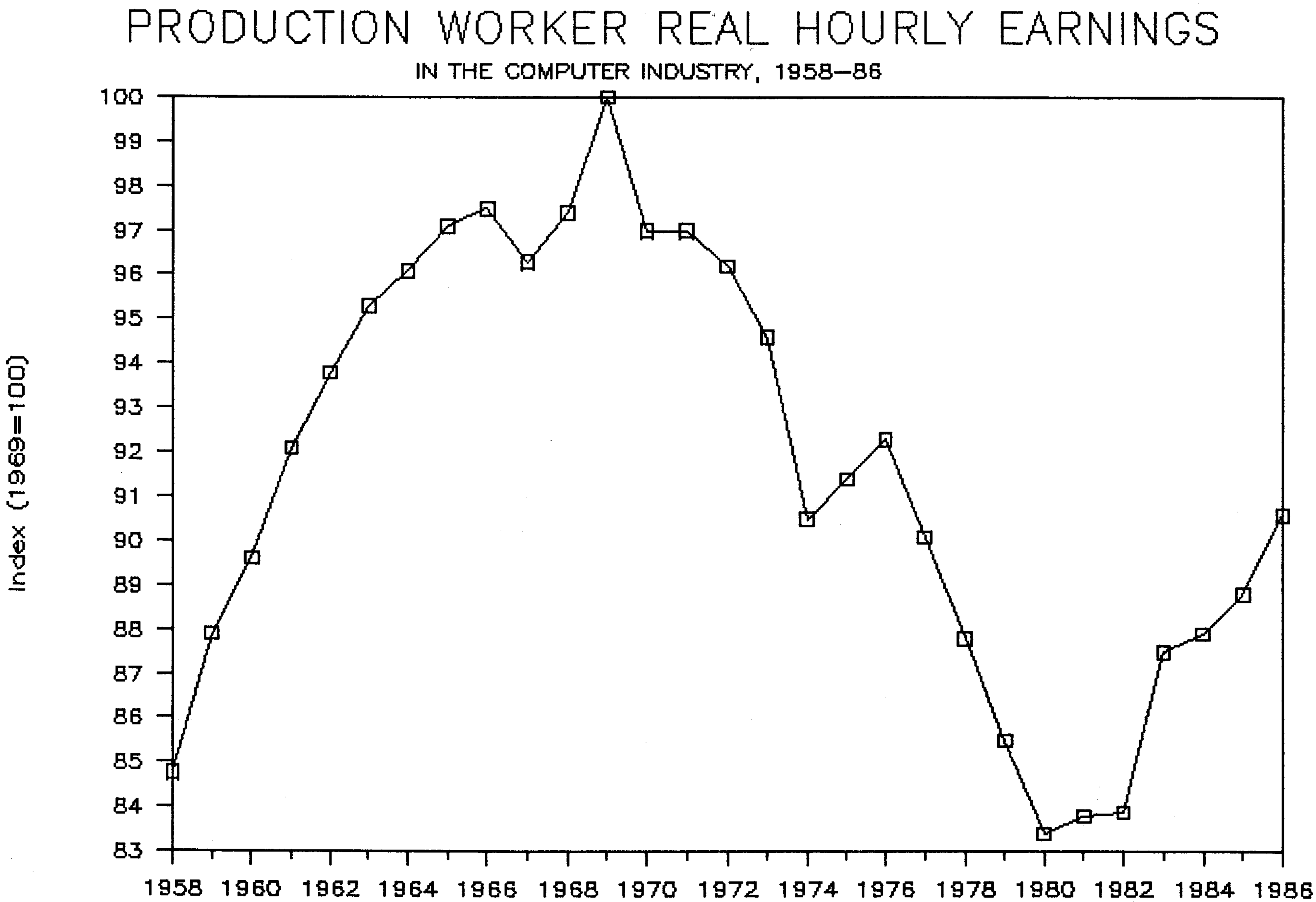

FIGURE 6

Source: Bureau of Labor Statistics, Employment and Earnings.

TABLE 1

OCCUPATIONAL DISTRIBUTION OF EMPLOYMENT IN THE U.S. COMPUTER INDUSTRY, 1968 AND 1985

	1968		1985		
	Estimated Number (000)	Share	Estimated Number (000)	Share	Percent Increase 1968-85
Engineers and Scientists	15.0	6.0%	75.5	14.9%	403%
Managers	22.1	8.8%	57.6	11.3%	161%
Other Professional and Administrative Occupations	69.2	27.7%	126.5	25.0%	83%
Clerical Workers	48.2	19.3%	84.0	16.6%	74%
Skilled Production Workers	34.2	13.7%	58.5	11.6%	71%
Semi-Skilled Production Workers	61.2	24.5%	103.8	20.5%	70%
TOTAL EMPLOYMENT	249.9	100.0%	505.9	100.0%	102%
Production Workers Relative to Engineers and Scientists	6.4		2.1		

Source: CPS Tapes, 1968 and 1985; and *Employment and Earnings*.

TABLE 2

AVERAGE EARNINGS OF OCCUPATIONAL GROUPS IN SAMPLES OF FULL-TIME EMPLOYEES IN THE U.S. COMPUTER INDUSTRY, 1967 AND 1984

(in 1984 dollars)

	1967 Actual[a]	1984 Actual	1967 Sample Evaluated at 1984 Wages[b]
Engineers, Scientists and Managers	$39,614	$42,455	$38,444
Other Professional and Administrative Occupations	$31,594	$28,169	$30,157
Clerical Workers	$16,625	$18,208	$16,844
Skilled Production Workers	$24,527	$25,609	$23,479
Semi-Skilled Production Workers	$19,851	$16,884	$16,080
Earnings of Engineers, Scientists, and Managers Relative to Earnings of Semi-Skilled Production Workers	2.00	2.51	2.39

[a] 1967 wages converted into 1984 dollars via the CPI-W.

[b] Estimated by fitting an earnings equation for each occupational group to the 1985 sample and then applying the estimated coefficients to the 1968 sample.

Source: CPS Tapes, 1968 and 1985.

TABLE 3

CHANGES IN AVERAGE EARNINGS OF OCCUPATIONAL GROUPS IN SAMPLES OF FULL-TIME EMPLOYEES IN THE U.S. COMPUTER INDUSTRY, 1967 TO 1984

	Percent Change in Actual Earnings	Percent Change in Earnings, Controlling for Changed Composition of the Labor Force
Engineers, Scientists and Managers	+7%	-3%
Other Professional and Administrative Occupations	-11%	-5%
Clerical Workers	+10%	+1%
Skilled Production Workers	+4%	-4%
Semi-Skilled Production Workers	-15%	-19%

Source: CPS Tapes, 1968 and 1985.

TABLE 4

AVERAGE EDUCATION AND EXPERIENCE FOR DIFFERENT OCCUPATIONAL GROUPS IN THE U.S. COMPUTER INDUSTRY, 1968 AND 1985

	Average Years of Education		Average Years of Labor Market Experience	
	1968	1985	1968	1985
Engineers, Scientists and Managers	16.0	16.7	15.2	16.4
Other Professional and Administrative Occupations	15.6	16.1	12.3	13.7
Clerical Workers	13.5	13.9	15.9	17.9
Skilled Production Workers	13.0	14.0	22.2	16.2
Semi-Skilled Production Workers	12.0	13.0	17.7	19.4

Source: CPS Tapes, 1968 and 1985.

TABLE 5

DISTRIBUTION OF INCOME FOR SAMPLES OF FULL-TIME EMPLOYEES IN THE U.S. COMPUTER INDUSTRY, 1967 AND 1984

(shares of total labor income, by quintiles)

	1967	1984	Difference (in percentage points)
Top Fifth	35.9%	39.9%	+4.0
Second Fifth	23.0%	23.8%	+ .8
Third Fifth	18.0%	17.5%	- .5
Fourth Fifth	14.0%	12.3%	-1.7
Bottom Fifth	9.0%	6.5%	-2.5

TABLE 6

ESTIMATED INCOMES OF THE HIGHEST AND LOWEST PAID DECILES OF FULL-TIME EMPLOYEES IN THE U.S. COMPUTER INDUSTRY, 1967 AND 1984

(in 1984 dollars)

	1967	1984	Percent Change
Top Decile	$55,181	$62,462	+13%
Bottom Decile	$ 8,323	$ 5,965	-28%
Top Decile Relative to Bottom Decile	6.6	10.5	

Source: CPS Tapes, 1968 and 1985.