

# **Trade and Inequality: A Review of the Literature**

**Edward N. Wolff  
New York University**

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## **1. Background**

The last three decades have witnessed some sharp changes in labor earnings and earnings inequality in the United States. The first is that labor earnings, adjusted for inflation, have stagnated since 1973, after rising briskly in the preceding quarter century. The second is that the dispersion of earnings among all workers (or among all male workers) in the economy has trended upward since 1970, after remaining flat over the preceding 25 years. The third is the rising returns to schooling, particularly a college education, since 1980 or so.

### **A. Average Earnings**

Figure 1 and Table 1 document trends in both overall average wages and salaries and overall average employee compensation, defined as wages and salaries plus the fringe benefits provided by employers, over the period from 1947 to 1997. I have used as wide an assortment of measures of labor compensation as possible from available data sources. Fortunately, the results are surprisingly consistent among these alternative data sources and series. These include the Bureau of Labor Statistics series on hourly wages and salaries of production and non-supervisory workers in the total private sector and the Employment Cost Index (ECI) for all workers in private industry; National Income and Product Account (NIPA) data on employee compensation for all workers, including those employed in the government; and Current

Population Survey data on median and mean earnings for year-round, full-time workers. In the case of the NIPA data, I also include a portion of proprietors' income in my measure of total labor earnings and divide this total by the sum of employed and self-employed workers. The reason for including only a portion of proprietors' income is that part of the income of self-employed workers is a return on the capital invested in unincorporated businesses. The results show that the resulting time-series is quite insensitive to the fraction used in the calculation.

The data show a very rapid growth in wages and salaries over the period 1947-1973, where it peaks in almost every series, followed by a moderate decline between 1973 and 1997. For the period before 1973, annual growth rates for wages and salaries are in the range of 1.8 to 2.7 percent. For the period 1973-1997, four of the seven series show a decline in real earnings, ranging from -0.1 to -0.8 percent per year, while the other three show either no change or a very modest increase (at most, 0.3 percent per year). All the wage series except one show some pick up in wage growth (or, at least, a smaller decline) in the period after 1989, compared to the 1973-89 period.

The results are somewhat different for total employee compensation, the sum of wages and salaries and fringe benefits. As with real wages and salaries, all series show robust growth in the period before 1973, ranging from 2.6 to 2.7 percent per year. For the 1973-1997 period, the data show a slight increase, of about 0.1 to 0.2 percent per year. Here, too, the growth in compensation seems to accelerate somewhat after 1989. A comparison of lines 3 and 12 indicates the reason for the difference in time trends between wages and salaries on the one hand and total employee compensation on the other hand. While the former have remained relatively flat after 1973, employee

benefits have risen very rapidly, at 1.2 percent per year.

### **B. Inequality Trends**

Figure 2 shows trends in income inequality in the U.S. in the postwar period.<sup>1</sup> The first, based on the March Supplement to the Current Population Survey, is for family income and is the longest consistent series available, running from 1947 to 1997. Inequality shows a slight downward trend from 1947 to 1968, with the Gini coefficient falling by 7 percent. The series bottoms out in 1968 and then rises thereafter, with the rate of increase accelerating after 1976. The 1997 Gini coefficient is 0.429, 0.081 points above its 1968 value. The second series is for household income, beginning in 1967. It is almost perfectly correlated with the first series, a correlation coefficient of 1.00 (see Table 2).

The remaining series are for labor earnings, which are much shorter in duration. The first of these is based on labor earnings for all employed persons. It shows a slight upward trend from 1967 to 1986, though it has a correlation coefficient with the first series of only 0.39 -- probably because the series ends before the very large increase in inequality. The next series is also for labor earnings, though for full-time, full-year workers. It shows a much more marked increase between 1972 and 1990, and has a correlation of 0.86 with the first series. The fifth series is based on hourly wages and runs from 1979 to 1995. It also shows an upward trend over this period though not quite as pronounced as for family or household income. Still, its correlation coefficient of 0.82 with family income inequality. A sixth series, not shown on Figure 2 because of

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<sup>1</sup> See the footnotes to Table 2 for sources and methods.

differences in scale, is, like the third series, for labor earnings for all employed persons but runs from 1963 to 1986. Its correlation with family income inequality is also low, 0.30, also because it ends before the large run-up of inequality.

We are, of course, primarily interested in the inequality of labor earnings in this analysis. Unfortunately, the consistent time-series for these series are rather short. Moreover, none of them (as far as I am aware) covers both the slight downward drift in inequality between the late 1940s and the late 1960s and its sharp increase in the 1990s. However, most of the earnings series appear to be highly correlated with the family income inequality series. As a result, I shall occasionally refer to the latter as a proxy for inequality in personal labor earnings.

### **C. Earnings by Educational Attainment**

Another indication of the dramatic changes taking place in the labor market is the sharp rise in the returns to education, particularly a college degree, that occurred during and after the 1980s. This trend is documented in Figure 3.<sup>2</sup> Among males, the ratio in annual earnings between a college graduate and a high school graduate increased slightly between 1975 and 1980, from 1.50 to 1.56, and then surged to 1.92 in 1998. For females, the ratio actually dipped slightly between 1975 and 1980, from

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<sup>2</sup> The figures are for annual earnings, which are not adjusted for hours worked or the experience level of the workers. The source for the data in Figure 3 is the U.S. Bureau of the Census, "Detailed historical income and poverty tables from the March Current Population Survey 1947-1998", available on the Internet.

1.45 to 1.43, before climbing to 1.76 in 1998.

Among men, the increase in the return to a college degree relative to a high school degree was due, in part, to the stagnating earnings of high school graduates (see Figure 4). Between 1975 and 1998, there was no net change in annual earnings in 1995 dollars, while the earnings of men with a bachelor's degree increased by 17 percent. The biggest increase in earnings occurred among males with an advanced degree (master's or higher), who saw their annual incomes grow by 25 percent. Among males who did not graduate college, earnings plummeted by 15 percent.

#### **D. Overview of the Paper**

The remainder of the paper is divided into five parts. In the first (Section 2), I provide a brief overview of trade theory that is pertinent to the issue of both average wages and wage inequality. Section 3 reviews the pertinent literature on trends in average earnings and its relation with international trade. Section 4 focuses on one crucial aspect of this literature -- namely, the factor content of trade. Section 5 will consider the literature that treats the relation between international trade and both the dispersion of earnings and returns to education, since the latter two phenomena are intermixed in most of these studies. Moreover, in Sections 3 and 5, particularly Section 5, much of the literature that confronts the relationship between earnings trends and international trade also considers other factors, particularly the role of technology on earnings. As a result, we shall briefly review the relevant literature on other factors that affect changes in average earnings and earnings inequality. Concluding remarks are made in Section 6.

## 2. Trade Theory

It might be helpful to provide a brief introduction to trade theory, since it forms the underpinnings of much of the work on the effects of trade on earnings. By the early twentieth century, the dominant trade model had become the Heckscher-Ohlin (HO) model of international trade (see Heckscher [1919] 1949, and Ohlin, 1933). The HO model is an expansion of the Ricardian model of comparative advantage (see below) but allowed for two factors of production, labor and capital. Its focus was on the use of scarce and abundant factors of production. The main implication of the model is that countries would benefit from trade by concentrating their production in goods that used the abundant factor more intensively.

The key assumption in the model is that all countries face the same technology but differ in the relative abundance of factors of production. The HO theorem states that a country will export the goods that use its relatively abundant resource more intensively and import the goods that use the scarce resource more intensively. Trade shifts domestic production from the product using the scarce factor more intensively to that which uses the abundant factor more intensively. Labor and capital shift out of the production of the good using the scarce factor more intensively to the good using the abundant factor.

The main implication of this model for the purposes here is that trade specialization is dictated by relative factor abundance. In particular, a country will export products that use intensively those factors in which a country is relatively abundant and import products that use intensively those factors which are relatively scarce.

One key implication of the HO model is that factor prices will be equalized across

industries within a country and across countries as well. In the original Heckscher-Ohlin formulation, the proof of factor-price equalization is based on a two-good, two-factor model. Vanek (1968) extended the model to the multigood, multifactor case, and the model is now referred to as the Heckscher-Ohlin-Vanek (or HOV) model. The model was further generalized by Deardorff (1982). The main implication of this model for the purposes here is that wages will tend toward parity among countries that trade with each other.

The argument for factor price equalization runs as follows. Because of the fixed functional relationship between outputs of goods and inputs of factors, there is implied a similar fixed relationship between the price of a good and the wage of its factors. Because of the assumption that factors of production are mobile across industries, we can therefore assume that a common factor price exists. What is implicit in the HO model is that trade transforms a domestic demand curve for labor into a global demand curve. Since prices are set on the margin, factor prices in this global setting are also set on the margin and therefore become equalized across countries.

One immediate implication of the HO model is that the effects of both internationalization and technological change on wages should be studied across industries and not within industry. In a general equilibrium framework, with product prices held fixed, it is immaterial if new technology reduces the input of unskilled workers in every sector. What is germane is whether technological change is concentrated in sectors that are intensive in unskilled workers or in skilled workers.

The Stolper-Samuelson (1941) theorem extends the HO model by directly linking product prices to factor prices, particularly wages. Stolper-Samuelson used a general

equilibrium model which showed how a the imposition of a tariff would be advantageous to the scarce factor of production.

The argument runs as follows: In a small country, the tariff will raise the price of the imported good relative to the export good by the amount of the tariff. With homogeneous goods, the price rise of the imported good will be matched by an equal increase in the price of the domestically produced import-competing good. This, in turn, causes resources to shift toward the import-competing product and away from the export good. As a result, the demand for and hence the relative wage of the factor used intensively in the import-competing industry will rise relative to the factor used less intensively.

Since, from the HO model, import-competing goods will make intensive use of the country's scarce factors, it is the relative price of the scarce factor that must rise. With free entry and zero profits (in competitive equilibrium), the prices of all factors employed in the import-competing sector will rise by the same amount as the rise in the price of the import-competing good. If there are other factors besides the scarce factor employed in the import competing sector, then the relative factor price of the scarce factor must rise relative to this average and hence relative to the price of the import competing good. Finally, since the price of the import competing product is equal to the price of the import and both have risen relative to other prices, this rise in the wage of the scarce factor is therefore an increase relative to the price of all goods and thus an increase in real terms.

The direct implication of the Stolper-Samuelson theorem is that trade liberalization will have the opposite effect. In particular, free trade will lower the price of the import

competing product and thus lower the real wage of the scarce factor of production in a country. This result will become important when we consider the literature on the effect of trade on relative wages in the United States.

The alternative view comes out of the theory of comparative advantage, formulated by David Ricardo in 1817. It should be noted that what distinguishes his work from the later Heckscher-Ohlin model is the assumption that different countries have different technologies and specialize in different goods. Specialization in the production of a good, due to comparative advantage in production, will allow a country to export goods for which it has a comparative advantage, and import goods in which it does not, thus allowing both countries to gain from trade.

In this model, Ricardo defines a "nation" as a geographic area that has both a "factor endowment" -- an amount of labor in his case -- and a "technology", which determines the output of different goods that can be produced by labor. Labor is assumed to be mobile between different industries but not between countries. If two countries (England and Portugal in his case) differ in their comparative advantage of producing two goods, then both countries will gain from trade.

A weakness of the Ricardian model is the use of only one factor of production. Jacob Viner later extended the model to the multi-factor case (see Viner, 1968). In the model, now known as the Specific Factors or Ricardo-Viner model, it is assumed that there is one factor, labor, that is mobile across sectors and other factors that are sector specific. The latter are often interpreted as technological inputs. The sector specific factors are paid different wages in each sector, and the wages are determined by the price of the output it helps produce. The mobile factor is paid the same wage in each

sector. However, this wage responds differently to changes in goods prices than in the Stolper-Samuelson theorem. In particular, in the case when capital is sector specific while labor is mobile within a two-sector economy, a rise in the relative price of one good then raises the real return to capital in that sector, lowers the real return to capital in the other sector, and has an ambiguous effect on the real wage of labor, depending on the importance of the more expensive good in the budgets of the workers (also, see Deardorff and Hakura, 1994, for more discussion). This result will also become important when interpreting some of the empirical work on the relation between trade and inequality.

### **3. Explanations of Stagnating Earnings**

It is helpful to begin the discussion with a general overview of the factors that have been cited to account for movements in average wages. I show a set of these variables in Table 3, as well as their correlations with the annual change in earnings. The first set are technological factors. With an aggregate Cobb-Douglas production function, earnings growth should be perfectly correlated with labor productivity growth (also see Figure 5). As shown in the first row of Table 3, the two are highly correlated according to all three measures of earnings growth.

How does technological change affect wages? Some economic historians emphasize that, typically, when new technology or products reach the market they are relatively difficult to use, unreliable and in need of frequent attention, and limited in their range of application. The introduction of new technology thus appears to call forth the need for highly skilled and educated workers and therefore higher paid employees.

If we accept this argument, then R&D activity, which is an indicator of the development of new technology, should be positively correlated with the growth in earnings. In this regard, the evidence is mixed. Industry R&D expenditures as a share of GDP is positively correlated with all three indices of wage change, especially with the change in NIPA mean wages and salaries (see Panel A of Table 3). However, the correlation coefficients are actually negative for the ratio of private R&D expenditures to GDP, as well as for scientists and engineers engaged in R&D per employee.

With regard to investment, the prevailing view is the capital-skills complementarity hypothesis. The argument is that greater investment may lead to a greater demand for skilled and therefore high paid labor since new capital normally embodies the latest and, presumably, more complex technology, which requires greater skills to put into operation (see, for example, Griliches, 1969). Measures of investment are used to allow for the possibility that new technology may normally be embodied in new capital, particularly new equipment and machinery. The growth in the ratio of capital stock to employment may also reflect the rate at which new vintages of capital are introduced into the industry.

Here, again, the results are mixed. Total fixed investment as a share of GDP and total equipment investment as a share of GDP have a substantial negative correlation with earnings growth, while investment in structures as a ratio to GDP has a small positive correlation with wage gains (see Panel B). The growth of total capital, equipment and machinery, and structures per worker all have small correlations (though mainly negative) with changes in earnings.

A few words should be said about computerization. Computers are like a two-edge

sword. Their introduction can radically alter the workplace, requiring high-skilled computer experts and technicians and engineers to implement the new technology and therefore be positively associated with earnings. However, once in place, computers tend to simplify tasks and thus increase the demand for low-skilled and lower paid workers. The results (Panel B) show negative correlations between computers and high-tech investment, especially the growth of OCA per employee, and earnings growth (also see Figure 6).

International competitiveness, as measured by the ratio of exports to GDP and the ratio of imports to GDP, may also affect earnings growth. We shall discuss this in greater detail below. However, the correlation results (Panel C) strongly suggest that trade, especially the imports and exports of goods (as opposed to services), has had a negative effect on wages (also see Figure 7).

Structural and organizational dimensions of production may also affect wage growth. The shift of employment to services may reduce average earnings, since services generally pay less than goods producers. The results (Panel D) show strong negative correlations with the growth in earnings (ranging from -0.45 to -0.60). Unionization may be associated with earnings growth since unionized trades, firms and industries usually pay more than non-unionized ones. In fact, the unionization rate has strong positive correlations with wage gains (ranging from 0.47 to 0.60). The minimum wage should have a positive effect on earnings growth, since it raises wages at the bottom and may, through an "accordion effect" increase wages through much of the occupational ladder. However, the results show that the minimum wage valued in constant 1992 dollars has small negative correlations with earnings

growth.

### **A. General Overview of the Literature**

In contrast to the literature on rising earnings inequality (see Section 5), there has been relatively little work done to explain the growth of average wages in the United States, particularly its slowdown after 1973. Some have maintained that technology is the main culprit. Johnson and Stafford (1993) argued that the erosion of large returns from American technological leadership has been the principal factor in explaining the stagnation of American wages since 1973. Acs and Danziger (1993), using CPS data over the period 1979 to 1989, reported that average earnings had declined among male workers. They attributed the decline mainly to increases in the returns to education and experience, which they interpreted as deriving mainly from technological change. They did not find any significant effect from shifts in industrial employment patterns on the basis of 13 broad industry grouping.

Others looked to institutional factors, such as unionization and the minimum wage. Freeman (1993) argued that the decline of unions in the American economy and/or the decline in the real value of the minimum wage since the late 1960s removed the "safety net" supporting the wage level of unskilled workers, thereby allowing it to fall. Ferguson (1996), using three-digit industry level data on unionization and aggregate time series data on wages over the period 1978-1986, estimated that 18 percent of the increase in the gap between real wage growth and aggregate labor productivity growth could be ascribed to the decline in unionization and perhaps another 25 percent to the declining ability of unions to raise wages.

Gordon (1996) argued that the change in these two factors was part of a broader

range of institutional changes in the 1980s in which American corporate managers exerted increasing pressure on workers, partly in reaction to rising international competition. Gordon further documented the declining real wage of American workers and argued that the growing power of management and the concomitant decline in worker power were largely responsible for this trend. Reich (1998) took issue with Gordon and reported that most of the increase in managerial labor occurred in the early part of the postwar period, when labor power was increasing.

Levy and Murnane (1996) pointed to skills as an important determinant of changes in earnings. They reported as one of their major findings that employers are now screening employees more on actual skills possessed rather than simply years of schooling or college degree. Using two large sets of panel data, the first of high school graduates in 1972 and the second of high school graduates in 1980, they examined whether the relation between math and reading scores on standardized tests and the earnings of the high school graduates six years after graduating. They found that the correlation between earnings and test scores was higher for the later panel than the earlier one and that high math test scores were, in particular, more highly correlated with wages for the later graduates. They identified several "basic skills" that were now more highly valued by employers: (i) the ability to read and perform mathematics at a ninth-grade level; (ii) effective oral and writing communications skills; (iii) ability to work effectively with workers from different social, racial, and ethnic backgrounds; and (iv) computer skills.

Several papers have investigated factors that have affected wages on the industry level. A couple have looked at the relation between industry technological change and

industry wages. Using CPS data for 1979 and 1989 segmented into 39 industries, Allen (1996) found that returns to schooling are higher in industries that are intensive in R&D and high-tech capital and that wage differentials between industries are positively related to R&D intensity, intensity of usage of high-tech capital, capital vintage, the growth in total factor productivity, and the growth of the capital-labor ratio. However, Bartel and Sicherman (1997), matching industry level measures of technological activity to the National Longitudinal Survey of Youth over the 1979-1993 period and controlling for individual fixed effects, found no evidence that the industry wage premium was correlated with the industry rate of technology change.

Levy and Murnane (1992) concluded in their survey of sources of earnings inequality that firm- and plant-specific effects are important sources of earnings differences among workers. Davis and Haltiwanger (1991), using data on U.S. manufacturing plants from 1963 to 1986, provided some evidence of this, particularly that one half of the total wage variation among manufacturing workers was accounted for by differences in average wages among plants. Moreover, these plant specific effects on wages were associated with such factors as plant size and age, industry, and capital intensity. Groshen (1991) provided similar evidence -- namely, that occupation and establishment along explained over 90 percent of the variation of wages among blue-collar workers.

Dunne and Schmitz (1992), also using manufacturing plant data, estimated that workers at establishments classified as the most technology intensive earned 16 percent more than those at the least technology intensive plants. Dunne, Foster, Haltiwanger, and Troske (2000), using more recent establishment data, concluded that

a substantial portion of the rising dispersion in wages is due to increases in wage differentials between establishments. The latter, in turn, are attributable to plant-level productivity differences and are correlated with both computer intensity and overall capital intensity.

Other factors considered in the literature include profitability. Blanchflower, Oswald, and Sanfey (1996), using panel data for the manufacturing sector derived from the CPS over the period 1964 to 1985 and controlling for workers' characteristics, unionization, and industry fixed effects, concluded that a rise in an industry's profitability lead after a lag to increased average wages within the industry. They estimated that rent-sharing alone may account for as much as one quarter of earnings inequality among full-time workers.

## **B. Trade and Wages**

With this background, we can now consider the role of trade on movements in average wages. The prevalent view in this regard is that the expansion of international trade after 1973 was a principal factor in explaining wage stagnation. The prevailing argument derives from the Heckscher-Ohlin model of international trade with factor-price equalization (see Section 2).

Several studies have used the HOV framework to analyze trends in wages in the United States. Leamer (1992) argued that increased capital formation among American trading partners abroad has led toward factor price equalization -- in particular, wage equalization across countries. Wage convergence can come about either through a rise in wages among America's trading partners or through a decline in U.S. wages. It is likely that the latter trend has dominated over the last three decades. Wood (1994)

makes a similar argument.

Lawrence and Slaughter (1993) concluded that international trade played almost no role in explaining the slow growth of worker compensation since the 1970s, especially in relation to labor productivity growth. Instead, using aggregate time-series data for the U.S. business sector, they found that the stagnation of real wages in the U.S. (and its convergence with that of trading partners) was due mainly to slow productivity growth in the nontraded goods sectors of the American economy between 1979 and 1991. For trade to have been the dominating factor in reducing the return on labor, the real product wage -- worker compensation deflated by production prices (instead of the CPI) -- would have had to decline. Instead, they found that the real product wage grew just as rapidly as worker productivity over this period.

Others have looked at the effects of trade on industry level wages. Freeman and Katz (1991) found from regressing industry level wages on industry imports and exports that the former had a depressing effect on wages while the latter had a positive effect. Davis (1992), using industry level wage data from nine advanced countries and four middle-income countries, found that the growth of the import share induced a large and statistically significant convergence toward the average structure of relative industry wages, while the growth in export share caused a smaller but statistically significant divergence. Gaston and Treffler (1994), using 1984 CPS data with worker characteristics matched with trade data, concluded that exports had a positive wage effect and imports a smaller negative wage effect, even after controlling for worker characteristics.

#### **4. The Factor Content of Trade**

Much of the literature on the effects of trade on wage inequality revolves around the factor content of trade, so that it is helpful to briefly summarize the literature on this before treating the inequality issue.

##### **A. Literature Background**

The main approach used to analyze factor content is the Heckscher-Ohlin model with factor-price equalization. The main implication of this model for the purposes here is that trade specialization is dictated by relative factor abundance. In particular, a country will export products that use intensively those factors in which a country is relatively abundant and import products that use intensively those factors which are relatively scarce.

This prediction has been subject to a long series of studies. There are two types. The first involves comparing the resource content of exports with that of the domestic substitutes for imported products in a single country. This is legitimate since by the assumptions of the HOV model, the technology used in a country to produce products which are imported is the same as that used in other countries to produce these products. Moreover, the factor prices faced in the countries are the same, so that relative costs are identical.

The most widely known tests of the effects of relative factor endowments on trade patterns were conducted by Leontief (1956, 1964) using input-output data for the United States. The main finding is that despite the fact that the U.S. was then the most capital-intensive country in the world, it exported goods that were relatively labor-intensive and imported goods that were relatively capital-intensive. This phenomenon

became known as the "Leontief paradox." Many explanations were offered for the Leontief paradox. These include (1) R&D differences among countries; (2) skill differentials between countries; (3) differences in educational attainment and other human capital attributes; and (4) relative abundance of land and other natural resources (see Caves, 1960, for more discussion).

The second type of test involves comparing trade patterns between two or more countries and relating these patterns to differences in factor abundance. One of the earliest of these studies was by MacDougall (1951, 1952), who compared British and American exports to see whether the British share of capital-intensive exports was smaller than the American share, as the model would predict due to the higher capital-labor ratio in the United States. He did not find any systematic evidence to support this prediction.

In a much more comprehensive study, Leamer (1984) examined trade patterns for over 100 economies and found that actual patterns could be explained fairly well by an endowment-based model with 10 factors, including capital, several types of natural resources and land, and three skill classes of labor. However, Leamer did not test for correspondence between the factor content of trade and the relative abundance of these factors within a country. In a later study, Bowen, Leamer, and Sveikauskas (1987) computed the amount of each of twelve factors of production embodied in the net exports of 27 countries in 1967 on the basis of the U.S. input-output matrix of total input requirements for that year. These factor contents were then compared to the relative factor abundance of the 27 countries. Using regression tests, they failed to find any correspondence between the two (in contradiction to the HOV model).

Trefler (1993, 1995) used another technique to investigate the Leontief paradox. Like Bowen, Leamer, and Sveikauskas (1987), he first computed both the labor and capital requirements of the net exports of a set of countries on the basis of the technology matrix of a single country (the United States). He then compared the labor and capital requirements with the national endowments of both labor and capital to determine whether the Leontief paradox held. This was generally confirmed. He then relaxed the assumption of factor-price equalization and showed that cross-country differences in factor prices could account for the fact that more capital abundant countries had net exports that were labor intensive, and conversely.

### **B. The Skill Content of Trade**

Growing out of the HOV model, several papers have investigated the skill content of trade. One of the earliest, Keasing (1965), used American data on employment for five occupational groups and 15 industries to classify workers into a skilled and unskilled category. Comparisons of the skill content of exports were made among 9 OECD countries for 1957. Keasing found that relative to other countries, U.S. exports were the most skill intensive, followed by West Germany, Sweden, and the United Kingdom. Japan ranked last in this group in 1957.

Engelbrecht (1996) looked at the skill content of German exports and imports. Using German input-output data for 1976, 1980, and 1984 and detailed occupational data by industry for those years, he concluded that comparative advantage resulted more from specialization in particular skill types than from the overall human capital endowment of a country. In particular, German exports were strongly endowed with labor from skilled manual occupations (such as metal workers, tool makers, and mechanics) and

engineers.

Lee and Schluter (1999) looked at the skill content of U.S. trade. They constructed a dichotomous variable for skilled and unskilled workers on the basis of nine major occupational groups. The former consisted of executive, administrative, managerial, professional, and technical workers; and the latter consisted of sales, clerical, craft, operative, and service workers, laborers, and farmers. Using U.S. input-output data for the period 1972-1992, they found that the ratio of high-skilled to low-skilled workers was greater for exports than imports but the difference in the ratios remained relatively unchanged over this period.

More recently, Wolff (2000) investigated the factor content of U.S. trade. It is first of interest to look at the changing composition of U.S. trade. Results for exports in current dollars are shown in Table 4. In 1996, the most important U.S. export was (non-electrical) industrial machinery, which made up 12.6 percent of all exports. This category includes office, computing, and accounting equipment (OCA). In 1996, OCA by itself comprised 5.1 percent of all exports. The second most important export was electrical and electronic equipment, accounting for 9.3 percent, followed by shipping and other transportation services (at 8.2 percent), motor vehicles and parts (at 6.9 percent), chemicals and chemical products (at 5.6 percent), other transportation equipment such as aircraft (at 5.4 percent), and wholesale and retail trade (at 4.8 and 4.6 percent, respectively). Altogether, industrial machinery, electrical and electronic equipment, transportation equipment, and chemicals made up almost 40 percent of all American exports.

There have been some very striking changes in export composition over the half

century. In 1947, the most important U.S. export (excluding transportation services) was processed food products, at 10.9 percent; followed by agriculture, forestry, and fishing (at 9.5 percent); (non-electrical) industrial machinery (at 9.2 percent); primary metal products such as steel (at 9.0 percent); motor vehicles and parts (at 5.7 percent); and textile mill products such as fabrics (at 5.5 percent). Since 1947, agriculture and food exports have steadily declined in relative importance, from 20.3 percent to 6.5 percent in 1996, as did exports of primary metal products, from 9.0 to 1.9 percent. Textile mill products plummeted from 5.5 to 0.8 percent. Both industrial machinery and motor vehicles remained high over the half century, actually increasing their share. The biggest gains were made by electrical and electronic equipment, from 3.2 to 9.3 percent.

As shown in Table 5, the three leading imports in 1996 were motor vehicles and parts, at 14.2 percent, industrial machinery except electrical (at 14.1 percent), and electric and electronic equipment (at 13.2 percent). Together, this group constituted 41.5 percent of all imports. It is also of note that these three industries were also among the leading four industries in terms of exports. In a somewhat distant fourth place in terms of imports was oil and natural gas (at 8.4 percent), followed by apparel and other textile (at 6.7 percent) and chemicals and chemical products (at 5.8 percent).

There have been even more dramatic changes in import composition than exports over the period from 1947 to 1996. In 1947 the leading import sector was, by far, processed foods and food products, accounting for 29.0 percent of all imports. This was followed by agricultural, forestry, and fishing products (at 15.4 percent), paper and paper products (at 14.5 percent), primary metal products, like steel (at 10.3 percent),

and metal mining including iron and copper (at 7.1 percent). Agriculture, food products, and primary metal products were also among the leading four exports in 1947.

Between 1947 and 1996, processed foods and food products declined steadily from 29.0 to 3.4 percent of all imports, agriculture from 15.4 to 2.6 percent, paper and paper products from 14.5 to 2.0 percent, and metal mining from 7.1 to 0.0 percent. The share of primary metal products in total imports, after doubling from 10.3 to 20.5 percent between 1947 and 1967, tailed off to 4.3 percent in 1996. In contrast, the import share of non-electrical industrial machinery rose steadily between 1947 and 1996, from 1.2 to 14.1 percent, as did that of electrical and electronic equipment, from almost zero to 13.2 percent and apparel, from 0.4 to 6.7 percent. Imports of motor vehicles and parts were volatile, first increasing from virtually zero in 1947 to 6.0 percent in 1958, dropping to 3.3 percent in 1967, expanding to 18.9 percent by 1987 (a reflection of the surge in Japanese car imports), and then diminishing to 14.2 percent in 1996. The other notable change is that oil imports swelled from 5.1 percent of all imports in 1947 to 23.8 percent in 1977, reflecting the steep oil price increases of the mid-1970s, and then abated to 8.4 percent in 1996.

Overall, import composition changed much more than export composition. The correlation in import shares between 1947 and 1996 is a meager 0.13. The correlation in import shares between 1958 and 1996 reaches only 0.28; that between 1967 and 1996 is 0.49; that between 1977 and 1996 is 0.70; and, finally, that between 1987 and 1996 is 0.96. In contrast, the correlation in export shares between 1947 and 1996 is a fairly high 0.64, and the correlation coefficient between 1996 export shares and those of other years rises to 0.83 with 1958 export shares, 0.89 with 1967 export shares, 0.91

with 1977 import shares, and 0.97 with 1987 import shares. In sum, while the composition of U.S. exports has remained fairly constant since the mid-1960s, import composition has stabilized only since the late 1980s.

Using U.S. input-output data from 1948 to 1996, Wolff (2000) then examined the factor content of U.S. trade. In the tabulations shown in Tables 6 and 7, the factor content is computed by pre-multiplying the export or import vector by the pertinent vector of factor coefficients.<sup>31</sup>

Results are shown in Table 6 for the direct skill content of U.S. trade. Two skill measures are used. The first is called "Substantive Complexity" (or SC) and is based on the fourth (1977) edition of the Dictionary of Occupational Titles (DOT). For some 12,000 job titles, the DOT provides a variety of alternative measures of job-skill requirements based upon data collected between 1966 and 1974. SC is a composite measure of cognitive skills derived from a factor analytic test of DOT variables. It was found to be correlated with General Educational Development, Specific Vocational Preparation (training time requirements), Data (synthesizing, coordinating, analyzing), and three worker aptitudes - Intelligence (general learning and reasoning ability), Verbal and Numerical. The second measure is the mean education of the workers employed in an industry.

The main result is that comparative advantage in U.S. international trade has been

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<sup>3</sup> In Wolff (2000), total (direct plus indirect) factor contents are also computed. The results are quite similar to those for the direct factor content alone and are not shown here.

in industries intensive in their use of high cognitive skill workers. Moreover, the comparative advantage in high cognitive skill industries has been rising over time.

Panel A shows trends in the average Substantive Complexity (SC) of employment directly generated by both exports and imports. In 1950, the average SC content of exports was 3.40, compared to an average SC score of 3.27 for imports -- a difference of 0.14. By 1990, the average SC level of exports grew by 24 percent to 4.21 and that of imports by 14 percent to 3.72, so that the gap more than tripled to 0.48.

The results for actual educational attainment are a bit of a surprise. They do show that workers in export industries have a higher mean schooling level than those employed in import industries. The gap does increase a bit over time but much less than that for SC.

Panel A of Table 7 shows the capital intensity of exports and import. This comparison forms the basis of the Leontief Paradox. The results show a pronounced and continuous rise in the capital intensity of exports over the period from 1947 to 1996. In contrast, the capital intensity of imports rose steeply between 1947 and 1977 and then slipped from 1977 to 1997. The reason is the tremendous increase of oil imports during the 1970s (see Table 5), which is a very capital-intensive industry. Another important finding is that the capital intensity of both exports and imports was below the overall capital-labor ratio of the economy in 1947 but equal to or above overall capital intensity by 1996. Imports, in fact, exceeded the overall capital-labor ratio by 1958 and remained above average through 1996. This indicates a shifting of both exports and imports toward more capital intensive industries (primarily durable manufacturing).

The results show that, in fact, imports have been more capital intensive than exports (the "Leontief Paradox"). However, what is more telling is that the capital intensity of exports relative to imports, after falling between 1947 and 1977, climbed from 1977 to 1996. The capital intensity of exports rose by a factor of 4.9 between 1947 and 1996, compared to a 3.3-fold increase for imports. The capital intensity of exports relative to imports increased from a ratio of 0.55 in 1947 to 0.81 in 1996. These results thus indicate a gradual shifting of U.S. comparative advantage back toward capital intensive goods, particularly since 1977.

Panel B shows results for total net stocks of equipment per worker. Again, we find a continuous rise in the equipment intensity of both exports and imports between 1947 and 1996. In 1947, both exports and imports were less equipment intensive than the overall economy but by 1958 imports had exceeded and by 1967 exports had exceeded the economy-wide equipment per worker ratio. The results also show the equipment intensity of exports rising faster than that of imports over the years 1947 to 1996. Equipment per worker in export industries increased six-fold over this period, compared to a factor of 4.6 for imports. As a result, the equipment intensity of exports relative to imports grew from a ratio of 0.70 in 1947 to 0.93 in 1996, with most of the gain occurring after 1977. Thus, while imports have continued to remain more equipment intensive than exports, comparative advantage is clearly shifting back toward industries with a high equipment to worker ratio.

The results are even more dramatic for OCA per worker (see Panel C). The OCA intensity of exports has grown much faster than that of imports between 1947 and 1996. Moreover, while imports were more intensive in OCA than exports in 1947, the

situation reversed since The OCA intensity of exports relative to imports climbed from a ratio of 0.34 in 1947 to 0.78 in 1958, 1.19 in 1987, and 1.20 in 1996. U.S. comparative advantage now lies in industries that intensively use office and computing equipment.

Panel D of Table 7 shows both R&D expenditures generated by exports and imports as a percent of net sales. The results are surprising. The (direct) R&D intensity of U.S. exports in 1958 was almost three times as great as that of imports. The R&D intensity of both exports and imports increased between 1958 and 1987 and then fell off somewhat in 1996. However, over the 1958 to 1996, R&D intensity rose much faster for imports than exports -- a factor of 4.2 versus 1.5. As a result, by 1996, the R&D intensity of imports was slightly greater than that of exports. Interestingly, neither exports nor imports were as R&D intensive as overall manufacturing, except for exports in 1987.

## **5. Explanations of Rising Earnings Inequality**

A considerable literature has now accumulated on factors that might have caused earnings inequality to rise since the early 1970s. It is helpful to begin the discussion with a general overview of the factors that have been cited to account for movements in average wages. I show a set of these variables in Table 8, as well as their correlations with the family income inequality over the period 1947 to 1997. The first set are technological factors. The first of these variables is labor productivity growth -- GDP in 1992 dollars per Persons engaged in production (PEP) and the second is total factor productivity (TFP) growth. These two indicators trend downward from the high growth period of 1947-67 to the first slowdown in 1967-73 and then fall sharply in the second

slowdown of 1973-79 before recovering somewhat in the 1979-97 period (see Figure 9). Not surprisingly, the productivity growth rates are negatively correlated with income inequality but the correlations are very low (in absolute value): -0.21 and -0.07, respectively.

The second set of technological indicators are measures of R&D activity -- the ratio of total R&D to GDP and the number of scientists and engineers engaged in R&D per 1,000 employees. As shown in Figure 10, the last two of these variables track much better with movements in income inequality than does productivity growth. The ratio of total R&D to GDP rose between the early 1950s and the 1960s and then falls in the 1970s before rising again in the 1980s. Its correlation with family income inequality is 0.29. In contrast, the number of scientists and engineers engaged in R&D per 1,000 employees increased between the late 1950s and early 1960s, leveled out and then fell in the early 1970s before rising sharply after 1976. It has the highest correlation with income inequality of the two variables -- 0.87.

Another source of bias in technological change might derive from investment in equipment and machinery -- particularly computers (see Section 3 above). Various investment indicators are shown in Panel B. The ratio of equipment investment to GDP rose fairly slowly between the late 1940s and the early 1970s, from about 4 percent to 5 percent, and then shot up in the ensuing 25 years, reaching 9.1 percent in 1997. Its correlation with family income inequality is quite high, 0.80. In contrast, investment in structures as a percent of GDP averaged around 4 percent from 1947 to 1985 and then dropped to around 3 percent in the 1990s. Its correlation with family income inequality is, as a result, strongly negative, -0.81.

Equipment investment per PEP, like the ratio of equipment investment to GDP, remained relatively flat between 1947 and 1961 and then climbed sharply from 1961 to 1997 (see Figure 11). It is also highly correlated with family income inequality, at 0.78. Investment in OCA per PEP grew slowly from 1947 to 1977 and then surged at an incredible pace thereafter (see Figure 11). It is even more strongly correlated with family income inequality, a coefficient of 0.81. Indeed, OCACM (the sum of communications equipment and OCA) per PEP has an even higher correlation coefficient with family income inequality, 0.84.

The third set of factors, shown in Panel C, measure trade intensity. Imports into the U.S. economy, after increasing slightly from 3.9 percent of GDP in 1950 to 5.4 percent in 1970 then shot up to 13.1 percent in 1997 (see Figure 12). Likewise, exports rose slightly from 4.2 percent of GDP in 1950 to 5.5 percent in 1970 and then more dramatically to 11.8 percent in 1997. As shown in Figure 12, there is a sharp break in these two series, as well as the ratio of imports plus exports to GDP, in the early 1970s, almost coincident with the rise in income inequality. The correlation of income inequality with the ratio of exports to GDP is 0.74, that with the ratio of imports to GDP is 0.74, and that with the ratio of the sum of exports plus imports to GDP is 0.75. The correlation coefficients between inequality and merchandise exports and imports as a share of GDP are somewhat lower.

The fourth set of variables, shown in Panel D, reflect institutional and structural changes. The first of these is unionization. The proportion of the work force represented by unions peaked in 1954, at 25.4 percent, and then diminished almost continuously to 14.1 percent in 1997 (see Figure 13) On the surface, the timing is

different from the trend in inequality, which began its upward spiral in the late 1960s. Still, the correlation between the two series is very strong, -0.83.

The second is the minimum wage in constant dollars, which peaked in 1968, the same year as income inequality bottomed out (see Figure 13). The correlation between the two series is -0.50. A related variable is the ratio of the minimum wage to average hourly earnings. This also peaked in 1968, and its correlation with family income inequality is -0.66.

The next variable reflects the shift of employment to services. However, unlike inequality, the rise in the share of employment in services has been rather continuous in the postwar period, with no notable break in the series in the early 1970s (see Figure 14). The simple correlation between this ratio and family income inequality is 0.66. A related trend is that white-collar workers as a share of total employment increased relatively constantly throughout the period 1947 to 1997, from 35 percent to 59 percent (see Figure 14). The last variable in this panel is the ratio of part-time to total employment. This is an indirect indicator of the shift of employment out of the primary labor force to the secondary labor market. The ratio of part-time to total employment grew by almost 50 percent, from 11.6 percent in 1950 to 17.9 percent in 1997. However, the share of part-time workers in the labor force showed two major increases -- the first between 1953 and 1957, when income inequality was stable, and the second from 1990 to 1996, when income inequality was rising. Still, the correlation between the two series is 0.60.

## **A. General Overview of the Literature**

### **1. Skill-biased technology change.**

The most prevalent view on the cause of rising wage inequality is biased technological change, due to the introduction of computers and the general diffusion of Information Technology (IT). The argument is that the last twenty years have witnessed a major technological revolution led by widespread computerization and the consequent diffusion of information technology. This change has skewed the income distribution by placing a high premium on college-educated and skilled labor while reducing the demand for semi-skilled and unskilled workers. One important piece of evidence is that the rate of return to a college education (the wage premium paid to a college graduate relative to a high school graduate) approximately doubled over the decade of the 1980s.

This argument has been made by Bound and Johnson (1992) and Berman, Bound, and Griliches (1994), who identify the declining ratio of production to non-production workers within industry as the major determinant of changes in relative wages between skilled and unskilled workers. The fact that both the employment share and relative wages shifted in favor of production workers is evidence of biased technological change.

Work on the subject has been limited in three ways. First, most studies measure skills by the relative shares of production and non-production workers in total employment. This division does not constitute a particularly sharp distinction between skilled and unskilled jobs (see Burtless 1995). Second, because of available data, the analysis is generally confined to manufacturing, which accounted for only 15.3 percent of total employment in 1995. It may be precarious to make inferences to other sectors on the basis of results for manufacturing. Third, the measure of skill bias is indirect --

that is, it is inferred from the rising share of non-production workers in conjunction with their rising relative earnings. Very few direct tests exist of skill-biased technological change.

Mincer (1991), using aggregate time-series data for the U.S. over the period 1963 to 1987, and Davis and Haltiwanger (1991), using data on production and non-production workers in U.S. manufacturing plants from 1963 to 1986, provided some of the early evidence to support this hypothesis. Mincer found that R&D expenditures per worker explained a significant amount of the year-to-year variation in educational wage differentials, while productivity growth was also a significant factor but had weaker explanatory power. Davis and Haltiwanger found that the employment shift toward non-production workers occurred disproportionately in large plants between 1977 and 1986, and this was accompanied by a sharp upgrading of worker education and occupational skill levels.

Lawrence and Slaughter (1993) reached a similar conclusion, after eliminating international trade as a culprit in rising earnings inequality. Katz and Murphy (1992), developed a model that accounted for changes in both the demand and supply of unskilled and skilled labor. Using CPS data over the period 1963 to 1987, they concluded that while the supply of college graduates fluctuated over time, there was a steady increase in the demand for skilled labor in the U.S. over the period.

Berman, Bound, and Griliches (1994), using data from the Annual Survey of Manufactures over the period 1979 to 1987 for 450 manufacturing industries, found that over two-thirds of the increase in the ratio of non-production to production workers within manufacturing was due to the increased use of production workers within

industry, and less than one third to a reallocation of labor between industries. The inferred from this the existence of skill biased technological change. Berman, Bound, and Machin (1997) also provided evidence that the increase in the share of skilled (non-production) workers in total employment occurred across a wide range of OECD countries. Yet, they also found that the trend decelerated in almost all OECD countries during the 1980s (with the notable exception of the United States). Allen (1996) also concluded that technology variables accounted for 30 percent of the increase in the college wage premium over the period from 1979 to 1989.

Juhn, Murphy, and Pierce (1993), using a time-series of CPS data between 1963 and 1987, documented the rising variance of earnings within schooling and experience groups. They concluded that it was due to rising employer demand to and hence premium on unobservable skills.

Several papers have looked at the effects of computer usage or IT on earnings. Reich (1991) argued that American workers are divided into two distinct groups -- "symbolic analysts" who produce knowledge and new Information Technology and ordinary clerical and production workers, who are outside the IT revolution. Globalization has rewarded the first group of workers with increased earnings but depressed the earnings of the second group.

Krueger (1993) argued that pronounced declines in the cost of personal computers caused their widespread adaption in the workplace and shifted the production function in ways that favored more skilled workers. He also estimated the rate of return to computer usage at 15 to 20 percent. This finding was later challenged by DiNardo and Pischke (1997), who estimated, using German household data, a similar return to the

use of pencils. They argued that computer use per se was not causing workers to earn a premium but, rather, was associated with unmeasured skills that were being rewarded in the workplace. Handel (1998) also showed that the returns to computers fall by half in cross-sectional estimates when other correlates, such as "reading news or magazine articles", are included as explanatory variables. However, in later work, Autor, Katz, and Krueger (1998) supplied new evidence that there was a substantial and increasing wage premium associated with computer use, despite a large growth in the number of workers with computer skills.

In a more direct test of the effects of new technology on earnings, Adams (1997), using world patent and CPS earnings data for 24 manufacturing industries over the period 1979-1993, found that a rise in patenting activity is associated with a widening of the earnings gap between college and high school graduates. One direct test of skill biased technological change is provided by Betts (1997) for Canadian manufacturing industries between 1962 and 1986. Using a translog cost share equation and treating production and non-production workers as separate inputs, he found evidence of bias away from production workers in 10 of the 18 industries used in the analysis.

A counter argument is presented by Howell (1997), who pointed out an important anomaly -- namely, that while employment in low-skill jobs was declining relative to more skilled jobs, the proportion of low wage workers has actually been rising. He also found that the entire increase in the ratio of non-production to production workers since 1979 took place between 1980 and 1982; between 1983 and the early 1990s, the ratio remained essentially unchanged. Glynn (1997) found, after dividing American workers in educational quartiles, that the employment position of the low schooled workers

sharply deteriorated between 1973 and 1981, when wage inequality grew slowly, but hardly declined at all after 1981, when wage inequality surged. Bresnahan (1997) also argued, after a review of the pertinent literature, that there is no direct evidence that the actual use of IT (particularly personal computers) is associated with job enrichment. He concluded that "There is little complementarity between highly skilled workers and PC us, certainly not enough to affect skill demand."

Mishel, Bernstein, and Schmitt (1997) argued that in order to explain the sharp rise in earnings inequality after 1979, the rate of bias in technological change must have accelerated during the 1980s. However, there is no evidence to this effect, and, indeed, the rate of conventionally measured productivity growth slowed down since the early 1970s. Murphy and Welch (1993b), after examining decennial Census of Population data on employment by occupation over the period 1940 to 1980 and CPS data for 1989-91, found that there was a steady increase in the demand for skilled labor between 1940 and 1990 but no particular acceleration during the 1970s and 1980s. Juhn (1999), including 1990 Census of Population data, reported similar results.

## **2. The shift to services.**

One of the notable changes in the composition of the labor force during the postwar period is the shift of jobs from goods-producing industries to services. The share of employment in services grew from 47 percent in 1947 to 71 percent in 1997. Almost all of the employment growth during the 1980s and 1990s occurred in the service sector. Some have argued that the dispersion of earnings is greater in services than goods-producing industries because of the greater mix of professional and managerial jobs with relatively low-skilled clerical and manual work, so that the employment shift will

lead to rising inequality.

Bluestone and Harrison (1988a, 1988b), who were among the first to observe rising earnings inequality in the United States beginning in the 1970s, argued that the proximate cause or both rising inequality and the growth in low wage employment was the deindustrialization of the American economy, particularly the shift of workers out of high wage manufacturing and towards low wage service industries.

Various estimates of the effect of structural shifts in employment have been offered. Grubb and Wilson (1989) calculated, using Census of Population data for 1960 and 1980 and 14 economic sectors, that almost two-thirds of the overall increase in earnings inequality (measured by the Theil coefficient) over this period could be explained by shifts in the sectoral composition of employment. However, Blackburn (1990), using CPS data and 41 industry classification, estimated that at most 20 percent of the increase in male earnings inequality between 1967 and 1985 could be attributed to the changing industrial composition of the labor force. Blackburn, Bloom and Freeman (1990), using a 43 industry classification, also estimated that about 20 percent of the increase in the earnings differential between white male college graduates and high school graduates was accounted for by shifts of employment among these industries.

Katz and Murphy (1992), dividing employment into 50 industries and three broad occupational groups, found that shifts in employment among both industries and occupations within those industries clearly favored more-educated workers relative to less-educated ones over the period 1947-1987. The demand for more educated (and experienced) workers within industry/occupation accelerated during the 1980s,

especially within manufacturing. Karoly and Klerman (1994), using regional data for the United States, estimated that between 15 and 20 percent of the rise in male wage inequality between 1973 and 1988 was due to shifts in the industrial composition of the workforce. Moreover, Murphy and Welch (1993a) attributed only 16 percent of the overall change in the demand for college educated workers to changes in industrial shares. Bernard and Jensen (1999) investigated inequality at the state level within the United States. They found that increases in inequality at the state level were strongly correlated with changes in industrial mix, particularly the loss of durable manufacturing jobs.

### **3. Institutional Factors.**

Two institutional trends, in particular, have achieved prominence in the literature on rising inequality. The first of these is declining unionization. The proportion of the work force represented by unions peaked in 1954, at 25.4 percent, and at 34.7 percent as a fraction of the non-farm labor force. After 1954, the trend was downward, and by 1997, only 14.1 percent were union members. Unions have historically negotiated collective bargaining agreements with narrow wage differentials between different types of jobs. This is one reason why the dispersion of earnings in manufacturing has tended to be lower than that of service industries. The decline in unions has led to widening differentials in the overall wage structure.

The second factor is the declining minimum wage. The minimum wage has fallen by 30 percent in real terms between its peak in 1968 and 1997. This has helped put downward pressure on the wages of unskilled workers and may account, in part, for the growing wage disparities between the unskilled and skilled workers and the decline in

the average real wage since 1973. Gordon (1996) argued that the change in unionization and the minimum wage was part of a broader range of institutional changes in the 1980s in which American corporate managers exerted increasing pressure on workers, partly in reaction to rising international competition.

Freeman (1993) argued that the decline of unions in the American economy and/or the decline in the real value of the minimum wage since the late 1960s removed the "safety net" supporting the wage level of unskilled workers, thereby allowing it to fall. Blackburn, Bloom and Freeman (1990) estimated that as much as 20 percent of the rising differential of earnings between college graduates and other educational groups between 1980 and 1988 might be due to deunionization. Changes in the minimum wage, on the other hand, had a minimal impact. Both Freeman (1993) and Card (1992) estimated that between 10 and 20 percent of the increased wage inequality among men was due to the decline in unionization.

Horrigan and Mincy (1993) attributed considerably under a third of the declining share of earnings received by the bottom quintile of wage earnings to the fall in the minimum wage. DiNardo, Fortin, and Lemieux (1996), using a semi-parametric estimation technique on CPS data from 1979 to 1988, concluded that the decline in the real value of the minimum wage over this period accounted for up to 25 percent of the rise in male wage inequality and up to 30 percent of the rise in female wage inequality. Fortin and Lemieux (1997) estimated that about 30 percent of rising wage rate dispersion in the U.S. was due to the decline in the real value of the minimum wage. Lee (1999), using regional data drawn from the CPS together with regional minimum wage levels over the 1980s, concluded that the decline in the real minimum wage over

the period accounted for as much as 70 percent the rise in wage dispersion in the lower tail of the wage distribution among men and from 70 to 100 percent among women.

### **B. Growing international trade.**

The increasing trade liberalization of the 1970s, 1980s, and 1990s is, perhaps, the second leading contender to explain rising inequality. Imports into the U.S. economy jumped from 5.4 percent of GDP in 1970 to 13.1 percent in 1997, while the share of exports grew from 5.5 to 11.8 percent. According to standard trade theory, as trade increases, there is a growing tendency of factor prices -- particularly, wages -- to equalize across countries. This can take the form of rising wages among our trading partners as well as declining wages in our own labor force. As imports of manufactured products produced in low-income countries such as Indonesia, China, Thailand, Mexico, and Brazil increased, downward pressure was placed on the wages of unskilled and semi-skilled workers in American manufacturing industries. This process explains both the falling average real wage of American workers (see Section 1) as well as the increasing gap between blue-collar workers and professionals who work in industries such as law, medicine, education, and business services that are well shielded from imports.

A large literature has also accumulated on the effects of international trade on wage differentials. In the main, two different approaches have been used to analyze the linkage between trade and earnings inequality. The first is the factor content of trade model, advanced mainly by labor economists, which puts primary emphasis on the effective supplies of less skilled and more skilled labor (see, for example, Berman, Bound, and Griliches, 1994). Relative to trading partners, particularly those from third

world countries, the scarce factor of production in the United States is unskilled labor.

Imports embody both unskilled and skilled labor, which when added to the domestic supply of these two factors, determines their effective supply. Because imports to the U.S. are generally less skill intensive than domestic production (see Section 4 above for empirical support), the opening of the domestic economy to imports augments the relative effective supply of low skilled workers and lowers that of high skilled workers and thereby puts downward pressure on the wages of the former relative to the latter. A related argument is that immigration may have increased the relative supply of low skill workers, thereby increasing downward pressure on their relative wages.

The alternative view, advanced primarily by trade economists, derives from the Stolper-Samuelson theorem, an off-shoot of the Heckscher-Ohlin model of international trade (see Section 2 above). The principal contention is that it is exogenous output prices, not endogenous factor quantities, that determine relative wages between skilled and unskilled workers (see, for example, Leamer, 1996). The Stolper-Samuelson theorem provides a direct linkage between factor prices and output prices which are set on the world market. The model shows that if two countries have the same technology and face the same (world) output prices, those two countries will have the same relative wage structure, regardless of the level of trade. Therefore, if trade is liberalized with less skill intensive underdeveloped countries, the relative output price of the less skill intensive products will fall in a country such as the United States, as will the relative wage paid to less skilled workers. The movement of relative wages in the advanced country is thus linked to changes in relative output prices, not to the volume of trade.

Perhaps, not surprisingly, the studies which emanate from the first theoretical

approach, the factor content of trade, generally conclude that increased trade had a minimal effect on relative wage movements. The reason is that U.S. international trade is just too small to have much impact on wages or employment. Almost all of these studies estimated that the rising volume of imports in the United States accounted for no more than 25 percent of the shift in demand between low skilled and high skilled workers (see Table 9 for a summary of the major studies in this area).

Katz and Revenga (1989) investigated the effects of the aggregate trade imbalance and other variables on U.S. and Japanese relative wages. They reported that the trade imbalance was a significant variable in their regression analysis and concluded that the U.S. trade deficit helped increase the relative wages of educated and experienced workers in the United States. However, the effects were relatively small, accounting for at most 15 percent of the increased educational and experience wage differentials.

Borjas, Freeman, and Katz (1992) focused on different groups of labor within the labor market. They concluded that trade lowered the relative employment of the unskilled, the groups with the greatest increase in effective supply due to trade. In particular, they identified the relative changes in demand for different types of labor due to expanding trade. They showed that changes in trade in the 1980s caused a decrease in the relative demand for unskilled labor, and the same changes in trade are associated with a fall in the relative wage of unskilled labor relative to what would have occurred without the increase in trade. On the basis of their analysis, they concluded that rising trade flows explained between 15 and 25 percent of the 11 percent increase in the earnings differential between college graduates and high school graduates between 1980 and 1988.

However, Borjas, Freeman, and Katz (1992) also added the effects of immigration on the relative supply of low skilled and high skilled workers. According to their empirical analysis, immigration during the 1980s augmented the relative supply of low skilled workers considerably more than high skill ones. When the effects of immigration are added to that of expanding international trade, they calculated that the two factors accounted for between 30 and 50 percent of the 10 percent decline in the relative weekly wage of high school dropouts over the 1980-1988 period.

Krugman and Lawrence (1993, 1994) compared the change in the ratio of white-collar to blue-collar wages with the change in their relative employment in U.S. manufacturing sectors from 1979 to 1989. They found that nearly all industries were employing more of the white-collar workers, and the shift in the mix of employment toward skill intensive industries was not substantial. The rise in the demand for white-collar labor was due to changes of employment patterns within industry rather than the shift of the economy's industry mix in response to trade. In particular, there was no evidence that there was a significant shift in the mix of employment toward the more skill intensive industries. They concluded that the falling demand for the less skilled workers was domestic in origin and due to technological change. However, Krugman and Lawrence (1994) did find that imports from developing countries significantly reduced employment of unskilled production workers in developed countries.

Hanson and Harrison (1995) reached a similar conclusion to that of Krugman and Lawrence in their examination of relative wages in Mexico. They examined the extent to which the increase in the wage gap between skilled and unskilled workers in Mexico was associated with Mexico's trade reforms since 1985. They found that the rising

wage skill premium was due mainly to changes of technology within industry and even within plant.

Baldwin and Cain (1994) estimated that trade pressures explain at most 9 percent of growth in U.S. wage inequality from 1977 to 1987 and even less of the further increase in wage inequality after 1987 and none of the fall in wage inequality from 1967 to 1977. After 1987, unskilled-labor augmenting technical change seems most important factor; for the 1967-77 period, factor-supply growth seemed the most important factor.

Brauer and Hickok (1995) investigated developments affecting the demand for labor of different skill levels. Using educational attainment as their skill index, they first observed that for full-time, year-round male workers in ages 25-34, the ratio of annual earnings between high school and college graduates fell from 88 percent in 1979 to 68 percent in 1989. Among those with less than a high school diploma, the ratio relative to college graduates fell from 72 to 54 percent over the same period.

They measured the skill level of an industry by the percent of employees in an industry with at least one year of college. Import penetration is defined as the ratio of imports from developing countries to total domestic demand. They reported a substantial surge of imports from developing countries in apparel and leather and a more modest increase in machinery and electronics. They then tested the relative price effects of trade by examining the implicit value added deflators for both high skill and low skill manufacturing, as well as other private industries in the economy. They found that both high skill and low skill manufacturing prices fell relative to the rest of the economy but low skill manufacturing prices did not decline relative to the prices of high

skill manufacturing over the 1979-89 period. They also found that employment shares and even absolute levels of employment fell in both high skill and low skill manufacturing.

They then examined the effects of the change in the import penetration ratio from developing countries on real average hourly earnings by industry. They found that the apparel and leather industries, in particular, experienced large declines in earnings. However, other industries that did not face significant import competitions such as primary metals, food products, and wood products also experienced large wage reductions as well. Thus, the relation between changes in import penetration and changes in wages was quite weak across industries. They did find, however, a somewhat stronger link between import changes and employment changes than between imports and wages. In particular, the import surge in apparel and leather may have translated more into employment losses rather than wage declines. However, even here, several other industries that did not experience increased import competition also suffered substantial employment declines.

They concluded that technological change combined with the overall growth in the capital stock, increased competition from abroad, both from developing and industrialized countries, and the shift in demand for the products of different industries all explained portions of the growing wage inequality but that no effect was dominant. They estimated that technological change accounted for slightly less than half of the explained portion of the widening wage gap between high school and college graduates between 1979 and 1989, shifts in product demand across industries explained another 30 percent, and changes in trade accounted for only about 15

percent.

Katz and Murphy (1992) also reported similar results, that increases in import penetration ratios could not explain changes in relative wages during the 1963-1987 period as a whole, though they did detect some effect for the more restricted 1983-87 period. However, they did find that trade-induced changes in relative demand moved in the correct direction to explain changes in wage differentials between skilled and unskilled workers but the effects were quite small in magnitude. Bound and Johnson (1992) also concluded that the effects of trade on earnings differentials were negligible because the effect of trade on relative demand shifts were very low. Lawrence and Slaughter (1993), like Brauer and Hickok (1995), did not find that the price of low skill manufactured goods declined relative to the price of high skill manufacturing goods. Other studies along this line that found minimal impacts from international trade on the divergence in compensation between more skilled and less skilled workers include Berman, Bound, and Griliches (1994).

The notable exception is Wood (1991, 1994, 1995), who using this approach, found large effects, with international trade accounting for as much as half of the decreased demand for low skilled workers. Wood's research was based on the factor content approach (see Section 4). He used this approach to calculate how much skilled and unskilled labor are used to produce the goods that are exported and how much would have been used to produce the goods that are imported. The difference between the two is used to determine the impact of trade on the demand for skilled and unskilled workers.

One strong assumption used by Wood is that goods imported from developing

countries are non-competing imports. He therefore deviated from the usual approach summarized in Section 4 by calculating the amount of skilled and unskilled labor that is actually used in producing the imports in the developing countries themselves. The rationale for this is that imports from developing countries consist of products that are of low skill intensity and are no longer produced in developed economies like the United States.

Wood then used the labor content of imports estimated from the developing countries to compute how much labor is displaced in the domestic economy of the developed country. Wood estimated that the amount of unskilled labor displaced is less than the amount that is employed in the production of the imported goods in the developing country but more than the amount employed in the production of the import-competing good in the developed country. He therefore found much larger displacement effects than the conventional methods used by Sachs and Shatz (1994), for example, suggest (see below). Wood (1995) estimated that international trade reduced the demand for unskilled labor by 22 percent, compared to the Sachs and Shatz estimate of only 6 percent. Wood (1995, p. 57) concluded that "the main cause of the deteriorating situation of unskilled workers in developed countries has been the expansion of trade with developing countries." However, in later work, Wood and Anderson (1998) concluded that trade expansion during the 1980s had a greater effect on the acceleration in skill upgrading than on skill upgrading itself.

There is a wider range of estimates of the effects of international trade on relative wages in the United States devolving from the second approach. Leamer (1992) investigated the effects of the U.S.-Mexico Free trade Agreement on wages of

American workers. He estimated that changes in real earnings induced by low-wage foreign competition ranged from a \$3,000 to a \$30,000 increase for professional and technical workers, an increase of \$7-\$67 per \$1,000 of capital, and a decline of \$900 to \$9,000 for the earnings of other workers.

In several related papers, Bhagwati (1991), Bhagwati and Dehejia (1993), and Bhagwati and Koster (1994) argued that what was pertinent for examining the effects of trade on relative wages was the effect of trade on the relative price of tradables and non-tradables. Moreover, the empirical evidence indicates that the U.S. terms of trade have behaved in a manner opposite to what would be predicted by the Stolper-Samuelson theorem together with trade liberalization. Moreover, real wages did not fall in terms of producer prices (as predicted by the Stolper-Samuelson theorem) but only in terms of consumer prices, and the divergence of consumer prices from producer prices was not due to trade.

Furthermore, the ratio of skilled to unskilled workers in manufacturing increased during the 1980s instead of declining and the relative price of skill intensive goods did not rise during the 1980s but instead fell slightly. In fact, the relative price of imported, unskilled-labor intensive industries seems to have increased rather than fallen. These papers concluded that observed changes in wages are due to technological improvements that have favored skilled-labor intensive sectors, and indeed that have been biased in favor of skilled labor employment. Another possibility is that increased randomization of comparative advantage in manufactures because of globalization may imply higher labor turnover. This, in turn, could have reduced skill acquisition on the job by unskilled workers and hence reduced improvement in their real wages over time.

Lawrence and Slaughter (1993) found little effect of changes in output prices on the earnings structure during the 1980s. The measured wage inequality as the ratio of wages between non-production and production workers, which rose by 10 percent over the period 1979 and 1989. On the basis of the Stolper-Samuelson theorem, if the price of skilled labor increased relative to unskilled labor as a result of trade, two implications follow. First, the price of goods made by skilled workers must have increased relative to that of unskilled workers. As a result of the relative rise in the wages of skilled labor, the ratio in the number of skilled to unskilled workers should also have fallen.

Using data from the NBER Trade and Immigration database and data on U.S. terms of trade from BLS export and import prices, they found that neither occurred. First, the ratio of non-production workers to production workers actually rose over this period. Second, they found no evidence that the price of low skill manufactured goods fell relative to that of high skill manufactures, as would be predicted by the Stolper-Samuelson model together with the expansion of international trade. As a result, they dismissed international trade as an explanation for changes in relative wages because employment ratios and international prices moved in the opposite direction from that predicted by the Stolper-Samuelson theorem.

Sachs and Shatz (1994) focused on the steep decline of overall employment in manufacturing, the widening wage gap between skilled and unskilled workers, and the sharp reduction of employment in low-skilled manufacturing. They constructed a special database detailing imports and exports of goods for 131 manufacturing industries and 150 trading partners. They estimated that the increase in net imports over the period 1978-1990 was associated with a drop of 7.2 percent in production jobs

in manufacturing and only a 2.1 percent fall in non-production jobs in manufacturing. However, this accounted for 39 percent of the loss of manufacturing jobs over the period. They also computed that the prices of less skill intensive goods fell by 10 percent relative to the price of skill intensive goods, as predicted by the Stolper-Samuelson theorem. However, this by itself could not have accounted for even as much as a 10 percent decrease in the wages of low skilled workers relative to high skill workers. All in all, they surmised that these trends contributed somewhat to the widening wage gap between skilled and unskilled workers, though technology change probably played the dominant role.

Leamer (1996) used the HO model to analyze the effects of globalization on the relative wages of skilled and unskilled labor. Using price, TFP growth, and initial factor share data for 450 4-digit SIC industries, he was able to calculate what factor price changes would have occurred as a result of the change in actual trade patterns in order to maintain the zero profit condition in each sector as mandated by the Stolper-Samuelson assumptions. The analysis was conducted for the decades of the 1960s, 1970s, and 1980s. He estimated that trade effects were responsible for 40 percent of the decline in the relative wages of less skilled workers during the 1980s. However, his model has been criticized because it requires long lags -- in particular, he relied on price changes in the 1970s to account for changes of wages in the 1980s.

Krugman (1995) offered one way of reconciling these two approaches. He argued that the relevant counterfactual to consider is what the prices of tradable goods and services (and therefore factor prices) would have been if trade had not increased. Using observed changes in commodity prices is inappropriate since such changes

reflect a whole host of characteristics besides international trade. He proposed that the change in world prices depends critically on the **volume** of trade. If trade expanded less, than the impact on world prices would have been smaller. He then developed a CGE (Computable General Equilibrium) model of world prices on the basis of commonly accepted supply and demand elasticities with which to infer changes in the prices of tradables induced by trade expansion.

He concluded that world supply and demand would not have changed very much as long as trade increases were small relative to the world totals of such products. With the assumed price elasticities, prices would have had to adjust by only a small degree to absorb the resulting changes in world demand. Consequently, only a small proportion of actual changes in relative commodity prices and hence of factor prices reflect the expansion of world trade. Moreover, using simulated price changes in tradables yield similar results even using the Stolper-Samuelson approach.

There are several other studies that do not fit neatly into these two categories and that also investigated the effects of international trade on earnings. Murphy and Welch (1991) found a close correspondence between changes in net imports over the 1967-1986 period among three industry groups, durables, non-durables, and services, and changes in employment patterns of less educated and more highly educated workers. They argued that an increase in net imports in a particular sector should reduce the labor demand in that sector. In particular, they found that exact matches existed between the signs of relative labor demand changes predicted by changes in international trade with both the observed changes in the distribution of employment between industries and the relative wages of different educational groups of workers.

They concluded that changes in trade patterns were largely responsible for the loss of low-skilled employment in U.S. manufacturing. Deardorff and Hakura (1994) also argued that over the period since 1970, changes in trade were accompanied by changes in relative wages between less skilled and more skilled workers. Their results concurred with those of Murphy and Welch.

Feenstra and Hanson (1995, 1997, 1999), using the NBER Manufacturing Productivity Database for the period 1979-1990, estimated in the first study that rising imports explained 15 to 33 percent of the increase in the wages of non-production workers relative to production workers during the 1980s in manufacturing, while in the second, they found that foreign outsourcing of intermediate inputs and expenditures on high-technology capital, particularly computers, explained a substantial amount (a minimum of 35 percent) of the relative increase in the wages of non-production workers during the 1980s in manufacturing.

Borjas and Ramey (1994, 1995) argued that the impact of imports on wages and employment would be particularly pronounced in highly concentrated industries like automobiles. Using SMSA level data, they reported a strong negative correlation between the share of employment in high concentration import industries and the relative wages of less skilled workers, both over time within cities and in a cross-section of cities.

Bernard and Jensen (1997), using plant level data, estimated that rising exports accounted for almost all of the rise in the wage differential between high-skilled and low-skilled workers. They found that shifts between exporting and non-exporting plants (within the same industry) were associated with roughly half of the growth in U.S.

employment and payroll shares of non-production relative to production workers over the 1980-87 period. Explicit measures of plant-level technological investment were associated with the same shifts between production and non-production workers over the 1980-87 period within a typical plant but not with the theoretically more important shifts between plants that export and those that do not.

In a somewhat different approach, Haveman (1993) looked at the effects of trade on worker displacement within manufacturing industries. He found that workers displaced from industries that engaged in international trade experienced about 37 weeks of transitional unemployment, compared to 21 or 22 weeks for other displaced workers. He attributed roughly 4 weeks of the 16 week difference to the trade designation of the industry (whether it was an exporter, import competitor, or trade neutral), with the remaining 12 weeks associated with the personal characteristics of the workers. Two years after displacement, workers from industries engaged in trade that have suffered declines in employment recovered 5 to 9 percent less of their pre-displacement wages than other displaced workers.

In a related study, Kletzer (1994) examined the effects of international trade of job losses within U.S. manufacturing over the period 1979 to 1991. She estimated that the elasticity of an industry's displacement rate with respect to its import penetration ratio was only in the range of 0.11 to -0.07 with respect to the ratio of exports to shipments. The negative estimated effect of the import penetration ratio on the probability of the worker re-employment could not be separated from the negative effects of worker characteristics. Import penetration ratios had no significant explanatory power in predicting earnings recovery.

## 6. Concluding Remarks

As is evident the studies on the effects of international on earnings inequality have produced very mixed results. Some have found significant effects. However, the majority have found little or no effect. Moreover, of those that have found a large effect, it is unclear whether the effect is due to trade per se or to some other unmeasured effect, notably technology. Almost universally, the studies of trade and inequality fail to control for other possible factors that might have accounted for rising inequality, such as the decline in unionization, the decline in the real value of the minimum wage, the effects of computerization, and structural shifts in the economy.

It is also notable that the studies that have looked at specific effects of trade on the relative price of manufacturing industries or factor prices within particular manufacturing sectors have failed to find confirmation of the Stolper-Samuelson theorem (with the exception of Sachs and Shatz, 1994). As several studies have indicated, movements in the price of low skilled manufactures relative to high skill manufactures have not changed in the direction predicted by Stolper-Samuelson.

With regard to the effects of international trade on average real wages, the studies are too limited to draw much in the way of a conclusion. The only notable study to deal with this issue is Lawrence and Slaughter (1993), who found almost no effect of expanded international trade on the wage stagnation of the post-1973 period. All in all, on the basis of this literature survey, I would have to conclude that there is no compelling evidence that the expansion of international trade since the early 1970s played a substantial role in either the reduction in the real wage or in the increase of

the wage differential between skilled and unskilled labor.

I would also have to agree with Richardson (1995), who argued that the appropriate method to use on this issue is a general equilibrium approach that strings together trends of increased trade and inequality over both short and long time periods and is able to match particular labor outcomes, such as the change in the differential in earnings between skilled and unskilled workers. Moreover, such an approach requires explicit treatment of technology and technological change over the relevant time period. In particular, it is reasonable to assume that technological change could have altered both absolute and relative wages among different skill groups. Moreover, that same technical change could have affected trade patterns as well, so that the effects of new technology on trade patterns must also be explicitly considered in such a model. Indeed, it may make no sense to identify trade as a separate (and independent) explanatory variable or even technology, since trade itself can alter the direction of technological change. That is why a general equilibrium approach is called for.

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## Data Appendix

### 1. Employee compensation and employment data:

(a) BLS mean hourly and weekly earnings: Figures are from the Bureau of Labor Statistics and refer to the wages and salaries of production and non-supervisory workers in the total private sector. Source: Council of Economic Advisers, **Economic Report of the President, 1999** and **Economic Report of the President, 1981**.

(b) BLS Employment Cost Index (ECI): Figures are from the Bureau of Labor Statistics' Employment Cost Index for private industry, including both wages and salaries and the employer costs to employee benefits, as of December of that year. The index controls for the influence of employment shifts among occupations and industries. Sources: Department of Labor, **Report on the American Workforce, 1995** and Council of Economic Advisers, **Economic Report of the President, 1999**.

(c) NIPA employee compensation: Figures are from the National Income and Product Accounts (NIPA), available on the Internet. No adjustment is made for hours worked. Employee compensation includes wages and salaries and employee benefits. Proprietors' income is net income to self-employed persons, including partners in businesses and owners of unincorporated businesses.

(d) NIPA employment data: Figures are from the National Income and Product Accounts, available on the Internet. Full-time equivalent employees (FTEE) equals the number of employees on full-time schedules plus the number of employees on part-time schedules converted to a full-time basis. The number of full-time equivalent employees in each industry is the product of the total number of employees and the ratio of average weekly hours per employee for all employees to average weekly hours per employee on full-time schedules. Persons engaged in production (PEP) equals the number of full-time and part-time employees plus the number of self-employed persons. Unpaid family workers are not included.

(e) CPS earnings data: Figures are from the Current Population Survey, available on the Internet. The overall median is computed as a weighted average of male and female median earnings, with employment shares as weights. The data refer to persons 15 years old and over with earnings beginning in March 1980, and persons 14 years old and over as of March of the following year for previous years. Prior to 1989 earnings are for civilian workers only.

### 2. Output, investment and capital stock data

(a) Investment data refer to non-residential fixed investment in constant (1992)

dollars and GDP to GDP in constant (1992) dollars. Source: U.S. Bureau of Economic Analysis, National Income and Product Accounts, Internet.

(b) Capital stock figures are based on chain-type quantity indexes for net stock of fixed capital in 1992\$, year-end estimates. Equipment and structures, including information technology equipment, are for the private (non-government) sector only. Information processing and related equipment includes: (a) computers and peripheral equipment; (b) other office and accounting machinery; (c) communication equipment; (d) instruments; and (e) photocopy and related equipment. Source: U.S. Bureau of Economic Analysis, CD-ROM NCN-0229, "Fixed Reproducible Tangible Wealth of the United States, 1925-97."

(c) Investment flows by industry and by type of equipment or structures are for the private (non-government) sector only. The source is: U.S. Bureau of Economic Analysis, CD-ROM NCN-0229, "Fixed Reproducible Tangible Wealth of the United States, 1925-97."

3. Research and development expenditures performed by industry include company, federal, and other sources of funds. Company-financed R&D performed outside the company is excluded. Industry series on R&D and full-time equivalent scientists and engineers engaged in R&D per full-time equivalent employee run from 1957 to 1997. Source: National Science Foundation, Internet. For technical details, see National Science Foundation, **Research and Development in Industry**, (Arlington, VA: National Science Foundation), NSF96-304, 1996.

4. Imports and exports. Source for the aggregate data: U.S. Bureau of Economic Analysis, National Income and Product Accounts, Internet. Sources for the industry level data are U.S. input-output data for years 1947, 1958, 1963, 1967, 1972, 1977, 1982, 1987, 1992, and 1996 provided on computer tape or diskette by the Bureau of Economic analysis. The data are interpolated for years 1950, 1960, 1970, 1980, and 1990.

5. Unionization. Percent of labor force covered by unions. Estimates for 1950-1983 are the annual average number of dues paying members reported by labor unions. Estimates for 1983-1997 are annual averages from the Current Population Survey. Data exclude numbers of professional and public employee associations. Sources: (a) U.S. Department of Labor, Bureau of Labor Statistics, **Handbook of Labor Statistics 1978**, Bulletin 2, (Washington, DC: U.S. Government Printing Office), 1979; (c) U.S. Department of Labor, Bureau of Labor Statistics, **Handbook of Labor Statistics 1989**, Bulletin 23, (Washington, DC: U.S. Government Printing Office), 1990; and (d) Eva E. Jacobs, Editor, **Handbook of U.S. Labor Statistics**, Second Edition, (Lanham, MD: Bernan Press), 1998. Sources for the industry level data include in addition to the above: Kokkelenberg and Sockell (1985); Hirsch and Macpherson (1993), accompanying data files; and Bureau of Labor Statistics, Office of Employment Projections, Output and Employment data base.

6. Service sector employment. Sectors include wholesale and retail trade; finance, insurance, real estate; personal and business services; and government. The employment concept is Persons Engaged in Production (PEP). Source: U.S. Bureau of Economic Analysis, National Income and Product Accounts, Internet.

7. Minimum wage. Source: U.S. Bureau of the Census, **Statistical Abstract of the United States: 1998**, 118th edition, (Washington, DC: U.S. Government Printing Office), 1998.

5. The original input-output data are 85-sector U.S. input-output tables for years 1947, 1958, 1963, 1967, 1972, 1977, 1982, 1987, 1992, and 1996 (see, for example, Lawson, 1997, for details on the sectoring). The 1947, 1958, and 1963 tables are available only in single-table format. The 1967, 1972, 1977, 1982, 1987, 1992, and 1996 data are available in separate make and use tables. These tables have been aggregated to 45 sectors for conformity with the other data sources.

The 1950, 1960, 1970, 1980, and 1990 input-output tables are estimated from the benchmark U.S. input-output tables. The 1950 table is interpolated from the 1947 and 1958 input-output tables; the 1960 table is interpolated from the 1958 and 1963 input-output tables; the 1970 table is interpolated from the 1967 and 1972 input-output tables; the 1980 table is interpolated from the 1977 and 1982 input-output tables; and the 1990 table is interpolated from the 1987 and 1992 input-output tables.

**Table 1. Annual Percentage Growth Rate of Real Labor Earnings per Worker, Selected Measures, 1947-1997**

	1947-1973	1973-1997	1973-1989	1989-1997
<b>A. Wages and Salaries</b>				
1. BLS mean hourly earnings	2.1	-0.5	-0.7	-0.1
2. BLS mean weekly earnings	1.8	-0.8	-1.1	-0.1
3. BLS ECI Wage and Salary Index		0.1 <sup>a</sup>	0.1 <sup>b</sup>	0.0
4. NIPA wages and salaries per FTEE	2.3	0.0	-0.2	0.4
5. NIPA wages and salaries plus half of proprietors' income per PEP	2.4	-0.1	-0.4	0.5
6. CPS Median earnings for year-round, full-time workers	2.4 <sup>c</sup>	-0.4	-0.4	-0.4
7. CPS Mean earnings for year-round, full-time workers	2.7 <sup>d</sup>	0.3	0.2	0.4
<b>B. Total Employee Compensation</b>				
8. NIPA employee compensation per FTEE	2.6	0.2	0.1	0.3
9. NIPA employee compensation plus half of proprietors' income per PEP	2.7	0.1	0.0	0.4
10. NIPA employee compensation plus three fourths of proprietors' income per PEP	2.6	0.1	-0.1	0.4
11. BLS Employment Cost Index (ECI)		0.0 <sup>e</sup>	-0.1 <sup>f</sup>	0.3
12. BLS ECI Fringe Benefit Index		1.2 <sup>a</sup>	1.5 <sup>b</sup>	0.8
<b>C. Labor Productivity</b>				
13. GDP [1992\$] per FTEE	2.0	0.8	0.8	0.9
14. GDP [1992\$] per PEP	2.4	0.8	0.8	1.0

Note: Author's computations. All figures are in 1995 dollars, based on the CPI-U-X1 deflator.

See the Data Appendix for sources and methods. Key:

FTEE: Full-time equivalent employees

PEP: Persons engaged in production

a. 1980-1996.

b. 1980-1989.

c. 1960-1973.

d. 1967-1973.

e. 1976-1996.

f. 1976-1989.

**Table 2. Correlation Coefficients between the Gini Coefficient for Family Income And Other Inequality Indices**

Inequality Indices	Period	Correlation Coefficient
1. Gini coefficient, family income	1947-97	1.00
2. Gini coefficient, household income	1967-97	1.00
3. Gini coefficient, earnings	1967-86	0.39
4. Log Variance full-time, full-year earnings	1972-90	0.86
5. Gini coefficient, hourly wages	1979-95	0.82
6. Log Variance earnings	1963-87	0.30

**Note:** Authors' computations. Definitions and sources:

1. Source: U.S. Bureau of the Census, Current Population Survey, March Supplement, the Internet [<http://www.census.gov/ftp/pub/hhes/www/incpov.htm1>].

2. Source: U.S. Bureau of the Census, Current Population Survey, March Supplement, the Internet [<http://www.census.gov/ftp/pub/hhes/www/incpov.htm1>].

3. Annual wage and salary income, all persons, 16 years and over, with positive wage and salary income, based on the Current Population Survey, March Supplement. Source: Karoly (1992).

4. Wage and salary income for full-time, full-year workers, 16 years and over, with positive wage and salary income, computed from CPS Annual Demographic Files. Source: Gittleman (1992).

5. Hourly wage rates weighted by hours, computed from the March CPS. Source: Lerman (1997).

6. Annual wage and salary income, all persons, 16 and over, with positive wage and salary income, computed from CPS Annual Demographic Files. Source: Bluestone (1989).

**Table 3. Correlation Coefficients between the Change in Average Earnings and Technological, Structural, and Institutional Variables, 1947-1997**

Variable	Correlation Coefficient with the Change in		
	BLS Mean Hourly Earnings	NIPA Mean Wages and Salaries	NIPA Mean Employee Compensation
<b>A. Technology Variables</b>			
1. Labor productivity (GDP in 1992\$/PEP) growth	0.82	0.93	0.98
2. Industry R&D Expenditures			
a. Total industry R&D expenditures/GDP	0.28	0.51	0.40
b. Private R&D expenditures/GDP	-0.43	-0.24	-0.35
3. Scientists and engineers/FTEE	-0.25	0.00	-0.13
<b>B. Investment Variables</b>			
4. Non-residential fixed investment rates			
a. Total fixed investment/GDP	-0.62	-0.53	-0.59
b. Equipment investment/GDP	-0.60	-0.50	-0.56
c. Investment in structures/GDP	0.23	0.18	0.22
5. Annual growth in capital-labor ratios			
a. Total non-residential fixed capital/PEP	0.10	-0.03	-0.01
b. Private non-residential fixed capital/PEP	0.07	-0.15	-0.12
c. Private non-residential equipment/PEP	0.03	-0.12	-0.08
d. Private non-residential structures/PEP	0.16	-0.13	-0.15
e. Office, computing, and accounting machinery/PEP	-0.49	-0.52	-0.53
f. Computers and peripheral equipment/PEP	-0.32	-0.26	-0.25
g. OCA plus communication equipment/PEP	0.03	-0.11	-0.18
<b>C. Trade Variables<sup>a</sup></b>			
6. Export intensity			
a. Ratio of total exports to GDP	-0.71	-0.65	-0.67
b. Ratio of goods exports to GDP	-0.74	-0.72	-0.73
c. Ratio of service exports to GDP	-0.58	-0.46	-0.51
7. Import intensity			
a. Ratio of total imports to GDP	-0.67	-0.55	-0.58
b. Ratio of goods imports to GDP	-0.68	-0.56	-0.60
c. Ratio of service imports to GDP	-0.54	-0.37	-0.41
8. Overall trade intensity			
a. Ratio of total exports plus imports to GDP	-0.70	-0.60	-0.63
b. Ratio of goods exports plus imports to GDP	-0.72	-0.63	-0.66
c. Ratio of service exports plus imports to GDP	-0.58	-0.45	-0.49
<b>D. Structural and Institutional Variables</b>			
9. Employment in services as a percent of total employment	-0.60	-0.45	-0.46

10. Union members as a percent of the total labor force	0.60	0.47	0.52
11. Minimum wage (1992 \$)	-0.28	-0.17	-0.08

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**Note:** Author's computations. The correlation coefficients are computed from annual data. See the Data Appendix for sources and methods for each variable.

a. All trade variables and GDP are measured in current dollars.

**Table 4. Percentage Composition of U.S. Exports, with Industries Ranked By 1996 Exports, 1947-1996**

Industry	1947	1958	1967	1977	1987	1996
Industrial machinery exc. electrical	9.2	12.7	14.3	12.8	10.9	12.6
Electric and electronic equipment	3.2	4.5	5.4	6.5	7.4	9.3
Shipping and other transport services	13.0	12.0	10.6	6.7	8.8	8.2
Motor vehicles and equipment	5.7	4.8	5.5	7.9	7.6	6.9
Chemicals and allied products	3.8	5.3	6.0	5.3	5.9	5.6
Other transportation equipment	2.4	4.5	5.5	5.8	7.4	5.4
Retail trade	2.9	3.7	3.6	4.4	4.4	4.8
Wholesale trade	2.9	3.7	3.6	4.4	4.2	4.6
Real estate	0.3	1.3	1.6	2.6	3.4	4.6
Instruments and related products	1.1	1.4	2.4	2.4	4.0	4.1
Agriculture, forestry, and fishing	9.5	9.8	9.0	9.2	4.5	3.7
Food and kindred products	10.9	6.7	5.2	5.1	3.8	3.5
Rubber and plastic products	1.6	2.9	2.7	2.2	2.6	3.0
Fabricated metal products	2.2	2.9	3.6	4.0	3.4	2.4
Insurance	0.2	0.1	0.1	0.2	2.4	2.1
Banking, credit & investment companies	0.2	0.1	0.1	0.2	2.4	2.1
Primary metal products	9.0	5.0	4.4	2.6	1.7	1.9
Paper and allied products	1.7	1.6	2.0	1.8	2.1	1.8
Petroleum and coal products	3.1	3.4	2.1	2.3	2.1	1.5
Business & repair services, exc. auto	0.2	0.7	0.6	1.0	0.7	1.1
Professional services & non-profits	0.2	0.6	0.6	1.0	0.7	1.1
Apparel and other textile products	1.8	0.8	0.7	0.7	0.5	1.1
Lumber and wood products	1.0	0.6	1.0	1.4	1.2	0.9
Tobacco products	1.3	2.3	1.6	1.2	0.8	0.9
Amusement and recreation services	0.7	1.3	0.9	0.3	0.4	0.8
Textile mill products	5.5	1.3	0.9	1.2	0.8	0.8
Printing and publishing	0.4	0.5	0.7	1.0	0.7	0.7
Miscellaneous manufactures	1.0	0.6	0.9	0.9	0.9	0.7
Stone, clay, and glass products	1.0	0.9	0.9	0.8	0.6	0.6
Telephone and telegraph	0.2	0.3	0.4	0.7	1.1	0.6
Oil and gas extraction	1.2	0.2	0.3	0.2	0.5	0.6
Coal mining	2.1	1.7	0.8	1.5	0.8	0.3
Correlation with 1996 export composition:	0.64	0.83	0.89	0.91	0.97	1.00

Note: Author's computations. Exports are in current dollars. Industries are classified according to a 45-sector aggregation. Only industries which account for one percent or more of exports in any year are listed.

**Table 5. Percentage Composition of U.S. Imports, with Industries Ranked By 1996 Imports, 1947-1996**

Industry	1947	1958	1967	1977	1987	1996
Motor vehicles and equipment	0.2	6.0	3.3	12.2	18.9	14.2
Industrial machinery exc electrical	1.2	2.9	7.6	5.2	10.9	14.1
Electric and electronic equipment	0.1	1.3	6.7	7.6	11.5	13.2
Oil and gas extraction	5.1	11.4	6.0	23.8	7.2	8.4
Apparel and other textile products	0.4	0.4	0.3	4.1	6.5	6.7
Chemicals and allied products	3.1	3.7	4.3	3.6	4.9	5.8
Primary metal products	10.3	12.8	20.5	8.1	4.5	4.3
Instruments and related products	1.8	1.8	2.0	2.0	4.0	3.9
Miscellaneous manufactures	2.2	2.4	3.2	2.5	3.8	3.5
Food and kindred products	29.0	12.4	7.5	5.5	4.5	3.4
Rubber and plastic products	0.4	0.7	1.9	2.1	2.9	3.2
Agriculture, forestry, and fishing	15.4	8.4	5.7	1.9	1.7	2.6
Fabricated metal products	0.3	1.7	3.1	2.0	2.8	2.5
Other transportation equipment	0.3	1.2	1.8	1.5	2.4	2.1
Leather and leather products	0.5	0.5	0.5	1.8	2.3	2.0
Paper and allied products	14.5	9.6	7.2	2.6	2.5	2.0
Petroleum and coal products	2.7	6.2	5.5	7.6	3.3	1.8
Lumber and wood products	4.5	4.9	4.6	2.4	1.6	1.6
Transportation	0.3	0.1	0.6	0.2	0.6	1.3
Stone, clay, and glass products	0.9	1.6	1.6	1.2	1.6	1.3
Furniture and fixtures	0.0	0.0	0.2	0.5	1.3	1.2
Textile mill products	3.4	5.5	4.8	1.1	1.2	0.9
Banking, credit & investment companies	1.1	0.2	0.2	0.2	0.4	0.3
Insurance	1.0	0.2	0.2	0.2	0.4	0.3
Mining of nonmetallic minerals	2.9	1.9	1.1	0.4	0.2	0.2
Tobacco products	2.9	0.3	0.1	0.2	0.2	0.1
Metal mining	7.1	7.0	4.9	1.3	0.3	0.0
Correlation with 1996 import composition:	0.13	0.38	0.49	0.70	0.96	1.00

Note: Author's computations. Imports are in current dollars. Industries are classified according to a 45-sector aggregation. Only industries which account for one percent or more of imports in any year are listed.

**Table 6. Average Skill Content of Exports and Imports: Direct Labor Input Only, 1950-1990**

Skill Type	1950	1960	1970	1980	Percent Change	
					1990	1950-1990
<b>A. Substantive Complexity (SC)</b>						
Exports	3.40	3.59	3.80	3.92	4.21	23.6
Imports	3.27	3.32	3.52	3.59	3.72	14.0
Difference	0.14	0.27	0.28	0.33	0.48	
Total Economy	3.75	3.81	4.07	4.23	4.38	16.9
<b>B. Mean Educational Attainment</b>						
Exports	9.29	10.11	11.02	12.12	12.86	38.4
Imports	9.04	9.91	10.88	11.89	12.47	38.0
Difference	0.25	0.20	0.14	0.23	0.38	
Total Economy	9.40	10.30	11.50	12.50	13.00	38.3

a. Source: Wolff (2000). Computations are based on direct labor requirements only. Exports and imports exclude wholesale and retail trade and transportation margins.

**Table 7. Capital and R&D Intensity of Exports And Imports: Direct Inputs Only, 1947-1996**

Type of Capital	1947	1958	1967	1977	1987	Ratio	
						1996	1996/1947
<b>A. Ratio of Total Net Capital (\$1,000s of 1992 dollars) to Employment</b>							
Exports	20.2	38.0	49.4	70.1	83.2	98.3	4.9
Imports	36.7	80.9	82.0	160.3	107.3	121.0	3.3
Ratio	0.55	0.47	0.60	0.44	0.78	0.81	
Total Economy	54.7	65.8	76.9	83.5	87.7	95.6	1.8
<b>B. Ratio of Net Equipment (\$1,000s of 1992 dollars) to Employment</b>							
Exports	8.0	16.1	21.1	31.8	39.0	48.2	6.0
Imports	11.4	22.1	27.0	42.9	44.2	52.0	4.6
Ratio	0.70	0.73	0.78	0.74	0.88	0.93	
Total Economy	14.7	16.5	19.9	22.2	25.2	29.5	2.0
<b>C. Ratio of OCA (\$100s of 1992 dollars) to Employment [a]</b>							
Exports	0.5	1.0	1.0	1.9	12.2	44.0	93.2
Imports	1.4	1.3	0.9	2.1	10.2	36.8	26.3
Ratio	0.34	0.78	1.05	0.93	1.19	1.20	
Total Economy	0.9	1.2	1.1	1.6	9.2	33.9	39.6
<b>D. Ratio of R&amp;D Expenditures to Net Sales (Percent) [b]</b>							
Exports		1.96	2.18	1.79	3.49	2.87	1.47
Imports		0.70	1.07	1.60	3.23	2.92	4.19
Difference		1.26	1.11	0.19	0.26	-0.05	
Total Manufacturing		2.70	2.92	2.27	3.40	3.03	1.12

a. Source: Wolff (2000). Computations are based on direct labor and capital requirements only. Exports and imports exclude wholesale and retail trade and transportation margins.

a. The government sector is not included.

b. R&D data are available only for manufacturing. The ratios are of 1996 to 1958.

**Table 8. Correlation Coefficients between the Gini Coefficient for Family Income and Technological, Structural, and Institutional Variables, 1947-1997**

Variable	Period	Correlation Coefficient
<b>A. Technology Variables</b>		
1. Labor productivity (GDP in 1992\$/PEP) growth	1947-97	-0.21
2. TFP Growth	1947-97	-0.07
3. Total industry R&D expenditures/GDP	1953-97	0.29
4. Scientists and engineers/FTEE	1958-97	0.87
<b>B. Investment Variables</b>		
5. Non-residential fixed investment rates		
a. Total fixed investment/GDP	1947-97	0.63
b. Equipment investment/GDP	1947-97	0.80
c. Investment in structures/GDP	1947-97	-0.81
6. Non-residential fixed investment per Worker		
a. Equipment investment/PEP	1947-97	0.78
b. Office, computing, and accounting machinery/PEP	1947-97	0.81
c. OCA plus communication equipment/PEP	1947-97	0.84
<b>C. Trade Variables</b>		
7. Export intensity		
a. Ratio of total exports to GDP	1947-97	0.74
b. Ratio of goods exports to GDP	1947-97	0.66
8. Import intensity		
a. Ratio of total imports to GDP	1947-97	0.74
b. Ratio of goods imports to GDP	1947-97	0.73
9. Overall trade intensity		
a. Ratio of total exports plus imports to GDP	1947-97	0.75
b. Ratio of goods exports plus imports to GDP	1947-97	0.72
<b>D. Structural and Institutional Variables</b>		
10. Union members as a percent of the total labor force	1947-97	-0.83
11. Minimum wage (1992 \$)	1947-97	-0.50
12. Minimum wage / average hourly wage	1947-97	-0.66
13. Employment in services / total employment	1947-97	0.66
14. White-collar workers / total employment	1947-97	0.67
15. Ratio of part-time to total employment	1950-97	0.60

Note: Author's computations. The correlation coefficients are computed from annual data. See the Data Appendix for sources and methods for each variable.

**Table 9. Effects of International Trade on Relative Earnings:  
A Summary of Studies**

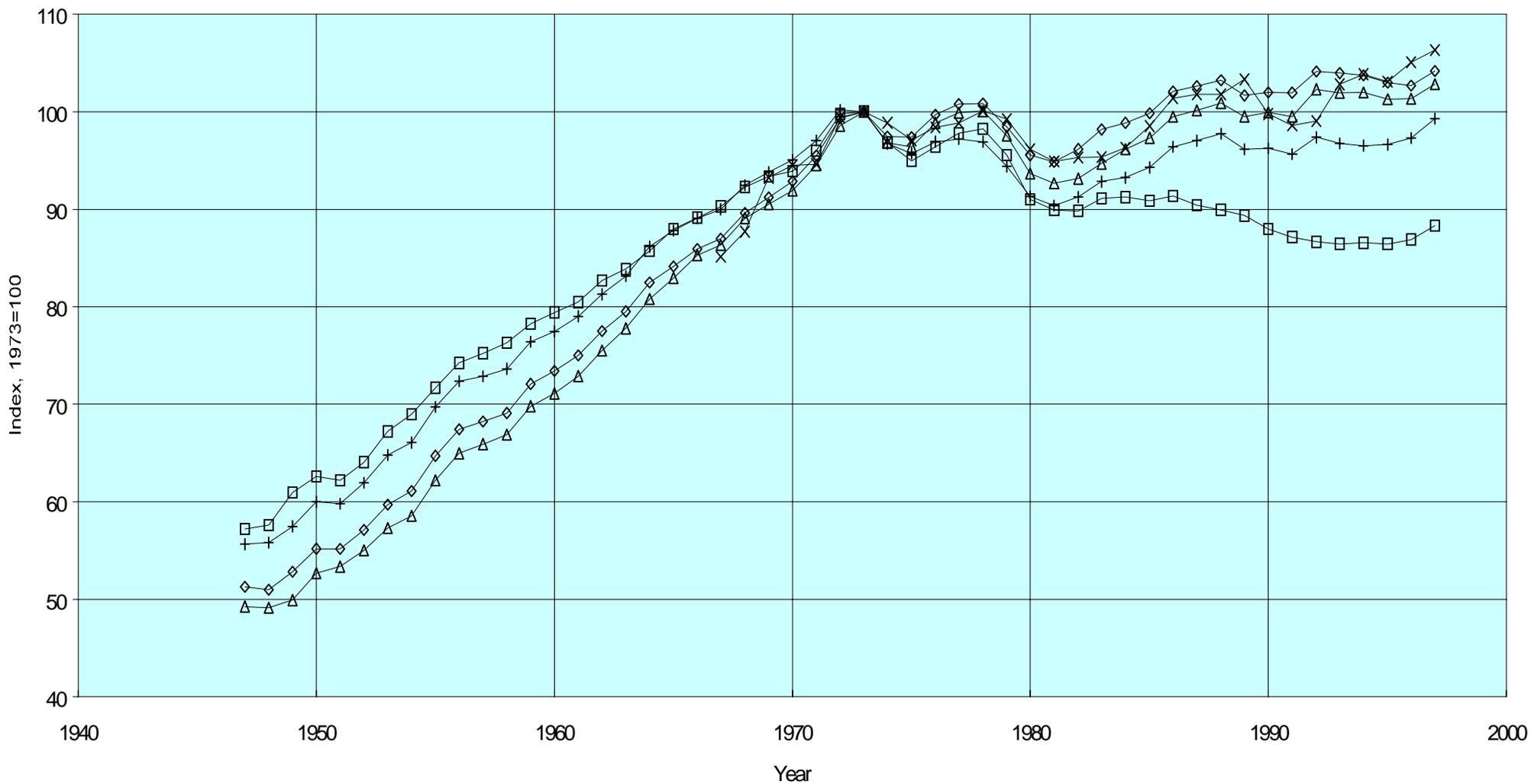
Study	Effect of Trade	Detailed Explanation
Borjas, Freeman and Katz (1992)	Substantial	Trade and immigration flows caused between 30 and 50 percent of the 10 percent decline in the relative weekly wage of high school dropouts, 1980-1988. Trade deficit caused between 15 and 25 percent of the 11 percent rise of the earnings of college graduates relative to high school graduates, 1980-1985.
Murphy and Welch (1991)	Substantial	Exact match exists between the signs of relative labor demand changes predicted by changes in international trade with both the observed changes in the distribution of employment between industries and relative wages.
Katz and Murphy (1992)	Small	Trade-induced changes in relative demand move in the correct direction to explain wage differentials, but are quite small in magnitude.
Bound and Johnson (1992)	Small or none	Effects of trade are negligible because estimates of total relative demand shifts are small.
Leamer (1992)	Substantial	Estimated changes in real earnings induced by low-wage foreign competition range from \$3,000 to \$30,000 increase for professional and technical workers, an increase of \$7-\$67 per \$1,000 of capital, and a decline of \$900 to \$9,000 for the earnings of other workers.
Krugman and Lawrence (1993)	Small	Compared the change in the ratio of white-collar to blue-collar wages with the change in their relative employment in U.S. manufacturing sectors from 1979 to 1989. They found that nearly all industries were employing more of the white-collar workers, and the shift in the mix of employment toward skill intensive industries was not substantial
Lawrence and Slaughter (1993)	None	Trade is dismissed as an explanation for changes in relative wages because international prices move in the opposite direction from that predicted by the Stolper-Samuelson theorem.
Baldwin and Cain (1994)	Small	Trade pressures explain at most 9 percent of growth in U.S. wage inequality from 1977-1987 and even less of the further increase in wage inequality after 1987 and none of the fall in wage inequality from 1967-1977. After 1987, unskilled-labor augmenting technical change seems most important factor; for 1967-77, factor-supply growth seems most important factor.

Sachs and Shatz (1994)	Small	Using a special database detailing imports and exports of goods for 131 manufacturing industries and 150 trading partners, they estimated that the increase in net imports over the period 1978-1990 was associated with a drop of 7.2 percent in production jobs in manufacturing and only a 2.1 percent fall in non-production jobs in manufacturing. By itself, these shifts could not have accounted for even as much as a 10 percent decrease in the wages of low skilled workers relative to high skill workers.
Leamer (1996)	Substantial	Using price, TFP growth, and initial factor share data for 450 4-digit SIC industries, he estimated that trade effects were responsible for 40 percent of the decline in the relative wages of less skilled workers during the 1980s.
Haveman (1993)	Substantial	Workers displaced from industries engaged in international trade under 37 weeks of transitional unemployment, compared to 21-22 weeks for other displaced workers. Roughly 4 weeks of the 16-week difference are due to the trade designation of the industry, with the remaining 12 weeks associated with the personal characteristics of the workers. Two years after displacement, workers from industries engaged in trade and that have suffered declines in employment recover 5-9 percent less of their pre-displacement wages than other displaced workers.
Kletzer (1994)	Small	The elasticity of an industry's displacement rate with respect to its import penetration ratio was 0.11 to -0.07 with respect to the ratio of exports to shipments. The negative estimated effect of the import penetration ratio on the probability of the worker re-employment could not be separated from the negative effects of worker characteristics. Import penetration ratios had no significant explanatory power in predicting earnings recovery.
Brauer and Hickok (1995)	Small	They examined the effects of the change in the import penetration ratio, the ratio of imports from developing countries to total domestic demand, on real average hourly earnings by industry over the 1979-89 period. They estimated that changes in trade accounted for only about 15 percent of the explained portion of the widening wage gap between high school and college graduates
Wood (1991, 1994, 1995)	Substantial	Uses the factor content approach to calculate the amount of skilled and unskilled labor used to produce exports in developed countries and imports in developing countries. He estimated that international trade reduced the demand for unskilled labor by 22 percent
Bernard and Jensen	Substantial	Shifts between exporting and non-exporting plants (within the

(1997)

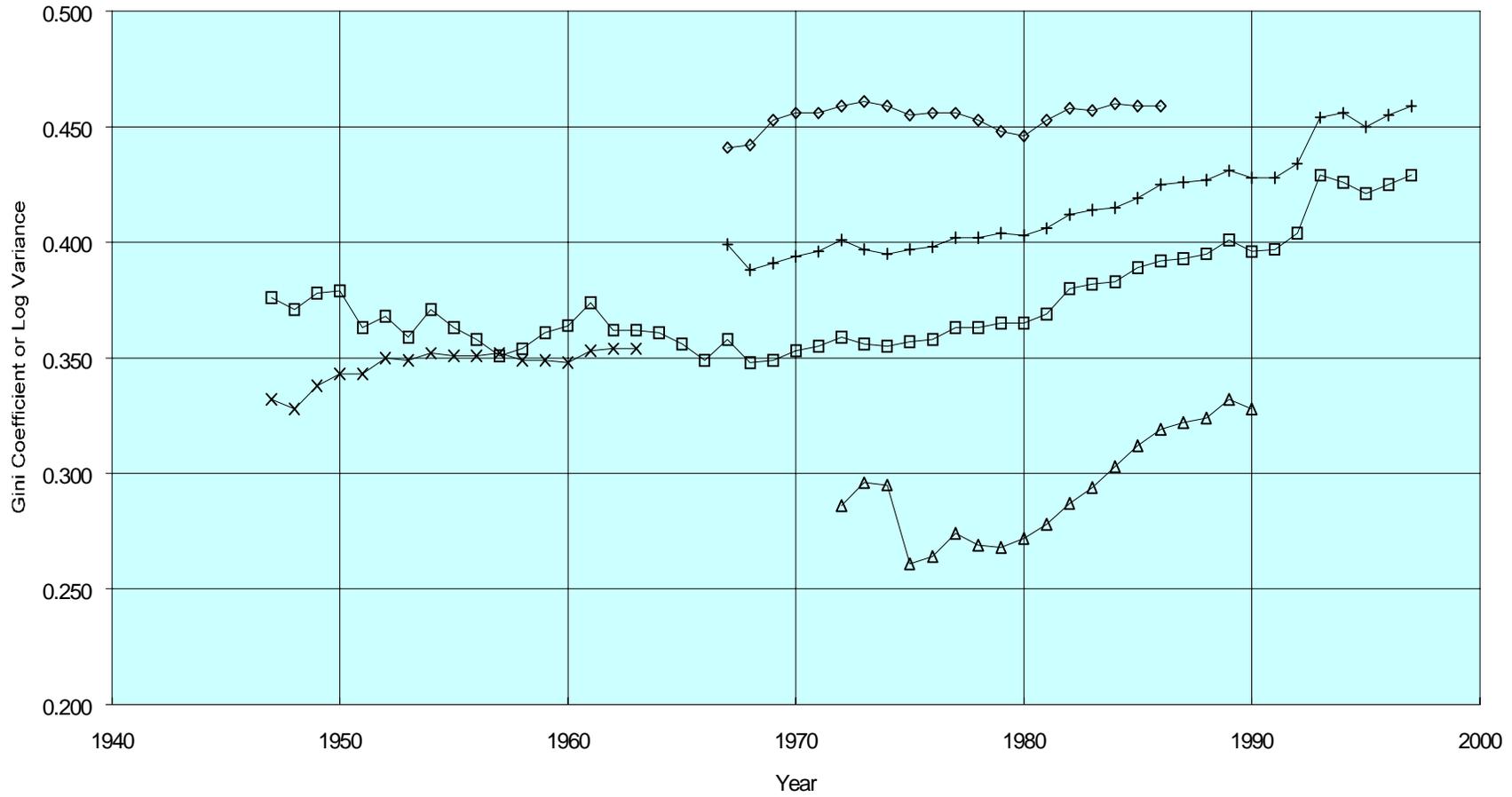
same industry) are associated with roughly half of the growth in U.S. employment and payroll shares of non-production relative to production workers over the 1980-87 period. Explicit measures of plant-level technological investment are associated with the same shifts between production and non-production workers over the 1980-87 period within a typical plant but not with the theoretically more important shifts between plants that export and those that do not.

Figure 1. Labor Earnings Indices, 1947-1997  
 [1973=100]



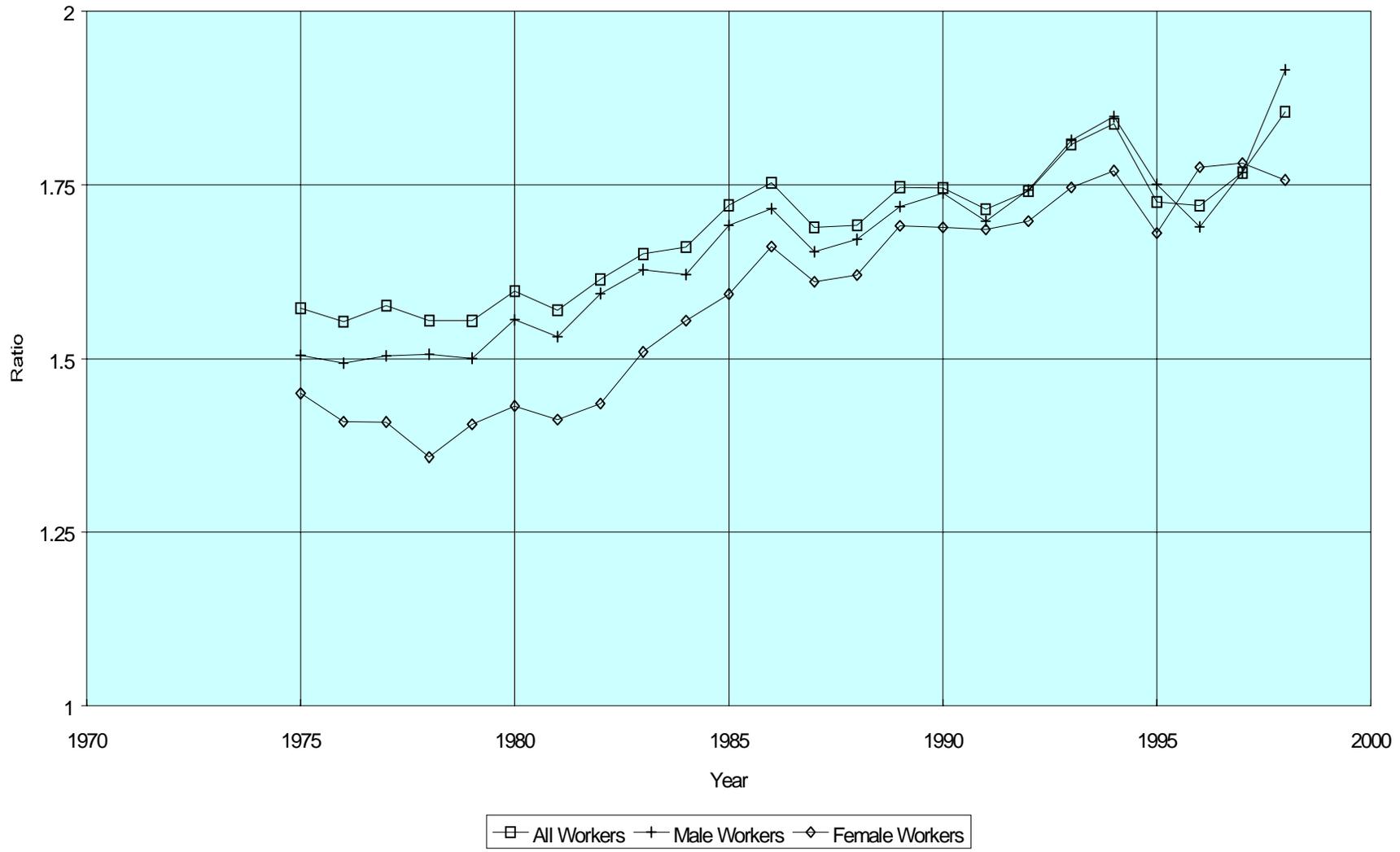
□ Mean Hourly Earning     
 + NIPA Wages and Salaries per FTEE     
 ◇ NIPA Employee Compensation per FTEE  
△ NIPA Employee Compensation plus 1/2 Proprietors' Income     
 × CPS Mean Earnings per Full-time, full-year Workers

**Figure 2. Inequality of Income and Earnings,  
1947-1997**

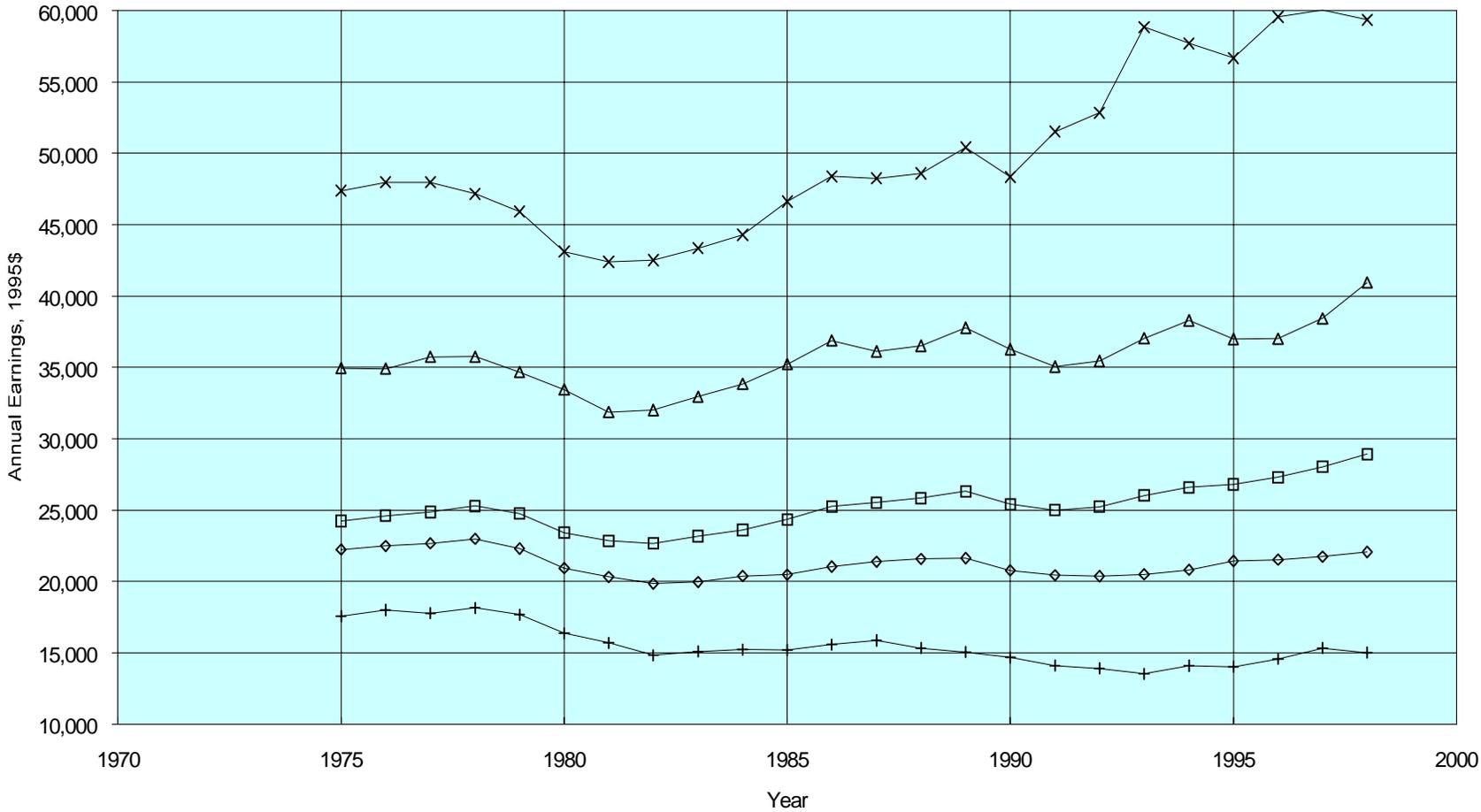


-□- Gini Coefficient: Family Income      -+ Gini Coefficient: Household Income      -◇- Gini Coefficient: Annual Earnings  
 -△- Log Variance: Full-time, Full-year Earnings      -x- Gini Coefficient: Hourly Wages

**Figure 3. Ratio of Mean Annual Earnings  
Between College Graduates and High School Graduates by Gender, 1975-1998**

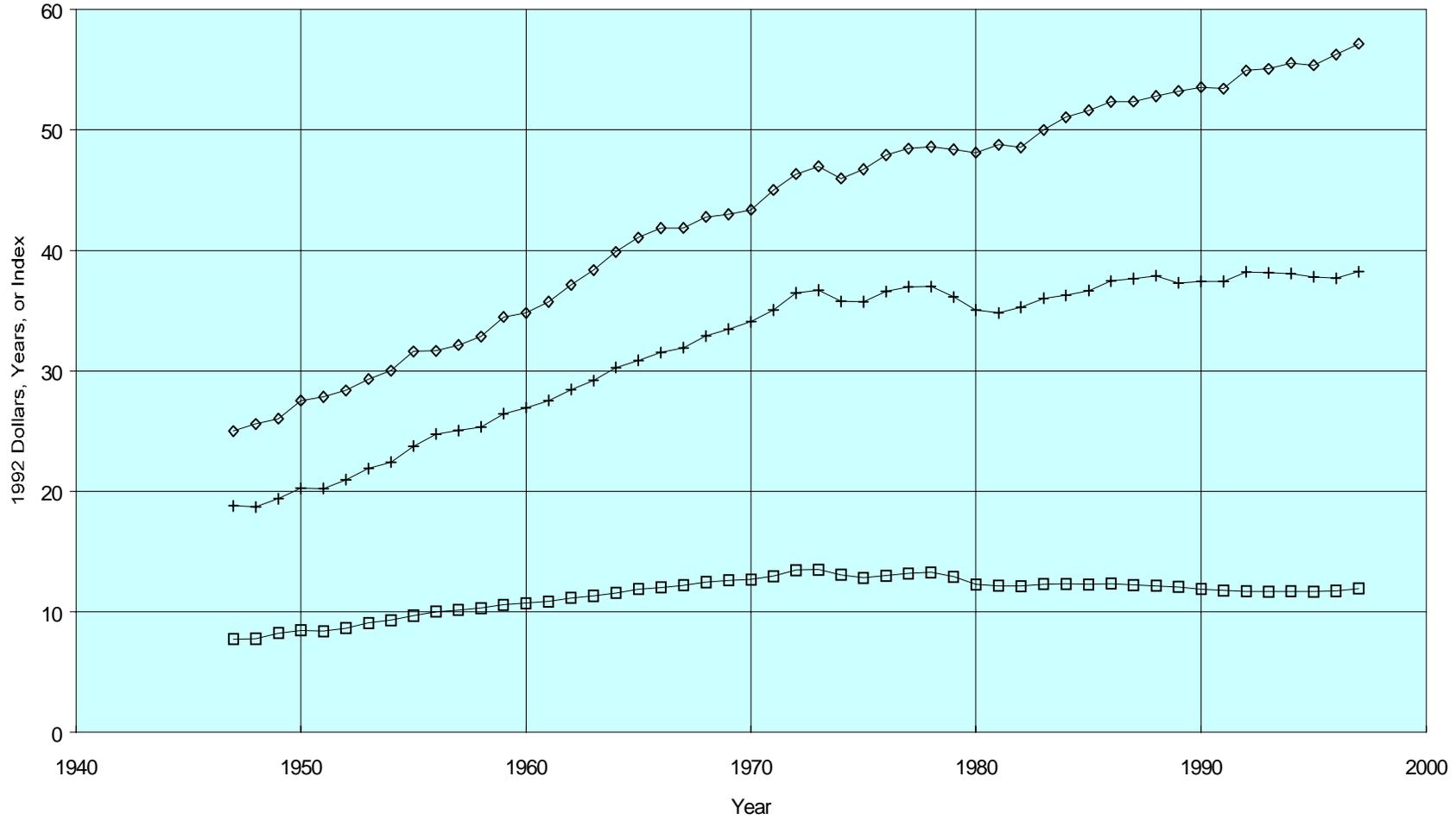


**Figure 4. Mean Annual Earnings, in 1995\$  
By Educational Attainment Level, 1975-1998**



□ All Workers  
 + Less than 4 Years of High School  
 ◇ High School Graduates  
 △ College Graduates  
 × Advanced Degrees

Figure 5. Earnings and Labor Productivity, 1947-1997



—□— Mean Hourly Earnings (1992\$) —+— NIPA Employee Compensation per FTEE (1992\$) —◇— Labor Productivity (GDP in 1992\$ per PEP)

Figure 6. Earnings, Equipment Investment, and OCA Investment, 1947-1997

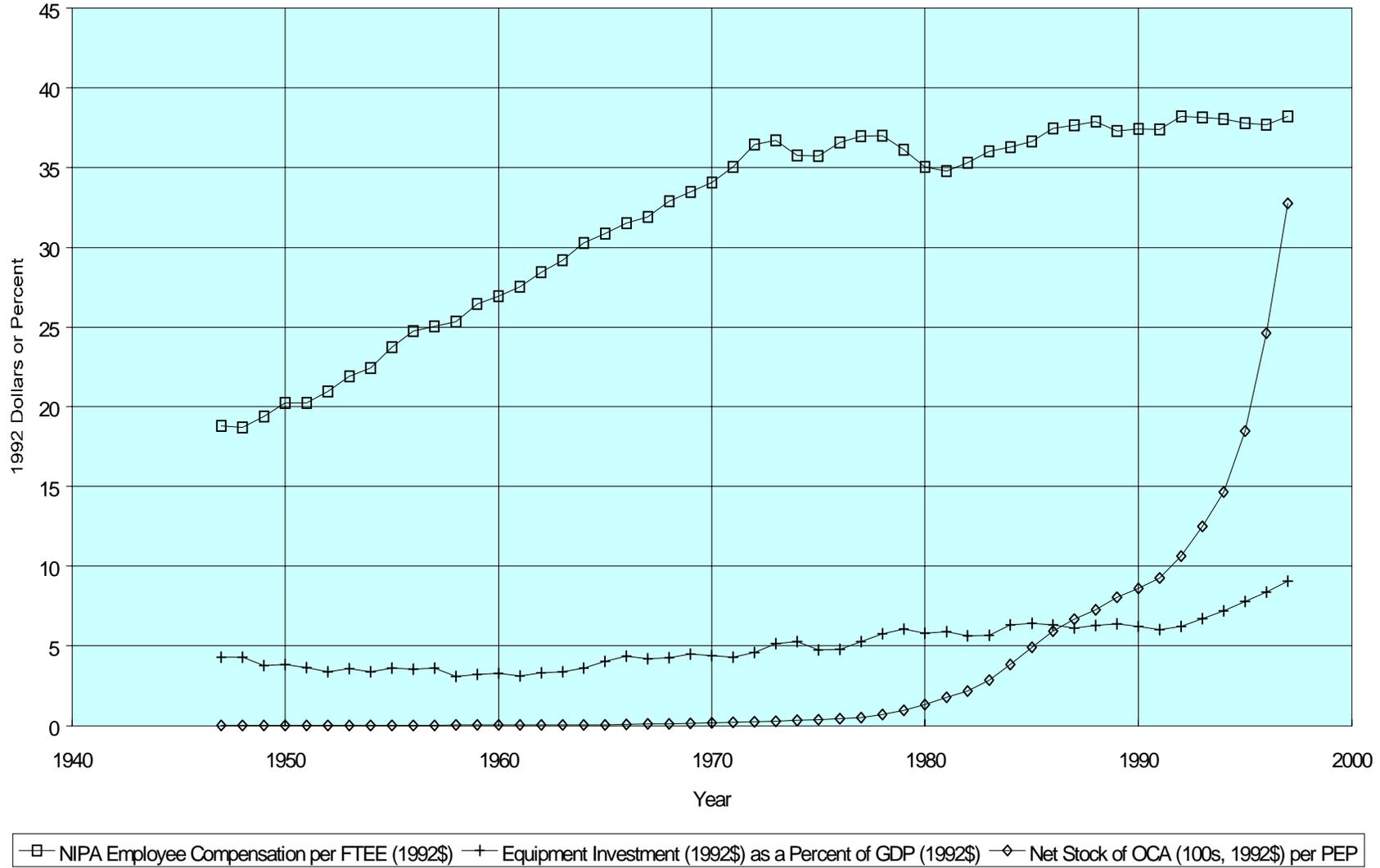
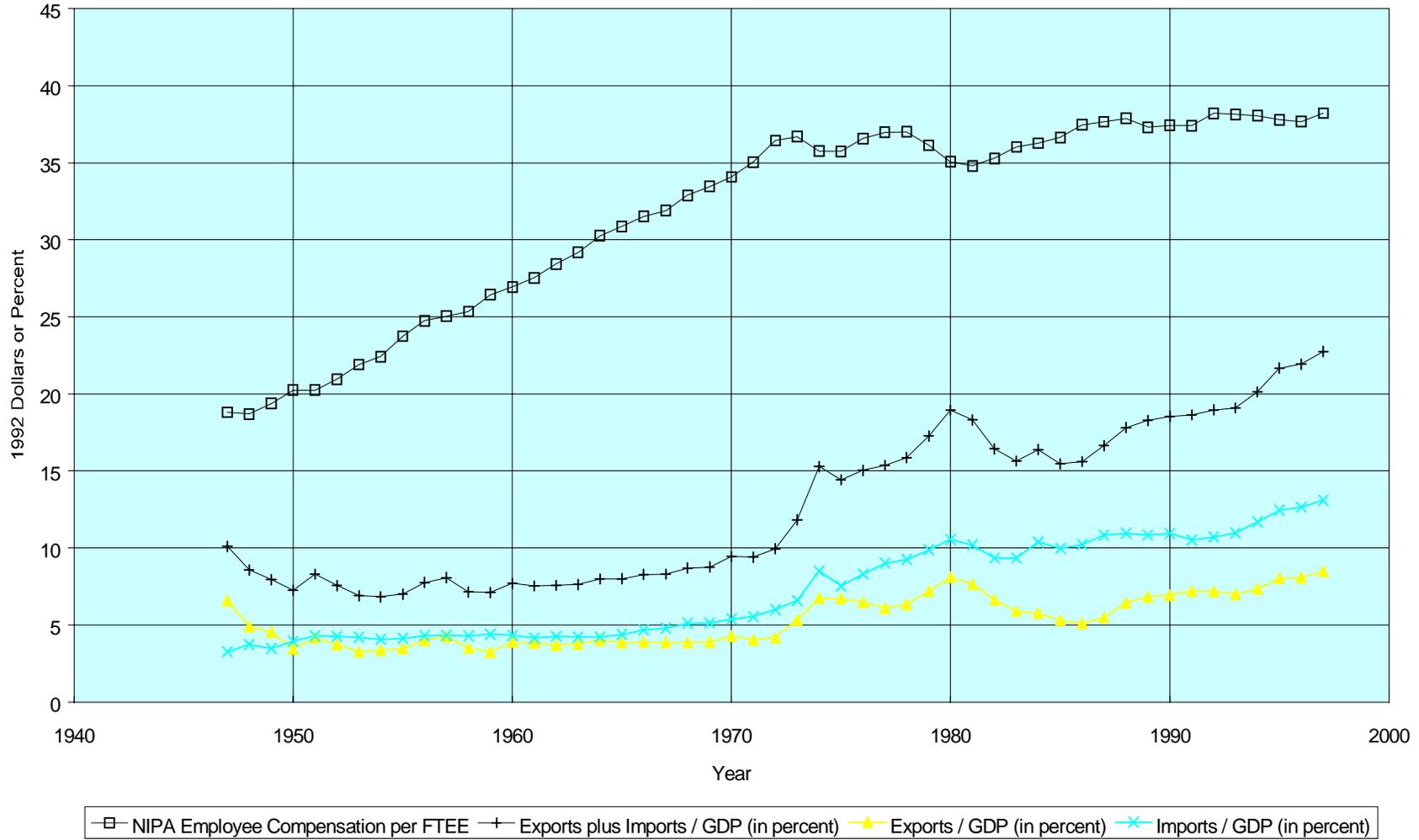
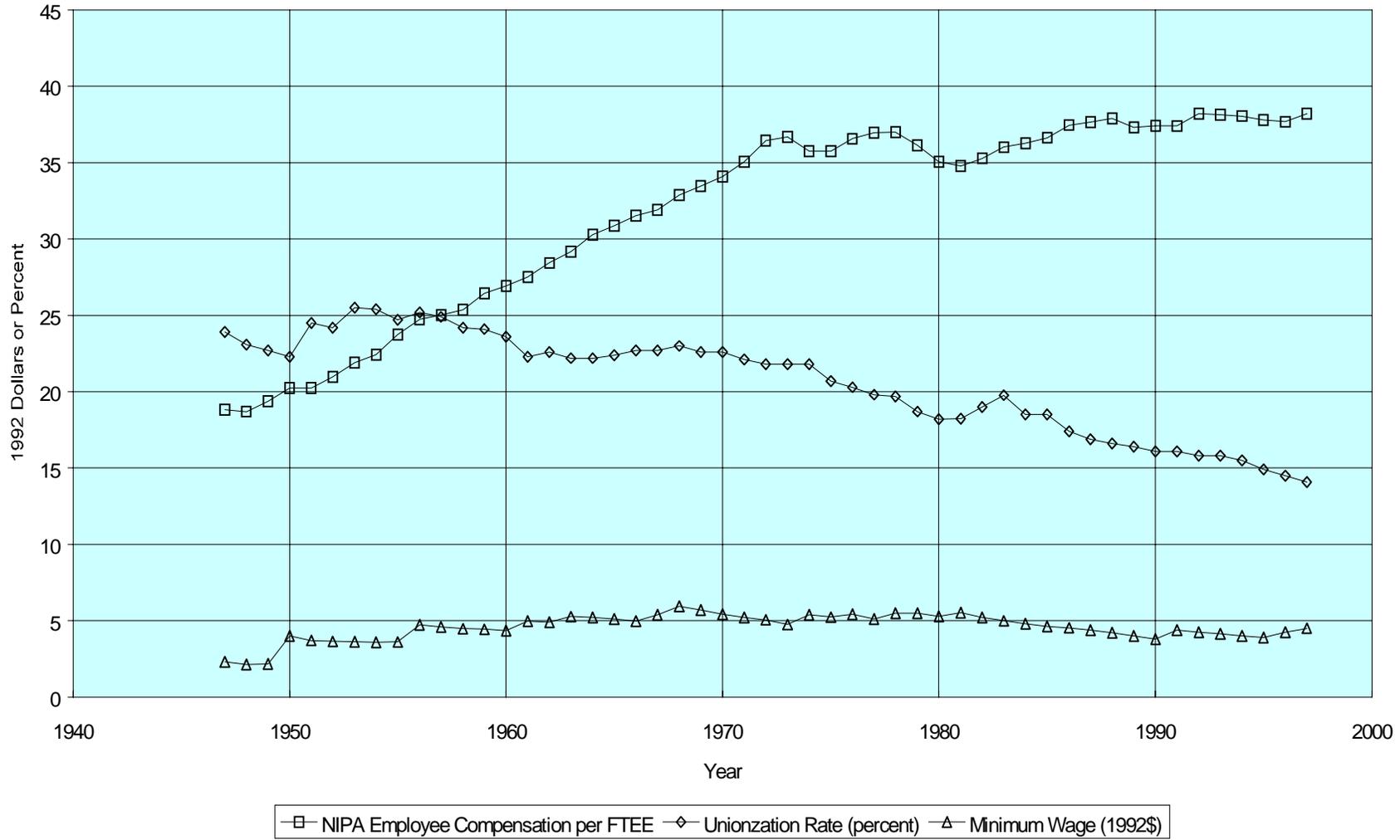


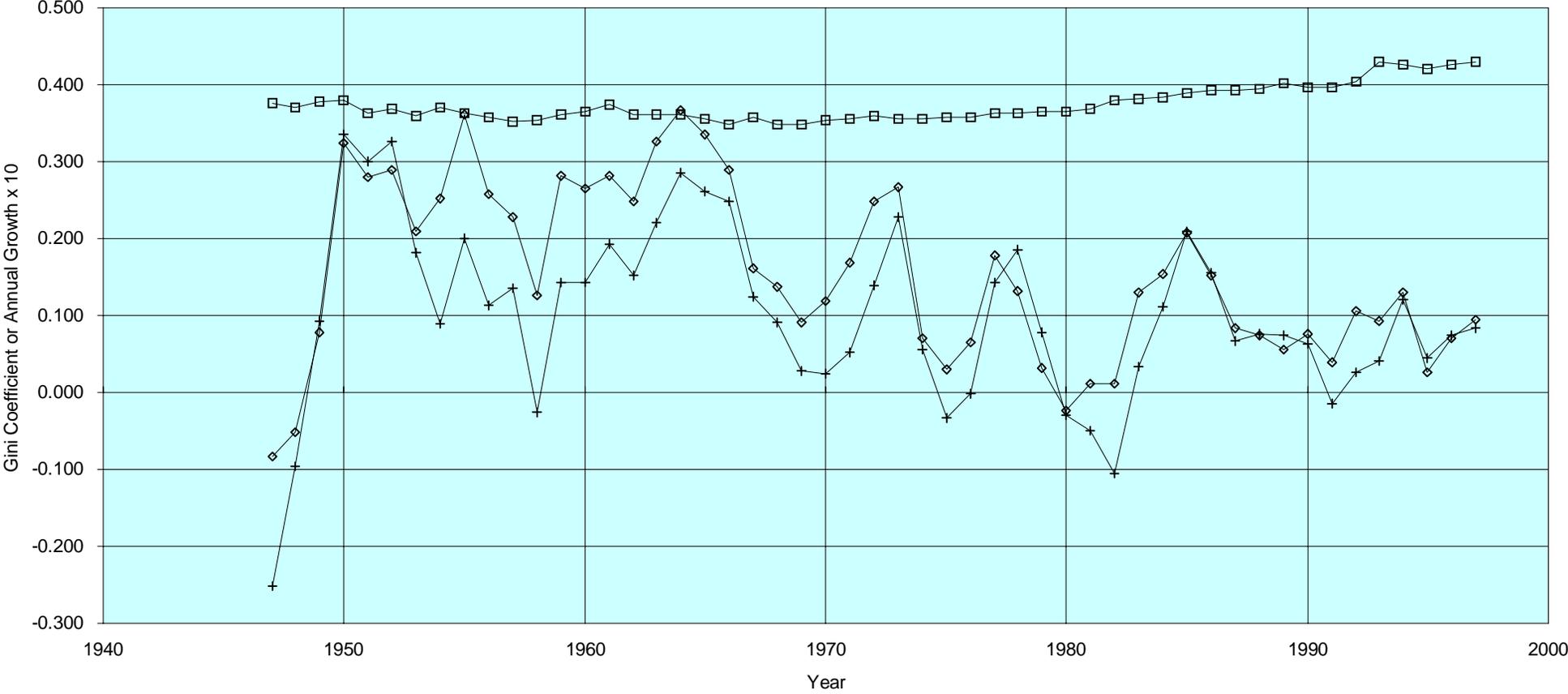
Figure 7. Earnings and International Trade, 1947-1997



**Figure 8. Earnings, Unionization,  
And the Minimum Wage, 1947-1997**

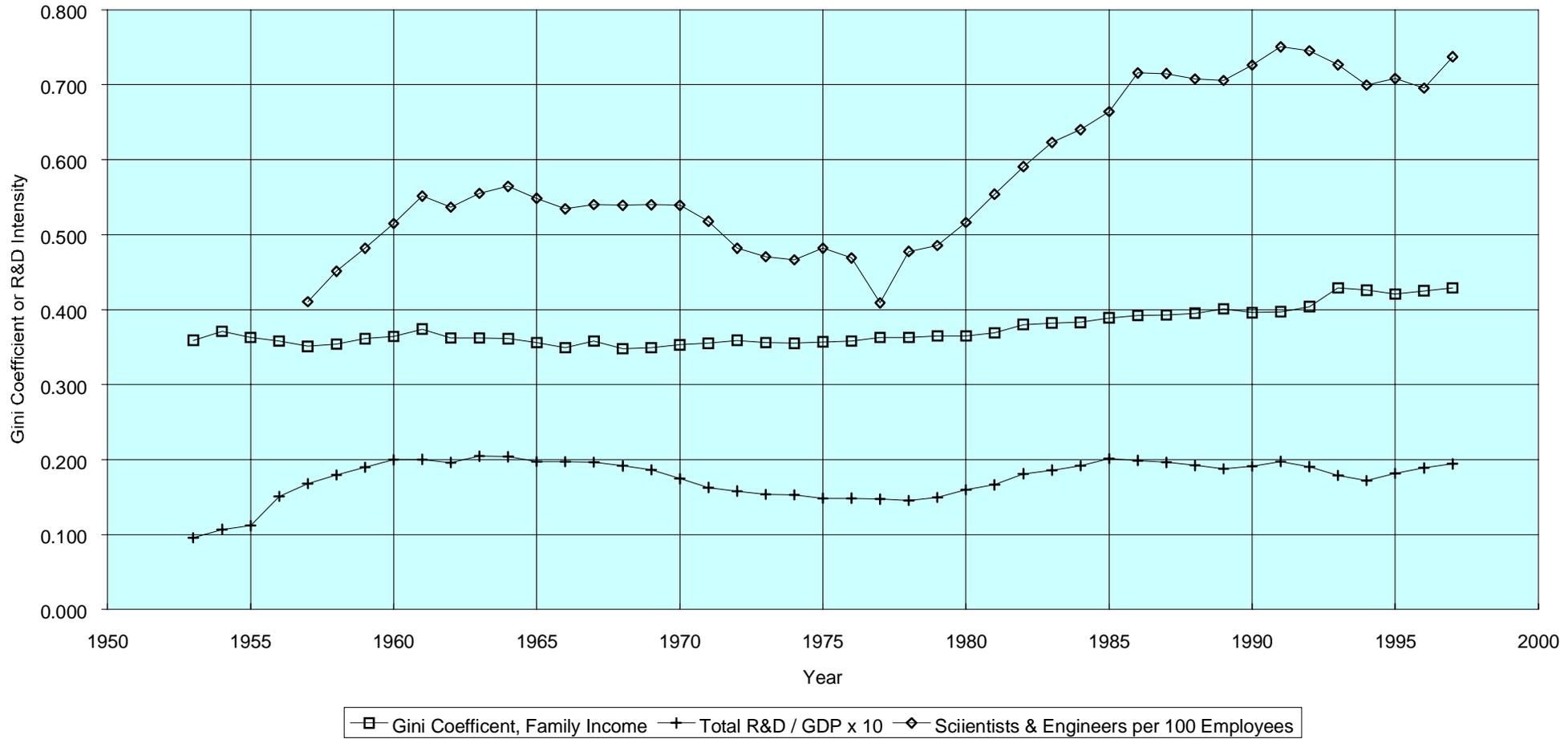


**Figure 9. Family Income Inequality, Labor Productivity Growth, And TFP Growth, 1947-1997**

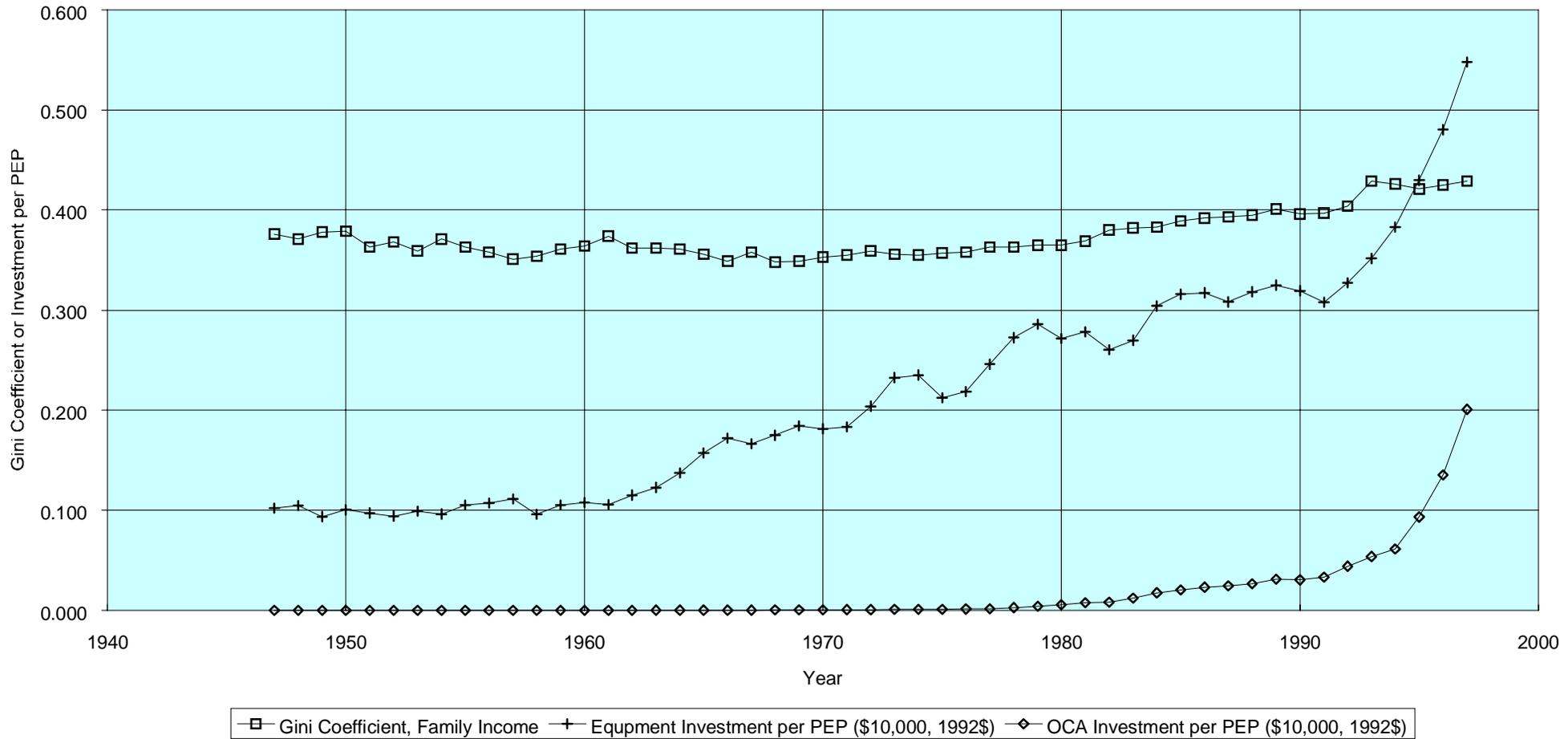


—□— Gini Coefficient, Family Income —+— TFP Growth x 10, (three-year running average) —◇— Labor Productivity Growth x 10 (three-year running average)

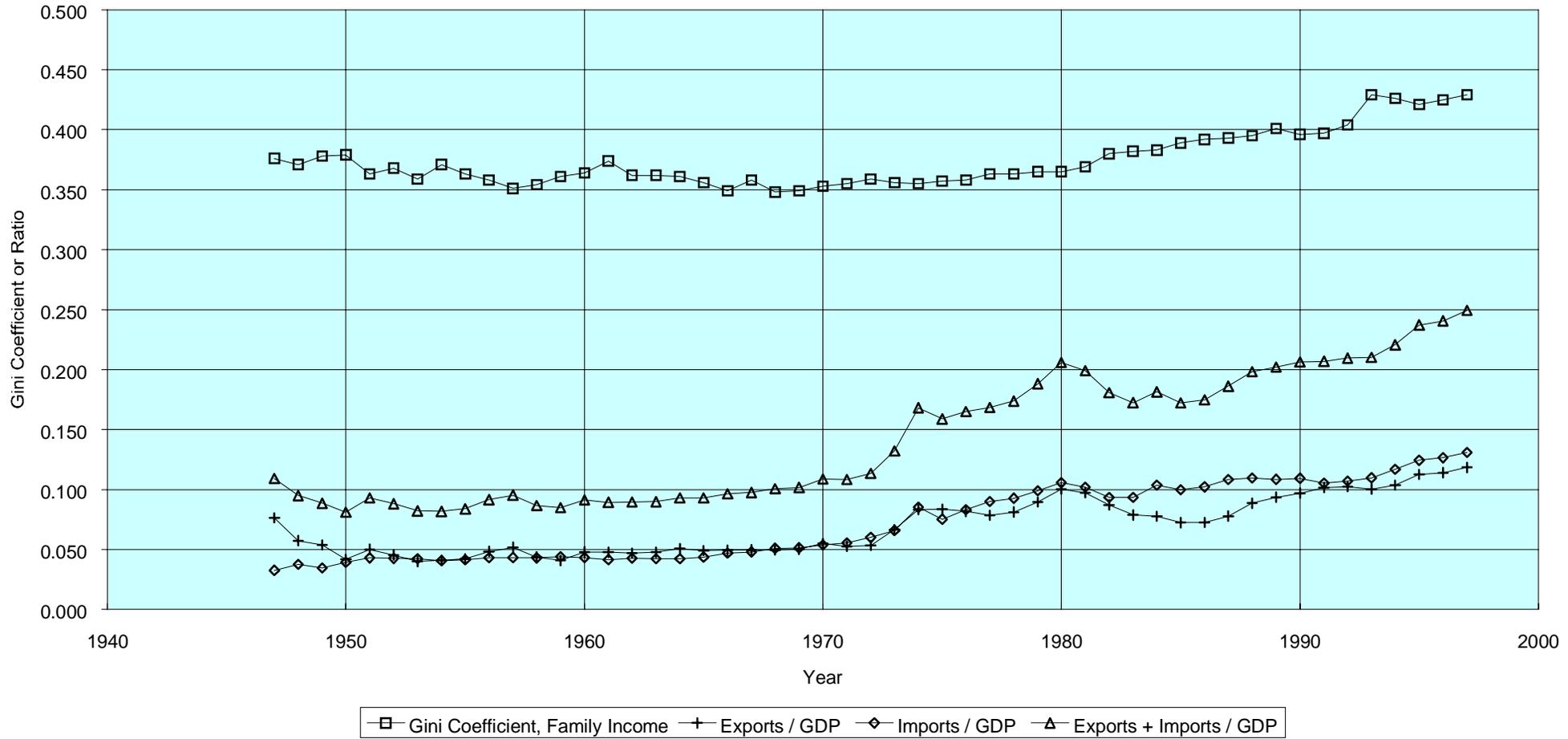
Figure 10. Family Income Inequality and R&D Intensity, 1953-1997



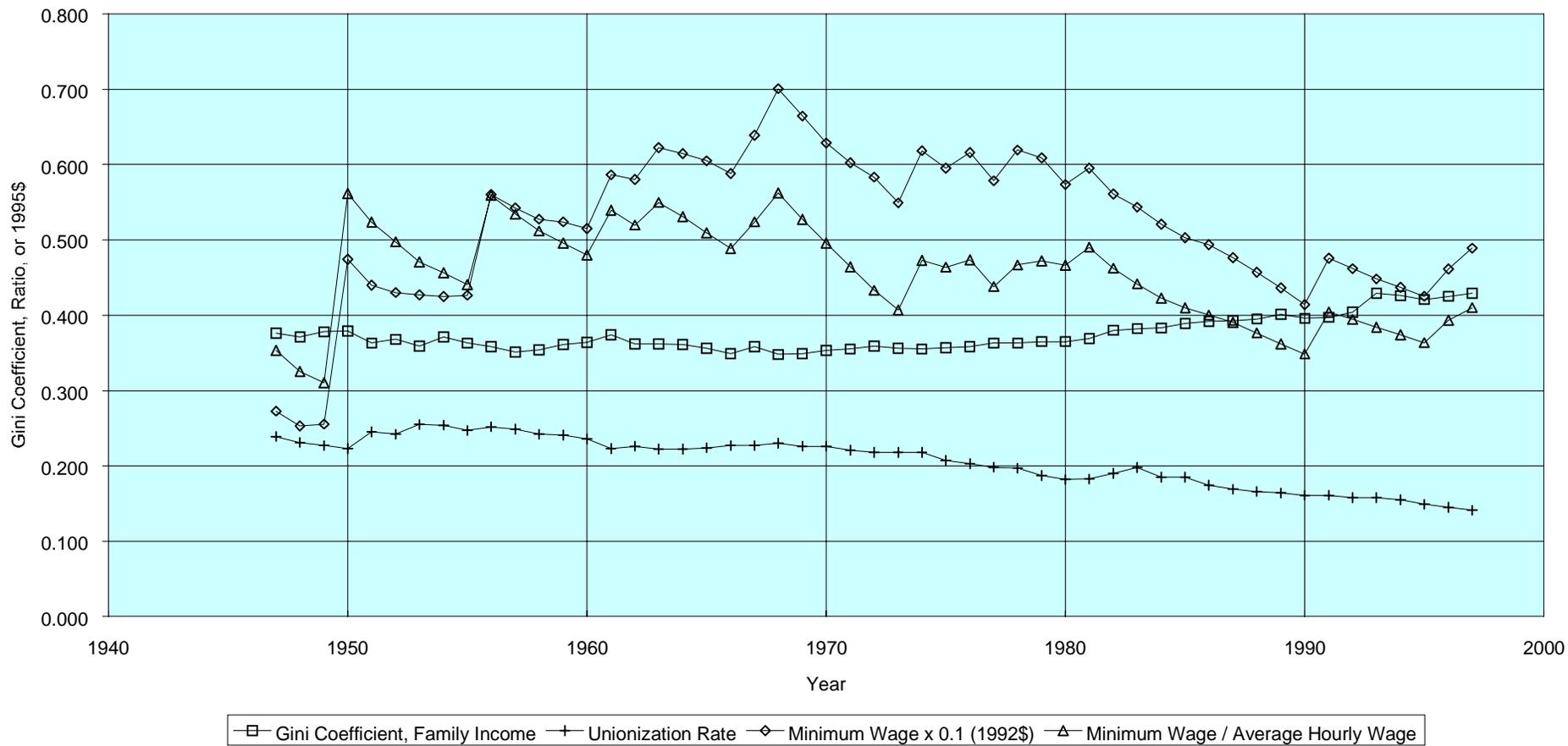
**Figure 11. Family Income Inequality and Investment in Equipment and OCA per PEP, 1947-1997**



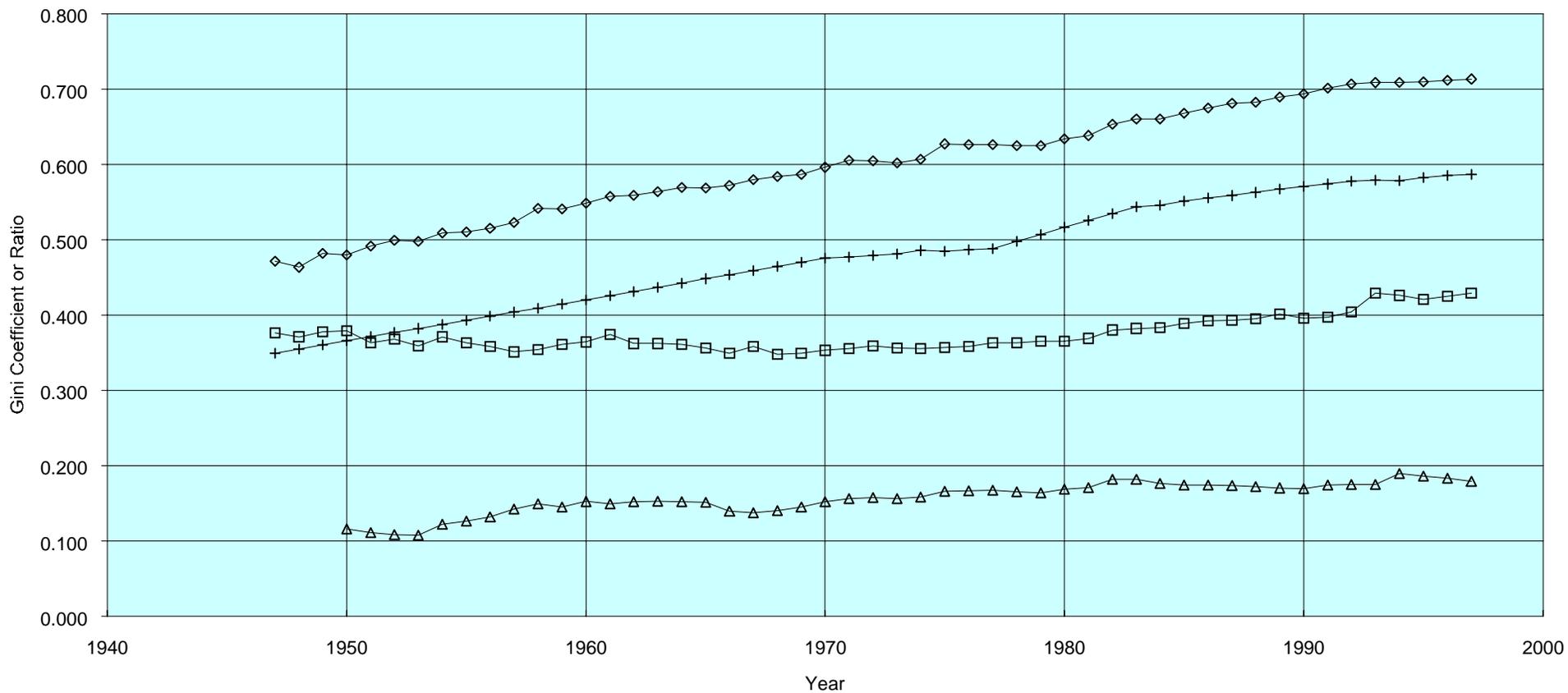
**Figure 12. Family Income Inequality and International Trade, 1947-1997**



**Figure 13. Family Income Inequality, Unionization, and The Minimum Wage, 1947-1997**



**Figure 14. Family Income Inequality and Employment Composition Trends, 1947-1997**



□ Gini Coefficient, Family Income  
 + White-Collar Employment / Total Employment  
 ◇ Service Sector Employment / Total Employment  
 △ Part-time / Total Employment