Stanford Center for International Development

Working Paper No. 193

The Effect of Macroeconomic Turbulence on Real Wage Levels and the Wage Structure: Brazil 1981-1999

by

Frank McIntyre*

John Pencavel**

November 2003

Stanford University
John A. and Cynthia Fry Gunn Building
366 Galvez Street | Stanford, CA | 94305-6015

* Assistant Professor, Department of Economics, Brigham Young University
** Professor, Department of Economics, Stanford University

The Effect Of Macroeconomic Turbulence On Real Wage Levels and the Wage Structure: Brazil, 1981-1999

Frank McIntyre* and John Pencavel**

September 2003

* Department of Economics, Brigham Young University, Provo, Utah, 84602-2363.

** Department of Economics, Stanford University, Stanford, California 94305-6072.

THE EFFECT OF MACROECONOMIC TURBULENCE ON REAL WAGE LEVELS

AND THE WAGE STRUCTURE: BRAZIL, 1981-1999

Frank McIntyre and John Pencavel

ABSTRACT

How does a turbulent macroeconomic environment affect real wage levels and the wage structure? A method for addressing this question is offered and then applied to data for Brazil between 1981 and 1999. Cohorts of workers are followed over time to determine whether movements in median wages are associated with age or with calendar year events. Changes in the wage structure - by gender, by schooling, and by formal-informal sector - are investigated. Profound macroeconomic impacts on real wage <u>levels</u> are clearly identified but effects on the wage <u>structure</u> are far less.

THE EFFECT OF MACROECONOMIC TURBULENCE ON REAL WAGE LEVELS AND THE WAGE STRUCTURE: BRAZIL, 1981-1999

Frank McIntyre and John Pencavel*

I. Introduction

In recent years, the literature in labor economics on the level and structure of real wages has concentrated on issues surrounding the impact on wages of technological change, international trade, immigration, fertility, and de-unionization. Rarely has this literature examined the effects of changes in macroeconomic policy on the wage structure. At the same time, at least since Keynes' General Theory, wages have occupied a key position in macro-economic models of the economy. The research in this macroeconomic tradition has tended to focus on a few key wage indicators and, typically, has chosen to overlook the detailed structure of wages. This paper attempts to link these two research traditions by investigating the effects of macroeconomic forces on an economy's wage level and wage structure.

Given the host of interrelated forces operating on wages, under typical circumstances, it will be difficult to discriminate between the effects of changes in monetary and fiscal policy on wages and the effects of many other variables. Therefore, we turn to an economy whose recent experiences cannot be described as typical. This economy is Brazil over the past two decades. For several reasons, Brazil provides an excellent opportunity to examine the effects of macroeconomic forces on the wage structure. First, by comparison with other countries, Brazil's wage distribution is very wide and so the opportunity to identify changes in this wage structure should be easier than in a society where wage dispersion is much narrower.[1] Second, Brazil has endured extraordinary macroeconomic disturbance over the past twenty years or so with price inflation varying from four percent per year to over thirty percent per month. The sharp changes in fiscal and monetary policy and, in some years, the accompanying price freezes provide a remarkable and distinctive set of circumstances to examine how macroeconomic shocks affect an economy's wage structure.

Brazil's inflation and growth record over the years from 1981 to 1999 (the period of study in this paper) are shown in Figure 1. Note that price inflation is measured in natural logarithms so, in this figure, values of more than 7 in 1989, 1990, 1993, and 1994 imply annual inflation rates of over one thousand percent![2] These astonishing inflation rates and lackluster real growth spawned a series of stabilization programs starting with the Cruzado Plan in 1986-87[3] through to the Collor Plan in 1990. Typically these programs involved price freezes, cuts in government expenditure, and currency reforms, but none of them led to more than a temporary respite from high and variable inflation until the Real Plan in 1994 which launched a new currency, changed government budgetary procedures, floated the foreign exchange rate, raised interest rates to encourage foreign capital, and further liberalized foreign trade. How have these macroeconomic shocks affected the real wages of different groups of workers?

Relevant to this question is Brazil's wage indexation policies that, from 1965, required some sort of mechanical adjustment of money wages to changes in prices. The indexation formulas were not simple. The adjustment multiplier (that is, the degree to which wages were adjusted to a given increase in prices) was a negative function of wages so, if nothing else were involved, inflation ought to have narrowed wage differentials. However, the wage adjustments also incorporated an estimate of productivity growth, an estimate that could be the subject of bargaining between workers and management. After changes in the indexation provisions in the late 1970s,[4] disputes between workers and management over the amount of wage adjustment attributable to productivity growth could be taken to arbitration. Furthermore, statutory requirements are not the same as what actually applies in practice: the statutory indexation regulations were less likely to cover workers in the informal sector of the economy. Hence, the wage indexation mechanisms in Brazil did not rule out either changes in the level or in the structure of real wages.

Some reasoning from Economics might suggest that wage dispersion increases in inflationary periods. For instance, an influential view is that, because price and wage changes are not synchronized, inflation tends to be associated with greater price and wage dispersion and, indeed, the distortion of relative prices and wages represents a major cost of inflation.[5] In addition, some have argued that workers with more schooling are better able to "deal successfully with economic disequilibria"[6] and, in an inflationary context, are more effective in protecting their real incomes. This would imply wage differentials by the schooling of workers that widen in inflationary periods or in times of macroeconomic instability. These are plausible conjectures although other models imply a narrowing of wage differentials in inflation.[7] There seems to be scant empirical information on this. Perhaps the closest precursor to this paper is the research of Carola Pessino[8] who examined wage differentials in Buenos Aires in the late 1980s and early 1990s. She found that the earnings premium associated with more years of schooling tended to rise in hyperinflation.

Prompted by this finding, we investigate earnings differentials by schooling and, indeed, by other characteristics for Brazil and ask whether wage dispersion increased during the years of macroeconomic turmoil. Wage and other information from annual household surveys between the years 1981 and 1999 (except in 1994 when no survey was taken) are used to estimate median wage regressions from which age-earnings profiles of different birth cohorts are constructed. We determine whether the shocks to these profiles are associated with macroeconomic, calendar year, events. A methodology is offered that, under certain circumstances, discriminates between the impact of calendar year (macro-economic) events on individuals' wages and the impact of age, experience, and other factors on these individuals' wages.

II. Estimation Procedures and Data

This section describes the methodology behind the wage series reported in Sections III and IV below.

Distinguishing Macroeconomic from Age Effects on Wages

Assume the logarithm of the hourly earnings, W_i, of individual i is a quartic function of this individual's age, a_i, and other factors, ε_i:

$$ln(W_i) = \sum_{j=0}^{4} \mu_j a_i^j + \varepsilon_i$$

and let these μ_j coefficients be a quadratic function of the individual's years of schooling, s:

$$\mu_j(s) = \sum_{k=0}^{2} \mu_{jk} s^k, \qquad j = 0,1,2,3,4.$$

Hence, the parametric form for the logarithm of hourly wages is

$$ln(W_i) = \sum_{k=0}^{2} \sum_{j=0}^{4} \mu_{jk} s_i^k a_i^j + \varepsilon_i \tag{1}$$

which permits nonlinear wage-age profiles that vary by years of schooling. Equation (1) is fitted to observations on male and female employees separately. The employees are aged from 15 to 70 years and the data are drawn from surveys for each calendar year from 1981 until 1999 (excluding the year 1994).[9] With eighteen calendar years and two genders, 36 regression equations are estimated in all:

$$ln(W_i(g,t)) = \sum_{k=0}^{2} \sum_{j=0}^{4} \mu_{jk}(g,t) s_i^k a_i^j + \varepsilon_i(g,t) \qquad (2)$$

where *g* stands for gender and *t* for calendar year.[10]

The series of calendar year cross-section relationships between wages and age (for each schooling level and for each gender) in equation (2) may be arranged to track the relationship between wages and age of a given birth cohort. That is, let *c* represent the year of birth of a given cohort, then necessarily $t = a + c$ and equation (2) describes an age profile for wages for people belonging to a particular birth cohort, *c* :

$$ln(W_i(g,c+a)) = \sum_{k=0}^{2} \sum_{j=0}^{4} \mu_{jk}(g,c+a) s_i^k a_i^j + \varepsilon_i(g,c+a) \qquad (3)$$

Hence, for each level of schooling and gender, a cohort's life cycle path of wages may be constructed.[11]

Our procedure is to associate macroeconomic effects on wages with calendar year effects and assess whether macroeconomic events in particular years have a discernible impact on wages. However, we intend also to investigate age effects and cohort effects on wages in which case, if macroeconomic effects are to be associated with calendar year effects, how is the linear dependence among age effects, cohort effects, and calendar year effects to be resolved? That is, if a person's cohort is associated with his year of birth, then the calendar year *t* is the sum of a person's cohort and his age: $t = a + c$. As is well known, this linear dependence among age, year of birth (cohort), and calendar year creates an identification problem in linear models that can be resolved only by imposing some normalization or exclusion restrictions on a description of the evolution of wages. Our procedure will be as follows.[12]

Suppose the wages on individuals born in different years (that is, belonging to different cohorts) with a given amount of schooling are followed over calendar time. For expository purposes, we ignore stochastic components of equations in what follows. We shall define a macroeconomic impact on wages to be present if, in the evolution of wages over calendar time for different cohorts, the calendar year changes are independent of cohort (that is, the wage changes are the same for all cohorts) so wage changes may be written as a function of calendar time only:

$$\Delta ln W(t, c) = f_1(t) \tag{4}$$

where Δ denotes the year-to-year change. Upon integration, this equation implies an additivity property when wages are expressed in levels:

$$ln W(t, c) = k_1 + f(t) + g(c) \tag{5}$$

where f_1 (t) is the time differential of $f(t)$ and where k_1 is an integrating constant. If equation (4) holds, then when organized by calendar year, the wages of people belonging to different cohorts change to the same extent at the same calendar time. In other words, in the case of Brazil in the 1980s and 1990s, the principal macroeconomic effects are expected to be those in years characterized by very high inflation rates and stabilization programs and, according to equation (4), such macroeconomic effects will be manifested in wage profiles that are displaced in the same calendar year even though this displacement corresponds to different ages for people belonging to different birth cohorts. Note, however, because $t = a + c$, the additivity property of equation (5) means there are necessarily age effects in the wage equation that are not separable from the cohort effects. That is, equation (5) may be written

$$lnW(a+c,c) = k_1 + f(a+c) + g(c)$$

and changes in wages with age are a function both of age and of cohort as given by the form of the function $f(a + c)$.

If the shocks to wages take the form of age effects and not macroeconomic effects, consider organizing the data on wages by age and follow the evolution of wages of people belonging to different cohorts as they age. Age effects are defined as wage changes that occur at the same age for people of different cohorts:

$$\Delta lnW(a,c) = h_1(a) \tag{6}$$

so wage changes are independent of cohort. Upon integration, this equation implies an expression for the level of wages in which age and cohort appear in an additive form:

$$lnW(a,c) = k_2 + h(a) + j(c) \tag{7}$$

where $h_1(a)$ is the time differential of $h(a)$ and where k_2 is an integrating constant. If equation (6) holds, then when organized by the ages of workers, the wages of people belonging to different cohorts change in a comparable manner at the same age. Once again, the linear dependence of age, cohort, and calendar year means that, if equation (7) holds, then calendar time effects enter the wage level equation in a distinctive fashion, namely,

$$lnW(t-c,c) = k_2 + h(t-c) + j(c) \tag{8}$$

and wage changes are a function of calendar time, t, and cohort, c, as given by the form of $h(t\text{-}c)$.

Hence, when wage profiles of different cohorts are graphed against calendar time, macroeconomic effects are manifested through shifts in these wage profiles that occur at about the same calendar year. Effects that are specific to particular cohorts are manifested in wage profiles whose shapes differ across cohorts when plotted against age. Age effects on wages are suggested when, upon organizing the data on wages of different cohorts by age, wages change at the same age.

The wages and wage differentials for a given age and schooling reported below are imputed from wage regression equations fitted to either male or female workers in a given calendar year. We seek to derive implications for the hourly earnings of the median man or woman in a given calendar year so we choose to estimate not the usual least-squares regression equations whose conditional expectation describe <u>mean</u> earnings. We prefer to estimate quantile regressions that describe <u>median</u> hourly earnings. This entails minimizing the sum of absolute deviations from the conditional function; that is, we minimize

$$\sum_i \left| ln(W_i(g,t)) - \sum_k \sum_j \mu_{jk}(g,t)(s_i^k)(a_i^j) \right|.$$

The method of quantile regression is well-suited to labor markets such as Brazil's where wage dispersion is very wide by international standards and where, as a consequence, the estimates of the conditional median of wages by least absolute deviations are more robust with respect to outlying observations.[13] We calculate standard errors for these median regressions by bootstrap methods in which regression coefficients are estimated from sub-samples selected (with replacement) from the original sample and the mean values of the calculated coefficients are used to construct their variances.[14]

<u>Data</u>

The data to estimate these wage equations come from the *Pesquisa Nacional de Amostra de Domicilios* (PNAD), Brazil's annual household survey conducted each September. Each year, approximately 300,000 people are interviewed. During the period of our study (that is, from 1981 to 1999), no PNAD survey was conducted in two years: 1991 and 1994. For 1991, in place of the PNAD survey, we draw on an excerpt of the Brazilian national census conducted in that year. We have no substitute source of data for 1994.

The Census procedures are similar to those of the PNAD, but they are not identical so 1991 values may diverge from those in adjacent years due to reasons associated with survey design and procedure.[15] They may not constitute authentic differences in the values of variables being examined. In fact, we shall see that, in some cases, the values of some variables for 1991 seem distinctive and the use of a different survey may account for this divergence. The PNAD surveys were substantially revised after the 1991 census. To ensure consistency over these years, we rely on the subset of information asked in all years both before and after 1991 as well as in the 1991 census.

Each year, a sample of employees aged between 15 and 70 years is assembled. These people are not in the military nor in school and they work neither in agriculture nor in domestic service.[16] Hourly earnings, the dependent variable in our regressions, is formed by dividing each worker's monthly (September) earnings by his or her estimated monthly hours of work.[17] We note whether an employer has signed his employee's Labor Card (*Carteira de Trabalho*, CTPS) and, for the analysis in Section IV below, we assign an employee to the informal sector of the economy if his employer has not signed his Card.[18] In the surveys, schooling attainment is measured as years of schooling except that, in the earlier years of the survey, individuals with between 9 to 11 years are coded together as are individuals with 12 or more years of schooling.[19]

Table 1 provides descriptive statistics for our samples of workers at the beginning, in the middle, and at the end of our period. These show a Brazilian labor force that aged and became better schooled from 1981 to 1999. Women constitute 37 percent of employees in 1999 compared with 28 percent in 1981. The fraction of employees working with a signed Labor Card fell five percentage points between 1981 and 1999. Without any controls, the real value of median hourly earnings among all workers was almost the same at the end of this period as at the beginning. The price deflator we use is the IPCA (*Índice Nacional de Preços ao Consumidor Amplo*), a price index formed by the Census division of the Brazilian government, IBGE (*Instituto Brasileiro de Geografia e Estatística*). It is designed to capture price movements affecting those earning from one to forty times the minimum wage. The index has been used since 1999 by Brazil's central bank for inflation targeting. It is based on consumption baskets and prices observed in several large metropolitan areas which, together, account for about 30% of the overall population. Other consumer price indices are available that target specific locations, such as São Paulo, or more specific groups, such as those making close to the minimum wage and we shall examine some of these. However, the IPCA, though imperfect, is probably the broadest available measure of consumer prices. We use its values for September in each year - September is the month of the PNAD household survey - as the price deflator.

III. Movements in Real Wages

The Median Worker

Figure 2 graphs index numbers (1999 = 100) of real wages for the median man and woman. These index numbers are imputed from the estimated wage equations at the median values of age and schooling for 1981 and 1999, the beginning and end of our estimating period, and hence these real wage series hold constant the age and schooling of workers.[20] So the real wages graphed in Figure 2 are "quality-constant" wage index numbers. Survey data are not available for 1994 so the 1994 values in Figure 2 and in subsequent graphs are simply interpolated values from adjacent years. This interpolation is somewhat heroic in this instance because inflation rates fell in Brazil from 2,000 percent in 1993 to 78 percent in 1995.

Although the turning points of the four wage series in Figure 2 are not precisely the same, the differences among them are negligible. They indicate a considerable fall in the real wages of the median worker from 1982 to 1984, a revival to 1986 accompanying the Cruzado Plan, and then a decline until the early 1990s. A minimum is recorded in 1991[21] before wages revive somewhat. By the end of our period, real wages for the median man are only about sixty percent of their level in 1982 while real wages for the median woman are between 70 and 80 percent of their 1982 values. Figure 2 shows some remarkable year-to-year changes in real wages: an increase of 20 percent from 1985 to 1986 and, then, in the following year, a fall of 19 percent; an apparent fall of 24 percent from 1990 to 1991 and then, the year after, an increase of 22 percent.[22]

This finding that, holding age and schooling constant, real wages fell between 1981 and 1999 in Brazil does not mean, of course, that personal incomes contracted. First, the age and schooling of workers rose and hence, not holding constant age and schooling, real wages in 1999 were little different from those in 1981 - as indicated by the first line of Table 1. Moreover, the fraction of adults at work rose over the period and, in part as a consequence, the real personal income of the population grew. These series are graphed in Figure 3.[23] The movements in real personal income per adult are positively correlated with our real wage series although modified by the growth in the fraction of adults at work. These data suggest that the real income of adults was higher at the end of the period than at the beginning because more adults were at work for pay and the improved "quality" of the work force kept real wages from falling.

Is this result - that, adjusted for the schooling and age of workers, real wages in 1999 were below those in 1981 - a product of the particular price index used to deflate money wages? There are well-known problems in constructing such price indices when consumption preferences are heterogeneous and when consumers are able to substitute among commodities whose relative prices are changing. These and other difficulties (such as the introduction of new goods and the changing quality of existing goods) are amplified in an economy with large changes in prices so that differences in the days when data are collected can have real consequences on price measurements. Consequently, it would be foolhardy to suggest that this conclusion about real wages is completely invariant to different price indices that might plausibly be constructed. Indeed Figure 4 considers the consequences of using other price indices to deflate the money wages of men using 1981 median values for schooling and age.

The solid line in Figure 4 is the same as the solid line in Figure 2 where the price deflator is the IPCA discussed at the end of Section II above. The dotted line in Figure 4 is the corresponding real wage series using the INPC (*Índice Nacional de Preços ao Consumidor*) as the deflator. This price index is also constructed by the IBGE and it focuses on workers earning from one to eight times the minimum wage. It is constructed from the same national surveys used to construct the IPCA. The dashed line in Figure 4 is the wage series using the IPC-FIPE as the deflator. The IPC-FIPE is a price index compiled by the *Fundação Instituto de Pesquisas Econômicas* (FIPE), a research institute associated with the University of Sao Paolo. (IPC stands for *Índice de Preços ao Consumidor*.) The price index is aimed at representing the prices of goods consumed by those earning two to six times the minimum wage and is based on a survey conducted exclusively in São Paulo.

All three real wage series graphed in Figure 4 have the same numerator and differ only in the price series used to deflate these money wages. It is evident that the year-to-year movements of all three real wage indices are similar. However, whereas the IPCA and the INPC deflators suggest that real wages were lower in the year 1999 than in 1981, the third real wage series, that using the IPC-FIPE deflator, implies real wages in 1999 were over twenty percent higher than in 1981! The IPC-FIPE price series is aimed at a smaller fraction of consumers than the other two indices and, moreover, it is restricted to Sao Paulo. Hence we retain a preference for the IPCA series as a deflator and use this in our subsequent analysis. Regardless, the different long-term findings about real wage movements cautions against very confident inferences.

Because the wages of some workers are expressed in terms of some proportion of (such as one-and-a-half or two times) the minimum wage, one might expect the movements in the real wage series graphed in Figure 2 to show an association with those of the real value of Brazil's minimum wage.[24] This is shown in Figure 5 where the correspondence between the two series in the 1980s is high. This link weakens in the 1990s.

There is also an association, not a close one, between the pace of price inflation and the decline in real wages in the late 1980s and the early 1990s. This is indicated by the scatter diagram in Figure 6 which suggests a lower level of real wages in periods of high inflation.[25] Figure 6 distinguishes among three periods: the diamonds mark observations from 1981 to 1987 when price inflation ranged between 100 and 206 percent per year; the asterisks identify observations from 1988 to 1994 when price inflation was between 417 to 2,737 percent per year; and the circles signify observations from 1995 to 1999 when price inflation receded from 78 to 4 percent per year. There is not a tight connection in Figure 6 between the level of real wages and price inflation. Loosely, it is compatible with research maintaining that increases in wages tend to lag behind increases in prices in inflationary times.[26]

Workers Arranged by Birth Cohort

Because wage equations are estimated in each year for men and for women controlling for age and schooling, a number of alternative perspectives on the wage structure may be provided. First, we impute the median wages of people with a given level of schooling who belong to the same birth cohort. Four birth cohorts (those born in 1960, 1950, 1940, and 1930) and two schooling groups (those with 4 years of schooling and those with 9-11 years of schooling) are identified and the predicted median hourly earnings of these groups are followed as they age.

The age profiles for real hourly earnings for four cohorts of men are given in Figures 7 and 8. Figure 7 shows these profiles for men with four years of schooling and Figure 8 for men with 9-11 years of schooling. A clear wage-age profile is not manifest in either graph. In Figure 8 for the better schooled workers, wages rise with age from 21 years to about 38 years for the 1960 birth cohort and, analogously, wages fall for workers in their fifties for the 1930 birth cohort. Hence, there are the components of a concave shape to the wage-age profile. However, the series are volatile. When the wage series of different cohorts overlap (i.e., when they are observed at the same age), recent cohorts tend to have lower wages than earlier cohorts. This is evident in the comparison of the 1940, 1950, and 1960 cohorts and less obvious in the case of the 1930 cohort.

Now map these same wage series not against age, but against calendar time as in Figures 9 and 10. Whereas the changes in real wages are not coincident across cohorts in Figures 7 and 8 when wages are plotted against age, changes in wages are synchronized across cohorts in Figures 9 and 10 when wages are plotted against calendar time. In other words, the shocks to wages are not associated with age but with calendar year events linked to macroeconomic events such as the policies of the Cruzado Plan introduced in 1986.

The corresponding real wage series for women are shown in Figures 11 and 12 when mapped against age. As was the case with men, there is no close link with age. When women's wages are plotted against calendar time as in Figure 13, they look like the corresponding movements of men (Figures 9 and 10). For those women with 9-11 years of schooling, the age-earnings profile of the 1940 cohort is above that of 1950 cohort which, in turn, is above that of the 1960 cohort. The fact that the shocks to these wage series tend to be synchronized with calendar time when the women are of different ages is compatible with the notion that these calendar year shocks indicate macro-economic events affecting labor markets.[27]

Are these swings in real wages that are coincident for different cohorts in the same calendar year the incidental result of our procedure of fitting the equations separately by calendar year? To determine this, we pooled data across years and formed a sample of men with schooling *s* who were born in year *c*. To this single cohort, we formed the median of hourly earnings in each year. (Of course, for a single birth cohort, each calendar year corresponds to a different age.) This procedure was applied to men born in 1960, in 1950, and in 1940 for four years of schooling and for 9-11 years of schooling (so there were six cohort-schooling series in all). The patterns of real wage movements by calendar year (or, equivalently, by age) is qualitatively similar to the patterns graphed in Figures 7 through 10. Hence our findings regarding the synchronization across cohorts of wage shocks by calendar year are not the product of our estimating methods.

Are these results for Brazil different from what would be derived for other countries? This is not the place to undertake a comprehensive comparison across various economies, but we may indicate the consequences of applying the very same methods to workers in the United States. We make use of the information supplied in each March U.S. Current Population Survey from 1982 to 2000 to construct data and apply the same procedures to these data as was applied to the Brazilian data. We use the price index for personal consumption expenditures as the price deflator. Thus, Figures 14 and 15 show the movements in the real average hourly earnings of U.S. men with sixteen years of schooling for four birth cohorts. Figure 14 maps these wages against age and Figure 15 maps these wages against calendar time. Figure 14 suggests real wages that rise strongly with age until about age 40 after which time wages increase more slowly until a peak is reached in about the mid-50s after which they start to fall. A concave age-earnings profile is evident.

Figure 15 relates these same wage movements to calendar year. Though there may be calendar year effects in these wages for U.S. workers, unlike the Brazilian data, such calendar year impacts are much less apparent and they do not seem synchronized across cohorts. Figures 14 and 15 for U.S. workers are quite unlike the analogous graphs for relatively well-educated Brazilian men in Figures 8 and 10. In the United States during the 1980s and 1990s, for well-educated men, movements in the central tendency of earnings are associated with the evolution of pay with age or work experience; in Brazil, the primary driving force on wages was not age but calendar time and the shocks imparted to wages by profound macroeconomic events such as inflation and government stabilization programs.

IV. Wage Differentials

From real wage levels, we turn to wage differentials. What is the size of particular wage differentials and how have they changed? To illustrate our procedure, consider male-female wage differentials. Suppose $ln[W_M(t, a, s)]$ is the imputed logarithm of the wage observed in calendar year t for the median male employee aged a and with schooling s. Suppose $ln[W_F(t, a, s)]$ is the corresponding imputed logarithm of the wage for the median female employee. To save on notation, suppress *a* and *s* although it needs to be remembered that all male-female and other differentials are calculated holding age and schooling constant. The facts on the real wage levels of men and women have been presented above in Figures 7 through 13 which reported instances of large year-to-year changes. As for wage differences, in year *t*, the male-female differential in the logarithm of wages, the so-called <u>wage gap</u>, is $\Delta(t) = ln[W_M (t)] - ln[W_F (t)]$.

The change in gender wage differentials (that is, the change in the wage gap) from year-to-year is

$$\Omega(t) = \Delta(t) - \Delta(t-1) = \{ln[W_M (t)] - ln[W_F (t)]\} - \{ln[W_M (t-1)] - ln[W_F (t-1)]\}$$
$$= \{ln[W_M (t)] - ln[W_M (t-1)]\} - \{ln[W_F (t)] - ln[W_F (t-1)]\}.$$

It is evident that, if the year-to-year changes in male wages are identical to year-to-year changes in female wages, then $\Omega(t)$ will be zero. More generally, if $\Omega(t)$ is small relative to $ln[W_M (t)] - ln[W_M (t-1)]$ and to $ln[W_F (t)] - ln[W_F (t-1)]$, then calendar year effects reveal themselves mainly in changes in real wage levels, not changes in wage differentials.

This issue touches on a long tradition in Economics which has suggested that the principal costs of inflation are the associated distortions in <u>relative</u> prices. The argument here is that inflation causes not only substantial changes in absolute prices but also large changes in the relative prices of different commodities and people find it costly to distinguish between the two aspects of price changes. In an inflationary environment, more resources have to be assigned to deciphering the informational content of price changes and less efficient resource allocation results. To determine the relevance of this argument for Brazil, we offer not only information about wage gaps, $\Delta(t)$, but also information about year-to-year changes in wage gaps, $\Omega(t)$. In this way, we assess whether inflation introduces noise into the price mechanism's allocation function by triggering wide variations in wage differentials.

Wage Differentials by Gender

The difference between the logarithm of male median wages and the logarithm of female median wages, the male-female wage gap, $\Delta(t) = ln[W_M(t)] - ln[W_F(t)]$, is graphed for four birth cohorts in Figures 16 and 17 against age. Figure 16 describes men and women with four years of schooling and Figure 17 describes those with 9-11 years of schooling. For both schooling levels, a noisy, inverted U, profile with age is suggested: male-female wages rise from about a 0.20 point difference in log wages when workers are in their early twenties to about a 0.60 point difference when workers are in their late forties before falling to about a 0.40 point difference when in their late fifties.[28] According to Figures 8 and 12, for those with 9-11 years of schooling, the wages of both men and women rise with age, but they rise faster for men than for women and, therefore, the wage gap in Figure 17 tends to grow with age.

Figures 7 through 13 have suggested that real wage levels have been sensitive to calendar year events and they are not closely related to the ages of workers. The opposite seems the case for male-female wage differentials: Figures 16 and 17 indicate a somewhat noisy inverse U shape to the age profile of the ratio of male to female wages while Figure 18 displays relatively less volatility when male-female wage ratios are plotted against calendar year for each cohort-schooling group. In fact, the male-female wage gap in Figure 18 drifts downward over time suggesting smaller male-female differentials by the end of the 1990s compared with the two decades earlier.

The contrast between real wage levels and wage differentials is portrayed in Figures 19 and 20 which show the year-to-year changes in male and female real wage levels (these are the dotted lines) and the year-to-year changes in the male-female wage differential for workers belonging to one cohort, namely, those born in 1950. Figure 19 describes workers with 4 years of schooling and Figure 20 workers with 9-11 years of schooling.[29] In both figures, year-to-year changes in wage levels dominate year-to-year changes in the wage differentials. In other words, notwithstanding highly inflationary conditions in many years that generated some sharp changes in real wage levels, by comparison, wage differentials remained remarkably stable. Of course, a necessary part of this contrast between real wage levels and wage differentials is the sharp change in the price deflator in many years. That is, $\Omega(t)$, the year-to-year change in the wage gap (the solid line) differences out changes in the price deflator (or, at least, we assume it differences out by applying the same price deflator to male as to female wages). By contrast, the movements in $ln[W_M (t)] - ln[W_M (t-1)]$ and $ln[W_F (t)] - ln[W_F (t-1)]$ (the dotted lines) each incorporate the changes in the price deflator.

Wage Differentials by Schooling

Consider now wage differentials by schooling where the schooling differences are those between workers with 9-11 and 4 years of schooling. The frequency distribution of employees by years of schooling in 1981 and 1999 is given in Table 2. This shows the increase in schooling attainment over this period and also indicates that, in both years, there is bunching at 4 years and 9-11 years of schooling.

For workers of a given age, gender, and cohort, construct the difference in any year between the logarithm of wages imputed for those with 9-11 years of schooling (call this $ln[W_9 (t)]$) and the logarithm of wages imputed for those with 4 years of schooling (call this $ln[W_4 (t)]$). This wage differential, $ln[W_9 (t)] - ln[W_4 (t)]$, for men in all four cohorts is graphed in Figure 21. The difference in wages by schooling levels for the 1940 cohort tends to be larger than that for the 1950 cohort which, in turn, is larger than that for the 1960 cohort. For this 1960 cohort, the schooling wage differential rises from .50 log points at age 21 years to .80 log points when aged 29 years after which age it varies little.[30]

When these schooling wage differentials are plotted against calendar time as in Figure 22, for the 1950, 1940, and 1930 cohorts, they tend to drift downwards from about 1.0 log points in the early 1980s to about 0.85 log points by 1996. For the 1960 cohort, the growth in schooling wage differentials with age in Figure 21 reappears in Figure 22 as a drift upwards over calendar time. The decline in schooling wage premia for older cohorts in Brazil might be viewed as consistent with arguments stemming from Heckscher-Ohlin models describing the impact of trade on relative wages. The notion would be that increasing trade tends to lower the returns to relatively scarce factors and, in Brazil, this would be well-schooled labor. The defect with this explanation is that movements in schooling wage differentials are not closely associated with changes in Brazil's trade policy over this period.

For many years, Brazil pursued import-substitution policies. The oil-price shocks of the 1970s reinforced these policies because they confirmed the view that the country ought to be less dependent on imports. This policy was reexamined in the late 1980s and early 1990s and some trade liberalization policies adopted. Between 1989 and 1992, average tariffs were cut from about 39 to 15 percent and the list of forbidden imports was repealed. Also, the MERCOSUL agreement establishing a customs union with Argentina, Uruguay, and Paraguay was signed in March 1991. How do these changes in trade policies square with the movement of schooling wage differentials? Figure 22 suggests that some of the decline in the schooling wage differentials for the older cohorts predates the trade liberalization measures although a disjunction may be evident around 1991-92. Nothing of this sort is apparent for the 1960 cohort. On this evidence, the proposition that the drop in the differentials is driven by trade is wanting.[31]

Figure 23 plots changes in schooling real wage levels and schooling wage differentials against calendar time. The dotted lines show year-to-year changes in the logarithm of wages of those with 4 years of schooling and of those with 9-11 years of schooling while the solid line shows year-to-year changes in the wage gap (that is, changes in $ln[W_9(t)] - ln[W_4(t)]$). In most instances, year-to-year changes in wage levels (the dotted lines) exceed year-to-year changes in the wage gap (the solid line). This is consistent with the view that macroeconomic shocks have tended to shift the entire wage distribution and have left differentials largely undisturbed. This is not consistent with the notion that an environment of high inflation and macroeconomic instability generates large swings in relative prices, in this instance, in relative wages by schooling.

Wage Differentials by Formal-Informal Sector

In the labor markets of many countries, it is common to distinguish between those markets where the state's regulations are largely observed and those markets that are largely beyond the scope of state regulation. We call the former the "formal" sector and the latter the "informal" sector. For Brazil in the 1980s and 1990s, we define the formal sector to consist of those jobs in which employers have signed their employees' Labor Cards (Carteira de Trabalho, CTPS). Many countries have the equivalent of Brazil's Carteira de Trabalho which is designed to record each worker's pay and employment history including his mandatory contributions to social security.

The Labor Card is issued to the employee, but the employee enjoys the benefits from its possession only if the employer signs it. In this way, the Card is an asset whose value depends on the behavior of both the employee and the employer: the worker must tender it to the employer and the employer must sign it and, by this action, agree to the regulations accompanying it. An employee benefits when working at a job with a signed Labor Card because he is thereby covered by various labor standards and pension benefits. However, these regulations involve costs for the employer so the firm has an incentive to hire the worker without signing the Card if this enables the employer to avoid or reduce costly government regulations. In some jobs, this incentive may be passed on to workers, at least in part, in the form of a preference for those employees who work without their Cards being signed. In this way, two sectors develop: one sector where employers routinely sign Labor Cards and compliance with government regulations is the norm; and another sector where evasion of government regulations is inexpensive and jobs are typically filled by people who work without their Labor Cards being signed. Some people work exclusively in the formal sector and their movements from job to job are recorded in their Labor Cards as prescribed by statute while others work exclusively in the informal sector with their Labor Cards disregarded. Some workers can be expected to move from a job in one sector to a job in the other sector.[32]

The workers in those jobs where employers sign Labor Cards are more likely to have their wages indexed to changes in prices in the manner specified by statute. In this respect, wage indexation is one component of the portfolio of benefits that are likely to apply more fully to workers whose Labor Cards have been signed by their employers. These features make it plausible that an indicator of employment in the formal sector is provided by whether the employee works with a signed Labor Card.

Information on the characteristics of employees working with and without a signed Labor Card is given in Table 3. Those working with signed Cards tend to be better schooled, they are older, their female representation is greater, and their pay is much higher: the hourly earnings of those working with a Card is about eighty percent greater in 1999 than the hourly earnings of those working without a Card. Denote the hourly earnings of those working with a signed Labor Card by W^F (F for "formal") and the hourly earnings of those working without a signed Labor Card by W^N (N for "informal"!). Figure 24 graphs the annual changes in median male real wages of the two groups, $\Delta ln(W^F)$ and $\Delta\ ln(W^N)$, and, in thirteen out of eighteen years, the real wages of those working with signed Cards changes less (in absolute value) than the real wages of those working without signed Cards.[33] This means that the money wages of those working with signed Cards are adjusted more fully or more rapidly to changes in prices than are the money wages of those working without signed Cards. The fact that the real wages of those working with a signed Labor Card tend to fluctuate less than the real wages of those working without a signed Labor Card is consistent with the notion that the statutory indexation provisions operate more effectively in the formal than the informal sector.

Once observed characteristics of workers are held constant, the wage gap between formal sector and informal sector workers narrows considerably. For instance, in 1990, the "raw" wage differential, $ln(W^F) - ln(W^N)$, for men is 0.351 and for women it is 0.605. However, in a cross-section regression equation on 1990 data, after controls for schooling, age, industry, occupation, and region are introduced, these differentials fall to 0.135 and 0.092, respectively. In 1992, the "raw" differential is 0.641 for men and 0.756 for women; the adjusted differentials are 0.343 for men and 0.331 for women.

A simple way of describing the relation between wages in the formal and informal sectors is to assume that wages in the formal sector are adjusted by some administrative process (in the high inflation years, this would be predominantly the statutory indexation provisions) and then to compute the effect of these changes in the formal sector on wages in the informal sector. To measure the association between the real wage in Brazil's informal sector and the real wage in its formal sector, we fit versions of the following regression equation

$$ln(W^N)_t = \alpha + \beta ln(W^F)_t + u_t \qquad (9)$$

by ordinary least-squares allowing for the stochastic term to follow a first-order autoregressive process: $u_t = \rho\, u_{t-1} + \varepsilon_t$ where ε_t is white noise. Also, we estimate a first-difference specification:

$$\Delta ln(W^N)_t = \gamma + \delta \Delta ln(W^F)_t + v_t \qquad (10)$$

where again the stochastic term is permitted to be serially correlated: $v_t = \omega\, v_{t-1} + \zeta_t$.. In principle, more complex time-series processes for u_t and v_t might be entertained, but the availability of only 18 annual observations severely constrains what may be countenanced.

The results are reported in Table 4. The estimates of β and δ are little different from unity implying that a one percent increase in formal sector wages is associated with about the same one percent increase in informal sector wages.[34] Though standard errors prevent strong inferences, this is consistent with our earlier findings, namely, that the wage structure has changed relatively little over almost twenty years notwithstanding some remarkable macroeconomic episodes.

V. Conclusions

When the movements of wages of workers belonging to different birth cohorts are followed over time, "time" may correspond to age or calendar year. If the changes in wages of these workers are closely associated with their ages, then necessarily these wage changes are occurring in different calendar years because the workers have been born in different years. This association between wages and age is called an "age effect". If the changes in the wages of these workers are closely associated with calendar years, then necessarily these wage changes are occurring at different ages for these workers because they were born in different years. This association between wages and calendar year is called a "calendar year effect". In Brazil between 1981 and 1999, the principal movements in real wages are associated with calendar time, not with age. Calendar year effects in wage changes dominate age effects. For instance, the median male real wage in the private sector rose by 20 percent from 1985 to 1986 and then fell by 19 percent the following year.

This connection with calendar time suggests the impact of macroeconomic events and with attempts to restore macroeconomic balance through stabilization programs. Wages are not closely associated with age or labor market experience. This holds not only for those with little schooling who may have undertaken little human capital investments, but also for those with more schooling.[35] This experience is shown to differ from that of U.S. workers (at least over the past two decades or so) for whom age effects on wages appear to dominate calendar year effects.

The real wages of workers belonging to different cohorts tend to move at about the same calendar time and are associated with macroeconomic shocks. Real wages tend to be lower in periods of very high price inflation. This is true for the wages of men and women and the wages of workers in the formal and informal sectors. Although macroeconomic factors appear to have delivered the principal shocks to wages and age effects are of secondary importance, there have been notable changes in some wage differentials over this period.

- Male-female wage differentials have narrowed from about 0.59 log points in 1981 to 0.47 log points in 1999. (See Figure 18.)[36]
- Schooling wage differentials narrowed somewhat for older cohorts, but increased for the

1960 birth cohort. (See Figure 22.) Part of the rise in the schooling wage differential for the 1960 cohort may be an ageing effect, the result of well-schooled people enjoying rising wages from an age of 21 years to about 30 years. (See Figure 21.) For the 1950 and 1940 birth cohorts, schooling wage differentials of about 1.0 log points had become about 0.90 by the end of the 1990s.[37]

Macroeconomic events do not appear to be linked to these changes in the wage structure. While macroeconomic shocks have a clear impact on real wage levels, wage differentials are much less affected. Expressed differently, tumultuous macro-economic instability appears to have affected real wage levels, but has left the wage structure largely unchanged. Year-to-year changes in wage differentials (what was called $\Omega(t)$ at the beginning of Section IV above) tend to be smaller than year-to-year changes in the levels of real wages. Support for the view that greater inflation is accompanied by greater wage dispersion is largely lacking - at least when this dispersion is measured by differences in wages across schooling groups or by age or by gender. Indeed, the analysis of formal-informal sector wages suggests a one percent increase in formal sector wages tends to be associated with the same one percent increase in informal sector wages.

Our results about real wages will be dependent on our choice of price index with which to deflate money wages. Also the relative volatility of real wage levels rather than wage differentials may be the outcome of using a poor price deflator whose effects "cancel out" in analyzing wage differences. We have investigated the consequences of using many different price deflators and we report in Figure 4 the consequences of three different price deflators. Two of these price indices move very closely together. The year-to-year movements in the third index are similar although the deviations accumulate over time so that, after two decades, important differences are implied. We use what we believe to be the most suitable price index among those available though recognize that, as is often the case, the choice set is narrower than we would like.

These results for Brazil suggest that macroeconomic turmoil can have major consequences for the level of real wages. Sharp changes in real wages are associated with calendar year events connected to shocks in the macroeconomic environment. The interesting feature of the Brazilian experience is that important shocks to real wage levels affected the wages of different workers in a comparable fashion so that the wage structure was far less volatile than real wage levels. An explanation for this may reside in Brazil's provisions for indexing wages to prices, but evidently indexation did not prevent substantial year-to-year swings in real wages (as shown in Figure 2). Moreover, the indexation regulations permitted ample scope for movements in relative wages. Indeed, in some settings, the degree of indexation was the outcome of bargaining between workers and employers. This makes us wonder whether the relative stability of the wage structure may be the outcome of bargaining in which the maintenance of wage differentials played a key role in workers' objectives, a conjecture that is the subject of future research.

ENDNOTES

*. An earlier version of this paper was presented at the Conference on Labor Market Reforms in Latin America on 8-10 November 2001 at Stanford University. The comments of our discussant, Vittorio Corbo, are acknowledged as are those of Emanuel Ornelas and two very helpful anonymous referees. McIntyre thanks the National Science Foundation for research support. Pencavel thanks the Center for Research in Economic Development and Policy Reform at Stanford University for research support.

1. According to the World Bank's Indicators in 2000, the Gini coefficient for household income for Brazil was 0.60 whereas it was 0.54 in Mexico, 0.49 in Russia, 0.41 in the United States, 0.38 in India, 0.36 in the U.K., 0.33 in France, and 0.25 in Japan.

2. The price series is the implicit GDP deflator published by the IMF. It is the same as the IPCA series we use below as our default price index.

3. The impact of the Cruzado Plan on wages will be evident in the graphs that follow. It was a classic populist program that, among other things, mandated increases in money wages. Here is a brief description: "Whatever the original intentions of the programme with regard to fiscal and monetary instruments, the [Cruzado] Plan was implemented in a highly populistic fashion, with significant real wage increases, an overvalued currency, and a large budget deficit.....[T]he early outturn of the programme was outstanding: rapid growth, higher real wages, and low inflation. The pro-worker rhetoric of the regime increased markedly as the Cruzado Plan achieved its early successes. The Cruzado Plan collapsed very fast, no doubt because of the highly unfavourable initial conditions, especially the very high inherited external debt....As the reserve situation deteriorated, the exchange rate had to be devalued sharply in late 1986, which led to an explosion of inflation, and a reversal of real wage increases and real GDP growth that had been achieved at the outset of the programme" Jeffrey D. Sachs, "Social Conflict and Populist Policies in Latin America", in Labour Relations and Economic Performance, ed. Renato Brunetta and Carlo Deli'Aringa (International Economic Association, Basingstoke: Macmillan, 1990, 150-51).

4. The 1979 reforms to the indexation provisions are described in Roberto Macedo, "Wage Indexation and Inflation: The Recent Brazilian Experience", in Inflation, Debt, and Indexation, ed. Rudiger Dornbusch and Mario Henrique Simonsen (Cambridge, MA: The MIT Press, 1983, 133-59).

5. Some of this literature is discussed in Alex Cuikerman, Inflation, Stagflation, Relative Prices, and Imperfect Information, (Cambridge: Cambridge University Press, 1984) and some evidence on Brazil to support it is found in Edward Amadeo and Gustavo Gonzaga, "Inflation and Economic Policy Reform: Social Implications in Brazil", in Social Tensions, Job Creation, and Economic Policy in Latin America, ed. David Turnham, Colm Foy, and Guillermo Larrain (Paris: OECD, 1995, 259-79).

6. Theodore W. Schultz, "The Value of the Ability to Deal with Disequilibria", Journal of Economic Literature, 13 (September 1975): 827-46, esp. 843.

7. For instance, Smith develops a model where more skilled workers are less risk averse than those who are less skilled but these skills are private information. To identify the more skilled, employers offer workers both nominal and real contracts and the more skilled are willing to work on the nominal contracts, but then their real wages will suffer in inflation. See Bruce D. Smith, "A Model of Nominal Contracts", Journal of Labor Economics, 7 (October 1989): 392-414.

8.See Carola Pessino, "From Aggregate Shocks to Labor Market Adjustments: Shifting of Wage Profiles under Hyperinflation in Argentina" (Centro de Estudios Macroeconómicos de Argentina, No. 95, December 1993) and Carola Pessino, "Returns to Education in Greater Buenos Aires 1986-1993: From Hyperinflation to Stabilization" (Centro de Estudios Macroeconómicos de Argentina, No. 104, June 1995).

9. Sample sizes average about 59 thousand for men and 30 thousand for women.

10. These surveys contain other information associated with workers' wages such as their occupation and region of residence. However, occupation and location tend to be endogenous variables and mediate between pay, on the one hand, and age and schooling, on the other hand.

11. For illustration, consider those born in 1960. They are aged 21 years in 1981 so we use the 1981 estimated wage equation to impute wages corresponding to $a = 21$. They are aged 22 years in 1982 so the 1982 wage equation is used to impute wages for $a = 22$. By the year 1999, members of the 1960 birth cohort are aged 39 years and the 1999 fitted wage equation is used to impute wages corresponding to $a = 39$.

12. See MaCurdy and Mroz for an analysis of the distinction between macroeconomic effects and cohort effects on wages. Thomas MaCurdy and Thomas Mroz, "Measuring Macroeconomic Shifts in Wages from Cohort Specifications", unpublished (Stanford: Stanford University, Department of Economics, 1989).

13. Of course, other points in the wage distribution could be examined though we shall have enough empirical regularities to discuss for one paper by simply focusing on the median.

14. See Gary Chamberlain, "Quantile Regression, Censoring, and the Structure of Wages", Advances in Econometrics: Sixth World Congress, Volume I, ed. Christopher A. Sims, (Cambridge: Cambridge University Press, 1994, 171-209). The number of replication samples is approximately 300. In terms of equation (3), ε_i are assumed distributed independently across calendar time and across ages.

15. The PNAD questionnaire is more detailed and has more structured questions than the Census. Also the PNAD interviewers are professionals whereas the Census interviewers may be students.

16. The hourly wage may not be an accurate measure of the price of time for these groups of workers. In-kind payments often constitute a large part of the compensation of agricultural workers

and domestic servants. The income of self-employed workers is a blend of their returns to labor and their returns to capital.

17. Specifically, each survey asks for the amount of money earned in the primary job for September. This is divided by 30/7 to get weekly earnings. These weekly earnings are then divided by the "normal" number of hours worked per week in the primary job. Hence monthly earnings in a specific month, September, are divided by a measure of "normal" weekly hours worked. As is discussed in the next paragraph, these hourly earnings are then divided by a price index for the month of September to arrive at real hourly earnings.

18. Information on whether the respondent has a signed Labor Card is provided in all survey years. However, the respondents who were asked for this information changed after the 1991 Census with the consequence that a number of government workers were not asked if their Labor Card was signed. These government workers tended to be older, better educated, and better paid than the average card holder. We code these people as having a card. There is a clear break in 1992 in the number of public school teachers who report having a signed Labor Card. One reason for this break is that the signing of teachers' Labor Cards seems under-reported before 1992. Because public school teachers are likely to be in the formal labor market, we code all public teachers in all years as having a signed Labor Card regardless of their response though we recognize the arbitrariness of dealing with this problem in this way.

19. In the data made available to us, some people are coded with 9-11 years of schooling and others with 12 or more years of schooling. When we estimate equation (2), those people coded with 9-11 years of schooling are assigned the value of 10 and those coded with 12 or more years of schooling are assigned the value of 14. Other procedures were investigated with negligible differences in inferences.

20. In Figure 2, "1981 weights" means 4 years of schooling and 31 years of age for men and 8 years of schooling and 29 years of age for women. "1999 weights" means 7 years of schooling and 34 years of age for men and 9-11 years of schooling and 34 years of age for women.

21. Recall that the 1991 data are from the Census so one has to wonder whether the Census's slightly different survey methods are generating the 1991 minimum or whether it is real.

22. Figure 2's wage series are derived from the point estimates of least-absolute deviation wage regression equations. To illustrate the precision of these point estimates, Appendix Figure A shows one of the real wage series - that for women using 1999 values of age and schooling as weights - and graphs the bounds on this series formed by the 2.5 and 97.5 percentiles of the distribution. Evidently we have considerable confidence in the inferences from the point estimates, a consequence of the very large sample sizes in the household surveys.

23. The data are constructed from the same data source, the PNAD, as that underlying our wage series. The values for 1991 and 1994 are interpolated. The price series used to deflate personal incomes are the IPCA series used in Figure 2 and Table 1.

24. This series on the real minimum wage uses the monthly minimum salary in effect at the time of the household survey. (The minimum wage was sometimes updated more than once a year.) To derive a comparable hourly wage, we divide this monthly salary series by 30/7 and then by weekly hours worked where maximum hours were 48 before the 1988 Constitution and 44 from 1988 onwards. The minimum wage series graphed in Figure 5 is an index with 1999 = 100.

25. The particular real wage series used in Figure 6 describes the median man using 1999 values.

26. The classic statement of this notion is found in Kessel and Alchian and some supporting evidence for Latin America is contained in Carduso. See Rueben A. Kessel and Armen A. Alchian, "The Meaning and Validity of the Inflation-Induced Lag of Wages behind Prices", American Economic Review, 50 (March 1960): 43-66 and Eliana Carduso, "Inflation and Poverty" (Working Paper No. 4006, National Bureau of Economic Research, Cambridge, MA., March 1992). In the particular instance of Brazil, Kane and Morisett attribute the widening of the income distribution (where income consists of the sum of wages and interest) from 1970 to 1992 to the regressive effects of inflation. There is also a weak link between annual changes in real wages and changes in real GDP with real earnings increasing more in years when real GDP growth is higher. See Cheikh Kane and Jacques Morisett, "Who Would Vote for Inflation in Brazil?" (Policy Research Working Papers, WPS 1183, The World Bank, September 1993).

27. We examined whether cohort differences in these age-wage profiles are associated with the size of cohorts. For instance, can the 1960 birth cohort's lower age-wage profiles in Figures 9 through 13 be attributed to the 1960 cohort being relatively large? There is some weak evidence for this for those with 9-11 years of schooling for whom recent birth cohorts are slightly larger than earlier cohorts. No cohort size effect is evident for those with four years of schooling.

28. A log difference of 0.20 points implies the wages of men are 22 percent above those of women, a log difference of 0.60 points implies the wages of men are 82 percent above those of women, and a log difference of 0.40 points implies the wages of men are 49 percent above those of women. These estimates are consistent with the gender wage differentials reported by Panizza for Brazil in the years from 1992-97 (excluding 1994): for all workers in the private sector, he computed the wages of women to be about 0.32 log points below those of men. See Ugo Panizza, "The Public Sector Premium and the Gender gap in Latin America: Evidence for the 1980s and 1990s" (Research Department Working Paper # 431, Inter-American Development Bank, August 2000).

29. So, in terms of the earlier notation, the dotted lines graph $ln[W_M (t)] - ln[W_M (t-1)]$ and $ln[W_F (t)] - ln[W_F (t-1)]$ while the solid line graphs $\Omega(t)$, the year-to-year change in the wage gap. Although Figures 19 and 20 graph this for only the 1950 birth cohort, the smaller volatility in the wage gap relative to the volatility of wage levels holds also for the other birth cohorts.

30. In other countries, schooling wage differentials tend to rise with age although the differentials rise until later ages than appears to be the case in Brazil. As a rough comparison, in the 1990s in the United States, the ratio of the wages of college graduates to high school graduates was about 1.7. A log differential of about 1.0 (the approximate value in Brazil for the 1950 and 1940 cohorts

according to Figure 21) implies that the wages of those with 9-11 years of schooling are 2.72 times those with 4 years of schooling.

31. A more favorable assessment of Heckscher-Ohlin effects on wages is offered by Gustavo Gonzaga, Naércio Menezes Filho, and Cristina Terra, "Wage Inequality in Brazil: the Role of Trade Liberalization", Anais do XXIII Encontro Brasileiro de Econometria, (Salvador, BA, Brasil), August 2001. Total factor productivity seems to have been substantially affected by the liberalization of trade. See Donald A. Hay, "The Post-1990 Brazilian Trade Liberalization and the Performance of Large Manufacturing Firms: Productivity, Market Share and Profits", Economic Journal, 111 (July 2001): 620-41.

32. Indeed, in a thorough analysis of informal sector workers, Neri reports substantial transition of workers across sectors especially during periods of economic expansion. See Marcelo Côrtes Neri, "Decent Work and the Informal Sector in Brazil", Ensaios Econômicos da EPGE, 461 (2002).

33. The series plotted in Figure 24 are annual changes in median log real wages and the wages do not hold constant any variable such as age or schooling. Three of the five years when $\Delta\, ln(W^F)$ for men is greater than $\Delta\, ln(W^N)$ are 1990, 1991, and 1992. Two of these years involve data from the 1991 Census. This is another suggestion that the wage data derived from the Census are not quite consonant with those derived from the annual household surveys. For women, in fourteen years out of eighteen, $\Delta\, ln(W^F)$ is less than $\Delta\, ln(W^N)$ in absolute value.

34. This is broadly compatible with the finding of Neri and Thomas that, aside from self-employed workers (who are excluded from our analysis), the earnings of informal sector workers show about the same sensitivity to cyclical movements in the economy as formal sector workers. See Marcelo C. Neri and Mark R. Thomas, "Macro Shocks and Microeconomic Instability: An Episodic Analysis of Booms and Recessions" unpublished paper (July 2000).

35. The relative unimportance of age effects in wages holds also for some workers in other countries. See, for instance, Meghir and Whitehouse in their examination of British wages. Costas Meghir and Edward Whitehouse, "The Evolution of Wages in the United Kingdom: Evidence from Micro Data", Journal of Labor Economics, 14 (January 1996): 1-25.

36. These numbers are for the 1950 birth cohort with 9-11 years of schooling. If male wages are 0.59 log points above female wages, the proportionate male-female wage differential is about 80 percent. A 0.47 log point difference implies a proportionate wage differential of 60 percent. So this narrowing of male-female wage differences is not trivial.

37. These schooling wage differentials relate to men with 9-11 years of schooling compared with men with 4 years of schooling. A 1.0 log point differential implies a proportionate wage differential of 172 percent while a 0.90 log point differential implies a proportionate wage differential of 146 percent.

Table1

Descriptive Statistics by Year and Gender

	all workers			male workers			female workers		
	1981	1990	1999	1981	1990	1999	1981	1990	1999
median hourly earnings (1994 Reals)	1.14	0.88	1.13	1.15	0.92	1.15	1.04	0.81	1.10
median age in years	30	32	34	31	32	34	29	32	34
median years of schooling	4	6	8	4	5	7	8	8	9-11
% female	28.5	34.3	37.4						
% with Labor Card	79.1	76.9	74.8	77.3	74.9	71.3	83.7	80.9	80.6
% with ≤ 4 years of schooling	50.6	38.6	26.9	57.1	44.6	32.6	34.3	27.2	17.4
% with ≥ 9 years of schooling	25.6	34.3	44.8	19.0	26.3	34.8	42.2	49.6	61.5
% aged ≤30 years	50.3	45.6	39.2	48.9	45.1	40.3	53.7	46.5	37.4
% aged ≥50 years	10.4	10.7	11.4	11.7	12.1	12.1	7.3	8.0	10.2

Table 2
Frequency Distribution (in Percent) of Years of Schooling of Employees, 1981 and 1999

years of schooling	1981	1999
0	10.9	5.4
1	3.8	1.5
2	5.8	3.1
3	8.3	4.8
4	21.6	11.9
5	7.4	7.5
6	3.6	4.4
7	3.8	4.5
8	9.2	11.7
9-11	16.3	30.1
$\geq$12	9.4	15.0

Table 3
Descriptive Statistics by Year and Gender for those Working with Signed Labor Cards
and those Working without Signed Labor Cards

Those Working with Signed Cards	all workers			men			women		
	1981	1990	1999	1981	1990	1999	1981	1990	1999
median hourly earnings (1994 Reals)	1.28	1.00	1.29	1.34	1.06	1.33	1.12	0.84	1.24
median age	31	32	35	31	33	35	29	32	35
median years of schooling	5	7	9-11	4	6	8	8	9-11	9-11
% female	30.1	36.0	40.4						
% with ≤ 4 years of schooling	47.0	35.2	22.8	53.6	40.9	28.2	31.7	25.1	14.9
% with ≥ 9 years of schooling	28.5	37.6	50.3	21.4	29.2	39.9	45.0	52.4	65.7
% aged ≤30 years	48.9	43.6	35.7	46.7	42.1	36.1	54.3	66.2	35.2
% aged ≥50 years	9.7	10.0	11.5	11.0	11.5	12.2	6.6	7.2	10.4
Those Working without Signed Cards									
	1981	1990	1999	1981	1990	1999	1981	1990	1999
median hourly earnings (1994 Reals)	0.64	0.58	0.72	0.64	0.58	0.74	0.68	0.59	0.69
median age	28	30	31	28	29	30	30	31	32
median years of schooling	4	4	6	4	4	5	5	7	8
% female	22.2	28.4	28.7						
% with ≤ 4 years of schooling	64.4	50.0	38.9	69.1	55.5	43.4	48.1	36.1	27.7
% with ≥ 9 years of schooling	14.5	23.5	28.5	10.8	17.8	22.3	27.7	38.0	43.9
% aged ≤30 years	55.3	52.4	49.6	56.7	54.3	50.8	50.5	47.8	46.5
% aged ≥50 years	13.3	13.0	11.3	14.0	13.6	12.0	10.9	11.1	9.4

Table 4

Parameter Estimates from Regressing Informal Sector Wages on Formal Sector Wages

	equation (9)			equation (10)		
	α	β	ρ	γ	δ	ω
all workers	-0.567 (0.049)	0.983 (0.246)	0*	-0.007 (0.038)	0.906 (0.407)	0*
	-0.587 (0.047)	0.984 (0.245)	-0.031 (0.250)	-0.012 (0.025)	0.870 (0.325)	-0.436 (0.231)
men	-0.655 (0.062)	1.072 (0.249)	0*	-0.003 (0.036)	0.952 (0.355)	0*
	-0.655 (0.059)	1.076 (0.243)	-0.081 (0.205)	-0.009 (0.023)	0.911 (0.282)	-0.487 (0.234)
women	-0.493 (0.030)	0.763 (0.214)	0*	-0.017 (0.040)	0.748 (0.504)	0*
	-0.494 (0.032)	0.766 (0.222)	0.111 (0.325)	-0.019 (0.032)	0.730 (0.447)	-0.281 (0.208)

The asterisk denotes a parameter constrained to zero. Estimated standard errors are heteroskedastic-consistent.

Figure 1
Annual Price Inflation and Real Per Capita GDP Growth, 1981-1999

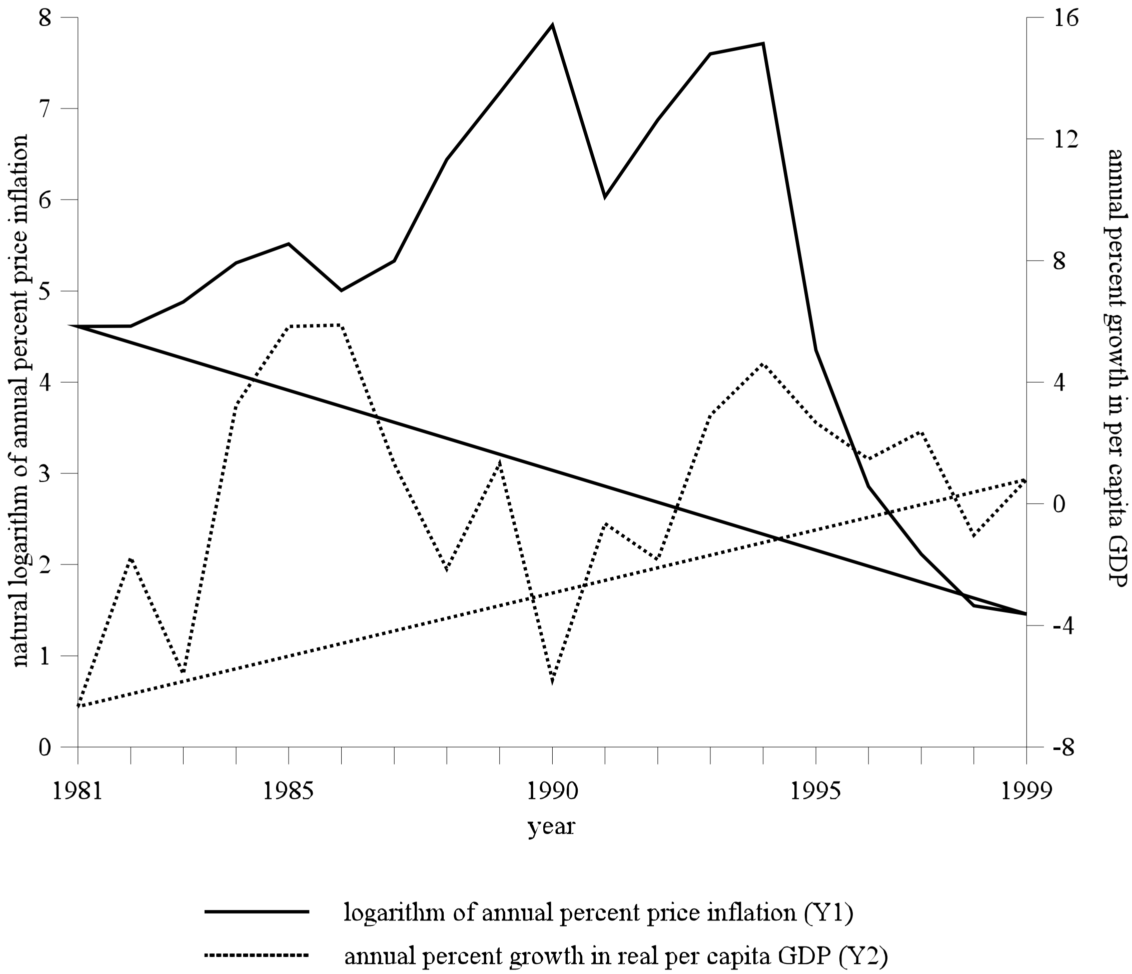


Figure 2
Index Numbers of Real Wages Holding Gender, Age, and Schooling Constant, 1981-1999

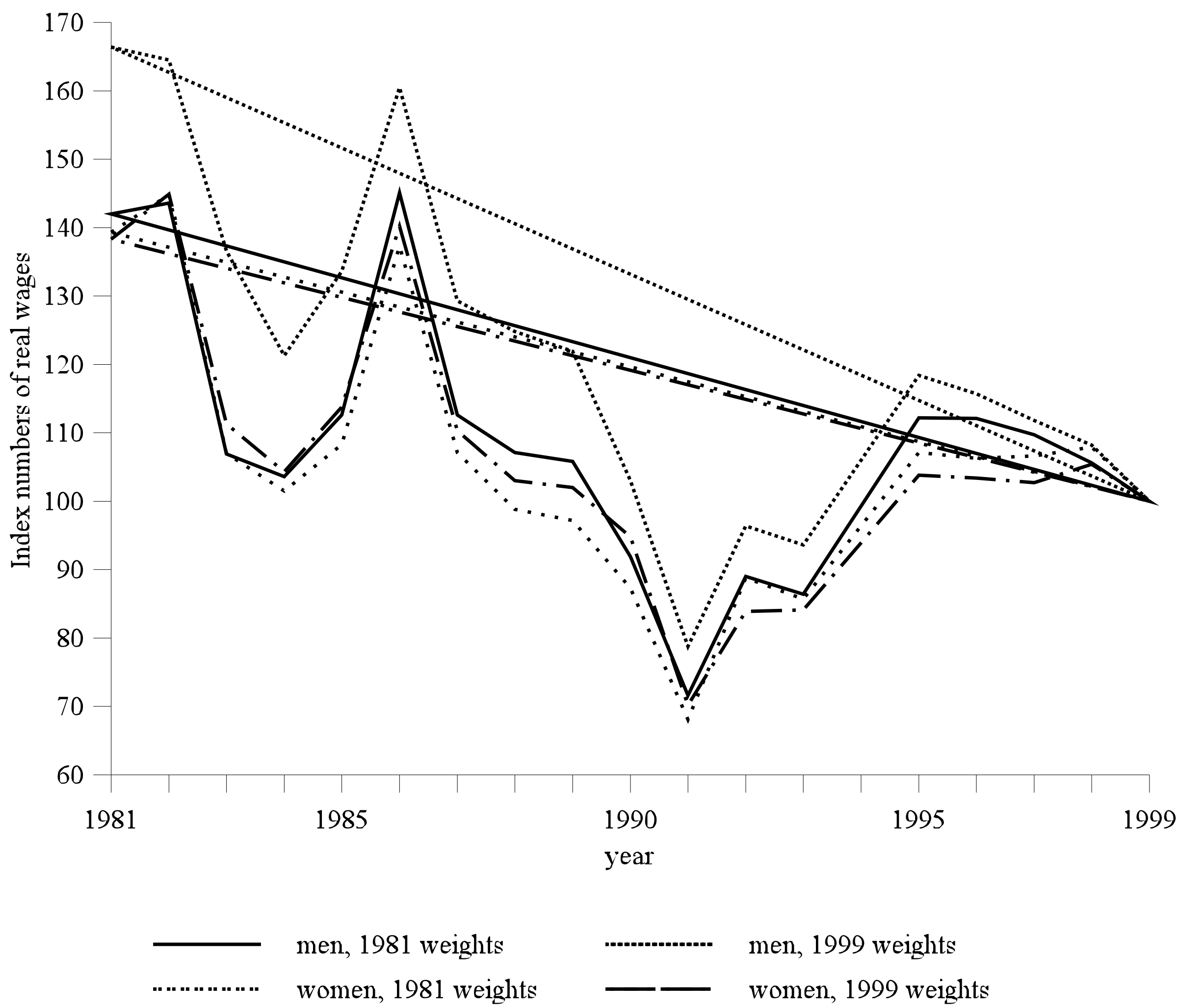
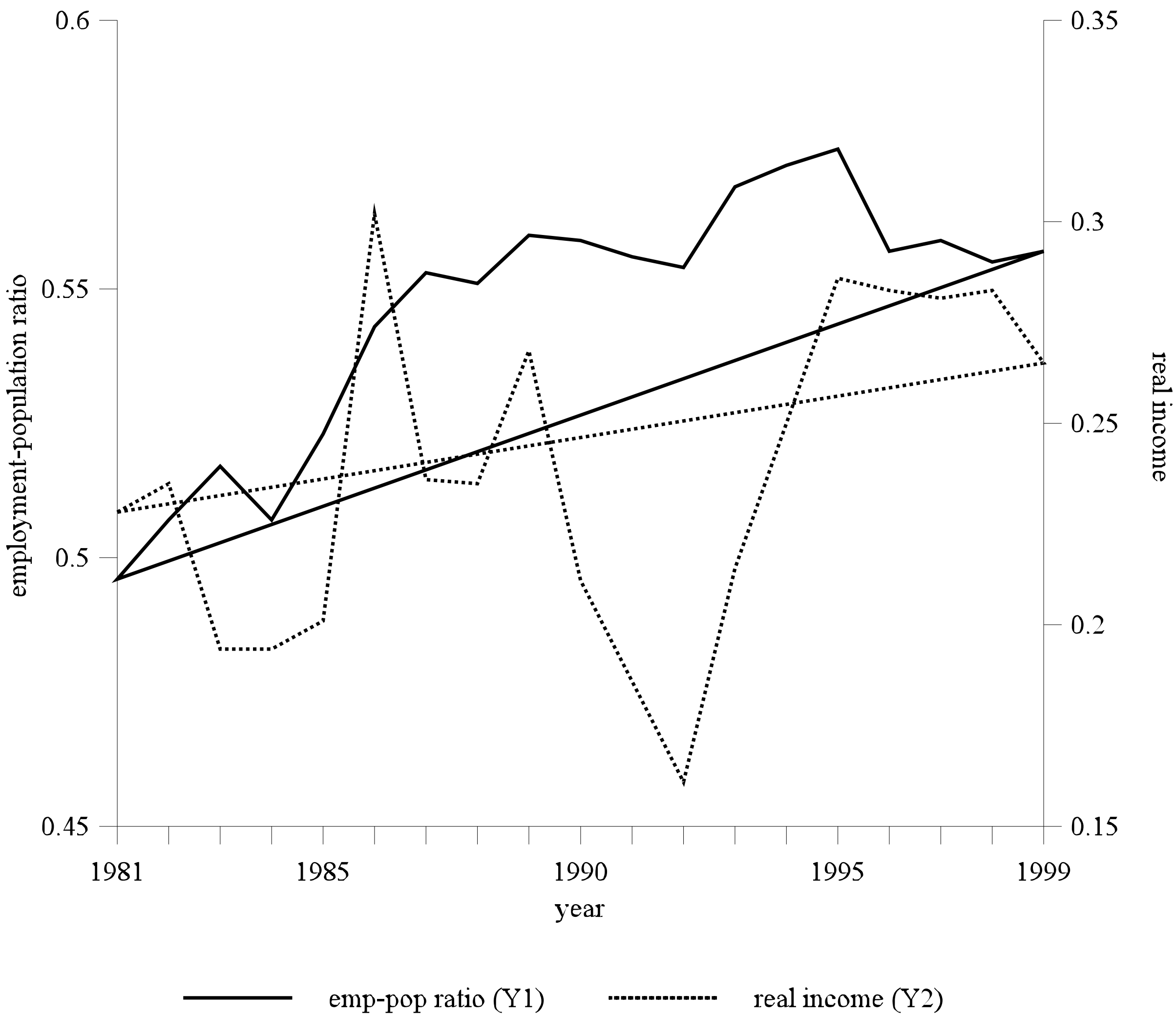


Figure 3
Employment-Population Ratio of Adults and Real Personal Income per Adult, 1981-1999



The employment-population ratio (measured on the left-hand axis) describes people aged 15-70 years. The data exclude those at school, domestic servants, agricultural workers, and the military. The real income series (measured on the right-hand axis) includes all sources of income divided by the population aged 15-70 years. Income is measured in thousands of July 1994 Reals.

Figure 4
Alternative Index Numbers of Male Real Wages for Median 1981 Values of Schooling and Age

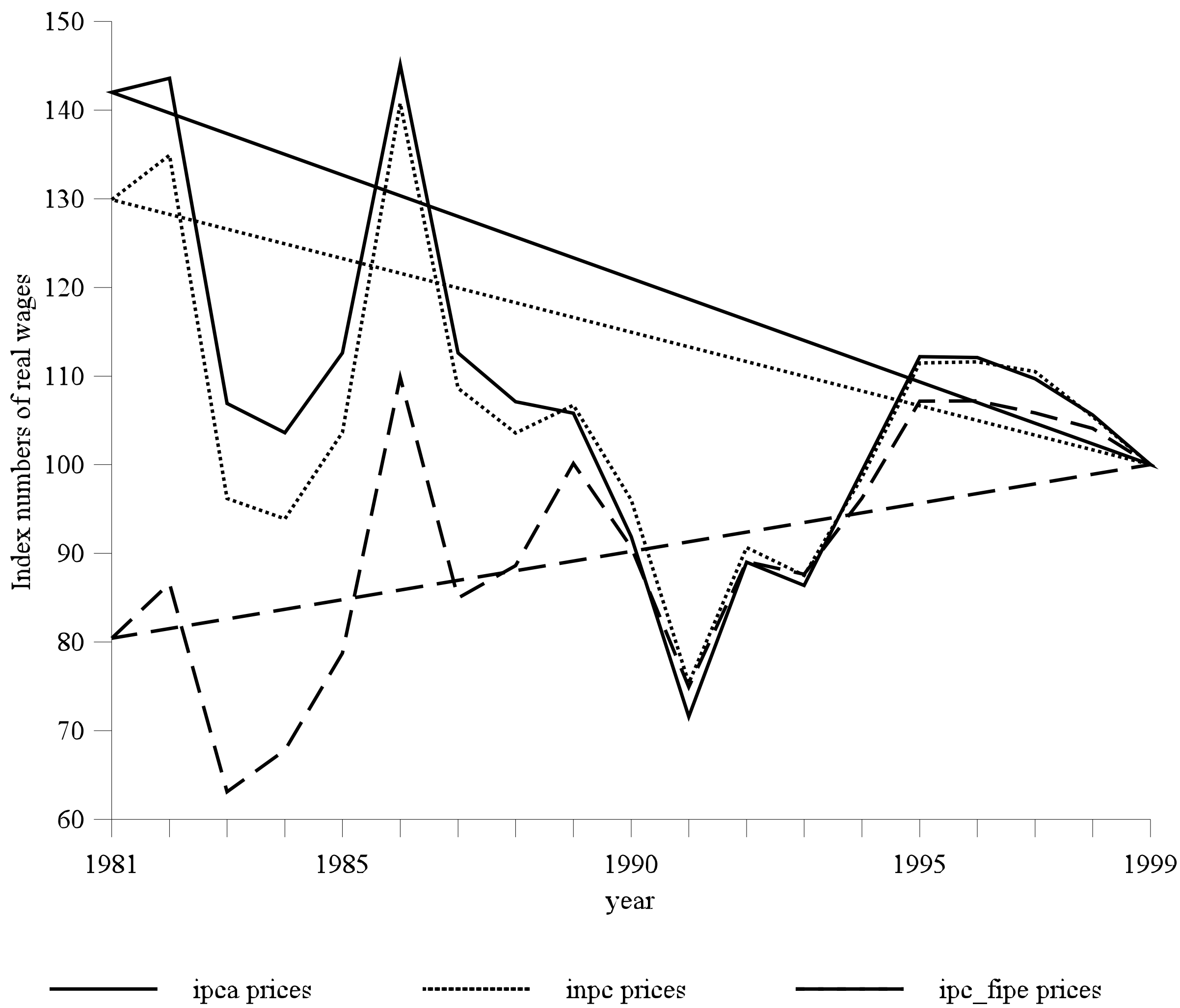


Figure 5

Index Numbers of Real Wages of the Median Male Worker
and Real Minimum Wages, 1981-1999

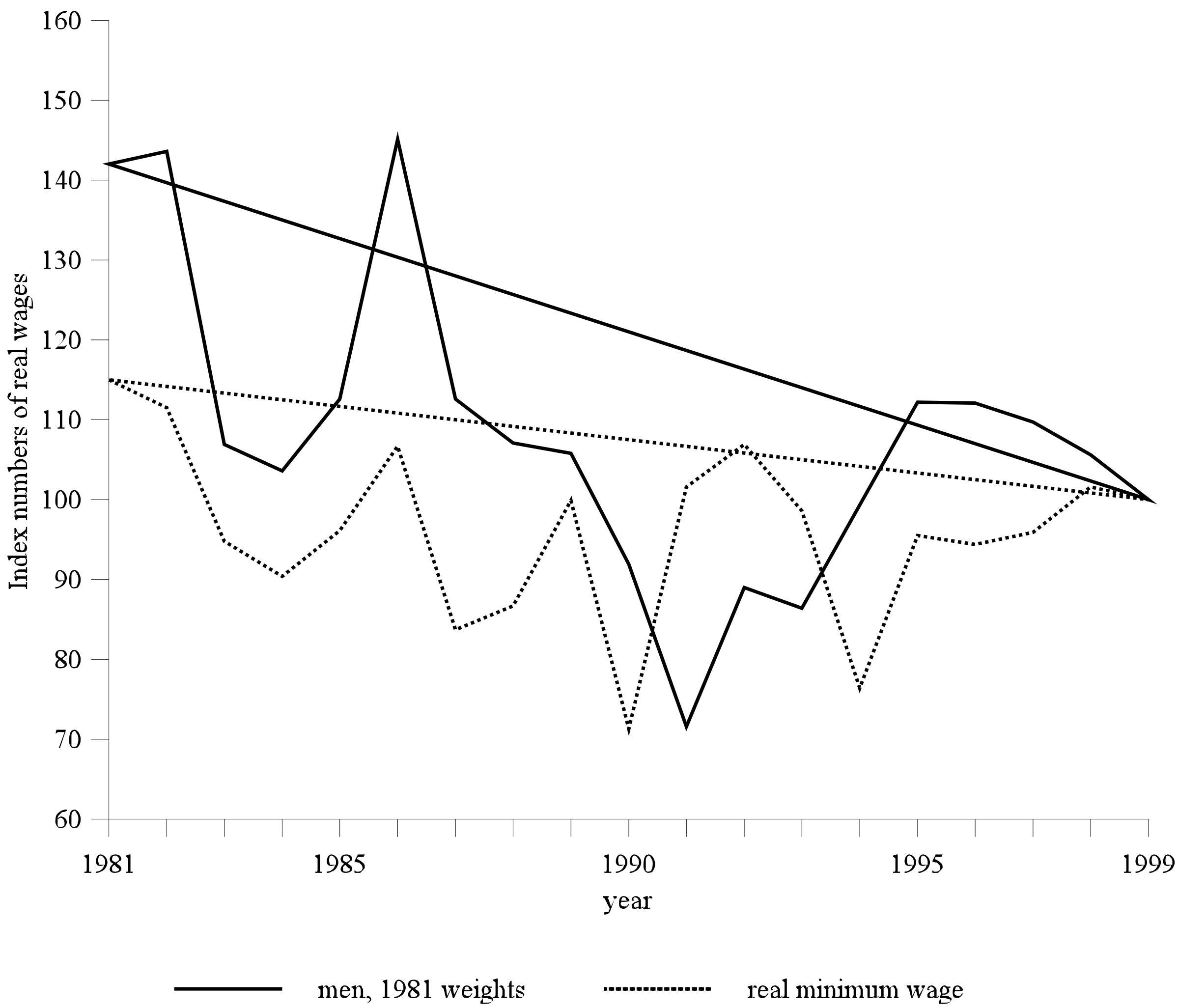


Figure 6
Real Wage Levels and Annual Price Inflation, 1981-99

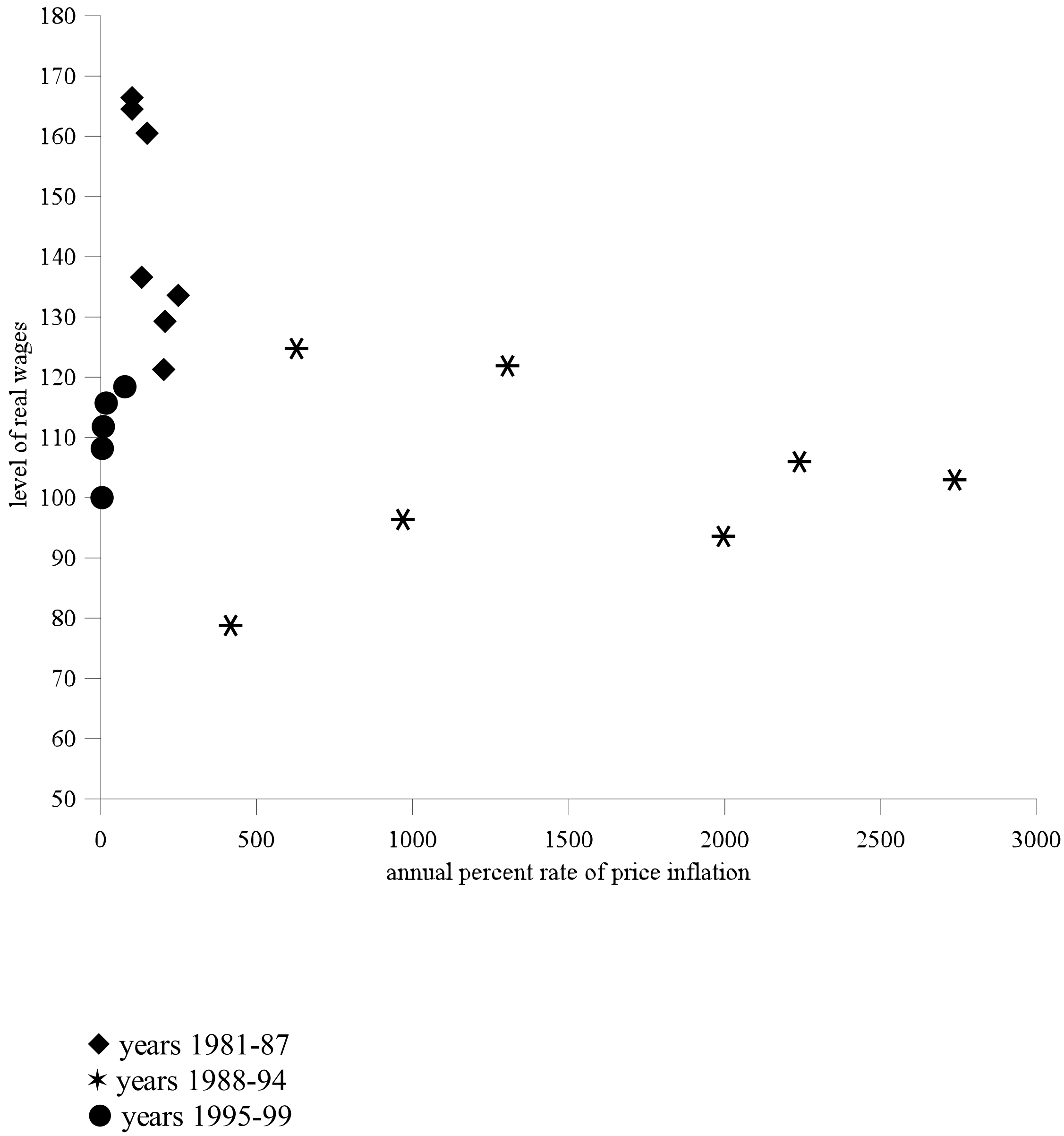


Figure 7
Real Hourly Earnings by Age and Cohort: Men with Four Years of Schooling

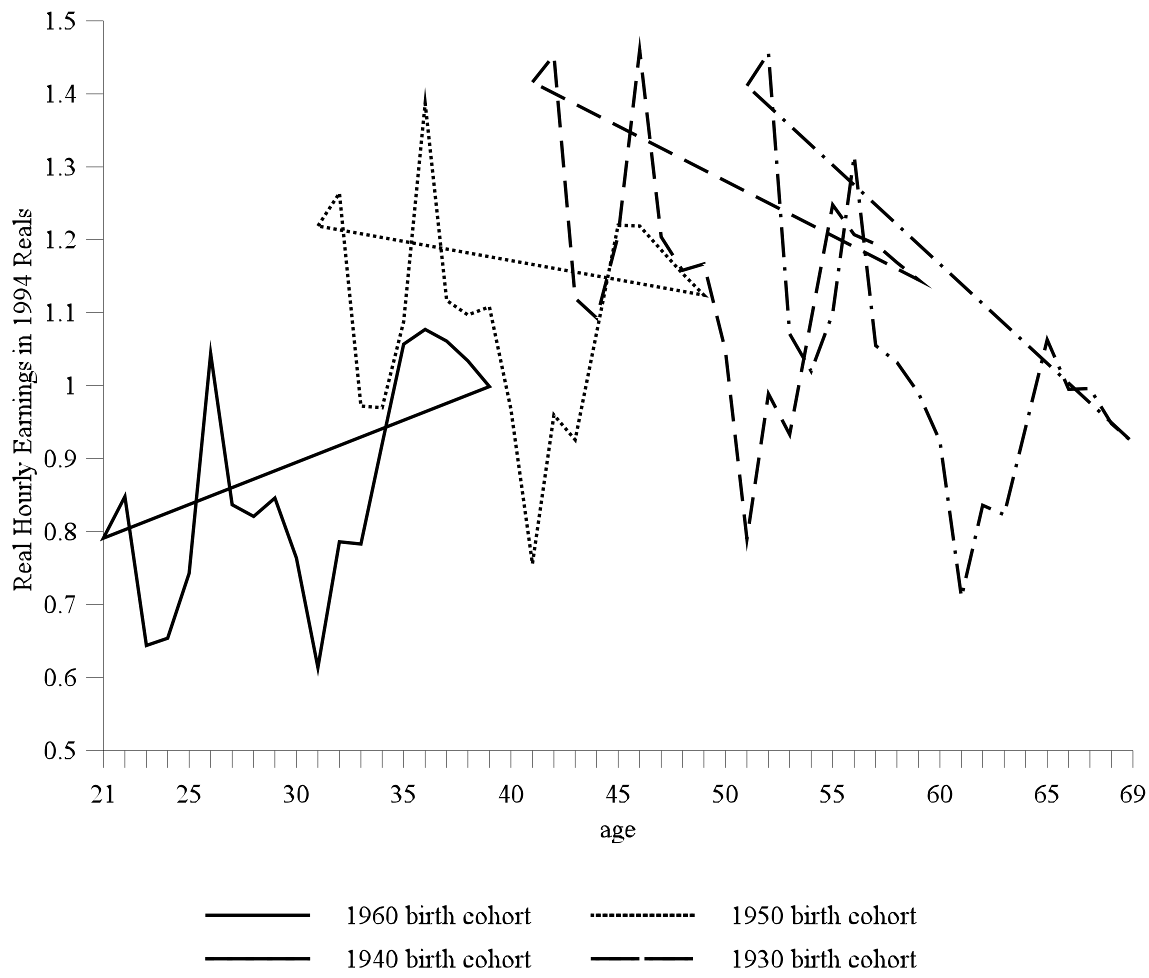


Figure 8
Real Hourly Earnings by Age and Cohort: Men with 9-11 Years of Schooling

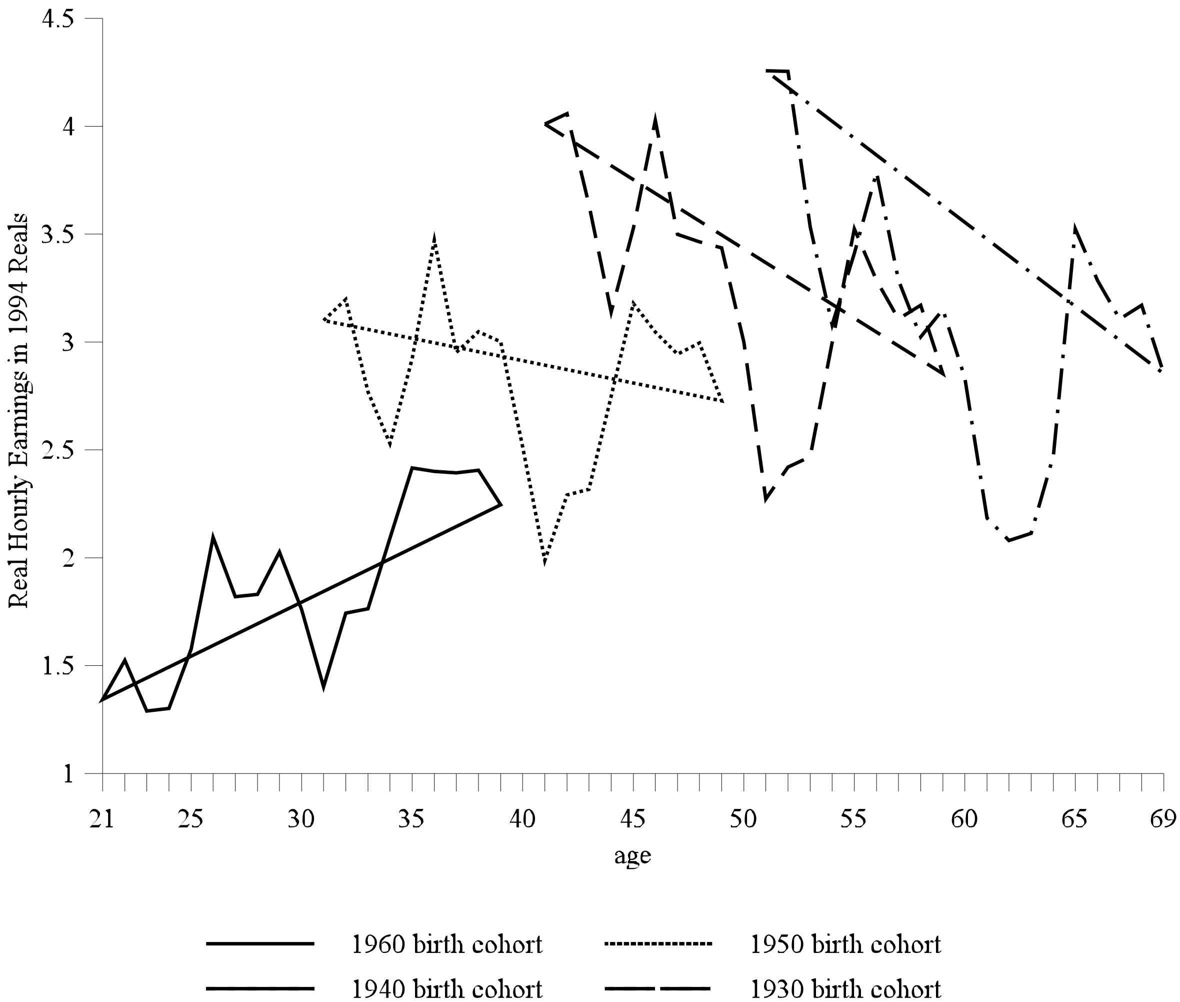


Figure 9
Real Hourly Earnings by Year and Cohort: Men with Four Years of Schooling

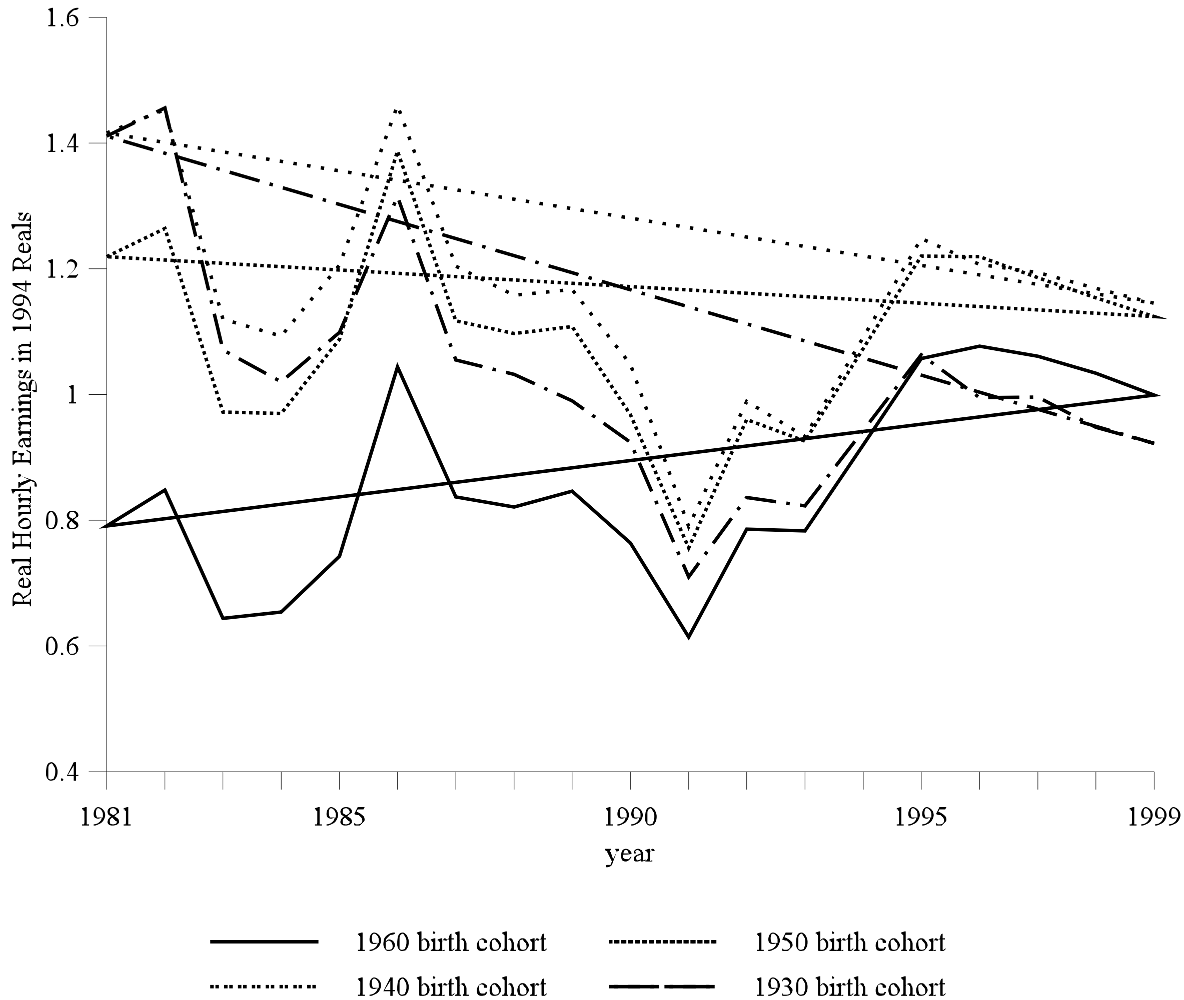


Figure 10
Real Hourly Earnings by Year and Cohort: Men with 9-11 Years of Schooling

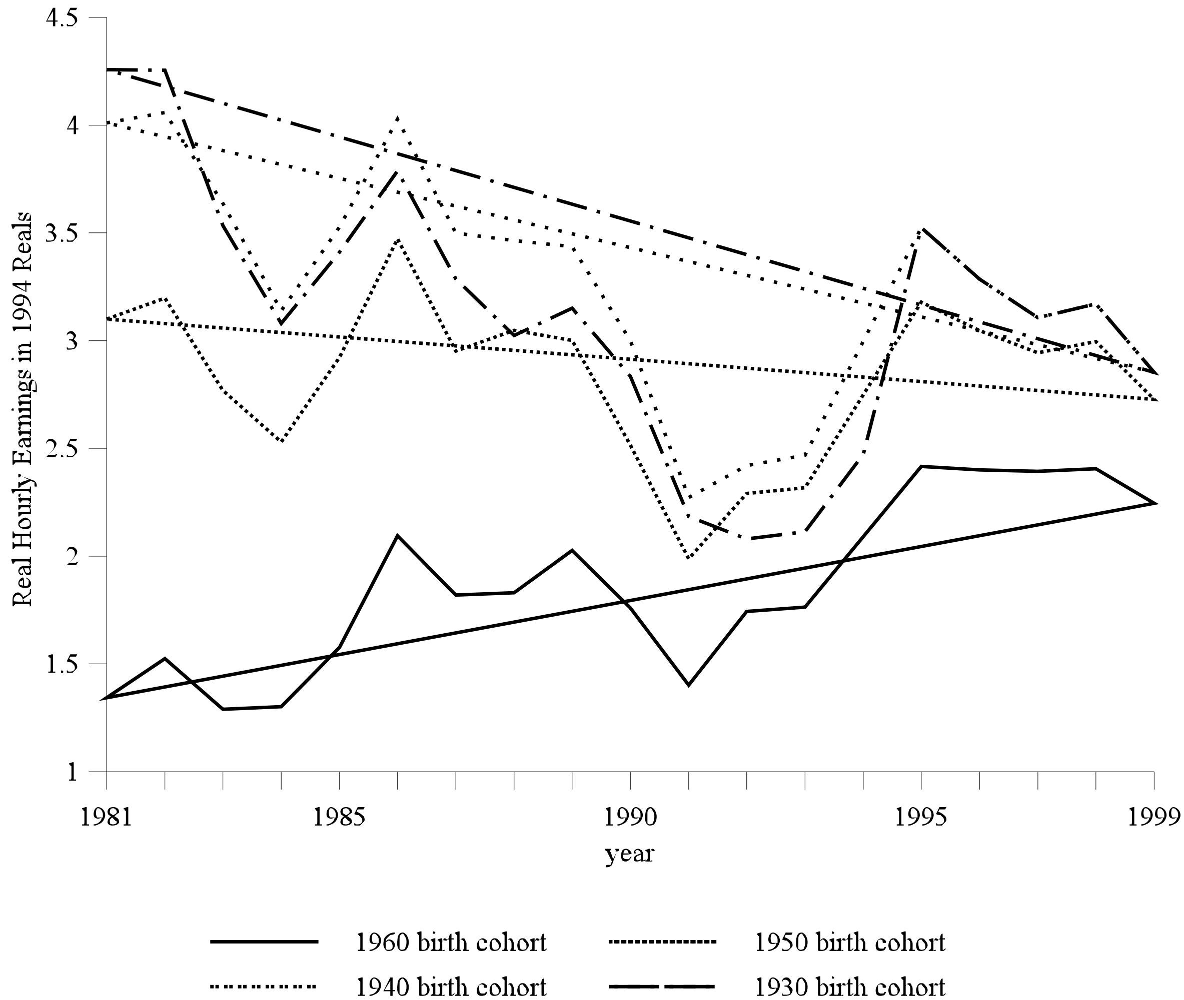


Figure 11
Real Hourly Earnings by Age and Cohort: Women with Four Years of Schooling

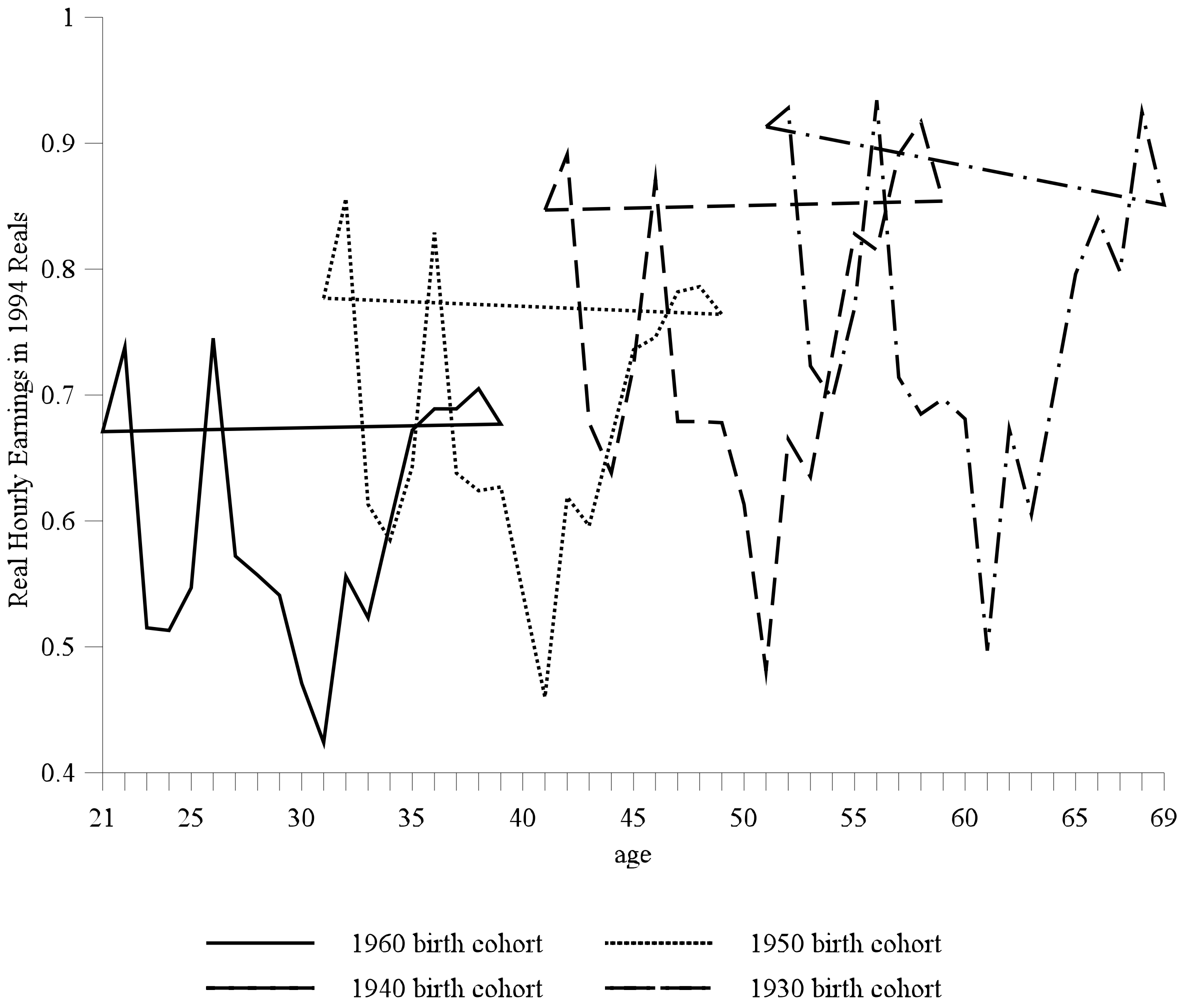


Figure 12
Real Hourly Earnings by Age and Cohort: Women with 9-11 Years of Schooling

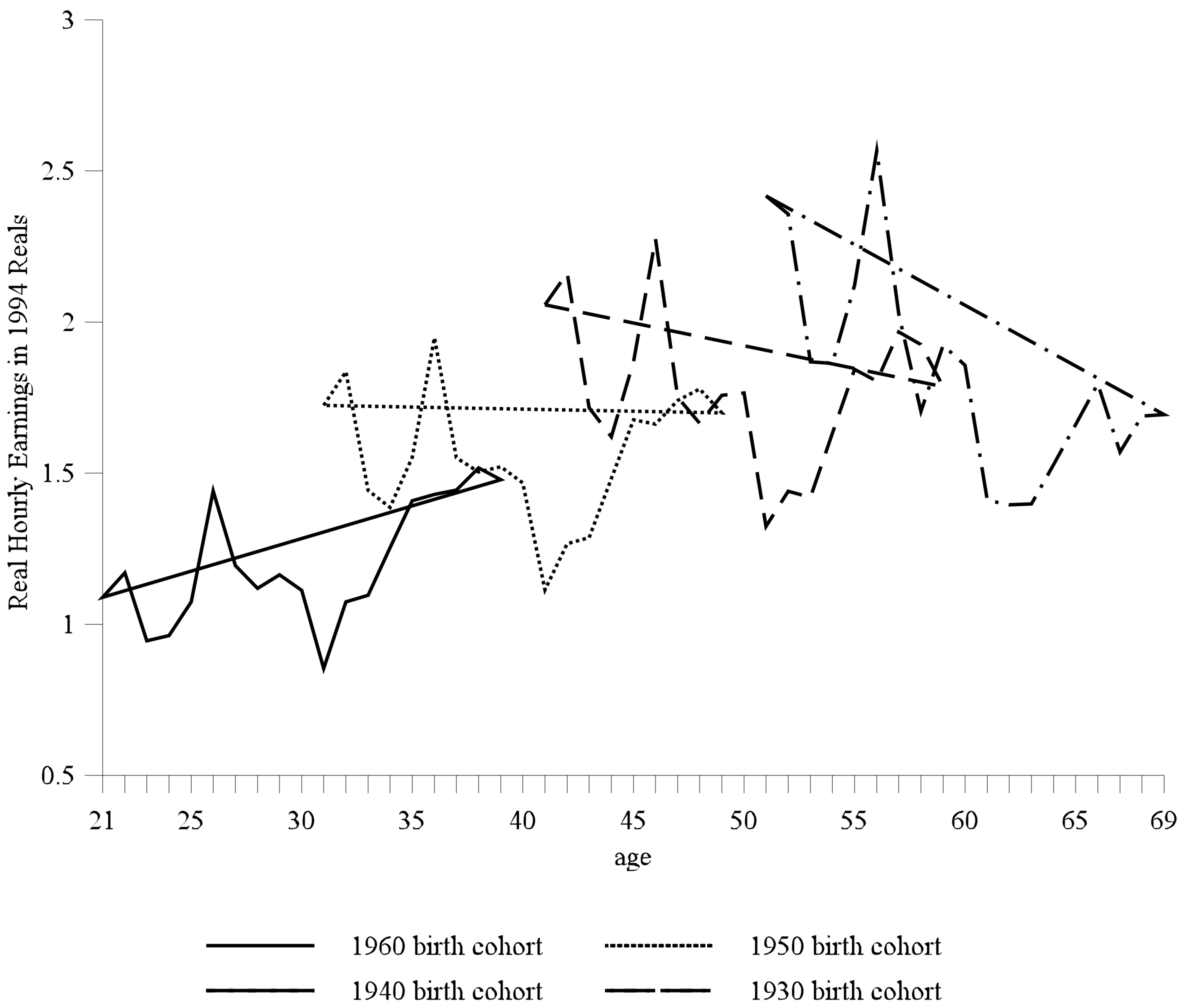


Figure 13
Real Hourly Earnings by Year and Cohort: Women with 4 and 9-11 Years of Schooling

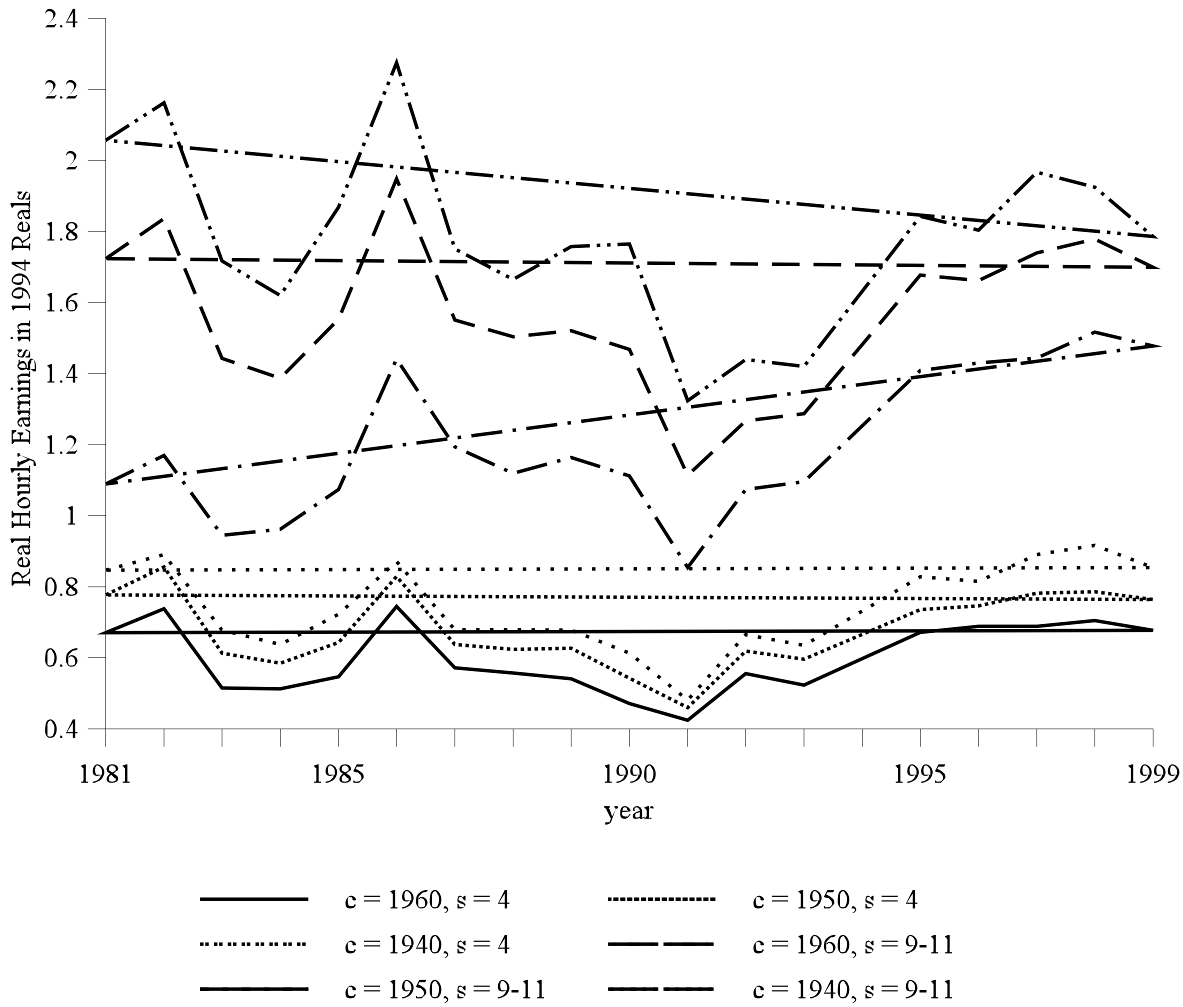


Figure 14
Real Hourly Earnings by Age and Cohort: Men with 16 Years of Schooling in the United States

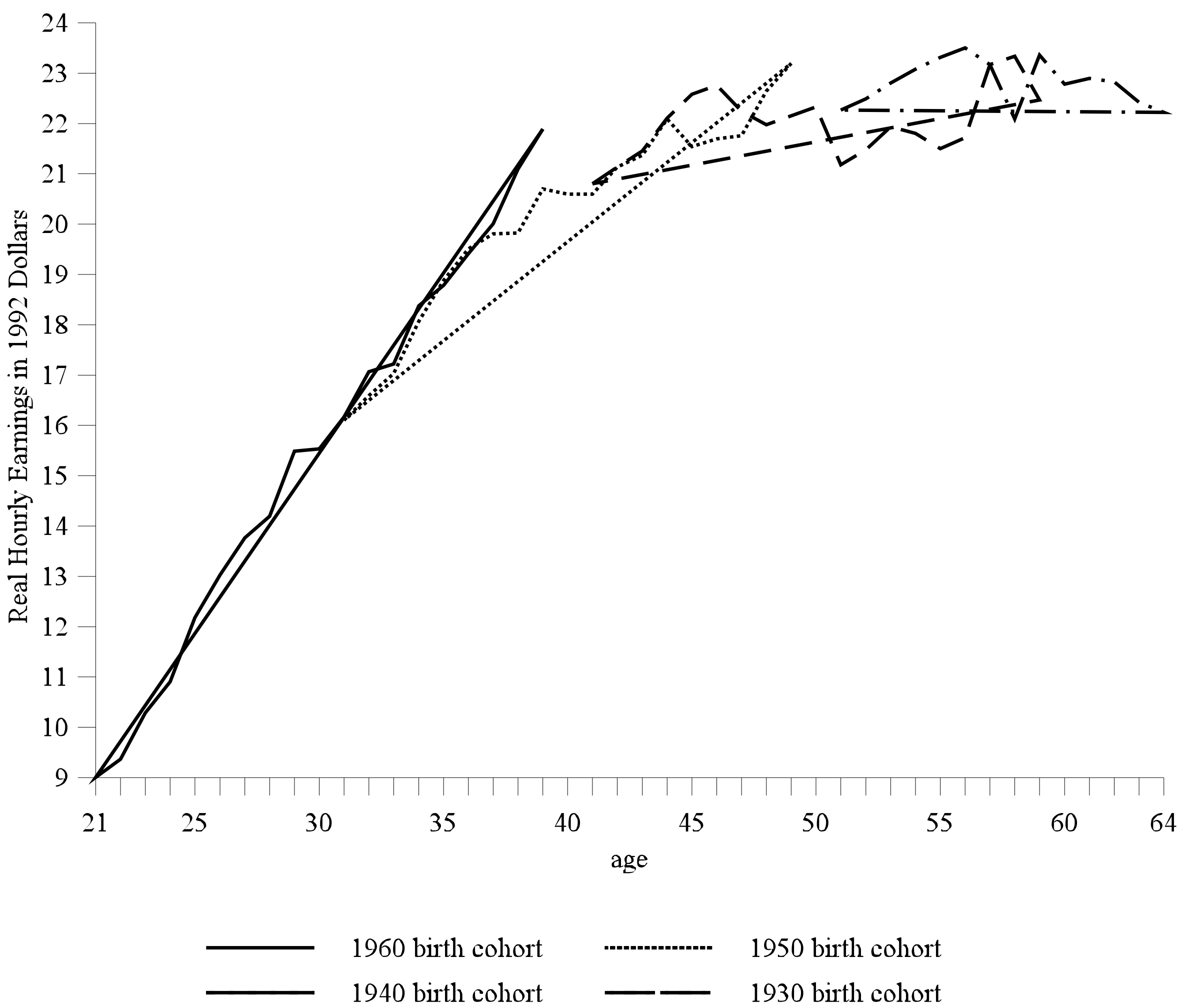


Figure 15
Real Hourly Earnings by Year and Cohort: Men with 16 Years of Schooling in the United States

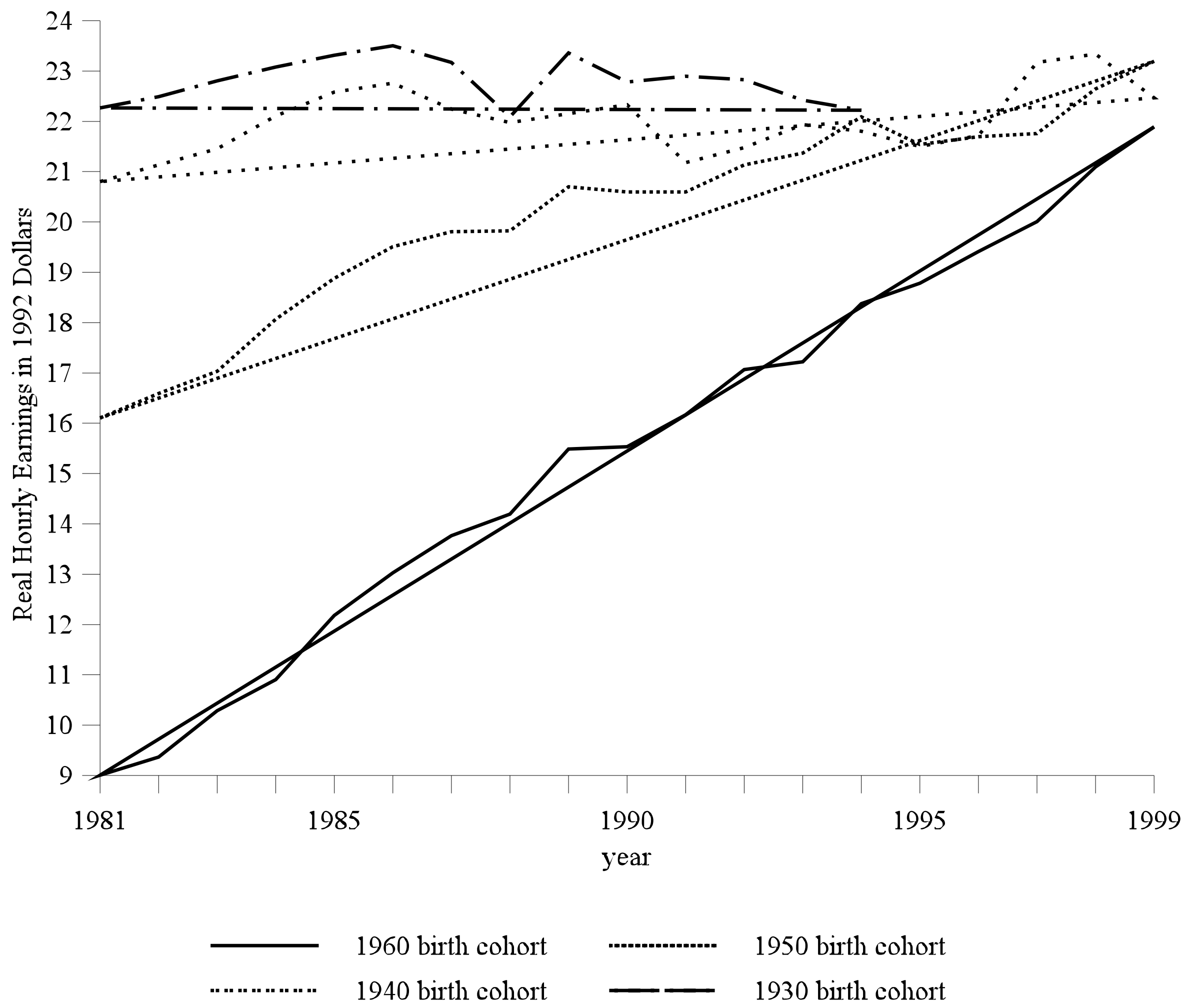


Figure 16
Male-Female Log Wage Differentials by Age and Cohort for Four Years of Schooling

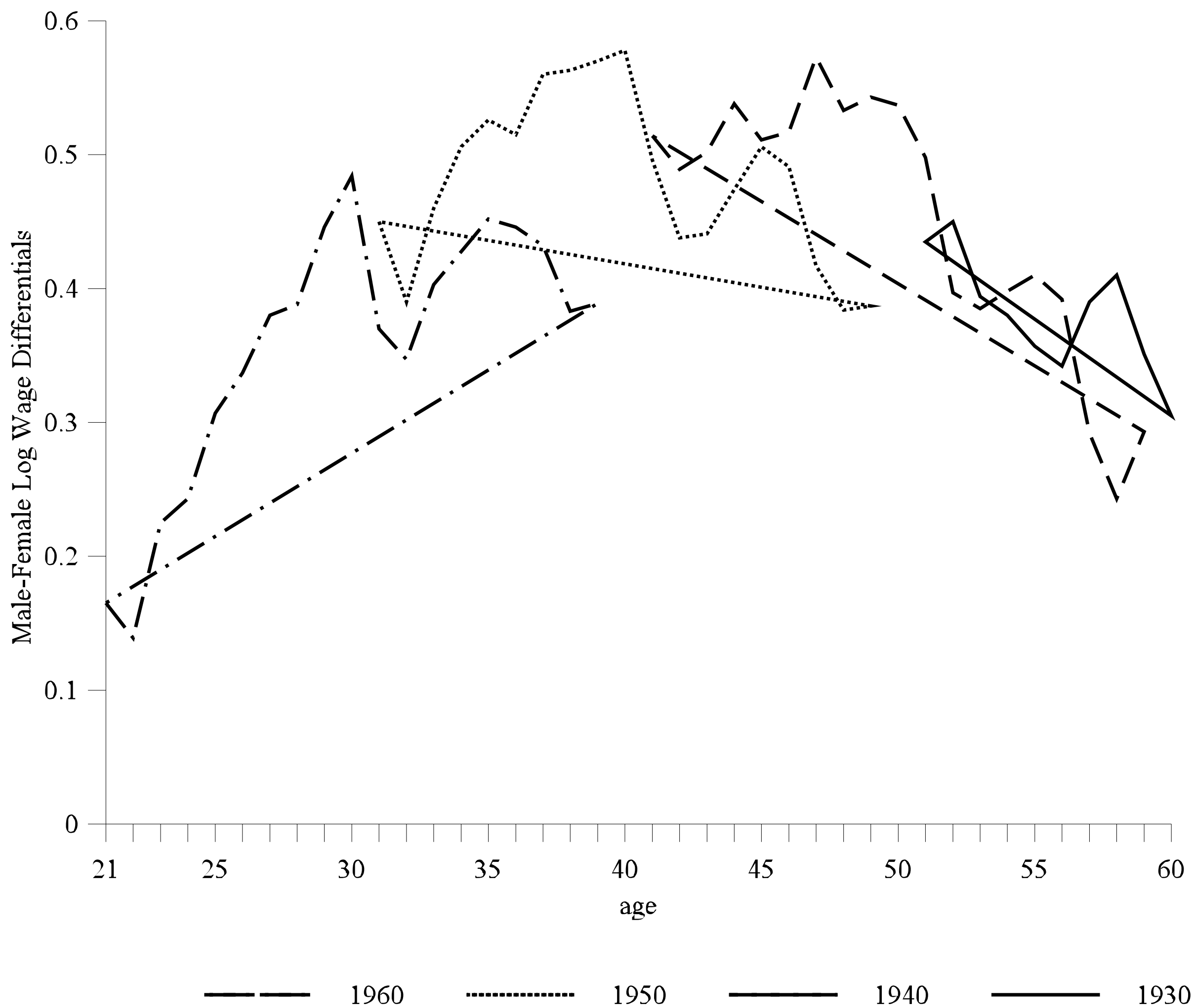


Figure 17
Male-Female Log Wage Differentials by Age and Cohort for 9-11 Years of Schooling

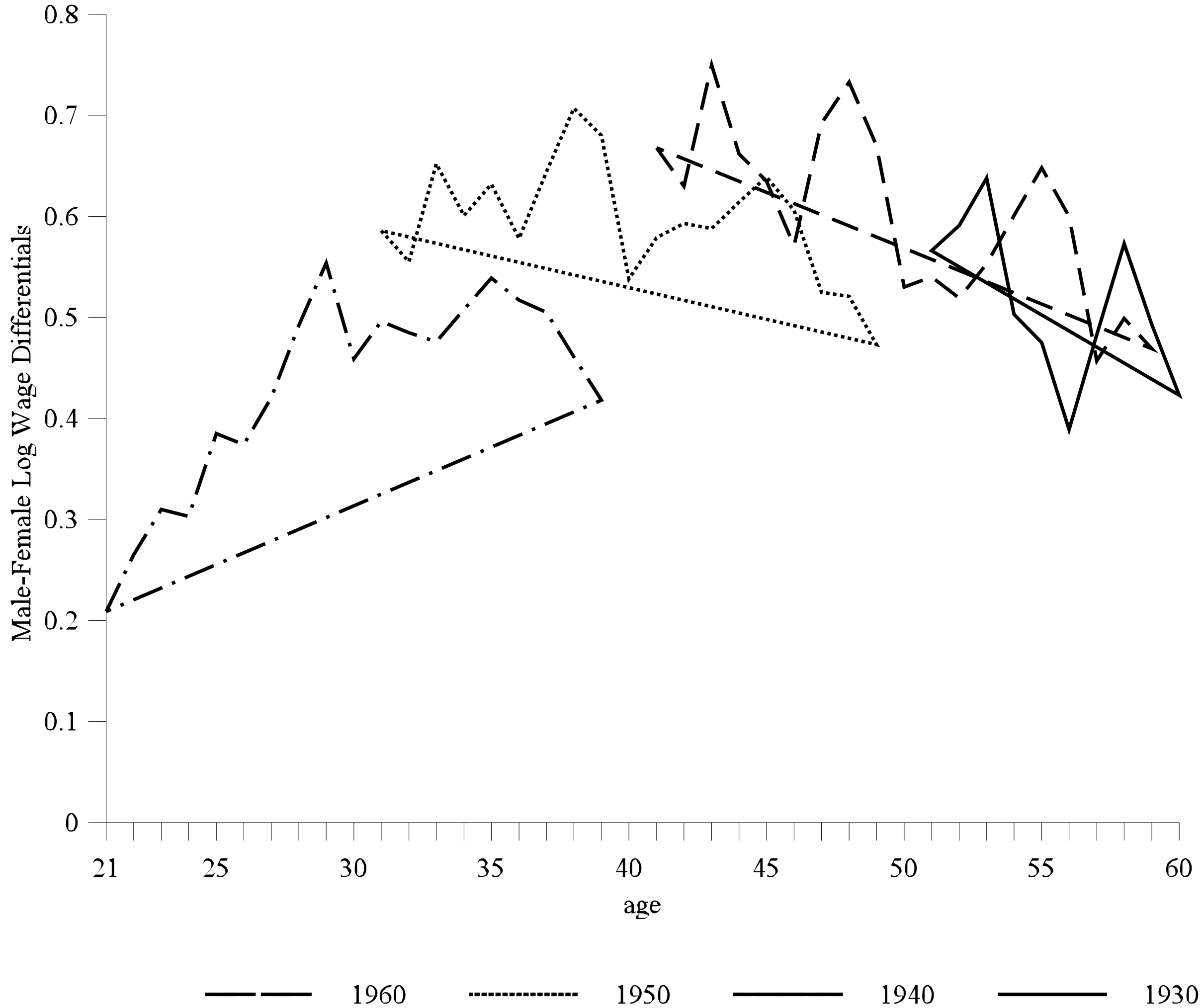


Figure 18
Male-Female Wage Differentials by Year, Cohort, and Schooling

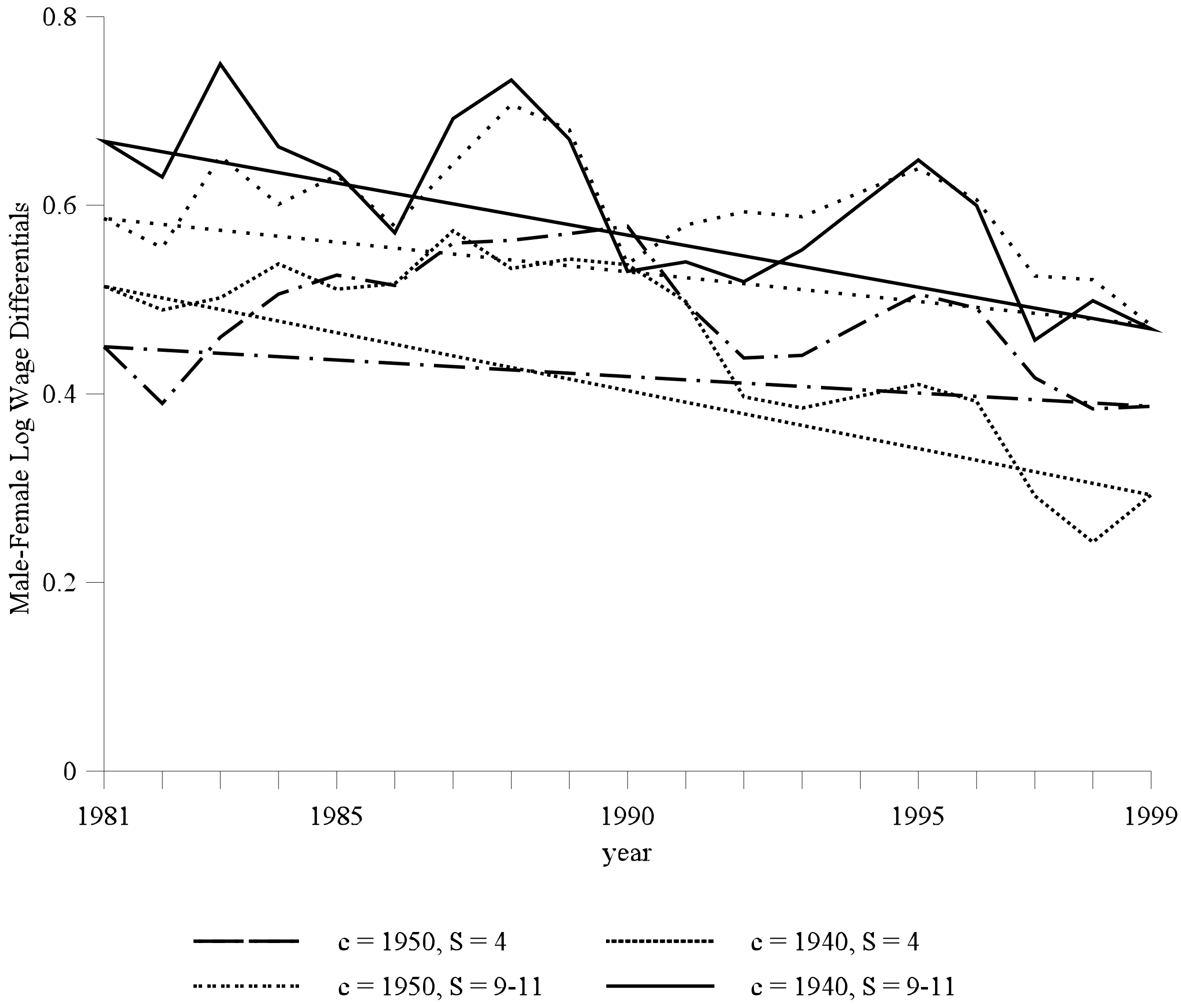


Figure 19
Changes in Wages and in Wage Differentials between Men and Women by Year:
1950 Cohort with Four Years of Schooling

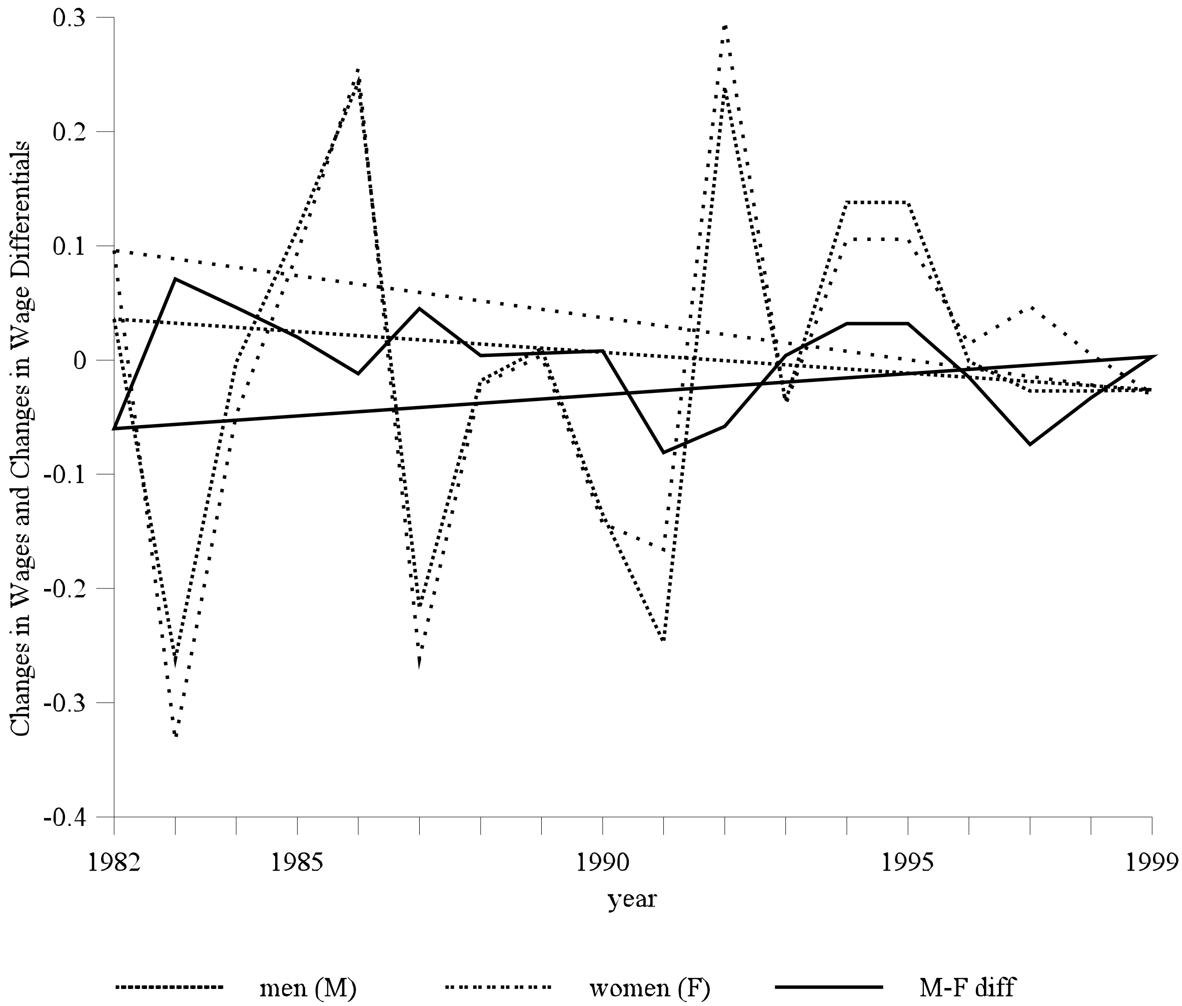


Figure 20
Changes in Wages and in Wage Differentials between Men and Women by Year:
1950 Cohort with 9-11 Years of Schooling

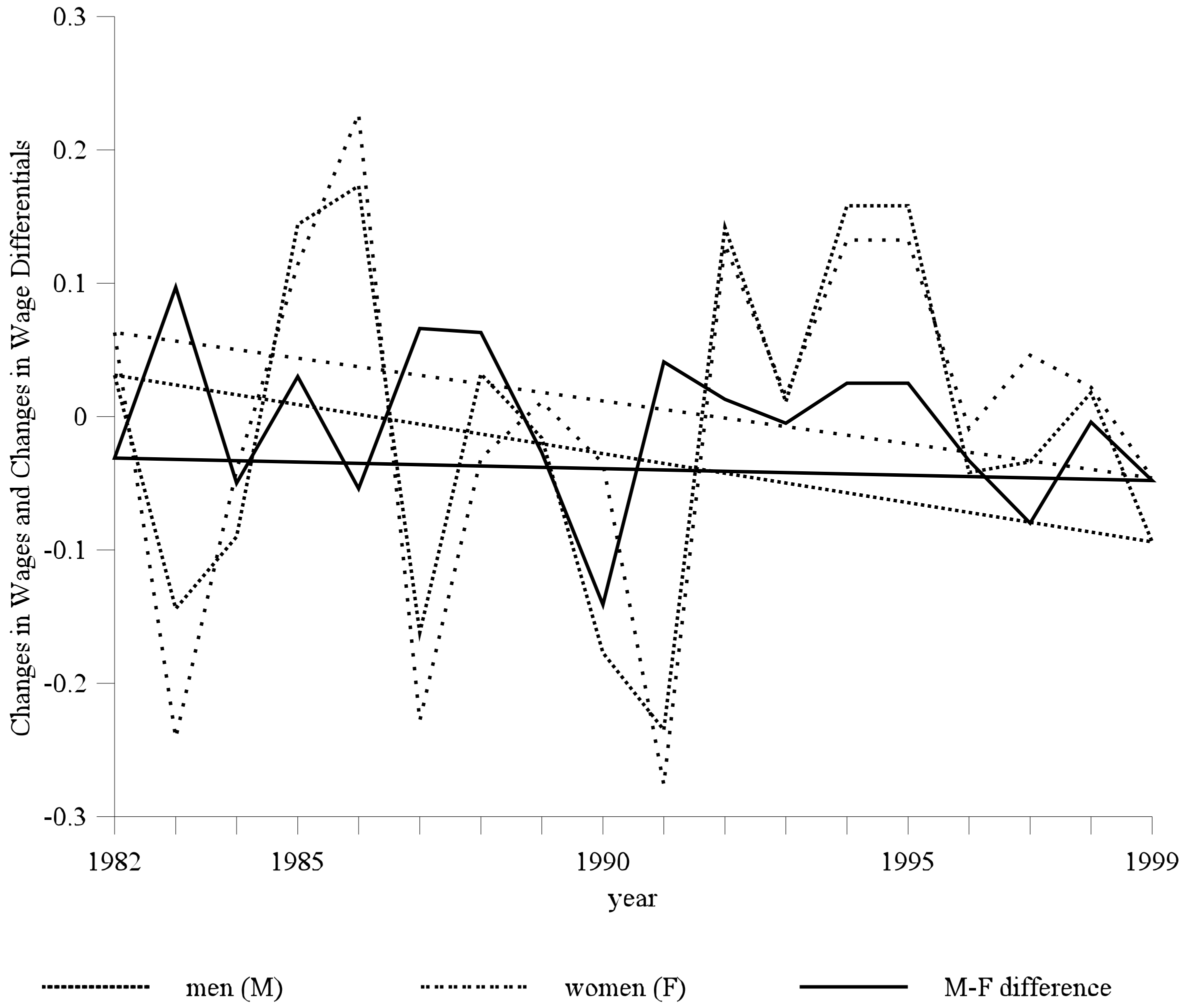


Figure 21
Schooling Wage Differentials by Age and Cohort for Men

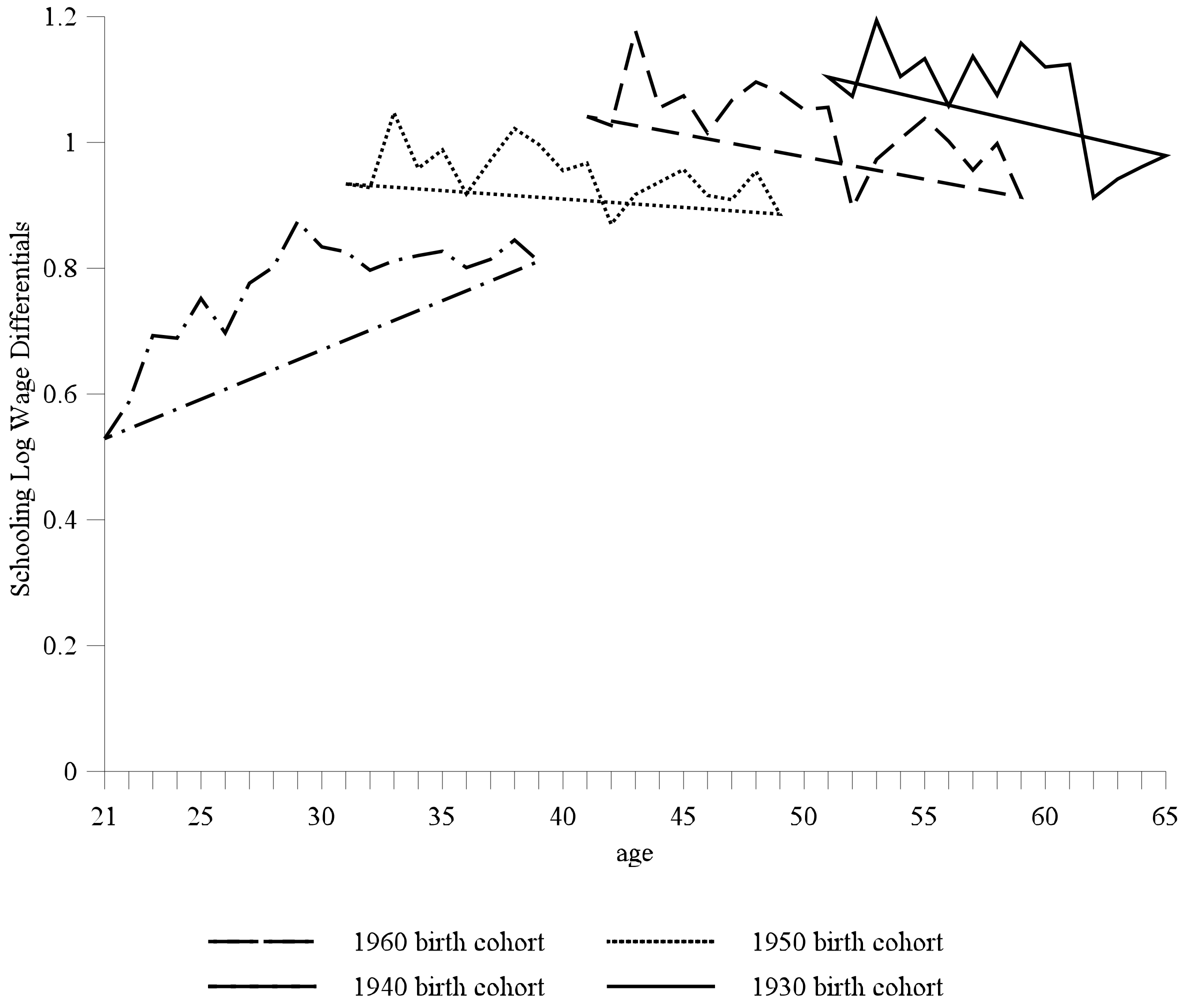


Figure 22
Schooling Wage Differentials by Calendar Year and Cohort for Men

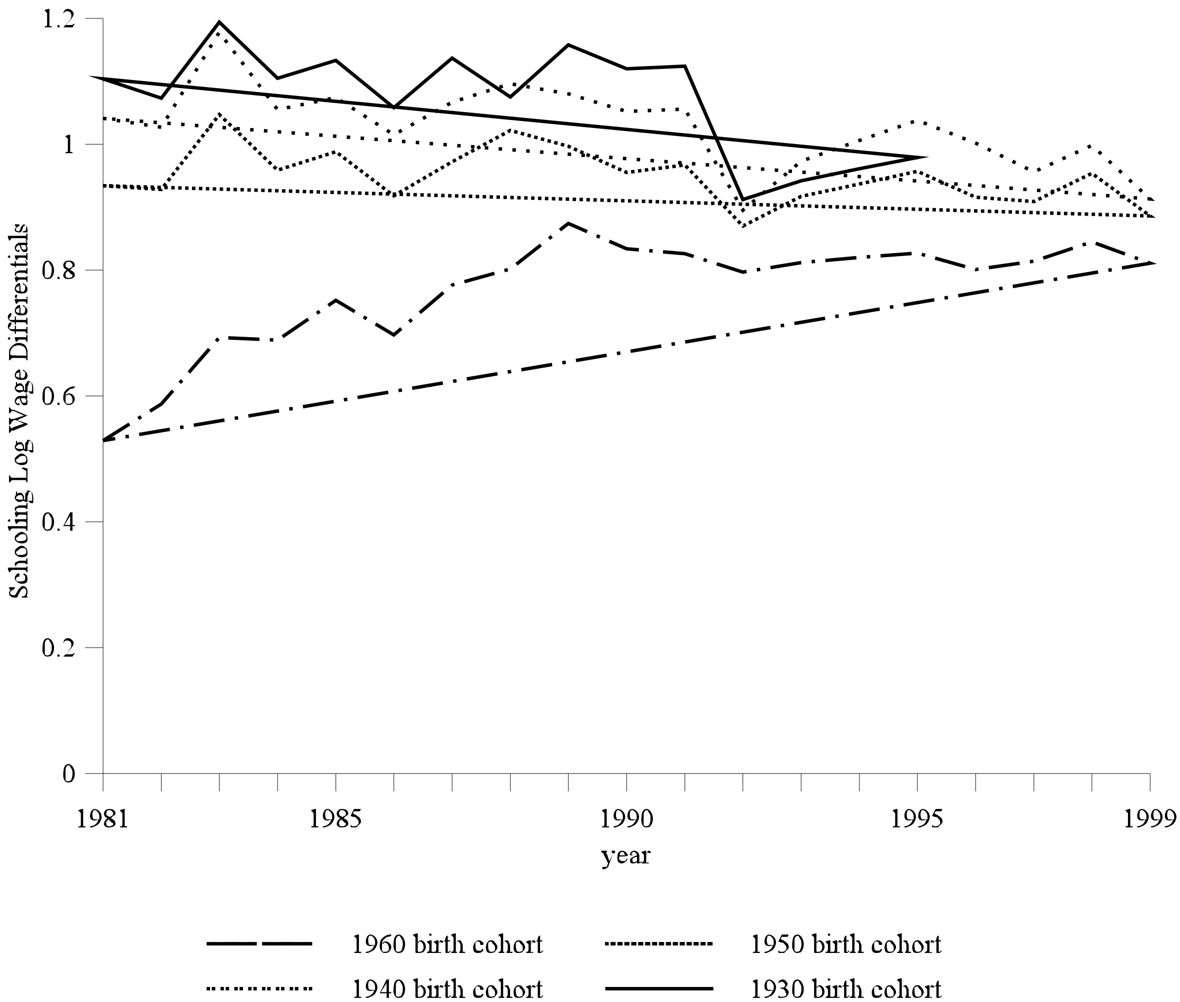


Figure 23
Changes in Wages and in Wage Differentials between Workers with 9-11
and with 4 Years of Schooling by Year: Men belonging to the 1950 Cohort

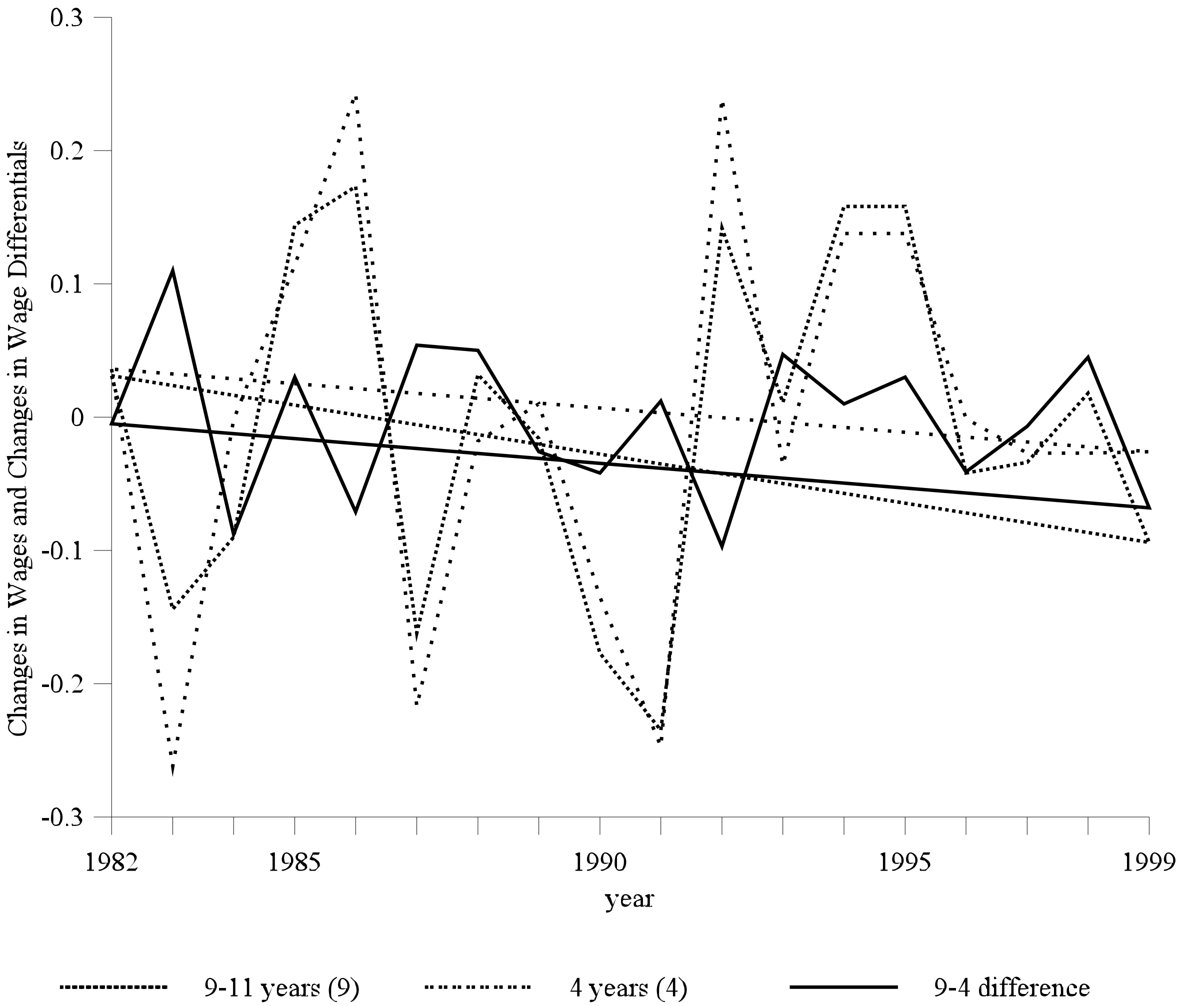


Figure 24
Annual Changes in Formal Sector and Informal Sector Real Wages, Men

Appendix Figure A
Index Numbers of Real Wages for Women (1999 Weights)
50, 2.5, and 97.5 Percentiles of the Distribution