Recent gains in women's earnings: better pay or longer hours?

The female-male earnings gap narrowed significantly between 1979 and 1987, reflecting increases in earnings per hour, rather than in hours worked

Michael W. Horrigan
and
James P. Markey

The dramatic increase in the participation of women in the labor force is probably the most significant U.S. labor market development of the post-World War II era. While research on the labor market behavior of women has addressed a wide spectrum of issues, much attention has focused on women's earnings, particularly in relation to men's. The existence of considerable earnings differences between the sexes is well documented. The evidence, however, suggests that these differences narrowed significantly in the 1980's. In 1979, median annual earnings of women working year round on a full-time basis were 60 percent of their male counterparts'. By 1988, this figure had risen to 65 percent. Female-male earnings ratios based on weekly and hourly earnings point to a similar narrowing of the earnings gap over the same period.

The ratio of female-to-male *annual* earnings can be affected by numerous factors, including gender differences in hours worked per year, differences in both the distribution of employment across occupations and the human capital characteristics of working women and men, and discrimination in labor market practices. This article examines the first of these three factors. In particular, it assesses the degree to which such differences in the earnings of year-round, full-time wage and salary workers reflect differences in hours worked in any given year.[1] It also examines how changes in these earnings differences are the result of changes in the labor supply patterns of women and men.

From an examination of the definition, measurement, and trend of the annual earnings differential of women and men, two significant findings emerge: (1) an alternative measure of the earnings differential which adjusts for differences in hours worked by women and men points to a smaller gap in any given year; and (2) the narrowing of the earnings gap since 1979 was almost entirely the result of a relative increase in women's earnings per hour, and not the result of a relative increase in hours worked.

Michael W. Horrigan and James P. Markey are economists in the Office of Employment and Unemployment Statistics, Bureau of Labor Statistics.

Definitional distinctions

Earnings data for year-round, full-time wage and salary workers are commonly used in studies comparing female/male annual earnings differentials. According to the Bureau of Labor Statistics' definition, a year-round, full-time worker is one who worked 50 weeks or more during the year and *usually* worked full time (35 hours or more).[2] Over the 1979–87 period, this group constituted between 55 and 61 percent of individuals with work experience. (See table 1.) Workers in this group are considered to have a strong attachment to the labor force, and their reported hours and earnings are probably more reliable than those reported by individuals who work part time or part year. However, an examination of year-round, full-time workers' annual hours indicates surprisingly diverse work schedules. This diversity is partly the result of the BLS definition, which permits an individual to work as many as 25 weeks part time and still be classified as a year-round, full-time worker.

The differences in women's and men's annual hours and earnings can be seen in table 2 for each of the following three groups: all year-

round, full-time workers (as defined by BLS); year-round, full-time workers with no part-time weeks—that is, "true" year-round, full-time workers; and year-round, full-time workers with some (fewer than 25) part-time weeks.[3] (See appendix for a description of the annual hours estimation procedure.) About 5.4 million, or 7.6 percent, of all year-round, full-time workers worked some weeks on a part-time basis in 1987.

Members of this group worked a significant number of weeks part time in 1987, a median of 7.7 weeks for women and 5.9 weeks for men. For these women and men, median annual earnings of persons with some part-time weeks were markedly below those of persons who did not work part time. There are also notable differences in the annual hours worked for these two groups. The average true year-round, full-time female worker was on the job 217 more hours than the average year-round, full-time female worker who worked some weeks part time. For men, the difference was 252 hours.

These differences indicate that the exclusion of those with part-time weeks from the year-round, full-time universe yields a more homogeneous group and avoids problems associated with estimating annual hours worked for year-round, full-time workers with some part-time weeks. (See appendix.) Thus, the remainder of this analysis focuses on true year-round, full-time workers—those without any part-time work.

It should be noted that restricting the universe to these workers could result in an annual earnings ratio that differs from the ratio for all year-round, full-time workers. This will occur, if: (1) the incidence of part-time weeks among year-round, full-time workers differs markedly between women and men; or (2) if the earnings gap between true year-round, full-time workers and those with some part-time weeks is substantially different for women than for men. The effect on the earnings differential of restricting the sample to true year-round, full-time workers turns out to be minor. Both series document the same narrowing of the earnings gap, and yearly differences in the estimated earnings differential for the two series are not systematic. (See table 3.)

Table 1. **Persons with work experience by work schedules and sex, 1979–87**

[Numbers in thousands]

Year	Total with work experience	Year-round, full-time schedules	
		Number	Percent of total
Both sexes			
1979	105,380	59,176	56.2
1980	106,342	59,601	56.0
1981	106,596	59,870	56.2
1982	106,423	58,537	55.0
1983	107,839	61,277	56.8
1984	111,353	64,850	58.2
1985	113,740	66,975	58.9
1986	115,810	68,686	59.3
1987	117,606	71,126	60.5
Men			
1979	57,563	38,016	66.0
1980	57,914	37,631	65.0
1981	58,209	37,371	64.4
1982	57,755	35,851	62.1
1983	57,997	37,197	64.1
1984	59,422	39,498	66.5
1985	60,858	40,735	66.9
1986	61,580	41,458	67.3
1987	62,247	42,598	68.4
Women			
1979	47,817	21,160	44.3
1980	48,428	21,970	45.4
1981	48,747	22,399	45.9
1982	48,668	22,687	46.6
1983	49,841	24,079	48.3
1984	51,931	25,352	48.8
1985	52,881	26,240	49.6
1986	54,230	27,229	50.2
1987	55,360	28,527	51.5

Implicit median hourly earnings

Even among true year-round, full-time workers there is a substantial difference in the reported annual hours of women and men. In 1987, women worked an average of 2,156 hours, while their male counterparts averaged 2,316 hours.

An implicit measure of hourly earnings of true year-round, full-time workers can be derived by dividing annual earnings by annual hours. This earnings measure fully adjusts for differences in hours worked.[4] In 1987, the *median* implicit hourly earnings for women was $8.11 and for men it was $11.75, resulting in a female-male earnings ratio of 69.0 percent.[5] As shown in table 3, the implicit hourly earnings measure consistently shows an earnings ratio around 4 percentage points higher than the earnings ratio based solely on annual earnings (not adjusted for hours).

Changes in the annual earnings differential of true year-round, full-time workers can involve two important factors: changes in annual hours of women relative to men, and changes in their relative wage rates. The results given above show that adjusting for changes in hours, as is done with the implicit hourly earnings statistic, does not have an impact on the trend in the earnings differential between women and men over the 1979–87 period. This indicates that most of the narrowing of the gap has been due to a relative increase in the wage rates of women as compared to men. Although the results shown above point to increases in

women's earnings per hour as the cause of their improved relative earnings, the use of medians in such historical analyses can be problematic.[6] (See box for a discussion of medians.) A precise measure of the independent effect of hours and earnings is possible using an alternative statistic based on means rather than medians. Means are necessary because statistics based on medians do not permit a decomposition of the earnings differential between women and men into an hours component and an implicit earnings per hour component. The mean of a distribution permits a decomposition of annual earnings into the separate components of earnings per hour and annual hours worked and does not suffer (as do medians) from estimation problems associated with a multi-peaked earnings distribution. The alternative proposed here, the log-gap earnings statistic, can also be applied to a wide array of group comparisons, such as white/black earnings differentials or differences in the returns to education.

The log–gap earnings statistic

As in the last section, the method adopted here uses the concept of implicit hourly earnings of true year-round, full-time workers as a starting point. For each sex group, the concept is defined as the ratio of average, or *mean*, earnings of the group to its average annual hours. By expressing implicit hourly earnings as the ratio of means, it is mathematically possible to estimate how the narrowing in the earnings gap between women and men can be attributed to changes in average annual hours worked and average earnings per hour.[7] The final estimating equation is expressed in the following form:

$$ln\,(E_w/E_m) = ln\left(\frac{E_w/H_w}{E_m/H_m}\right) + ln\,(H_w/H_m)$$

where:

ln = natural logarithm

E_w = average annual wage and salary earnings of women

E_m = average annual wage and salary earnings of men

H_w = average annual hours of women

H_m = average annual hours of men

and,

E_w/E_m = ratio of annual earnings of women to men

$\frac{[E_w/H_w]}{[E_m/H_m]}$ = ratio of implicit hourly earnings of women to men

H_w/H_m = ratio of annual hours of women to men

Table 2. **Median annual earnings and average annual hours of year-round, full-time wage and salary workers by sex and part-time status, 1987**

Characteristic	Number (thousands)	Earnings	Hours
Both sexes			
All year-round, full-time workers	71,126	$21,823	2,234
True year-round, full-time workers	65,700	22,436	2,253
Year-round, full-time workers with some part-time weeks	5,426	14,382	2,008
Men			
All year-round, full-time workers	42,598	26,312	2,298
True year-round, full-time workers	39,605	26,959	2,316
Year-round, full-time workers with some part-time weeks	2,993	17,150	2,064
Women			
All year-round, full-time workers	28,527	17,047	2,137
True year-round, full-time workers	26,095	17,531	2,156
Year-round, full-time workers with some part-time weeks	2,433	12,086	1,939

Table 3. **Ratio of female-to-male median earnings by alternative measures of earnings, 1979–87**

Year	All year-round, full-time workers	True year-round, full-time workers	
	Ratio of annual earnings	Ratio of annual earnings	Ratio of implicit hourly earnings
1979	.600	.602	.641
1980	.597	.596	.644
1981	.599	.602	.646
1982	.620	.622	.661
1983	.633	.635	.666
1984	.630	.622	.653
1985	.633	.632	.663
1986	.636	.639	.681
1987	.648	.650	.690

As the expression indicates, the earnings differential is separated into a pure earnings-per-hour component and a pure hours-worked-per-year component. Natural logarithms are used to measure the percentage change in the earnings differential between 1979 and 1987, as well as the proportion of that change resulting from a pure hours effect and the proportion from a pure earnings-per-hour effect.

The estimation of mean earnings is complicated by the Census Bureau's practice of truncating earnings at upper limits—often referred to as topcoding of the data. For example, in March 1980, the wage and salary earnings of individuals were topcoded at $50,000. Hence, anyone reporting wage and salary earnings above this amount had a value of $50,000 entered into his or her wage record.[8]

As a result of the topcoding of the data, estimation of an exact mean is not possible. If the recorded values of earnings are used, the resulting mean (referred to in the statistics literature as the Winsorized mean[9]) will underestimate the true mean. The degree of underestimation depends on the percentage of individuals with earnings above the topcoded level and the extent to which their earnings exceed the topcoded level. In the same manner, the degree of bias in measures of the differential between female and male earnings will depend on the differential nature of topcoding between women and men. As the following tabulation indicates, among true year-round, full-time workers, the proportion of women with topcoded earnings is consistently lower than the proportion of men. This suggests that using the published topcoded earnings figures in the calculation of "Winsorized" means will upwardly bias the ratio of female-to-male mean annual earnings in any given year.[10]

	Topcode value	Percent with topcoded earnings: Women	Men
1979	$50,000	0.22	2.59
1980	50,000	.19	3.38
1981	75,000	.05	1.38
1982	75,000	.10	1.90
1983	75,000	.09	1.99
1984	99,999	.09	1.03
1985	99,999	.08	1.25
1986	99,999	.12	1.60
1987	99,999	.17	1.67

A statistical procedure known as maximum likelihood estimation can be used to construct estimates of the average value of earnings in the open-ended or topcoded interval.[11] Another alternative is to conduct the analysis using the published topcoded information. Both alternatives are tested, and comparisons are made between the results of the two approaches.

Maximum likelihood technique. The basic idea of the maximum likelihood approach is to use statistical distribution theory to estimate the average value of earnings for those individuals whose earnings are topcoded.[12] The shape of the distribution of earnings is such that a particular distribution, the Pareto, is a good approximation for all incomes after the modal point of the distribution. Using this approximation, it is possible to estimate the mean value of earnings beyond the truncation point. Once this value is estimated, it is then possible to estimate a mean for the entire population.

Results. Using the maximum likelihood procedure to handle the topcoding problem, the ratio of female-to-male average annual earnings narrowed considerably between 1979 and 1987 for true year-round, full-time workers, from 57.2 to 62.0 percent. At the same time, the ratio of

Using medians to measure earnings

A measure of central tendency, the median of annual earnings is the level of earnings at which half of all workers have earnings above the median and half have earnings below. A desirable feature of the median is that it is not affected by extreme values which can have a substantial impact on the mean. Problems with the estimation of medians in the presence of multipeaked distributions, however, limit their usefulness in analyzing changes in earnings over time.

As shown in chart 1, the distribution of women's and men's annual earnings is not a smooth unimodal distribution, but rather a distribution characterized by numerous peaks. The peaks appear at regular intervals, reflecting the tendency of respondents to round their reported annual earnings to a multiple of $5,000. The procedure used for estimating median earnings divides the distribution into discrete earnings intervals. One of these intervals contains the median value of wage and salary earnings. For that interval, linear interpolation is used to estimate the median.

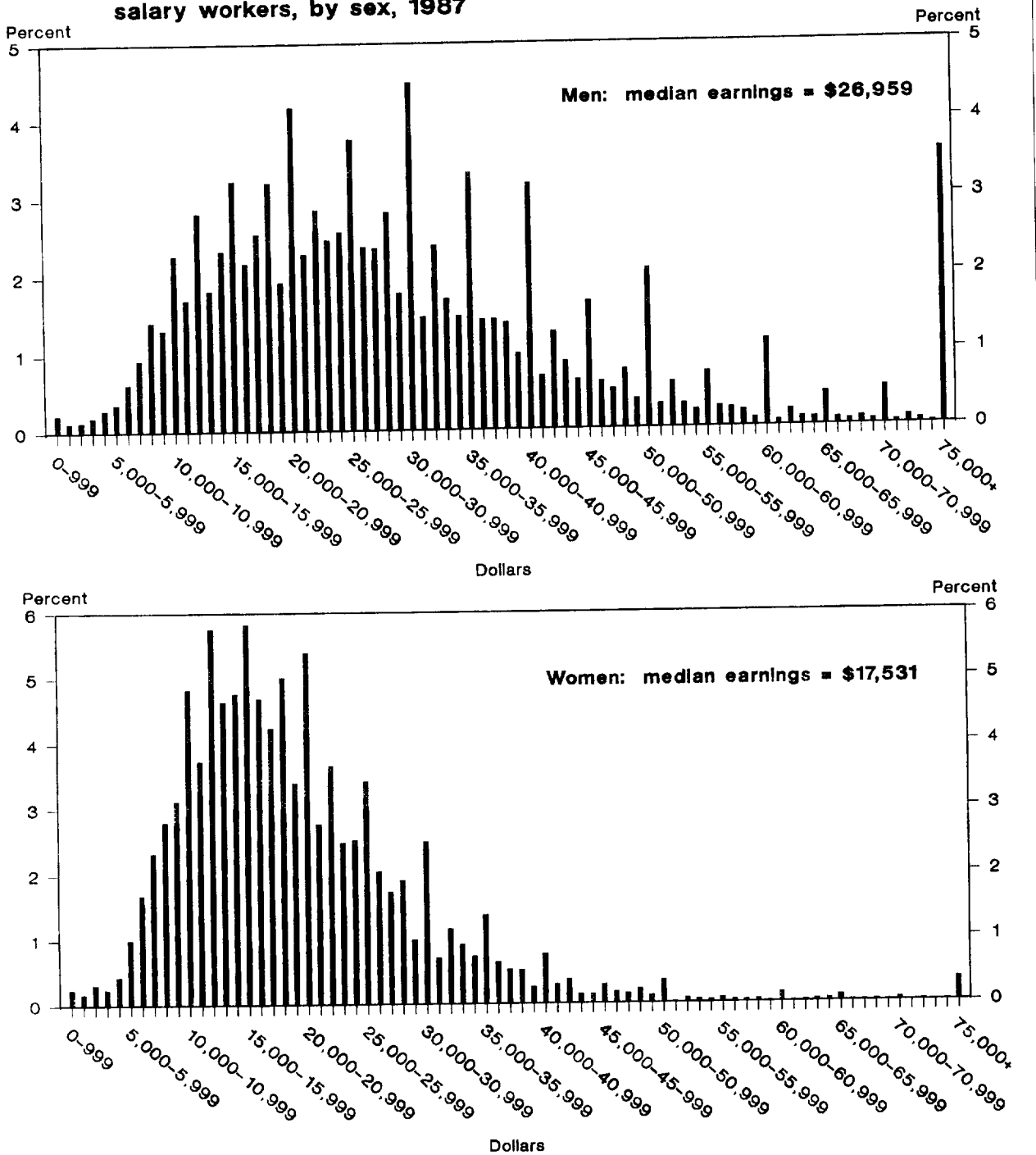
If the median falls into an interval in which there is a significant peak (local mode), it is possible that the median may very well be found in the same discrete earnings interval from one year to the next. Once through this interval, however, the median may rise quickly until it enters an earnings interval with another significant peak.

The behavior of medians over time may differ for men and women solely because of differences in the position of the median within the earnings distribution of each sex. If, in one year, for example, the men's median is in a peak earnings interval while the women's median is not, then in the next year the median for men may change much more slowly than the median for women, resulting in a narrowing of the earnings gap. Thus, an apparent narrowing of the female–male earnings gap over time may actually be a statistical artifact of the behavior of medians.

average annual hours of women to men remained stable. (See table 4.) As expected, most of the narrowing of the overall earnings gap was due to a narrowing of the gap in earnings per hour—accounting for more than 90 percent of the total change between 1979 and 1987.

The analysis was repeated using "Winsorized" means, that is, without adjusting the topcoded earnings figure. The results are very close to those derived using the maximum likelihood method of adjustment. In this case, earnings per hour accounted for nearly 94 percent of

Chart 1. **Annual earnings distribution of "true" year-round, full-time wage and salary workers, by sex, 1987**



NOTE: "True" year-round, full-time workers have no part-time weeks of work.

the change in the overall earnings gap between 1979 and 1987.[13]

Conclusion

Differences in the annual earnings of women and men working year round, full time narrowed between 1979 and 1987. Restricting the universe to true year-round, full-time workers had virtually no effect on the trend. Despite this finding, researchers should consider adopting this restriction because it provides a more accurate estimate of annual hours and earnings than is obtained for the group of all year-round, full-time workers. In addition, the exclusion of year-round, full-time workers with some part-time weeks eliminates the possibility that a change in the earnings differential of all year-round, full-time workers may come about as the result of a change in part-time weeks worked.

Significant gender differences in annual hours worked exist, even when the universes of women and men are limited to true year-round, full-time workers. After controlling for annual hours, the earnings gap in any given year is found to be significantly less, although the trend towards a narrowing of the gap remains intact. This implies that the narrowing results from the relative increase in women's earnings per hour, and not changes in relative hours worked. Because of potential problems in the use of medians in making such trend comparisons, this article uses an alternative statistic based on mean earnings. The alternative measure also permits the decomposition of changes in annual earnings into changes in hours worked and changes in earnings per hour. Estimates of this statistic confirm that the narrowing of the female-male earnings gap between 1979 and 1987 was almost exclusively a result of a relative increase in women's earnings per hour. □

Table 4. **Female-male ratios of earnings and annual hours, using alternative estimation procedures, 1979 and 1987**

Method	1979	1987
Maximum likelihood		
Total earnings	.572	.621
Implicit hourly earnings	.618	.667
Annual hours	.926	.931
Winsorized mean		
Total earnings	.590	.646
Implicit hourly earnings	.637	.694
Annual hours	.926	.931

Footnotes

For further information, the authors may be contacted at (202) 523-1944.

[1] For a comprehensive review of the literature on male-female earnings differentials, see Morley Gunderson, "Male-Female Wage Differentials and Policy Responses," *Journal of Economic Literature*, Vol. XXVII, March 1989, pp. 46–72. For a discussion of sex discrimination in the labor market, see Barbara Bergmann, "Does the Market for Women's Labor Need Fixing?" *Journal of Economic Perspectives*, Vol. 3, No. 1, Winter 1989, pp. 43–60. Also see Mark Sieling, "Staffing patterns prominent in female-male earnings gap," *Monthly Labor Review*, June 1984, pp. 29–33.

[2] An individual's class-of-worker status, such as wage and salary worker, is determined by the status of the longest job held during the year. Annual earnings, however, are based on earnings from all jobs, including any income from self-employment.

Information on individuals' work schedules is obtained from the March supplement to the Current Population Survey. Two questions, referring to work activity in the previous calendar year, are used to identify a year-round, full-time worker:

"During 198_, in how many weeks did. . .work even for a few hours? Include paid vacation and sick leave as work."

This is followed by the question,

"In the weeks that. . .worked, how many hours did. . . *usually* work per week?"

[3] Additional questions from the March supplement make it possible to separate "true" year-round, full-time workers from those year-round, full-time workers who worked some part-time weeks. Workers who *usually* work full time are asked:

"Did. . .work less than 35 hours for at least one week in 198_?"

A positive reply leads to the question,

"How many weeks did. . .work less than 35 hours in 198_?"

[4] Previous research has also recognized the potential distorting effect of annual hours differences on the female-male earnings differential. One method employed to correct this problem adjusts the annual earnings differential by multiplying it by the male-to-female ratio of average weekly hours of persons on full-time schedules. (See June O'Neill, "The Trend in the Male-Female Wage Gap in the United States," *Journal of Labor Economics*, Vol. 3, No. 1, Part 2, 1985, p. S91.)

It should be noted that any method which adjusts for differences in annual hours worked implicitly assumes that the annual hours are freely determined by the individual. However, the fewer hours worked by women may not necessarily reflect personal preferences for such schedules but rather result from the job-market options available to them. Their options, for example, could be limited by discriminatory practices of employers. Therefore, the construction of implicit hourly earnings does not take into account whether actual hours reflect personal preferences.

[5] This ratio of 69 percent for implicit hourly earnings of "true" year-round, full-time workers is very close to the 70 percent female-male earnings ratio of full-time workers using weekly earnings, and lower than the corresponding 73 percent figure using hourly earnings. It is important to note, however, that substantial differences exist among the three

earnings measures due to differences in both sources of earnings and types of worker. For a discussion of these differences, see "Earnings statistics from the Current Population Survey," in BLS *Measures of Compensation*, Bulletin 2239 (Bureau of Labor Statistics, February 1986), pp. 34–47.

[6] See Sandra A. West, "Measures of Central Tendency for Censored Earnings Data from the Current Population Survey," *Proceedings of the American Statistical Association Annual Meetings*, 1987. West's analysis is limited to weekly earnings data. The examination of medians in this article is largely an application of West's research to annual earnings data.

[7] To determine the extent to which changes in the annual earnings differential between women and men can be attributed to changing earnings per hour and changing hours worked per year, the following method is adopted:

Define the implicit hourly earnings ratio (*IHER*) of women to men as:

$$IHER = [E_w/H_w]/[E_m/H_m]$$

where (E_w,H_w) and (E_m,H_m) are the average annual earnings and hours of women and men, respectively. This expression can be rewritten as:

$$= [E_w/E_m]/[H_w/H_m]$$

Rewriting in terms of natural logarithms, taking the total differential, and rearranging terms yields:

$$\frac{d\ln(E_w/E_m)}{dt} = \frac{d\ln(IHER)}{dt} + \frac{d\ln(H_w/H_m)}{dt}$$

The total differential of the natural logarithm of a variable can be interpreted as a percentage change in that variable. Hence, this expression says that the percentage change in the ratio of annual earnings of women to men equals the sum of the percentage changes in the implicit hourly earnings ratio and the ratio of female-to-male annual hours worked.

[8] It should be noted that the earnings' topcodes on public-use data tapes are significantly lower than the earnings' topcodes maintained by the Census Bureau for internal use. Tables published by the Census Bureau—including estimates of mean annual earnings—are based on these higher topcoded values. However, because these Census tapes are not available to the general public, the statistics in this article are based on the lower topcoded information from public-use tapes.

[9] See Gouri K. Bhattacharyya and Richard A. Johnson, *Statistical Concepts and Methods* (New York, John Wiley and Sons, 1977), p. 31.

[10] Note that it is implicitly being assumed that the degree of topcoding is positively related to the degree of underestimation of the true mean. The degree of bias over time will also depend on changes in the differential degree of topcoding between women and men.

[11] The maximum likelihood method used in this article is taken from Sandra A. West, "Estimation of the Mean from Censored Income Data," *Proceedings of the American Statistical Association Annual Meetings*, 1986.

[12] Results are available from the authors upon request.

[13] Both methods were also applied to all year-round, full-time workers. Using either method to adjust for topcoding, the vast majority of the movement in the female-male earnings differential was accounted for by changes in the earnings per hour of women and men (95 percent in both cases).

APPENDIX: Estimating annual hours

The general approach taken to obtain annual hours is straightforward—weeks worked multiplied by usual weekly hours. For true year-round, full-time workers, this method should provide an accurate estimate of their annual hours. However, for year-round, full-time workers who worked some weeks part time, multiplying total weeks worked by usual hours would likely overestimate their annual hours. For this group, what is needed is an estimate of hours for the weeks they worked part time. The Current Population Survey obtains hours data for the workers' usual status (in this case full-time hours) and the number of weeks worked part time, but weekly hours worked part time are not obtained.

Previous research on CPS annual hours data recognized the problem of missing hours information for persons who worked mixed schedules. A proxy estimate was derived for the "unusual" weekly hours. (See Shirley J. Smith and Nancy F. Rytina, "Testing a New Measure of Annual Hours of Work," *Proceedings of the American Statistical Association Annual Meetings*, 1983.) The equation given below illustrates the procedure for estimating annual hours.

$$AH = [(W_t - W_o) \cdot H_u] + (W_o \cdot H_o^p)$$

where:

AH = Annual hours worked during the year
W_t = Total weeks worked during the year
W_o = Weeks worked in other status (in the case of year-round, full-time workers it is their part-time weeks)
H_u = Usual weekly hours
H_o^p = Proxy estimate for usual weekly hours in other status

The proxy hours (H_o^p) estimate is obtained by using usual weekly hours for persons who normally work the other status and who share the same characteristics of age, sex, race, and reason for working part time. For year-round, full-time workers with some part-time weeks, the usual weekly hours of year-round, *part-time* workers are used as the proxy estimate, after controlling for age, sex, race, and reason part time.