# Articles

# Sex Differences in Economic Well-Being

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**Despite large structural changes in the economy and major antidiscrimination legislation, the economic well-being of women in comparison with that of men did not improve between 1959 and 1983. The women to men ratio of money income almost doubled, but women had less leisure while men had more, an increase in the proportion of adults not married made more women dependent on their own income, and women's share of financial responsibility for children rose. The net result for women's access to goods, services, and leisure in comparison with that of men ranged from a decrease of 15 percent to an increase of 4 percent, depending on assumptions about income sharing within households.**

THREE THOUSAND YEARS AGO THE BIBLE (LEVITICUS 27:1–4) stated that "when a man explicitly vows to the Lord, the equivalent for a human being, the following scale shall apply: if it is a male from 20 to 60 years of age, the equivalent is 50 shekels of silver by the sanctuary weight; if it is a female, the equivalent is 30 shekels." In 1959 the relative values were virtually the same: the average hourly wage of American women was 63 percent that of men (unstandardized), and the ratio was 62 percent when standardized for age, race, and years of schooling. Sex differences in wages have been attributed to (i) differences in productivity, either innate, acquired, or socially imposed; (ii) differences in nonmonetary characteristics of male-dominated and female-dominated jobs (for example, risk of injury or location of job); and (iii) discrimination by employers, consumers, or other employees (*1*).

Not only did women earn much less than men in 1959, but the sexes differed greatly in their distribution of effort between market (paid) and nonmarket work (housework and child care). Between the ages of 25 and 64, on average, women devoted about three-fourths of their working hours to housework and child care and one-fourth to market work; for men the proportions were the reverse. Since 1959 there have been extraordinary changes in gender roles, relationships, and expectations. Better control over fertility and the expansion of jobs in the service industries contributed to a sharp rise in female employment (*2*). Real earnings (of men and women) grew rapidly in the 1960's, and some economists suggest that higher wages are a major force pulling women into the labor force (*3*). Other economists believe that a sudden failure of real earnings to grow (as in the 1970's) results in postponement of marriage and childbearing and an increase in female participation in the labor force (*4*).

The 1960's were a period of significant changes in public policy. In 1963 the Equal Pay Act outlawed separate pay scales for men and women performing similar jobs, and Title VII of the 1964 Civil Rights Act prohibited all forms of discrimination in employment. The expansion of government transfer programs (such as Aid to Families with Dependent Children, Medicaid, and food stamps) made it possible for some mothers to raise children independently of support from the children's fathers. Finally, many observers credit the feminist movement with raising women's consciousness and leading them to question traditional gender differentials with respect to work and family (*5*).

Although the exact effects of these diverse factors are still under dispute, there is no question that in recent decades there have been dramatic changes in U.S. labor markets and in American families. Between 1960 and 1980 women's share of the labor force grew from 33 to 43 percent; the participation rate increased particularly rapidly among married women with small children. The annual divorce rate rose from 9.2 to 22.6 per thousand married women; the general fertility rate fell from 118 to 68 births per thousand women 15 to 44; and the proportion of babies born to unwed mothers jumped from 5.3 to 18.4 percent.

What effect did these structural, legal, and behavioral changes have on the well-being of women compared with men? A complete answer to this question—one that takes account of feelings of self-worth, autonomy, and other psychological dimensions—is beyond the scope of this article and is probably impossible. Other questions, however, such as what changes have occurred in gender differences in work and income can be answered approximately, although conceptual problems and data limitations preclude precise results.

In this article, I describe changes in men and women's economic well-being, defined as access to goods and services and leisure. I take account of hours of work, money income, the imputed value of housework, the size and structure of households, and income-sharing within households. The conclusions are particularly sensitive to assumptions about sharing; therefore results are presented for two polar cases: one in which income is shared equally by all adults in the household and one in which adults share in proportion to their contribution to the household's total (that is, money and nonmarket) income.

Estimates were prepared for 1959, 1969, 1979, and 1983 from computer tapes of the Censuses of Population of 1960, 1970, and 1980, and the Current Population Surveys (CPS) of March 1980 and March 1984 (*6*). To conserve space, only the 1959 and 1983 results are reported in the tables; interesting departures from trends are mentioned in the text. Because the samples and methods used in the CPS differ slightly from those in the Censuses, the rates of change in the CPS from 1979 to 1983 were used to extrapolate the 1979 Census results to 1983, thus obtaining greater consistency with 1959 (*7*). Nonmarket hours of work were estimated with the aid of data from a 1975–76 time-use study conducted by the University of Michigan's Institute for Social Research (*8*). Although the estimates of hours of work and income are calculated to four or

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Table 1. Hours of work and income, ages 25 to 64, by sex, for 1959 and 1983.

| Variable | 1959 | | 1983 | | Women/men ratio | |
|---|---|---|---|---|---|---|
| | Women | Men | Women | Men | 1959 | 1983 |
| Hours of work (annual) | | | | | | |
| Market | 572 | 1,875 | 929 | 1,667 | 0.30 | 0.56 |
| Housework | 1,423 | 542 | 1,252 | 560 | 2.62 | 2.24 |
| Child care | 266 | 76 | 201 | 59 | 3.52 | 3.41 |
| Total | 2,261 | 2,493 | 2,383 | 2,287 | 0.91 | 1.04 |
| Income (1983 dollars) | | | | | | |
| Money | 4,139 | 18,776 | 9,026 | 22,321 | 0.22 | 0.40 |
| Imputed (housework) | 8,590 | 5,137 | 9,810 | 6,600 | 1.67 | 1.49 |
| Total | 12,729 | 23,913 | 18,862 | 28,920 | 0.53 | 0.65 |
| Effective income (1983 dollars) | | | | | | |
| Equal sharing* | 16,000 | 16,308 | 21,385 | 22,287 | 0.98 | 0.96 |
| Proportionate sharing† | 11,874 | 21,992 | 18,233 | 28,234 | 0.54 | 0.65 |
| Effective income/hour of work (1983 dollars) | | | | | | |
| Equal sharing | 7.08 | 6.53 | 8.97 | 9.75 | 1.08 | 0.92 |
| Proportionate sharing | 5.26 | 8.82 | 7.65 | 12.35 | 0.60 | 0.62 |

*Effective income with equal sharing equals the household's total income divided by the number of adult equivalents in the household. †Effective income with proportionate sharing equals the adult's own income multiplied by the ratio of the number of adults to the number of adult equivalents in the household.

five significant places, they are subject to a variety of possible errors—reporting, sampling, coding, and estimating—and differences of only a few percent should not be regarded as statistically significant.

The focus of this article is on men and women between 25 and 64, those adults who are most likely to be in the labor market and most likely to be responsible for children. Also, these are the ages when gender role differences are likely to be greatest. Some results are reported separately for blacks because both cross-section differences and trends vary substantially by race; differentials across age and schooling groups are also examined.

## Changes 1959 to 1983

*Hours of work.* Annual market hours of work for each individual are estimated directly from the Census and CPS samples by multiplying hours worked in the sample week by weeks worked in the previous year. This method may introduce error for individuals because of differences between hours in the sample week and average weekly hours in the previous year, but the estimate for aggregates are relatively unbiased. Total hours are divided by the total number of individuals in the group, regardless of work status, to obtain average hours.

Hours of work in nonmarket production are much more difficult to estimate. We would like to know how much time each individual in the samples spent in housework (including cooking, cleaning, laundering, yard work, repairs, and maintenance) and in child care, but the Bureau of the Census does not collect such information. Even apart from the Census, there are no systematic measures of nonmarket hours of work for the different years covered in this study. Thus we must rely on an estimating procedure that is far from ideal, but is preferable to ignoring changes in nonmarket work. To ignore these changes would be to assume that women on average increased their market hours of work by 70 percent between 1959 and 1983 without any decrease in hours spent in nonmarket work.

Nonmarket hours in this article are estimated from regression equations based on time-use diaries of 776 individuals on 4 days during 1975–76. Separate regressions for men and women were run with hours of housework (or child care) as the dependent variable. The predictor variables included race, age, marital status, hours of market work, and number and age of children. Average housework and child-care hours for men and women in 1959, 1969, 1979, and 1983 were calculated by applying the 1975–76 cross-section parameters to the characteristics of the individuals in the Census and CPS samples in the respective years. For example, a white married woman between 25 and 44 who was not working in the market and who had two or more children with at least one under age 5 was estimated as having 1756 hours of housework and 676 hours of child care per year. A white woman of the same age who was not married, without children, and working 2000 hours a year in the market, was estimated to have 621 hours of housework and no child-care hours. With this procedure, average hours change over time as the characteristics of the population change, but there is no change in hours for any fixed set of characteristics. It is possible that the underlying structure changed as well, although a comparison of child care, shopping, and miscellaneous household hours in 1965 and 1975 that held characteristics constant showed only small declines that were approximately equal for men and women (*9*).

Table 1 shows a very large increase in the market work hours of women compared with those of men between 1959 and 1983. This increase is attributable primarily to a jump in the proportion of women working in the market, from 34 to 54 percent and, secondarily, to a decline in the proportion of men working in the market, from 87 to 79 percent (see Table 2). The number of hours worked per worker rose slightly for women and fell slightly for men. The increase in the percentage working was particularly large for white women, married women, and women between 25 and 34. The decrease in the percentage working was particularly large for black men, men with low education, and men 55 to 64.

Housework hours fell for women and rose for men, while child-care hours fell for both sexes. Women's total hours of work (market plus nonmarket) rose by about 5 percent, whereas men's fell by about 8 percent. This differential change was equally true for whites and blacks, but was much larger for married persons than for nonmarried men and women. It was greater at ages 25 to 34 and 55 to 64 than at 35 to 54, and was particularly large for men and women with 12 years of schooling or less.

*Income.* Annual money income is directly available in the Census and CPS samples. It includes pre-tax cash income received by individuals from all sources, including labor and nonlabor income, as well as private and public cash transfer payments. The imputation of income for housework is more problematic, especially for those men and women who do not also work in the market (*10*). Hours spent in housework produce goods and services that enhance economic well-being, but what implicit wage should be attached to

Table 2. Selected labor market and family variables, ages 25 to 64, by sex and race, for 1959 and 1983.

| Variable | All | | | | Blacks | | | |
|---|---|---|---|---|---|---|---|---|
| | 1959 | | 1983 | | 1959 | | 1983 | |
| | Women | Men | Women | Men | Women | Men | Women | Men |
| Working in market (%) | 34.1 | 87.1 | 54.3 | 79.3 | 44.1 | 79.4 | 56.0 | 68.3 |
| Average annual hours of those working in market | 1677 | 2153 | 1711 | 2102 | 1478 | 1877 | 1752 | 1912 |
| Average hourly earnings (1983 dollars) | 5.81 | 9.23 | 7.65 | 11.41 | 3.86 | 5.71 | 7.29 | 8.74 |
| Not married (%) | 21.9 | 16.1 | 31.1 | 26.6 | 39.0 | 27.4 | 55.6 | 44.4 |
| One-adult households with children (%) | 2.7 | 0.4 | 5.8 | 0.7 | 6.3 | 0.7 | 13.3 | 0.8 |
| Number of children per adult | 0.682 | 0.676 | 0.515 | 0.435 | 0.900 | 0.779 | 0.714 | 0.469 |

those hours? For this article, the following calculations were used. If the individual worked at least 500 hours in the market, his or her market wage was used to value each hour of housework. For other individuals, an hour of housework was valued by the average hourly wage earned by market workers of the same sex, race, age, and education. Two alternative calculations, valuing the housework hours of "nonworkers" at either 1.25 or 0.75 of the wages of their market counterparts, did not significantly affect the trends in women/men differentials in income. No income was imputed for child-care hours because they do not result in goods or services for adults, although they may contribute to satisfaction.

Table 1 shows a striking increase in the average money income received by women, from $4139 in 1959 to $9026 in 1983. This is a real increase because all dollar figures for 1959 have been inflated to 1983 dollars by the Consumer Price Index. The women to men ratio of money income almost doubled, from 0.22 to 0.40. This increase in relative money income is primarily the result of the large differential change in market hours of work and secondarily to an increase in hourly earnings of women compared with men. Most of the increase in relative wages of white women occurred between 1979 and 1983, but black women realized large gains throughout the entire period since 1959.

The women to men ratio of imputed income from housework declined, following the trend in the housework hours ratio. Women's total income rose faster than men's, but the ratio was still only 0.65 in 1983, a year when women's hours of work (market plus nonmarket) exceeded those of men.

*Effective income.* Almost 90 percent of women and men 25 to 64 live in households with other adults or children, or both, and this affects their access to goods and services in several ways. First, there are usually economies of scale realized in larger households through joint use of housing, durable goods, and services. Thus, the effective income resulting from any given amount of money and imputed income tends to rise with household size (*11*). Second, if there are children present some income must be devoted to them, thus reducing the effective income available to the adult members of the household. Third, the adults in the household may, to a greater or lesser extent, share their income, thus increasing or decreasing the effective income of individuals relative to their own income.

To capture the effects of economies of scale and the presence of children, the number of "adult equivalents" for each household was calculated in the following manner. The first adult ($\geq$18 years) was given a weight of 1.0, the first child 0.4, each additional adult 0.8, and each additional child 0.3 (*12*). Teenagers' ($<$18) income is not included in the household's income under the assumption that they use it to pay for their higher consumption compared to younger children. The final results are not sensitive to plausible alternative weights for adults and children.

If income is equally shared within the household, the effective income of each adult is equal to the household's total income divided by the number of adult equivalents. Under the proportionate sharing assumption, effective income of each adult is equal to their own total income multiplied by the ratio of the number of adults to the number of adult equivalents in the household. This ratio simultaneously reflects the gain in effective income resulting from economies of scale and the loss in effective income attributable to the presence of children. For instance, assuming proportionate sharing, an adult living in a household with two other adults and one child would have the same effective income as if he or she lived alone.

Table 1 shows that both the level and trend of the women to men ratio of effective income are significantly affected by the assumptions about sharing. If income is equally shared, women have almost as much as men, but their relative position declined by 2 percentage points between 1959 and 1983. This decline is primarily the result of the increase in the percentage who are not married and therefore not benefiting from the higher income of a husband (see Table 2). Under the proportionate sharing assumption, women have much lower effective income than men, but their relative position rose by 11 percentage points.

Results for both equal sharing and proportionate sharing are presented because it is not possible to determine whether either assumption, or some intermediate one, is correct. Support for the equal sharing model comes from the observation that within a marriage spouses usually consume similar amounts of housing, food, clothing, and other goods and services, even when their contributions to total (market plus nonmarket) income are unequal. This redistribution within the household has been characterized as an altruistic, unilateral transfer by the "head" (*13*). The proportionate sharing model derives support from the observation that usually there is no "free lunch." Equal consumption of goods and services by spouses who contribute unequally to total income may be offset by inequality in other (unmeasured) dimensions of the relationship.

*Effective income per hour of work.* For summary purposes, it is useful to have an aggregate measure of economic well-being that combines leisure with access to goods and services. One such measure is effective income per hour of work (market and nonmarket). According to this measure, women's absolute income level rose under either assumption about sharing, but their position relative to men fell substantially, from 1.08 to 0.92, in the equal sharing model. If there was proportionate sharing, the ratio rose slightly, from 0.60 to 0.62, between 1959 and 1983. An alternative summary measure, which sets the value of an hour of leisure equal to the imputed wage of an hour of housework, also shows an increase of 2 percentage points in the women to men ratio under the proportionate sharing assumption, and a decrease if there is equal sharing.

Under the equal sharing assumption, changes in relative hours and relative wages have different effects for married and not-married persons. Also, changes in the percentage of married persons influence the women to men ratio of effective income per hour because

Table 3. Effective income per hour of work in 1983 dollars. (Whites include nonwhites other than blacks.)

| Population | 1983 | | | | Women/men ratio | | | |
|---|---|---|---|---|---|---|---|---|
| | Equal sharing | | Proportionate sharing | | Equal sharing | | Proportionate sharing | |
| | Women | Men | Women | Men | 1959 | 1983 | 1959 | 1983 |
| All | 8.97 | 9.75 | 7.65 | 12.35 | 1.08 | 0.92 | 0.60 | 0.62 |
| Whites | 9.23 | 9.86 | 7.77 | 12.58 | 1.10 | 0.94 | 0.60 | 0.62 |
| Blacks | 6.58 | 8.24 | 6.65 | 9.54 | 0.97 | 0.80 | 0.59 | 0.70 |
| Whites | | | | | | | | |
| Married | 9.53 | 9.33 | 7.45 | 12.72 | 1.16 | 1.02 | 0.56 | 0.59 |
| Not married | 8.45 | 11.93 | 8.60 | 12.07 | 0.78 | 0.71 | 0.73 | 0.71 |
| Whites by ages | | | | | | | | |
| 25–34 | 7.71 | 8.58 | 6.62 | 9.30 | 1.05 | 0.90 | 0.64 | 0.71 |
| 35–44 | 8.69 | 9.02 | 7.09 | 11.60 | 1.13 | 0.96 | 0.57 | 0.61 |
| 45–54 | 10.05 | 10.42 | 8.50 | 14.98 | 1.15 | 0.96 | 0.61 | 0.57 |
| 55–64 | 12.18 | 13.25 | 10.23 | 18.07 | 1.05 | 0.92 | 0.60 | 0.57 |
| Whites by education | | | | | | | | |
| <12 | 7.58 | 8.79 | 6.42 | 10.86 | 1.07 | 0.86 | 0.61 | 0.59 |
| 12 | 8.55 | 8.81 | 6.97 | 11.13 | 1.15 | 0.97 | 0.61 | 0.63 |
| 13–15 | 9.69 | 9.62 | 7.90 | 11.93 | 1.15 | 1.01 | 0.60 | 0.66 |
| 16 | 11.70 | 11.40 | 10.01 | 15.00 | 1.17 | 1.03 | 0.64 | 0.67 |
| ≥17 | 12.60 | 12.62 | 11.85 | 16.74 | 1.18 | 1.00 | 0.77 | 0.71 |

not-married women typically do not share in the higher income of men. For married persons, an increase in wives' relative wages has no effect on the economic well-being ratio because the higher earnings are shared with their husbands. An increase in wives' relative hours of work lowers the ratio proportionately. For not-married persons (not living with persons of the opposite sex) the determinants of effective income per hour of work under equal sharing are the same as under proportionate sharing.

If there is proportionate sharing, effective income per hour of work is determined primarily by wages and secondarily by the size and structure of households. Women are much more likely than men to be the only adult in a household with children, and this was even more true in 1983 than in 1959 (Table 2). The effect on the economic well-being of black women was particularly strong; in 1983, 13.3 percent of these women were the only adults in households with children, whereas for black men the figure was 0.8 percent.

*Economic well-being of demographic groups.* The broad trends in effective income per hour of work described above were experienced by women and men in most demographic categories, but there were some important differences by race, marital status, age, and education (Table 3). As expected, the levels of economic well-being in 1983 are appreciably lower for blacks than for whites, and rise with age and education. Married men are at a lower level than not-married men if there is equal sharing, but at a higher level if there is proportionate sharing. For women the interaction between marital status and the sharing assumption has the reverse effect.

The sharing assumption is particularly critical in interpreting the trend (women/men ratio) in sex differences among blacks. Under the equal sharing assumption, the ratio fell from 0.97 to 0.80 as a result of increases for black women in relative hours of work, percentage not married, and relative responsibility for children. If there was proportionate sharing, the women to men ratio rose from 0.59 to 0.70, primarily because black women had very large gains in hourly earnings.

Interpretation of the trends for married and not-married also depends on the assumption about sharing. If there is equal sharing, the decline in the ratio for the married was greater than for the not-married, primarily because of the large increase in hours of work of married women. Under proportionate sharing, the ratio for married shows a small increase, whereas the ratio for the not-married shows a small decrease. The latter is attributable to the relative growth of responsibility for children by not-married women.

The pattern by age is striking. Under proportionate sharing the 25 to 34 and 35 to 44 age groups show substantial increases in the women to men ratio of effective income per hour of work between 1959 and 1983; the two older age groups show decreases. Under equal sharing, all age groups show decreases of approximately the same magnitude. When whites are disaggregated by education we also see large and fairly uniform decreases by education under equal sharing, but under proportionate sharing there are decreases for the lowest and the highest educational groups whereas the three middle groups all show increases.

## Wage Differentials

Sex differences in wages play the major role in determining the economic well-being of women compared with men if the women are not married, or if they are married and household income is shared proportionately. Although the differential has narrowed somewhat in recent years, the average man still earns almost 50 percent more per hour than does the average woman of the same race, age, and education. This differential is also the norm within individual marriages when both spouses work for pay (*14*). Although federal and state laws require employers to have the same pay scale for men and women in the same job, the large wage differential persists, partly because women have fewer years of service than men in particular jobs, and especially because they have different jobs. Employers and male workers may be responsible for some job segregation, but factors outside the labor market are also important (*15*). Foremost among these is motherhood.

*Effect of children.* Motherhood can have an adverse effect on women's occupational choice and hourly earnings in several ways. First, many women leave the labor market during pregnancy, at childbirth, or when their children are young. These child-related interruptions are damaging to subsequent earnings because most births (76 percent) occur to women before the age of 30—the ages when men are making labor market investments that lead to higher earnings later in life. Second, even when mothers stay in the labor force, responsibility for children frequently constrains their choice of job; they accept lower wages in exchange for shorter or more flexible

hours, location near home, limited travel, and the like. Third, women who devote a great deal of time and energy to child care and associated housework will probably be less able to devote maximum effort to market work (*16*). Finally, the more children a woman expects to have, the less likely she is to invest in market-related human capital while in school and during the first few years of paid work.

The large impact of children on women's wages can be seen in Fig. 1, which summarizes the results of regressions of the logarithm of hourly earnings on the number of children in the household. The samples were restricted to white women who worked at least 1000 hours in 1983, and separate regressions were calculated for the 30 to 34 and 35 to 39 age groups. Compared to women who have no children, women with children earn considerably less per hour, and wages drop with each additional child. Number of children is negatively correlated with education, but the adverse effect of children on wages is still strong in those regressions that control for age and years of schooling. A control for potential sample selection bias (*17*) had no statistically significant effect on the results. Similar regressions for women in 1959, 1969, and 1979 revealed the same pattern; earnings fell significantly with each additional child. By contrast, similar regressions for men show that men with children have higher hourly earnings than those without, and there is no systematic relation between number of children and earnings.

*Recent changes.* Between 1959 and 1979 the women to men wage ratio rose slightly, by 2 percentage points. During the next 4 years, however, there was an unprecedented increase of 5 percentage points. Changes of approximately this magnitude were evident in all major industry groups, all major occupational groups, and in all regions of the country. The one characteristic that shows a highly variable pattern of change is age.

In Fig. 2, the ratios (and the change in the ratio) are plotted for single years of age. The underlying series have been smoothed with a five-term moving average and adjusted for any sex difference in years of schooling. Between 1979 and 1983, women's relative earnings improved at all stages of the life cycle, but the gain was much greater for those under 40 years of age. The increase was particularly large for the cohorts who were in their late thirties in 1983 compared with those who were the same age in 1979. One likely explanation is that the women in these cohorts (born in the late 1940's) were the first to alter significantly their expectations and behavior with respect to work and family: they had substantially fewer children than did the women who were born just 4 years earlier.

*Future prospects.* The data examined here suggest that the massive structural, legal, and behavioral changes of the last quarter century did not improve the economic well-being of women in comparison with men. The women to men ratio of money income rose from 0.22 to 0.40 as a result of relatively more paid work and higher wages for women. This gain, however, was offset by less leisure for women, a decrease in the percentage married, and a relative increase in women's financial responsibility for children.

Some analysts predict additional large gains in the wages of women relative to men as a result of normal market forces (*18*). They see no need for new public policy interventions to help women. For women to earn as much as men in competitive markets, however, they would have to behave like men with respect to subjects studied in school, choice of jobs, post-school investment, and commitment to career. This could result in extremely low fertility. The general fertility rate (births per 1000 women ages 15 to 44) in the United States has been below replacement level every year since 1973, and among women 30 to 39 who earned $25,000 or more in 1983, half had no children in their household (*19*).

Other observers are less sanguine about the economic prospects for women. They point to the persistence of the wage differential and occupational segregation, and they note that the fragmentation of families places additional economic burdens on women. They advocate major changes in the way wages are determined, favor affirmative action programs that come close to setting employment quotas, and urge large increases in paid maternity leaves and subsidized day care services. The social and economic effects of policies designed to help women and children can vary greatly. For instance, equal pay for comparable worth and paid leaves for childbirth and infant care would probably encourage more labor force participation by women. By contrast, direct payment to

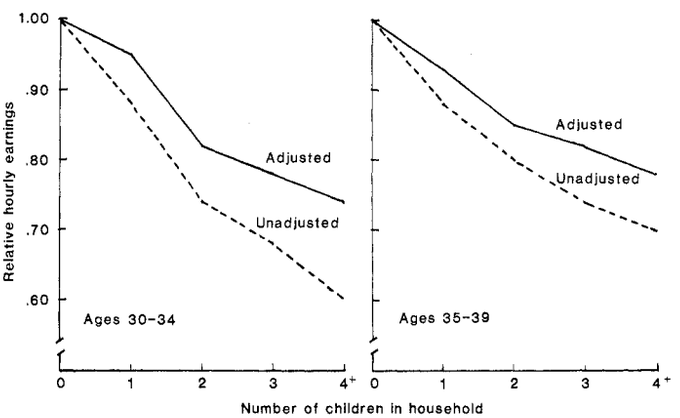


Fig. 1. Relative hourly earnings of white women by number of children in the household, unadjusted and adjusted for age and education, 1983. Limited to women who worked at least 1000 market hours in 1983.

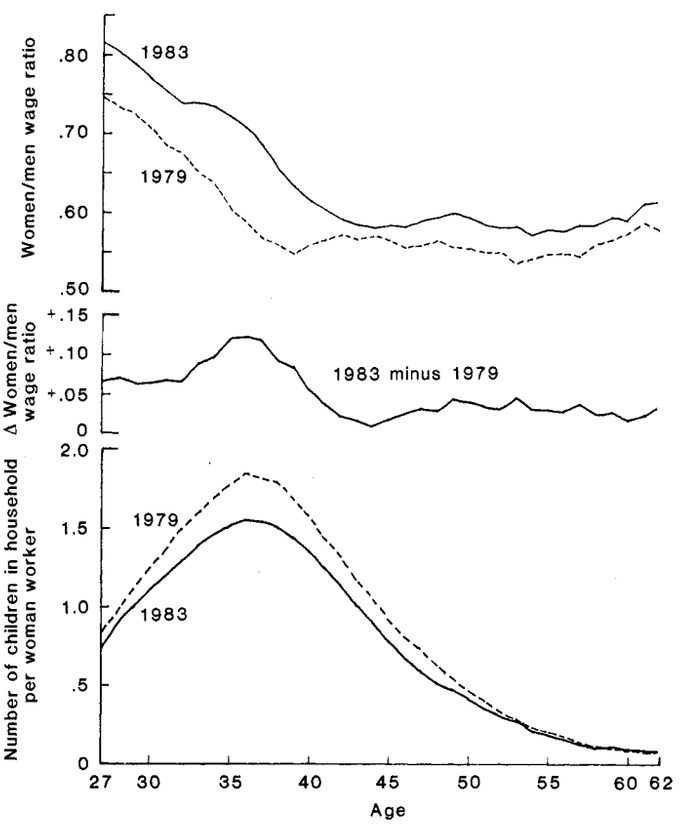


Fig. 2. Women to men wage ratios and number of children in household per woman worker, by single years of age (underlying series smoothed with a five-term moving average), 1979 and 1983.

mothers who personally take care of their children would encourage women to stay out of the labor force. Some policies would tend to lower fertility, others would raise it. Some would discourage employers from hiring women while others would not. A major challenge to social science research is to understand the economic and social consequences of alternative policies.

Although there is disagreement on theory and policy, virtually everyone agrees on one point. As long as parents are responsible for children and this responsibility is borne disproportionately by women, sex differences in the labor market are likely to persist.


REFERENCES AND NOTES

1. G. Cain, in *Handbook of Labor Economics*, O. Ashenfelter and R. Layard, Eds. (North-Holland, Amsterdam, in press).
2. V. R. Fuchs, *The Service Economy* (National Bureau of Economic Research, New York, 1968).
3. J. Mincer, in *Aspects of Labor Economics* (Princeton Univ. Press, Princeton, 1962), pp. 63–97.
4. R. Easterlin, *Birth and Fortune: The Impact of Numbers on Personal Welfare* (Basic Books, New York, 1980).
5. B. Friedan, *The Feminine Mystique* (Norton, New York, 1963).
6. U.S. Department of Commerce, Bureau of the Census, *Census of Population and Housing, Public Use Samples: One-in-One-Thousand Samples* (Washington, DC, 1960, 1970, and 1980); *Current Population Survey: Annual Demographic File* (Washington, DC, 1980 and 1984).
7. A check of this method for 1969 and 1979 (2 years when both Census and CPS data are available) revealed that the rates of change of earnings are similar in both sources.
8. Institute for Social Research, *Time Use in Economic and Social Accounts, 1975–1976* (University of Michigan, Ann Arbor, 1978).
9. J. P. Robinson, in *Time, Goods, and Well-Being*, F. T. Juster and F. P. Stafford, Eds. (Institute for Social Research, University of Michigan, Ann Arbor, in press).
10. M. A. Ferber and C. A. Green, *J. Hum. Resour.* **20**, 90 (1985).
11. E. Lazear and R. T. Michael, *Am. Econ. Rev.* **70**, 91 (1980).
12. ———, *Allocation of Income Within the Household* (Univ. of Chicago Press, Chicago, in press).
13. G. S. Becker, *A Treatise on the Family* (Harvard Univ. Press, Cambridge, MA, 1981).
14. V. R. Fuchs, "His and hers: Gender differences in work and income, 1959–1979" (NBER working paper 1501, National Bureau of Economic Research, Cambridge, MA, 1984); *J. Labor Econ.*, in press.
15. K. Mason, in *Women and the Workplace*, M. Blaxall and B. Reagan, Eds. (Univ. of Chicago Press, Chicago, 1976), p. 81.
16. G. S. Becker, *J. Labor Econ.* **3**, S33 (1985).
17. J. J. Heckman, *Econometrica* **47**, 153 (1979).
18. J. P. Smith and M. P. Ward, *Women's Wages and Work in the 20th Century* (Rand Corporation, Santa Monica, CA, 1984).
19. Calculated by the author from *Current Population Survey* tapes.


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# Design of Sequence-Specific DNA-Binding Molecules


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**Base sequence information can be stored in the local structure of right-handed double-helical DNA (B-DNA). The question arises as to whether a set of rules for the three-dimensional readout of the B-DNA helix can be developed. This would allow the design of synthetic molecules that bind DNA of any specific sequence and site size. There are four stages of development for each new synthetic sequence-specific DNA-binding molecule: design, synthesis, testing for sequence specificity, and reevaluation of the design. This approach has produced bis(distamycin)fumaramide, a synthetic, crescent-shaped oligopeptide that binds nine contiguous adenine-thymine base pairs in the minor groove of double-helical DNA.**


X-RAY ANALYSIS OF CRYSTALS OF RIGHT-HANDED DOUBLE-helical DNA (B-DNA) reveals that base sequence information can be stored in the local structure of the helix (*1, 2*). The DNA polymer consists of GC and AT base pairs like rungs on a twisted ladder. The helical twist, groove shape, base pair slide and roll, and handedness of double-helical DNA depend on base sequence (*1–7*). In this article I address the issue of whether a set of rules for the three-dimensional readout of B-DNA could be developed based on low molecular weight natural products commonly identified as antibiotic, antiviral, or anticancer DNA-binding drugs. This would allow the design of synthetic nonprotein molecules that bind B-DNA of any base sequence and site size. The tools of synthetic and mechanistic organic chemistry are used in combination with nucleic acid techniques such as high resolution gel electrophoresis to define, in part, the scope and limitations of this problem.

There are four bases possible for each nucleotide position on each strand of the DNA helix, and, within the constraints of the AT and GC complementary nature of double-helical DNA, for a binding-site size of $n$ base pairs there are $(4^n)/2$ distinguishable sequences for odd $n$ and $(4^n)/2 + (4^{n/2})/2$ for even $n$ (Table 1). During the past few years, a priority has been to develop the analytical methods needed to analyze precisely the sequence specificities of either natural or synthetic DNA-binding small molecules. These methods are footprinting (*8–18*) and affinity cleaving (*19–25*). With regard to the overall experimental approach, there are four stages of development for each new synthetic DNA-binding molecule: design, synthesis, testing for sequence specificity, and reanalysis of the design.

The initial design ideas are derived from examination of natural


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