Trends in Women's Labor Supply and the Family Income Inequality: 1982-2001*

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Abstract

This paper shows the results from an analysis of women's labor supply in the United States and draw inference on the relationship between female labor supply and family income inequality. Using the CPS data from 1982 to 2001, I analyzed the trends in the female labor supply. Disaggregated by education and family income, the data reveal a story that is not usually discussed elsewhere. Educational differentials in labor supply have been persistent, but income differentials have been narrowing. Women's education continues to be a strong force driving women's commitment to the labor market, whereas family income has become a less powerful disincentive for women's employment over time. It is not simply more women in the labor force that caused a greater, or smaller, income inequality. With more high-income women in the labor market working longer hours than before, the family income distribution has become more unequal.

Keywords: women's labor supply, labor force participation, hours of work, family income inequality.

The two most dramatic trends that changed the postwar U.S. labor market are the rise of women's attachment to the labor force and the growth of wage and income inequality. Each has received much attention from academic researchers and public critics alike. But our understanding is limited regarding the linkage between women's labor supply and labor market inequality.

Conventional wisdom about the relationship between the two issues seems to be dated and subject to reassessment based on proper methods and up-to-date data. For example, women's labor force participation was considered as a force for equalizing family income (for a review, see Treas, 1987). But this belief was based on the trend in the past, when the wives of rich families were less likely to be working in the labor force than those of poor families. As the labor supply of women with less income reached the highest level in the 1980s and then gradually declined in the 1990s, while wealthier women increased their labor supply steadily throughout the 1980s and 1990s, the "female labor supply as an equalizer" thesis needs to be reexamined. Another example is the popular image of women entering low-wage occupations, placing them in competition with low-wage men, and depressing the wages for those at the bottom of the earnings distribution. But empirical studies show little support for this argument (for a review, see Morris and Western, 1999). Occupational segregation separated men from women in the labor market, and wage inequality grew rapidly within each sex category, not between the sexes, undermining the "female labor supply as a disequalizing force" thesis.

In this paper, I present the up-to-date trends in female labor supply and draw inference on the relationship between female labor supply and family income inequality. Not only is the data used in this paper the most recent, but also the method attempts to

resolve a difficult question by combining the issues of labor force participation and the number of hours worked for those in the labor force. The results from multivariate analysis show that, controlling for other factors, women's education continues to be a strong force driving women's commitment to the labor market, and that the family income has become a less powerful disincentive for women's employment over time. It is not simply more women in the labor force that caused a greater, or smaller, income inequality. With more high-income women in the labor market working longer hours than before, the family income distribution has become more unequal.

Women's Labor Force Participation and Family Income Inequality

Historically, women's employment was not as common among wealthy and middle class families as in working class families in the nineteenth century and early twentieth century. Once the material prosperity of capitalism developed enough to allow some women to withdraw from the factories and other workplaces, a new group of women called "full-time housewives" emerged. Being a full-time homemaker became a symbol of middle class status. Leisure was regarded as something that only a minority of wealthy people could afford. This trend continued until the late 1950s.

The classical economics theory of female labor supply well reflects this historical trend. The negative relationship between family income and women's labor force participation is expressed as a "negative income effect," in microeconomics terms. Increases in a woman's income from non-labor sources -- i.e., earnings from other family members or unearned income such as dividends and Social Security -- decreases the

likelihood of her labor force participation, because the non-labor income raises the value of non-market activities, often termed "reservation wages" (Mincer, 1962). Empirical studies in economics, sociology, and demography have shown the negative effect of family income on women's labor force participation (for example, see Smith, 1980; Leibowitz and Klerman, 1995; Waite, 1976).

This theory also corresponds to the public view that the increase in women's labor force participation was a response to the decline in employment and stagnant earnings growth of men. Unemployment and underemployment of men have become more frequent since the early 1980s, due to economic recessions, mass layoffs, and increased job insecurity (Farber, 1997; Juhn and Murphy, 1997; Neumark, Polsky, and Hansen, 1999). Wage and earnings inequality among workers has been growing during this period. Male workers were the hardest hit. Real median wages for men have declined since the late 1970s, and low-wage, least- skilled male workers suffered the most (Morris and Western, 1999). This trend in male employment and earnings implies that women might have responded to the burden of financial necessities by seeking paid employment outside the household.

Women's response to the low-income family's financial necessities suggests its relationship to the distribution of income among families. If women from low income families are more likely to participate in the labor force, women's rising labor force participation might have been a force for equalizing the income distribution of families. Nine studies published in the 1970s and 1980s, according to a review by Treas (1987), confirmed an equalizing effect of women's labor force participation on family incomes in the United States, despite the diversity of the data and methods among these studies.

Maxwell (1990) also found that the increase in female labor force participation decreased income inequality in the United States from 1947 to 1984.

However, doubts about the "female labor force participation as an equalizer" thesis have grown since the late 1980s. Two approaches countered the thesis. First, as a body of evidence indicated a polarization of earnings distribution and the decline of low-wage male workers since the 1970s, there has been a growing sentiment that an influx of women entering the low-wage labor market has driven down the men's wages and exacerbated the earnings inequality. Along with other demographic shifts in the labor market, i.e. the influx of baby boomers and immigrants into the labor force, the rise of women's labor force participation seemed a likely candidate to be the cause of growing inequality. But empirical studies provide little support for this argument. Contrary to what one might expect to happen when women entered the labor force in large numbers, women's median wage saw a real increase, as opposed to a decline, and wage inequality grew within the sex category (Morris and Western, 1999). Occupational segregation by sex persisted to reduce the degree of direct competition between men and women in the labor market (Jacobs, 1989; Reskin and Roos, 1990). There is little support for the argument that women's labor force participation drove down the wages of men at the bottom of the distribution (Juhn and Kim, 1999).

But the second approach to the question of how female labor force participation affected family income distribution has a different focus. When disaggregating the data by various categories, including educational levels and family income, some researchers noticed that there was more than a simple story of a steady rise in average female labor force participation rates. After 1980, when the aggregate rate of female labor force

participation slowed its growth, increased participation came mainly from women with higher family income (Maxwell, 1990; Juhn and Murphy, 1997). These are the women who in the past were less likely to participate in the labor market, offsetting the rise in family income inequality. Because of assortative mating, the women with higher family income tend to have high level of human capital and earnings potentials themselves. As the number of zero earners decreases, and new entrants tend to be higher-wage workers than before, the dispersion of female earnings grows. Moreover, there is evidence that educational homogamy has been increasing for the past several decades (Mare, 1991). This can raise the covariance in husband's and wife's earnings. Consider the relationship between family income inequality and the variance and covariance of husband and wife's earnings as Mincer (1974), as well as Hout (1982), put it:

$$\sigma_F^2 = \sigma_H^2 + \sigma_W^2 + 2Cov_{HW}, \qquad (1)$$

where σ_F^2 is the variance in family income, σ_H^2 is the variance in husband's earnings, and σ_W^2 is the variance in wife's earnings, and Cov_{HW} is the covariance in husband's and wife's earnings. It follows that the increase in female earnings dispersion and the increase in the covariance between the spouses' earnings contribute to the rise in family income inequality. In particular, the recent influx of high-income women might have negated, or even reversed, the past trend of "female labor force participation equalizing family income" and instead contributed to the rise in family income inequality.

Several observers have already noted this possibility and presented their future projections on the new relationship between female labor force participation and family

income inequality. Reviewing the future projections made in the 1970s, Treas (1987) summarized the prospect that the women who would participate in the labor force in the years ahead would be those with high income, and that this new trend would cause greater inequality. Maxwell (1990) and Juhn and Murphy (1997) found that these projections were mostly correct. Since 1970, the increase in labor force participation has come mainly from the wives of middle- and high-wage men. Maxwell (1990) and Juhn and Murphy (1997) interpreted the results as suggesting that the new pattern of female labor force participation contributed to the growth of income inequality.

Women's Working Hours and Family Income Inequality

This paper expands on the research by combining the two issues of labor supply: labor force participation and hours of work. This is a crucial theoretical distinction in the study of labor supply. As Heckman (1993) identified the source of confusion in the early literature, the two issues have different labor supply functions:

$$\Pr(H>0 \mid W, Y) \qquad (2)$$

$$E(H \mid W, Y, H>0) \qquad (3)$$

In other words, the labor force participation equation (2) is the probability of having non-zero hours of work (H) given the current or future wage (W) and a non-labor income of (Y). The working hours equation (3) -- also called the labor supply function -- is the expected hours of work conditional on W and Y given that the hours of work is non-zero.

Women's hours of work have not usually been related to the growing inequality. Instead, academic and public debate has been lively regarding the "overworked American" thesis. Since Schor (1991) argued that the time Americans spent on paid employment has been rising since 1940, critics have pointed out the problems with Schor's measures, calculations, and data sources (Coleman and Pencavel, 1993; Jacobs and Gerson, 2001; Robinson and Godbey, 1997).

Although the debate drew attention to the issue of hours worked, particularly those of women, most critics and commentators regarded it as if it was separate from the other two familiar issues: female labor force participation and growing income inequality. It was later in the debate that two important points were noted. First, instead of the rise of working hours, it is the increase of women in the labor force that brought the time crunch to many American families (Hout and Hanley, 2002; Jacobs and Gerson, 2001). This should be nothing new, but it had been ignored by the early critics. The early discussion on the "overworked American" thesis did not disentangle the demographic shift in the labor force and the change in working hours for those already in the labor force.

The second point is that the focus on the working hours of *average* workers has misled the discussion. This is another surprising mistake, considering that women, unlike men, have a complex mechanism for labor supply decisions. Women, as a group, have a heterogeneous profile of market work: some work full-time in the labor force, others work part-time, while still others spend their entire time at home. Careful reassessment of the "overworked American" debate suggested that disaggregating the data by education, wage, and income levels reveals a different picture of women's working hours than the average number of working hours can show. Coleman and Pencavel (1993) found that

women with relatively little schooling were working fewer hours in the 1980s than in 1940, while the reverse is true of well-educated women. In a study that looks at the difference in hours by wage deciles, Costa (2000) showed that highly paid women worked fewer hours than the lower paid in the 1890s, but by 1991 the highest paid worked the longest day. Similar findings are also noted in Hout and Hanley (2002) and Jacobs and Gerson (2001).

Each of the two points that were noted from the critical reexamination of the debate delivers two lessons that guide the design of this study. First, changes in the combination of labor force participation and the hours of work should be analyzed jointly. Looking at only one factor can mislead the understanding of women's labor supply behavior. In this paper I investigate the trends in women's labor force participation and working hours. Furthermore, in order to examine the relative effect of each factor in jointly determining participation and working hours, I estimate a multivariate regression model that corrects sample selection bias due to the nonramdom participation in the labor force.

Second, moving beyond a particular interest in the behavior of the average worker is necessary in order to study inequality. Even though the issue of female labor supply is closely related to income distribution, the "overworked American" debate had little discussion on the relevance to the phenomenon of growing inequality. With rising inequality as the underlying theme of my analysis, I disaggregate the data by (1) women's education, and (2) family income other than women's earnings. I also examined whether the effects of education and family income on women's labor supply changed over time.

No past research has achieved both of the two goals in the empirical analyses. Jacobs and Gerson (2001) and Hout and Hanley (2002) pointed out the need to study employment and working hours jointly, but their studies were more about criticism of the "overworked American" debate than about the linkage between the female labor supply and the rising inequality. Maxwell (1990) and Juhn and Murphy (1997) examined the relationship between female labor force participation and income inequality, but they did not pay much attention to the hours of work. Costa's (2000) study is an investigation of hours inequality and its relation to earnings inequality, but her sample was limited to wage workers, ignoring the issue of labor force participation. Cohen and Bianchi's (1999) is the only study that addresses family inequality, labor force participation, and working hours. But this study measures the Current Population Survey's (CPS) item on the annual hours of work, which is sensitive to the problem of demographic changes in the work force, and thus less desirable than alternative measures available in the CPS (Jacobs and Gerson, 2001, p. 43). Another limitation of Cohen and Bianchi (1999) is that they estimated the sample selection model using Tobit equations, which is less than ideal for estimating female labor supply (for a justification of this critique, see the Appendix).

Data and Methods

The data for this paper come from a pooled sample of the March supplement to the Current Population Survey (CPS) for the period of 1982 to 2001. The CPS is a nationally representative sample of households, and the March supplement has various questions on demographics and work-related items. From each year's sample, I selected

civilian women who were aged 25 to 44 and were not in school. I have a narrower range of age than those used in other studies. This precludes the complication due to the changes in the retirement age and also facilitates the calculation of the large sample. Each year's sample has about 20,000 respondents, and the pooled sample of the 20 years' survey consists of 458,627 respondents. Table 1 shows the descriptive statistics of the sample.

(Table 1 about here)

The March CPS data have two reference periods for the hours of work: how many hours respondents worked for pay in the week before the survey, and how many hours respondents usually worked per week in the year preceding the survey. Different reference periods were used in the past research, and this was one of the sources of the discrepancies in the estimation of the working hours. For the analysis presented in this paper I used the "last week" reference period. This is primarily because the labor force participation measure in the CPS also refers to the respondents' activities in the last week. Some researchers used the annual number of hours calculated by multiplying the number of hours usually worked per week in the previous year and the number of weeks worked in the previous year (Schor, 1991; Coleman and Pencavel, 1993; Cohen and Bianchi, 1999). This might appear to be a reasonable method, based on the observation that the increase in the weeks worked per year was greater than the increase in the hours worked per week during the past three decades. However, following what Jacobs and Gerson (2001) noted, I did not use the calculated number of annual working hours. The most

important reason not to use the calculated annual hours is that the CPS measure of the number of weeks worked does not discern whether the respondent started a short spell of employment during the previous calendar year, or instead began a long spell of employment but just happened to start that spell at some point in the middle of the previous calendar year. When women increase their labor force attachment, the number of weeks worked during a year will inevitably rise because of the demographic changes in the labor force, rather than the actual changes in the weeks of work (Jacobs and Gerson, 2001).

To evaluate the income effect on women's labor supply, I calculated other family income by taking the logarithm of total family income less women's own earnings. Dollar values were adjusted for inflation to 1982 dollars using the Consumer Price Index. Some respondents (3,065 persons or 0.67% of the sample) had other family income which was less than zero. To avoid taking the logarithm of negative numbers, I rescaled the values linearly by adding their minimum value before taking the logarithm.

The following analyses begin with the plotting of the labor force participation rates and the number of hours worked by year, disaggregated by education and other family income. The descriptive plotting provides a very useful intuition for the understanding of the trends over time. But each plot only shows the differences in one factor at a time. The effects of women's education and family income are known to offset each other, but the question of which dominates over the other is still to be tested. Other important factors, such as marital status and presence of young children, also complicate the issue. These demographic factors should be controlled for.

For a complete picture of various factors determining women's labor supply, I estimate a multivariate model that evaluates the effect of various factors on women's labor supply. Instead of estimating separate models for labor force participation and the number of hours worked, I used a method that allows me to estimate the number of hours worked while at the same time controlling for the selection of the sample due to the labor force participation. Because non-workers do not have any number of hours worked, the number of hours can only be observed from a sub-sample of the population consisting of workers. But a problem arises, because we can reasonably argue that this sub-sample is not a random sample of the population. It is very likely that women in the labor force have some significantly different characteristics from women who are not in the labor force. The choice of whether or not a woman participates in the labor force and has non-zero hours of work involves a function of many factors, including her earnings potentials, available resources in the household, family responsibilities, and other unobservable but systematic factors. Since the employment status of a woman is not randomly assigned but a result of a systematic process, one should suspect a selection bias. Rather than the popular procedure known as Heckman's two-step method (Berk, 1983; Heckman, 1979), I used a maximum likelihood estimation of the model, which maximizes the product of the log-likelihood functions of the probability of being selected (i.e., being in the sub-sample of workers) and the density of the observed hours of work conditional on having been selected. The functional form is analogous to what one would get when multiplying the two equations of (2) and (3) above (Heckman, 1993):

$$E(H \mid W, Y) = E(H \mid W, Y, H>0) \times Pr(H>0 \mid W, Y). \quad (4)$$

In studying the combination of the two elements of women's labor supply – labor force participation and working hours – the simultaneous estimation of the two equations is more appropriate than the sequential, two-step method. The Appendix discusses the advantages of using the maximum likelihood estimation as opposed to alternative methods.

The regression estimates the parameters for the equation that predicts the number of hours worked, controlling for sample selection bias due to labor force participation. Different sets of independent variables were entered into the equation for the sample selection (i.e., labor force participation) and the equation predicting the number of hours, although the lists of variables overlap to some extent. The main interest of this study lies in the changes in the effects of other family income and women's own earning power, indexed by women's education (college degree). To test whether the effects changed over time, I included a set of interaction terms for years and each of the two effects. It is known from the studies that the effect of family income other than women's own earnings has been negative ("negative income effect"), and that the effect of women's own current and future earning power has been positive ("positive substitution effect": Mincer, 1964; Waite, 1976; Leibowiz and Klerman, 1995). I examine whether these orthodox notions about women's labor supply can hold for an up-to-date, pooled sample of two decades, and whether the income and substitution effects have changed their signs and magnitudes. If, apart from the pattern in the past, the income effect has become less negative over time, while the substitution effect has continued to be strong, this would suggest that the increase in female labor supply during the period came mostly from

women from rich families with greater human capital. This is indeed what the results suggest.

Although I do not use measures for the aggregate distribution of income, such as a Gini coefficient or standard deviation of income, disaggregating the data by education and income is an appropriate approach for the micro-level data set used in this study. To supplement the argument that the differential supply of labor by education and income has consequences for family income distribution, I estimated an ordinary least square regression predicting the family income. The model tests whether the labor supply of women affects the family income net of other relevant factors. If the changes in women's labor supply did happen, the consequence of the new pattern of female labor supply would have been reflected in the changes in family income.

Results

Figure 1 presents changes over time in the labor force participation rates of women by educational attainment. It shows now familiar story of gradual rise in women's labor force participation, from 68.2% in 1982 to 77.8% in 2001 on average. However, disaggregating by education reveals a substantial gap between the groups. College graduates have the highest participation rate, while women with the least schooling lags behind all others. The participation rate of the women with less than high school diploma had been very low and stagnant until 1996. It started to grow at a rapid pace from 1997, when the Personal Responsibility and Work Opportunity Reconciliation Act of 1996 began to drive women from welfare to work. Overall, the labor force participation rates

gradually increased in every education level, and the gap appears to be persistent over twenty years. The positive strength of education, human capital, and earnings potentials have been pulling more and more women into the labor force. This pattern is hardly new.

(Figure 1 about here)

Figure 2 shows a similar story. The graph plots the number of hours for women who have non-zero hours of work. The average number of hours worked has been increasing for the past two decades, from 35.3 hours in 1982 to 37.7 hours in 2001. Educational differentials in hours are also evident. Women with college degrees worked the longest hours, while women with less than high school diploma worked the shortest. Average number of hours declined during the recession of the early 1990s, and then it resumed the increase after the economic recovery in the mid 1990s. It should be noted that unlike the trend in the labor force participation rates the hours gap between the groups has been widening in the 1980s. The gap narrowed to some extent in the mid 1990s, but afterwards there has been a persistent gap. This implies that the occupational opportunities and wage-earning potentials provided by increase in women's education and investment in human capital had been the strongest until the late 1980 and continued to be effective until present.

(Figure 2 about here)

When disaggregated by other family income, however, the plots give a different picture. Figure 3 is the changes in the labor force participation rates by the deciles of other family income. The average participation rate is the same as in Figure 1. But there is a big dispersion for the two income groups in the extreme. Women at the bottom of the income distribution, the first decile, have the highest rate, whereas those at the top, the tenth decile, have the lowest. This corresponds to the view that low income women are compelled to work in response to the falling wages of their husbands. Remarkably, the gap has been narrowing for the two decades. It is due to the decline in the rate of the first decile against the general trend of a gradual increase. If the low-income women's work had to be characterized as a response to the financial burden of their families, the participation rate for this group should have been increasing, not decreasing, during the period of stagnant male earnings and growing inequality. Interestingly, the welfare reform of 1996 did not increase the participation rate of the lowest income group. The data shows us instead that the income effect has been diminishing, while the pulling factors of women's own human capital continue to be in effect, as in Figures 1 and 2. The greatest increase in the participation rates came from the wealthiest (the tenth decile) and the relatively well-off (the 6th-9th deciles).

(Figure 3 about here)

Figure 4 shows a similar trend in terms of the number of hours worked. This plot is for those who worked, excluding all non-workers, as in Figure 2. A narrowing gap is the common pattern. Diminishing effect of income on women's labor supply is the

common theme. Women at the bottom end of the income distribution (the first decile) gradually decreased the hours, while the rest of the population, particularly those in the 6th-9th deciles, added more hours. Women in the tenth decile show a deviation from a stable increase in the 1990s, but they still follow the long-term pattern of a gradual increase.

(Figure 4 about here)

One might wonder the net result from the two different aspects of women's labor supply. On the one hand, the trends in women's labor force participation indicates that the women with more schooling and greater human capital have continued to participate more in the labor market and to put more hours on paid employment throughout the past two decades. Family income, on the other hand, has an opposite effect. More family income seems to have been a disincentive for a woman to increase her commitment to the market work, whereas the women from lower income families have been working the most. The relationship between two opposite trends is puzzling when we consider assortative mating and the correlation between the spouses' earnings. If women who have college degrees are likely to marry men with high education and presumably high income, women's education should be positively associated with the amount of other family income. How can women's education and family income, which may index the same kind of material well-being, result in the opposing effects on women's labor supply? How can women with college degrees, who are also likely to have high family income, have

the highest rate of labor force participation and the longest hours, when in general family income has negative effect on women's labor force participation and hours of work?

(Figure 5 about here)

The key may lie in the steady increase in the degree of assortative mating (Mare, 1991). In the past, when women's paid employment was less common and women's educational attainment was lower and less heterogeneous than in the present, women's education was less associated with the family income other than own earnings. Women who have college degrees could often have less-than-average other family income. This has been changing throughout the past two decades. Women's educational attainment has become increasingly associated with other family income. Figure 5 illustrates this change. Proportion of women with college degrees within the top income decile (the tenth decile) was less than one third in 1982. This has been growing steadily, until the year 2001 when these women constituted 62.7%, almost two thirds, of the top decile. The proportion of college educated women in the top decile is greater than in the overall population, but the change in this subpopulation parallels the shift in the overall population. During the same period, the proportion of women who have college degrees has increased from 19% to 39% in the entire U.S. population. With more women who have college degrees filling the top income decile, the labor supply of the women from the top decile (see Figures 3 and 4) has been approaching the labor supply of the women with college degrees (see Figures 1 and 2). The negative effect of family income on women's labor supply has weakened and been offset by the increasing effect of women's own education.

The descriptive information on the trends in women's labor force supply leaves the question of the net results unanswered. When various factors which have offsetting effects on women's labor supply change over time, what are the net results? Were there any changes in the directions and degrees of each factor, controlling for the complex influences of changes in other factors? To answer these questions, I estimated sample selection bias models using maximum likelihood. Table 2 presents the results. These are the parameter estimates that maximize the log-likelihood function, which is the product of the probability of having non-zero hours of work and the density of the number of hours worked conditional on having non-zero hours. The estimates from the two elements of the procedure are divided into two panels in Table 2. The upper panel, "hours worked," lists the parameter estimates for the outcome equation predicting the number of hours conditional on having non-zero hours. The lower panel, "selection," shows the parameter estimates for the selection equation predicting the probability of having non-zero hours.

The two equations have different specifications. Different factors affect women's labor force participation and hours of work, although there are some overlaps such as education, other family income, and age. Methodologically, having a set of variables in the outcome equation, i.e. the hours equation, that includes all the variables used in the selection equation can result in the problem of identification. This is because the parameters of the outcome equation are identified only from the nonlinearity of the probit equation in the selection equation (Breen, 1996). It is therefore necessary to have a bigger set of independent variables in the selection equation than in the outcome equation. This is equivalent to place a restriction that some variables that affect the selection mechanism

have no effect on the outcome-- i.e., hours worked. In this analysis, the selection equation has all the independent variables that are entered in the outcome equation, plus some additional variables including race, number of adults in household, and more detailed categories of education and year dummies.

(Table 2 about here)

I used three types of specification according to different questions. Model 1 is the baseline model. Model 2 tests whether the effect of education has changed over time, while Model 3 tests whether the effect of family income has shifted during the period. The baseline model confirms the conventional notion about women's labor force over time. The hours equation and the selection equation show a similar pattern. Education has a positive effect on women's labor supply, while other family income has a negative effect. The coefficients for other control variables indicate a plausible pattern. The effects of old age and having preschoolers are negative. Married women with their spouses present have higher rates of participation than single women, but they work shorter hours than single, separated, or divorced women. Dummy variables for years show the rise and fall of women's labor supply. Labor force participation rose until the late 1980s, then declined a bit, and resumed the rise in late 1990s. Number of hours worked also increased until the early 1990s, declined in mid 1990s, and regained in the late 1990s. The changes in the number of hours correspond to the aggregate pattern in Figures 2 and 4.

The baseline model assumed that the effects of each factor are held constant over time. I allowed the effects to vary over time in subsequent models by adding the

interaction terms. This new specification reveals evidence of a pattern that previous research has only conjectured. The coefficients for the interaction terms in Model 2 shows the positive effect of college education on women's labor supply did not change during the period. The effect on women's employment in the selection equation even declined a little after the year 2000. The effect on hours increased at the beginning but ceased to grow in the 1990s. The results are consistent with the trend in Figures 1 and 2, where the employment gaps were parallel but the hours gaps were widening then becoming parallel. This pattern contradicts the argument of Juhn and Murphy (1997) and Cohen and Bianchi (1999) that the educational differentials in women's labor supply continued to grow and that the "pull" factors of increasing opportunitity for women with high education expanded over time. But it should be noted that the positive effect of education had already been strong from the beginning of the period. The effect has not grown during the period, neither did it decline substantially. The positive effect of women's education stays almost constant. Educational differentials in women's labor supply stopped growing but stayed at a stable level, keeping the gap between the better educated and the less educated persistent.

By contrast, the negative effect of other family income on women's labor supply has been diminishing. The effect on employment decreased until the mid 1990s, and then started to grow in the late 1990s but it did not reach the initial level of 1982 yet. Since the changes have been gradual over time, the level may fluctuate in the near future or start again to decrease. The decrease in the income effect on hours worked is evident, particularly in the 1990s. The coefficient has declined down to about two thirds of the initial level, from -2.987 to (-2.987+1.008=) -1.979. For example, consider two women,

each with income of 8 and 12 in logged values. Assume that they have average attributes on other variables: no college degree, 30-34 years old, married with spouse present, and no children under 6. In 1982, the low-income woman is expected to work (69.116-2.987*8-.309-1.289=) 43.6 hours. Her hours would drop to 43.4 in 1991, and to 42.4 in 2001. However, the high-income woman would increase her hours from (69.116-2.987*12-.309-1.289=) 31.7 in 1982 to 33.9 in 1991 and 34.5 in 2001. Since the richer women are increasingly more likely to have a college degree, add to this number two more hours (1.995) from the coefficient of college degree. Although initially the richer woman started from much shorter hours of work, the gap has been narrowing over the twenty-year period. Women from high-income families have been increasing their labor supply at a faster pace than other women, approaching the level of labor market commitment for the low-income women. During the same period, women from low-income families have been decreasing their once-highest labor supply. If the negative income effect was a force equalizing the income distribution in the past until the 1980s, this equalizing force has weakened. It is likely that it will continue to diminish in the future.

(Figure 6 about here)

If the income differentials in the hours of work have been narrowing, what is the consequence in relation with the family income distribution? In simple words, rich families, once relied on a male-breadwinner, are increasingly likely to have two earners working longer hours than before. The intuitive reasoning leads us to an increase in

family inequality. Although I do not explicitly test a causal relationship between the changes in women's labor supply and the family income inequality, I present indirect evidence that suggests the relationship between the two. Figure 6 shows the total family income for the women at different number of hours. Non-workers appear in the graph as having zero number of hours. The logged income values were standardized to the 1982 values to see the changes in relative terms. The plot reveals a runaway family income for the women working the longest hours (50-99 hours per week). About 7.6% of the sample is in this category. The increase was the fastest during the economic recovery of the late 1980s and the boom of the late 1990s. By contrast, the family income for the non-working women has been lagging behind everyone else, particularly during the recession of the early 1990s. The income gap between the families with non-working women and the families with the hardest working women was the biggest during the early and mid 1990s. The plot implies that the employment and working hours of women in a family can significantly alter the family income. More importantly, the degree of the association between the women's hours and the family income has been increasing, widening the gap between the male-breadwinner families, dual-earner families with moderate hours, and dual-earner families with the longest hours of work.

(Table 3 about here)

Table 3 shows a test of a hypothesis whether the association between women's hours and the total family income has been increasing over time. The number of hours worked is transformed into logarithm. The interaction terms between the number of hours

worked and the year dummies show that the association steadily increased in a linear way. This implies that women's hours of work have increasingly become more important than before. As Costa (2000) emphasized, the result suggest that studies of income inequality should take into account women's hours of work.

Conclusion

This paper shows the results from an analysis of women's labor supply in the United States disaggregated by education and family income, factors that affect the earnings and income inequality. The literature suggests contradictory notions on the relationship between women's labor supply and family income inequality. Recent changes identified in past research imply that changes might have already occurred. The approaches in the past research failed to examine the combination of the two aspects of labor supply: labor force participation and the hours of work. Popular debate on either of the issues did not integrate the two aspects with the phenomenon of growing inequality. Also, the issue of combining the two elements challenges the analysts due to the problem of sample selection bias.

Using up-to-date data sets and controlling for sample selection bias, I analyzed the trends in the female labor supply from 1982 to 2001. Disaggregated by education and family income, the data reveal a story that is not usually discussed elsewhere. Educational differentials in labor supply have been persistent, but income differentials have been narrowing. The results from multivariate analysis provide a fuller version of the story. Controlling for other factors, women's education continues to be a strong force

driving women's commitment to the labor market, whereas family income has become a less powerful disincentive for women's employment over time. It is not simply more women in the labor force that caused a greater, or smaller, income inequality. With more high-income women in the labor market working longer hours than before, the family income distribution has become more unequal. An indirect test of this argument shows that the association between women's hours worked and total family income has been continuously increasing for the past twenty years. Future research will have to investigate the relationship between the changes in women's labor force participation, demographic shifts, and income inequality more closely.

Appendix: Maximum Likelihood Estimation of Sample-Selection Models

Basics of sample selection models are easily available (Berk, 1983, Breen, 1996, Winship and Mare, 1992). Although some past studies have used Tobit model in studying the hours worked for females (Heckman, 1974; Cohen and Bianchi, 1999), one should carefully consider which model is appropriate between Tobit and sample-selection models. A simple data manipulation of replacing the missing values to zero would allow us to switch from sample-selection model to Tobit model. In terms of model specification and parameter estimation, both models can be implemented and estimated. To find out the answer, one should ask the substantive question of why the selection occurs. If the selection occurs because of some exogenous mechanism that has nothing to do with the actors we study, such as the situation where some data below the threshold are not

measured, Tobit model is appropriate. However, if the selection is a result of the behavior on the part of the actors we study, the sample-selection model is more appropriate, whether the threshold value is fixed or dependent upon another set of explanatory variables (Breen, 1996). Number of hours worked has a fixed threshold value, which appears to be an exogenous mechanism because of the obvious physical law of time being always positive. However, it is the individual's characteristics (and also familial and institutional factors that interact with the individual) that affect the decision to participate in the labor market and have nonzero hours of work. In other words, an individual may have zero hours of work not because she has negative hours of work but because she does not work at all.

In economics, a theoretical distinction is between labor supply choices at the extensive margin (i.e., labor-force participation and employment choices) and choices at the intensive margin (i.e., choices about hours of work or weeks of work for workers) (Heckman, 1993). Use of the Tobit model assumes that the choices at each margin becomes incorporated into one linear measure of hours and that they are determined by the same sets of explanatory variables. From this point of view, it is more appropriate to use sample-selection models to analyze the hours of work.

Between the Heckman two-step estimation and maximum likelihood estimation, the literature reports that the latter is to be preferred (Breen, 1996; Moffitt, 1999). In general, the maximum likelihood estimators of are asymptotically unbiased, asymptotically normal, and more efficient than the two-step estimators. Moreover, it is more plausible to assume that the two margins of labor supply choice are indeed

simultaneously, rather than sequentially, processed by an individual, even though each choice is dependent upon different sets of explanatory variables.

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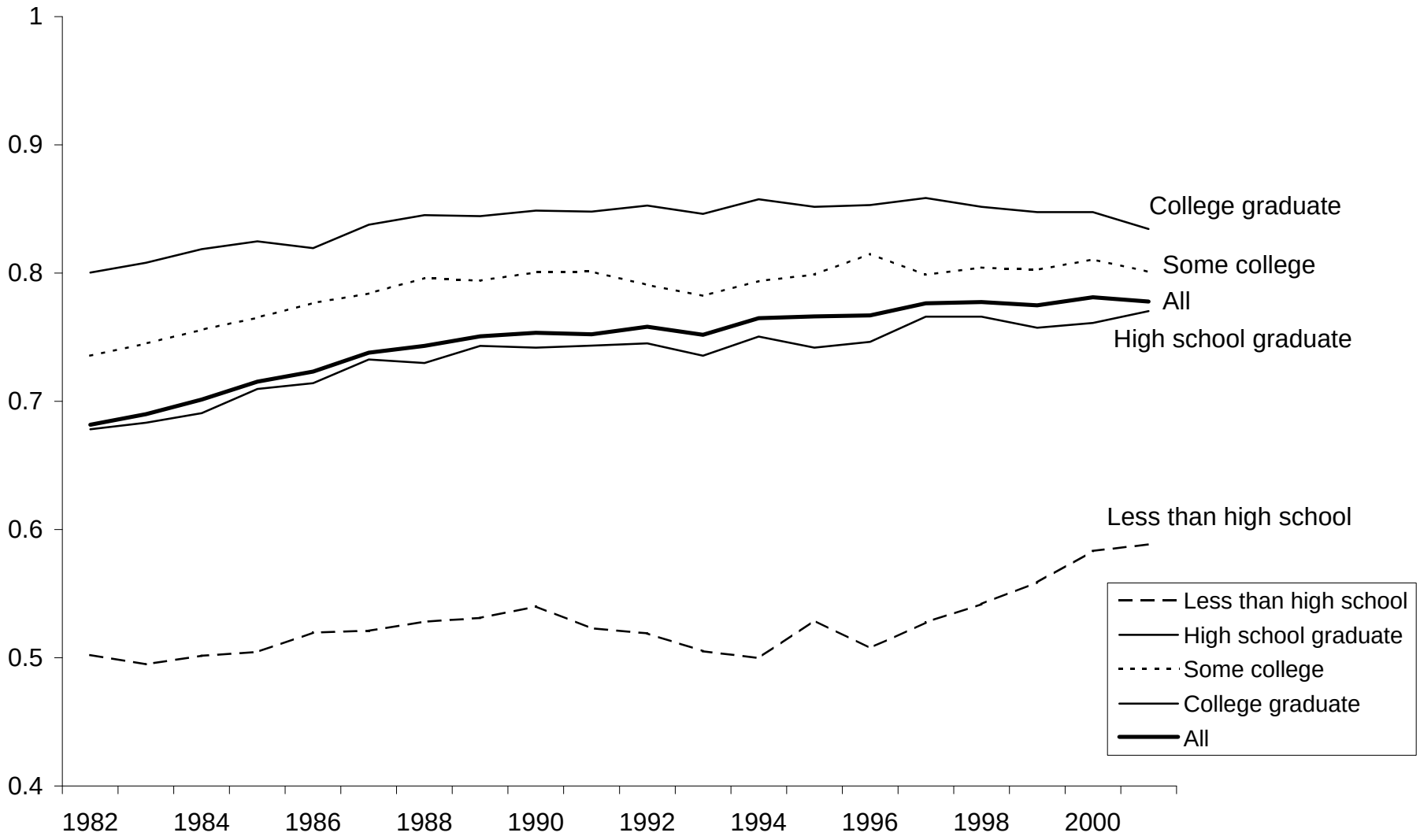

Figure 1. Labor Force Participation Rates by Education

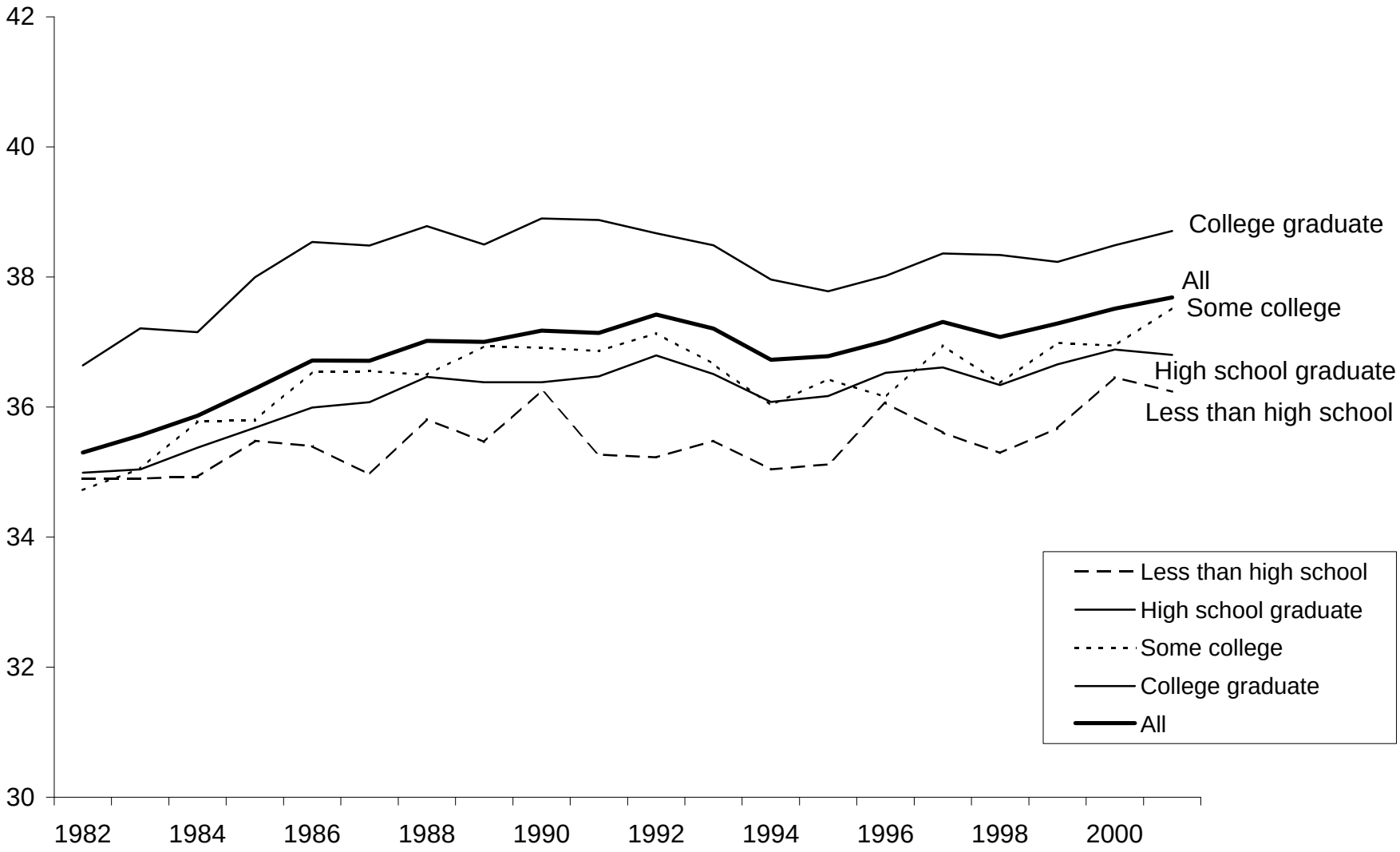

Figure 2. Hours Worked Last Week by Education

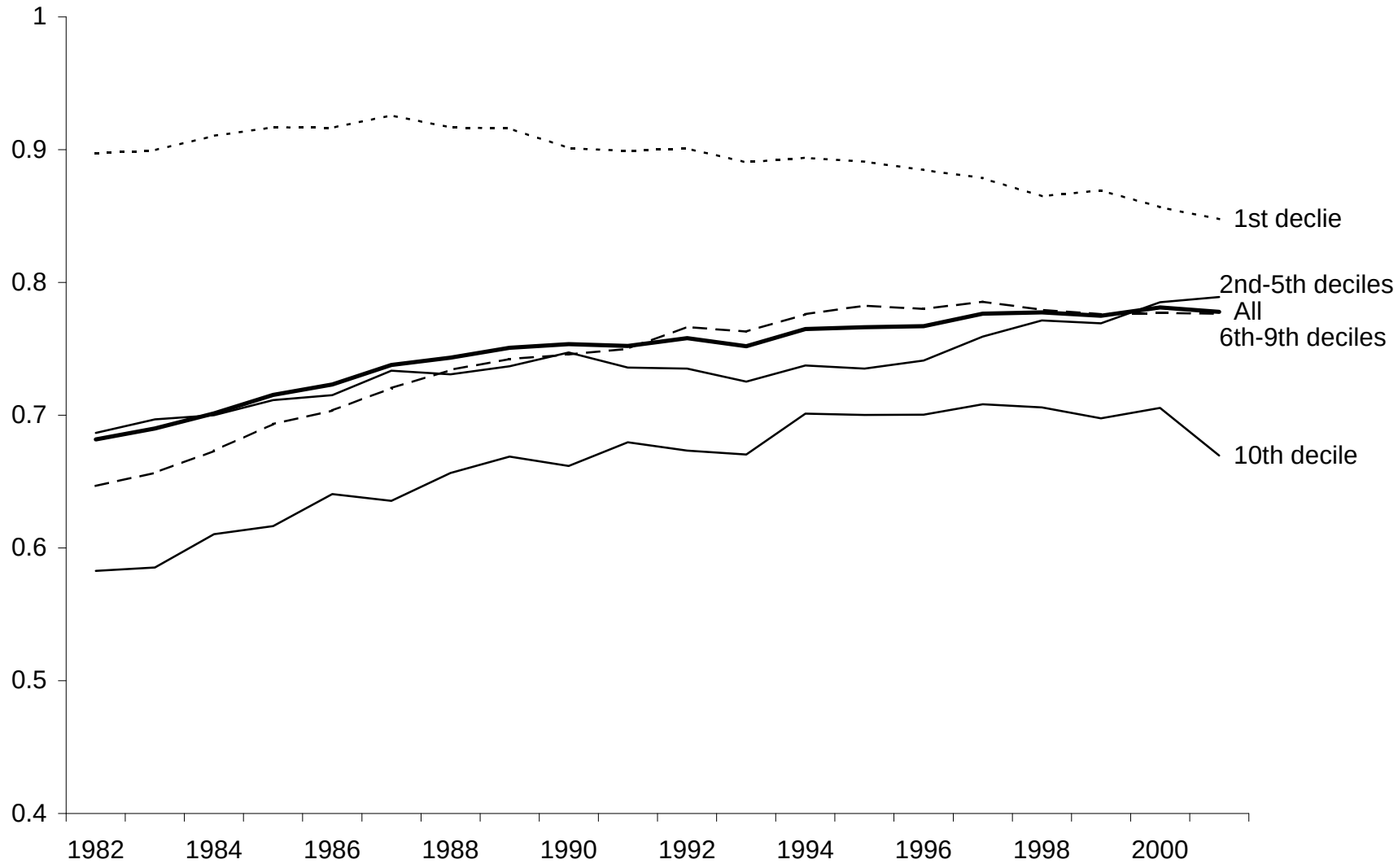

Figure 3. Labor Force Participation Rates by Other Family Income Deciles

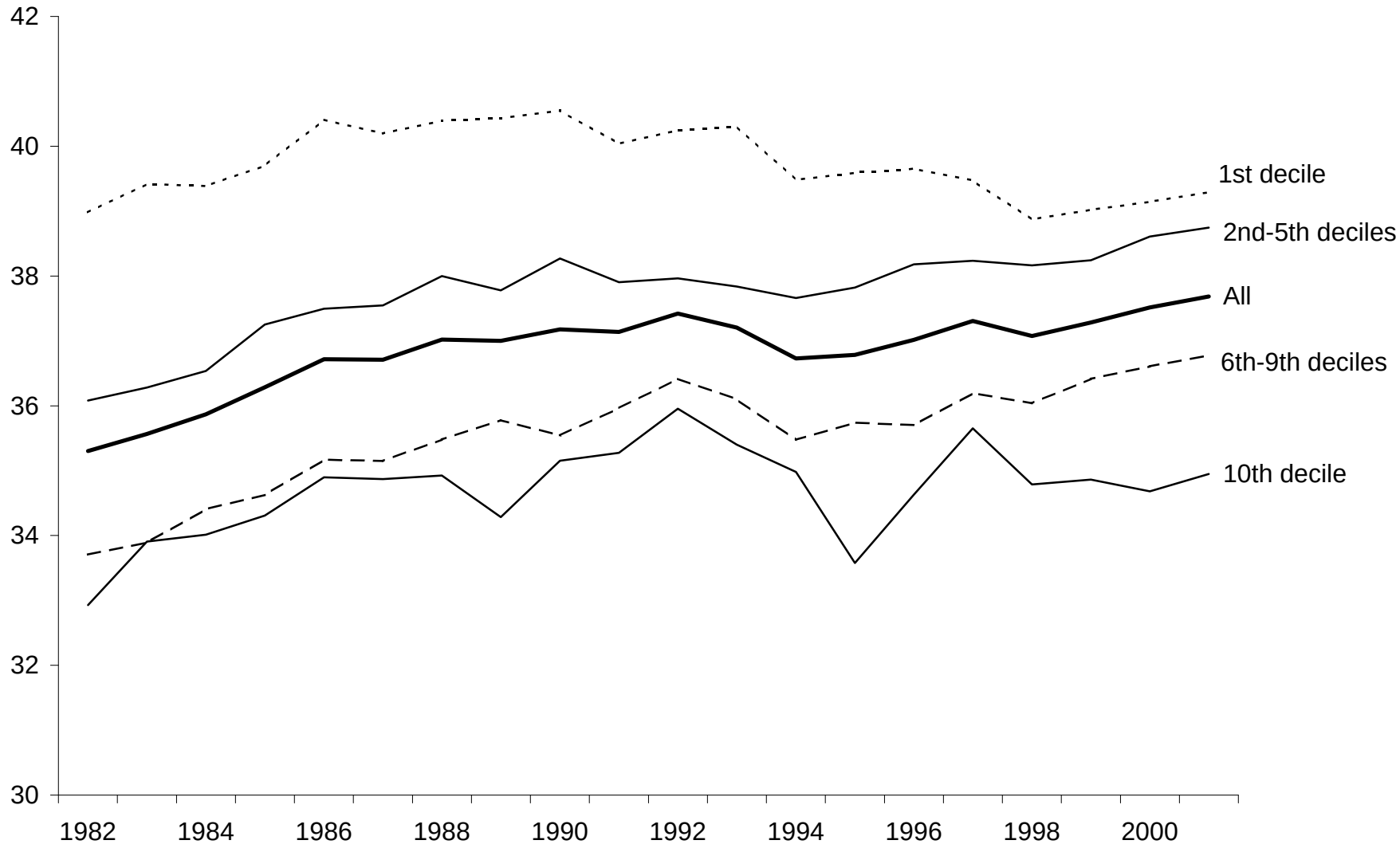

Figure 4. Hours Worked Last Week by Other Family Income Deciles

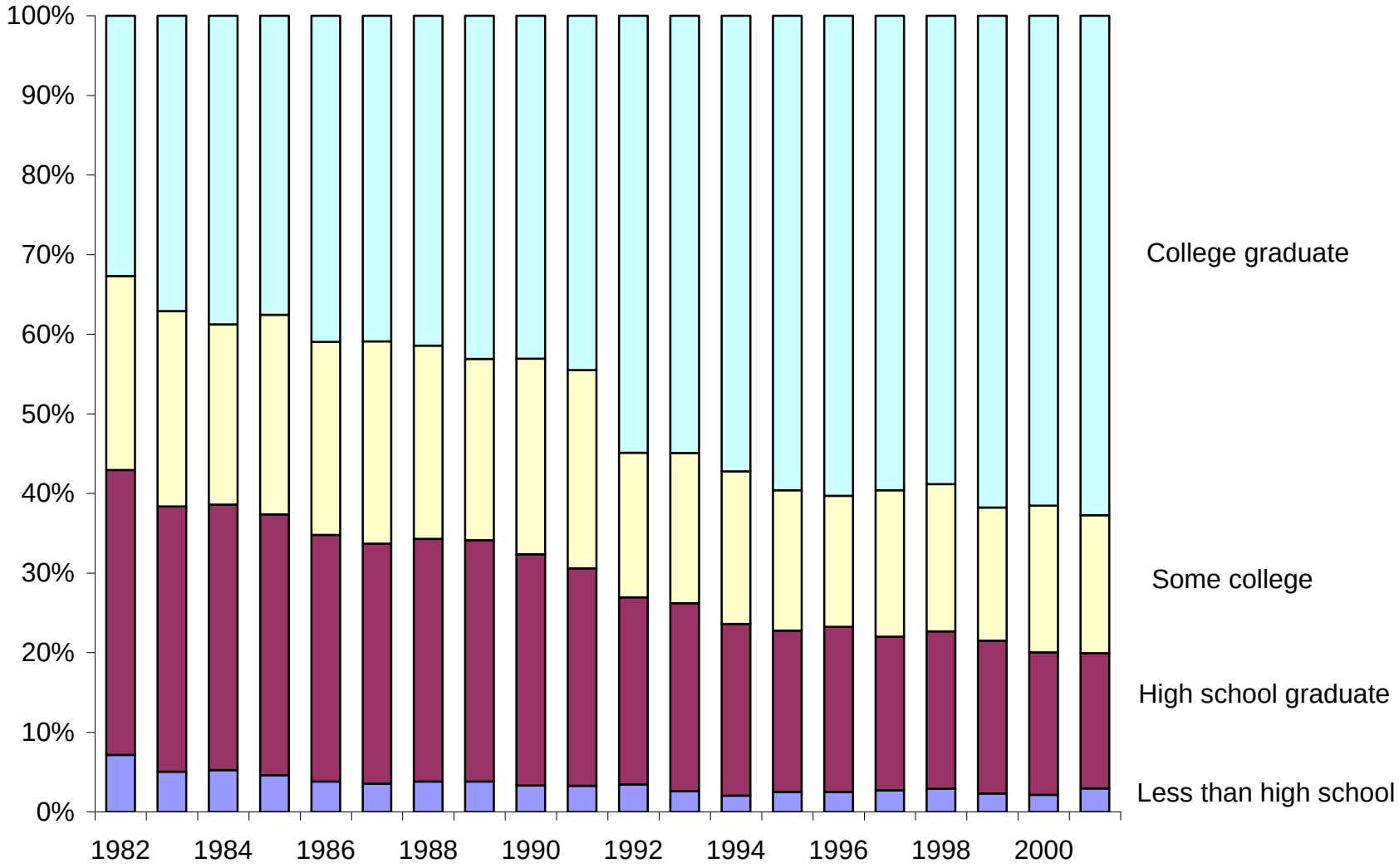

Figure 5. Composition of Educational Attainment within the 10th Income Decile

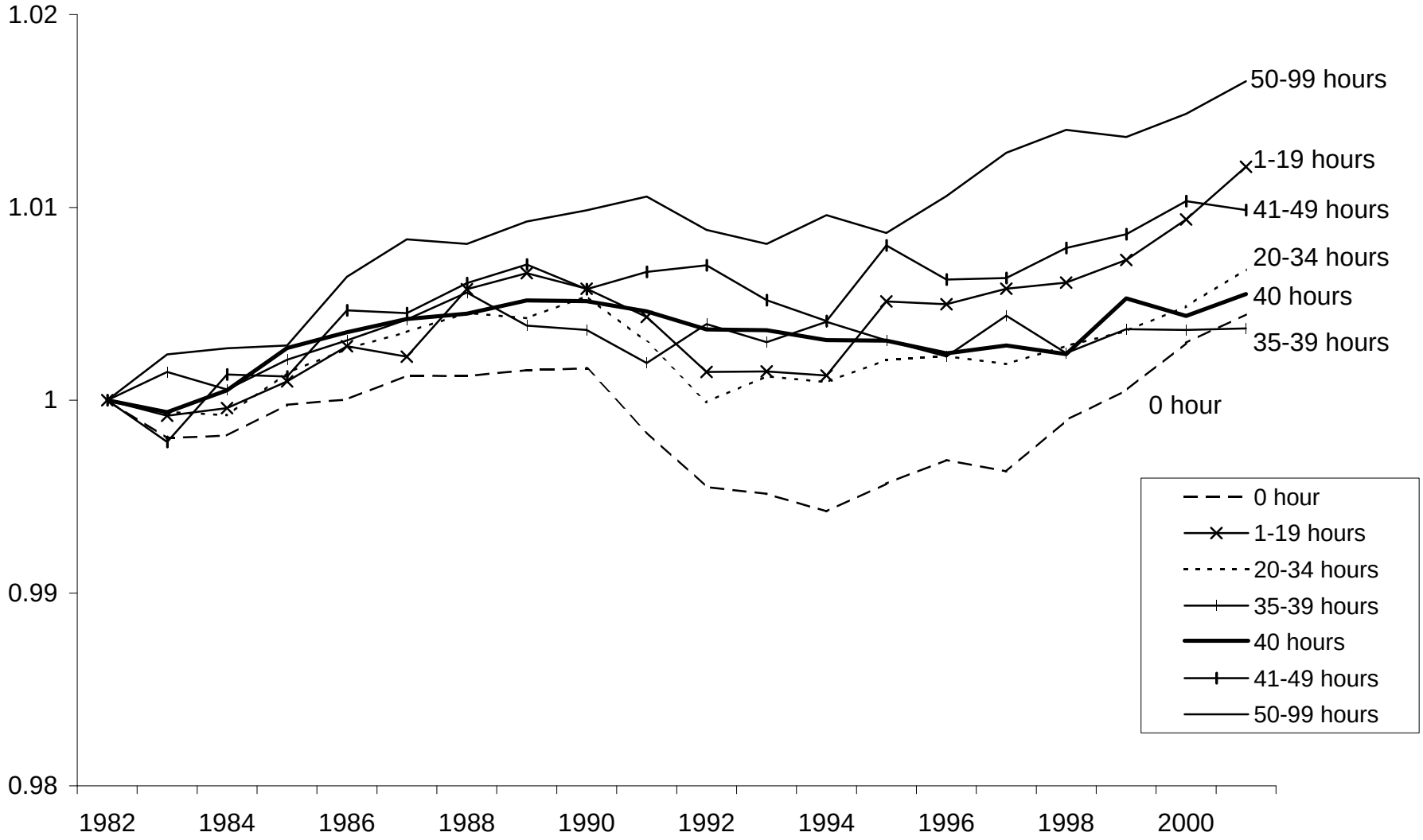

Figure 6. Logged Total Family Income by Hours Worked Last Week

Table 1. Descriptive Statistics.

	%	Valid N	Mean	SD	Min	Max
Hours worked last week		310,973 *	36.85	12.35	1	99
Employment status						
In labor force	74.57	341,991				
Employed	*70.53*	*323,473*				
Unemployed	*4.04*	*18,518*				
Not in labor force	25.43	116,636				
Log of other family income		458,627	10.43	0.44	6.59	12.96
College graduate	28.16	129,146				
Age						
25-29	25.51	116,977				
30-34	26.63	122,123				
35-39	25.49	116,893				
40-44	22.38	102,634				
Marital status						
Never married	17.00	77,969				
Married, spouse present	67.51	309,613				
Separated, divorced	15.49	71,045				
Number of children under 6		458,627	0.44	0.72	0	6
Number of adults in household		458,627	1.98	0.82	0	7
Nonwhite	14.96	68,594				

* 147,654 missing values (non-workers or no response). Other variables have no missing values.

Table 2. Maximum Likelihood Estimation of the Sample Selection Bias Models predicting the Hours Worked Last Week.

	Model 1		Model 2		Model 3	
HOURS WORKED						
Other family income	-2.516 (.066)	***	-2.516 (.066)	***	-2.987 (.128)	***
College graduate	2.006 (.056)	***	1.760 (.119)	***	1.995 (.056)	***
Age (omitted: 25-29)						
30-34	-.313 (.061)	***	-.313 (.061)	***	-.309 (.061)	***
35-39	-.706 (.064)	***	-.707 (.064)	***	-.698 (.064)	***
40-44	-.363 (.068)	***	-.365 (.068)	***	-.356 (.068)	***
Marital status (omitted: never married)						
Married, spouse present	-1.282 (.069)	***	-1.281 (.069)	***	-1.289 (.069)	***
Separated, divorced	.240 (.076)	**	.241 (.076)	**	.216 (.076)	**
Number of children under 6	-2.566 (.049)	***	-2.564 (.049)	***	-2.565 (.049)	***
Year (omitted: 1982-1985)						
1986-1989	1.053 (.069)	***	.937 (.080)	***	-1.362 (1.669)	
1990-1993	1.263 (.068)	***	1.164 (.081)	***	-5.033 (1.665)	**
1994-1997	.788 (.071)	***	.770 (.086)	***	-3.490 (1.692)	*
1998-2001	1.168 (.073)	***	1.111 (.089)	***	-9.319 (1.670)	***
College degree x year (omitted: 1982-1985)						
College degree x year (1996-1989)			.455 (.157)	**		
College degree x year (1990-1993)			.363 (.151)	*		
College degree x year (1994-1997)			.133 (.152)			
College degree x year (1998-2001)			.237 (.154)			
Other family income x year (omitted: 1982-1985)						
Other family income x year (1986-1989)					.233 (.160)	
Other family income x year (1990-1993)					.605 (.160)	***
Other family income x year (1994-1997)					.411 (.163)	*
Other family income x year (1998-2001)					1.008 (.160)	***
Constant	64.204 (.649)	***	64.270 (.650)	***	69.116 (1.304)	***
SELECTION						
Other family income	-.427 (.006)	***	-.426 (.006)	***	-.566 (.016)	***
Education (omitted: less than high school)						
High school graduate	.652 (.006)	***	.652 (.006)	***	.653 (.006)	***
Some college	.867 (.007)	***	.867 (.007)	***	.868 (.007)	***
College graduate	1.109 (.007)	***	1.097 (.017)	***	1.107 (.007)	***
Age (omitted: 25-29)						
30-34	-.025 (.006)	***	-.025 (.006)	***	-.024 (.006)	***
35-39	-.043 (.006)	***	-.043 (.006)	***	-.041 (.006)	***
40-44	-.069 (.006)	***	-.070 (.006)	***	-.067 (.006)	***
Marital status (omitted: never married)						
Married, spouse present	.024 (.007)	***	.024 (.007)	***	.021 (.007)	**
Separated, divorced	.043 (.008)	***	.043 (.008)	***	.038 (.008)	***

(continued on next page)

(Table 2 continued from previous page)

Number of children under 6	-.400 (.003)	***	-.400 (.003)	***	-.400 (.003)	***
Number of adults in household	.081 (.003)	***	.081 (.003)	***	.081 (.003)	***
Nonwhite	-.118 (.006)	***	-.118 (.006)	***	-.119 (.006)	***
Year (omitted: 1982-1983)						
1984-1985	.066 (.009)	***	.064 (.009)	***	-.392 (.220)	
1986-1987	.126 (.009)	***	.130 (.010)	***	-.863 (.217)	***
1988-1989	.200 (.009)	***	.200 (.010)	***	-.980 (.219)	***
1990-1991	.190 (.009)	***	.188 (.010)	***	-1.395 (.216)	***
1992-1993	.139 (.009)	***	.130 (.010)	***	-1.998 (.219)	***
1994-1995	.172 (.009)	***	.152 (.010)	***	-2.217 (.221)	***
1996-1997	.202 (.009)	***	.191 (.011)	***	-2.186 (.222)	***
1998-1999	.223 (.009)	***	.224 (.011)	***	-1.672 (.220)	***
2000-2001	.240 (.009)	***	.263 (.011)	***	-1.242 (.220)	***
College degree (or other family income) x year (omitted: 1982-1983) [a]						
Interaction by year (1984-1985)			.011 (.022)		.044 (.021)	*
Interaction by year (1986-1987)			-.016 (.022)		.095 (.021)	***
Interaction by year (1988-1989)			.003 (.022)		.113 (.021)	***
Interaction by year (1990-1991)			.012 (.022)		.151 (.021)	***
Interaction by year (1992-1993)			.037 (.021)		.205 (.021)	***
Interaction by year (1994-1995)			.073 (.021)	**	.229 (.021)	***
Interaction by year (1996-1997)			.041 (.022)		.229 (.021)	***
Interaction by year (1998-1999)			.005 (.022)		.181 (.021)	***
Interaction by year (2000-2001)			-.062 (.022)	**	.142 (.021)	***
Constant	4.114 (.062)	***	4.112 (.062)	***	5.574 (.164)	***
rho	-.122 (.012)		-.123 (.012)		-.123 (.012)	
sigma	12.062 (.017)		12.063 (.017)		12.062 (.017)	
lambda	-1.475 (.140)		-1.484 (.140)		-1.482 (.140)	
N	458,627		458,627		458,627	

Standard errors in parentheses.

*** p< .001, ** p< .01, * p< .05.

[a] Interaction of college degree and year dummies for Model 2; interaction of other family income and year dummies for Model 3.

Table 3. Ordinary Least Squares Regression of the Logged Total Family Income.

Hours worked (0 if nonworker)	.028	(.0007) ***
Education (omitted: less than high school)		
High school graduate	.162	(.0014) ***
Some college	.253	(.0015) ***
College graduate	.398	(.0015) ***
Age	.007	(.0001) ***
Marital status (omitted: never married)		
Married, spouse present	.243	(.0013) ***
Separated, divorced	-.040	(.0016) ***
Number of children under 6	-.009	(.0007) ***
Household size	.117	(.0006) ***
Year (omitted: 1982-1983)		
1984-1985	-.002	(.0029)
1986-1987	.017	(.0030) ***
1988-1989	.026	(.0031) ***
1990-1991	.017	(.0030) ***
1992-1993	-.027	(.0030) ***
1994-1995	-.035	(.0031) ***
1996-1997	-.026	(.0033) ***
1998-1999	-.008	(.0033) *
2000-2001	-.044	(.0136) **
Hours x Year (omitted: 1982-1983)		
Hours x Year (1984-1985)	.004	(.0010) **
Hours x Year (1986-1987)	.006	(.0010) ***
Hours x Year (1988-1989)	.006	(.0011) ***
Hours x Year (1990-1991)	.007	(.0010) ***
Hours x Year (1992-1993)	.009	(.0011) ***
Hours x Year (1994-1995)	.011	(.0011) ***
Hours x Year (1996-1997)	.010	(.0011) ***
Hours x Year (1998-1999)	.010	(.0011) ***
Hours x Year (2000-2001)	.023	(.0038) ***
Constant	10.002	(.0027) ***
N	447,918	

Standard errors in parentheses.
*** p< .001, ** p< .01, * p< .05.