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SLOWING WOMEN'S LABOR FORCE PARTICIPATION: THE ROLE OF INCOME INEQUALITY

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ABSTRACT

The entry of married women into the labor force and the rise in women's relative wages are amongst the most notable economic developments of the twentieth century. The growth in these indicators was particularly pronounced in the 1970s and 1980s, but it stalled since the early 1990s, especially for college graduates. In this paper, we argue that the discontinued growth in female labor supply and wages since the 1990s is a consequence of growing inequality. Our hypothesis is that the growth in top incomes for men generated a negative income effect on the labor supply of their spouses, which reduced their participation and wages. We show that the slowdown in participation and wage growth was concentrated among women married to highly educated and high income husbands, whose earnings grew dramatically over this period. We then develop a model of household labor supply with returns to experience that qualitatively reproduces this effect. A calibrated version of the model can account for a large fraction of the decline relative to trend in married women's participation in 1995-2005 particularly for college women. The model can also account for the rise in the gender wage gap for college graduates relative to trend in the same period.

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1 Introduction

The entry of married women into the labor force and the rise in women's relative earnings are amongst the most notable economic phenomena of the twentieth century (Goldin (2006)). These trends were particularly pronounced in the 1970s and 1980s, when full-year participation of married women grew from 38% in 1975 to a peak of 60% in 1996 and the male to female ratio in hourly wages dropped from 1.60 to 1.34. Since then, these indicators have stalled, as shown in figure 1. Moreover, this development is particularly pronounced for highly educated women. The labor force participation of married women with college degree and the gender wage gap of college workers saw no improvement since the early 1990s until the Great Recession. These observations are puzzling in light of the continued rise in women's educational attainment relative to men and their entry into professional high-earning occupations.[1]

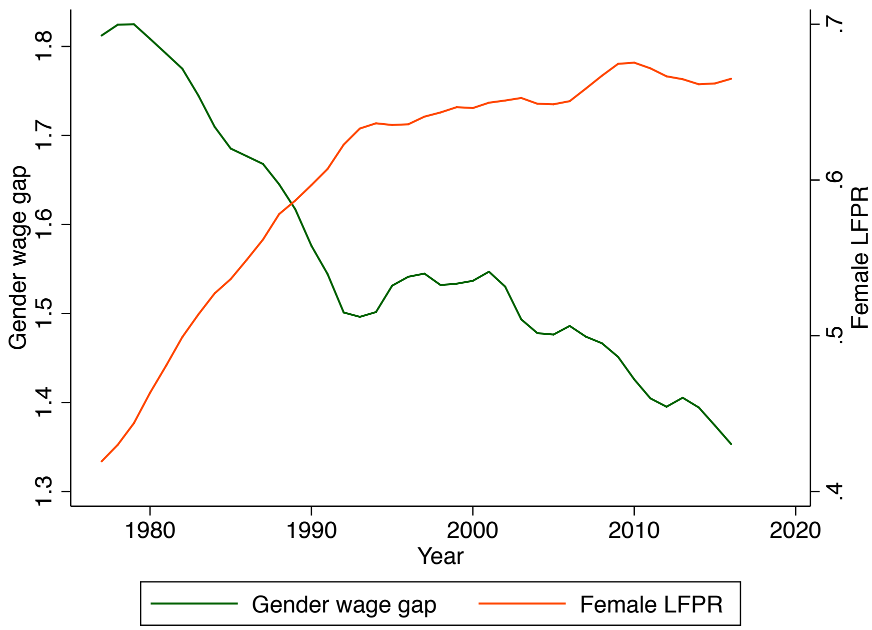


FIGURE 1: Gender wage gap and female labor force participation rate for full time full year workers.
Note: The gender wage gap is computed as the ratio between the mean wage of male full-time, full-year workers to the mean wage of female full-time, full-year workers. Labor force participation rate (LFPR) is defined as the fraction of adults in our sample who either worked or looked for work for at least 45 weeks during the year.
Source: March Supplement of CPS

This paper proposes an explanation that connects the discontinued growth of married women's labor force participation and wages relative to men since the early 1990s to the growth in top incomes for men, which substantially accelerated in those years. Specifically, we argue that the rise in top earnings for men reduced the labor supply of their female spouses. This in turn reduced these women's labor force participation and hours, and the resulting decline in their labor market

[1] Goldin et al. (2006) documents the rise in women's educational attainment, while Black and Juhn (2000) document women's entry in professional, traditionally male dominated, occupations.

experience depressed their wage growth relative to men. To illustrate this mechanism, we present empirical evidence on married women's labor supply and wages by their own education, and their husbands' education and earnings. We then develop a model of household labor supply with returns to experience that captures these disaggregated patterns of employment and wages to quantitatively explore this mechanism.

The first part of our analysis is empirical. We document a break in the trend for the labor force participation rate of married women in the early 1990s. The rate of labor force participation of married women increased by about 2 percentage points per year in the post war period up until this point, with a stronger growth for women with a college degree, converging rapidly to the participation rate of single women in the same education group. This convergence stopped in the early 1990s. The labor force participation rate for single women with less than college was approximately 5 percentage points higher than for married women in this education group in 1993-2007, whereas for women with college degree, the participation rate for single women remained 10 percentage points higher than for married women over the same period. The gap in labor force participation rate between single and married women dropped slightly during the Great Recession, mainly due to a decline in the participation rate of single women, and there was no further convergence after 2012, as the economy recovered.

We then examine labor supply and wages of married women by their own and their husbands' education, as well as their husbands' income. We find that the decline in the growth of labor force participation of married women is primarily concentrated among those with a college husband and is positively related to husband's income. Due to positive assortative matching, this channel disproportionally affected women with a college degree.

Turning to wages, we find that the growth in top incomes for married men is associated with an increase in the skill premium for this group, whereas there was no comparable increase of the skill premium for married women. We also show that there was no difference in the skill premium by gender for single workers. To reinforce this observation, we examine the evolution of the gender wage gap by educational attainment for married workers. We find that the gender wage gap completely stopped converging for workers with a college degree in the early 1990s, though it declined somewhat after the Great Recession. For non-college workers, the gender wage gap continued closing until the early 2000s, even if the participation of married high school women was also flat over this period.

Taken together, this evidence suggests a link between the growth in top incomes for married men and the flattening of participation and wages for married women since the early 1990s. To explore the mechanism behind this link, we develop a quantitative model of household labor supply, in the tradition of Chiappori (1992). Households are comprised of two partners of different gender, who share consumption and jointly choose labor supply on both the extensive and the extensive margin. Assortative matching by education, which is exogenous in the model, is matched to empirical patterns. A household type corresponds to the educational attainment of the spouses, where we distinguish between two categories: college completed and less than college. Individual wages depend on the level of education and on human capital. Human capital is accumulated according to past work experience, following Imai and Keane (2004), so that wages are endogenous and depend on the workers' past labor supply choices. The skill premium is determined by an exogenous common component and by a worker's cumulated experience. This implies that both the skill premium by gender and the gender wage gap by education are endogenous and depend on labor supply. In the model, an increase in the exogenous component of the skill premium causes labor supply of college men to rise, provided they are the primary earners in the households. Labor supply of their wives instead falls. For households with high asset levels, wives will drop out of the labor force, whereas for households with low asset levels, wives will continue to participate but work fewer hours. This will reduce their earnings relative to men, causing a smaller increase in the skill premium for college women relative to college men, and an increase in the gender wage gap.

We calibrate the model to match key empirical moments in 1980, such as the distribution of household income and spousal earnings and wives' labor force participation by household type. We conduct experiments to gauge the quantitative relevance of our hypothesis. Specifically, we increase the exogenous common component of the skill premium to match the observed rise in the male skill premium in the data in the 1990s. Our findings suggest that the rise in the skill premium can account for more than half of the decline relative to trend in married women's participation in 1995-2005, and more than two thirds of the decline for college women. The model can also account for one third of the rise in the gender wage gap for college graduates relative to trend in the same period.

This paper makes both an empirical and a theoretical contribution. Our empirical analysis extensively documents the behavior of labor force participation and wages of married women in relation to the earnings of their husbands by characteristics of the household and educational attainment of the spouses. This detailed level of disaggregation provides a novel perspective on female labor market outcomes, the determinants of household income inequality, and their relation to individual income dispersion. The theoretical analysis is based on a quantitative model of household labor supply. The model can qualitatively reproduce a negative effect on wives' labor supply of a rise in husbands' earnings even with a individual preferences that do not allow for income effects on labor supply. Here, it is variation in the spouse's earnings that influence each partner's labor supply responses. Existing studies of earnings inequality either restrict attention to men or abstract completely from the household structure. Our theoretical model comprises the first attempt to link the rise in the skill premium and top incomes for men to the recent trends in female labor force participation and gender wage inequality.

In our model, education, assortative matching patterns and marriage are exogenous. We abstract from education choice and assortative matching since our focus is on the choices of households who are already married, and education and choice of partner are typically completed before marriage. Additionally, we only allow for assortative matching by education, while in practice it may occur along other dimensions. For example, Hyslop (2001) shows that positively correlated labor market outcomes for spouses are almost entirely attributable to permanent factors, while Shore (2015) finds that husbands with volatile incomes tend to have wives with volatile ones. We take our results as prima facie evidence of the impact of growing inequality on married women's labor supply, and leave modeling of assortative matching to further work.[2]

Finally, marital stability is key for our mechanism, as wives would not have an incentive to reduce labor supply in response to an increase in their husbands' income if there was a substantial probability that their union would end. Since the reduction in women's labor supply we consider is primarily concentrated among households in which both spouses have a college degree and such couples have much lower divorce rates (Stevenson and Wolfers (2007)), we believe our analysis can provide useful insights.

1.1 Relation to the Existing Literature

There is an extensive literature on the rise in women's market work and the increase in their wages relative to men. Many of these explanations have focussed on the role of technological advances in increasing both the supply of female labor and female wages. Goldin and Katz (2002) show that the diffusion of oral contraceptives reduced the costs and increased the returns to women's education, contributing to a rise in their participation and wages. Greenwood et al. (2005) argue that advances in home appliances increased female participation by reducing the time required for home production. Albanesi and Olivetti (2016) show that improvements in maternal health and the introduction of infant formula are key to explaining the rise in participation of married women with children, and the rise in women's education and wages relative to men.

The existing literature has paid little attention to the slowdown of female labor force participation rates in the U.S. Fernandez (2013), Fogli and Veldkamp (2011) develop a learning paradigm to explain the secular rise in female labor force participation, where women update their assessment of the costs for children of being in the workforce based on the experience of past women. In this context, *S-shaped* learning dynamics imply a slowing down of the growth of female participation as its rate rises. Empirical evidence also suggests that evolving attitudes towards labor force participation play an important role. Fortin (215) uses the General Social Surveys to document the stalling of gender roles attitudes in the mid-1990s and concludes that this development can explain at least a third of the decline in the growth rate of female participation. Bertrand et al. (2015) examine gender identity in determining marriage formation and female labor force participation decisions. They find that couples where the woman has higher earnings potential than the man are less likely to get married, and that within couples, if the wife's potential income is likely to exceed the husband's, the wife is less likely to be in the labor force and earns less than her potential if she does work. Blau and Kahn (2013) study the fall in female labor supply in the U.S. compared to other OECD countries, and find that 28% of the difference can be attributable to differences in "family-friendly" policies. Finally, Goldin (2021) argues that "greedy jobs" – typically professional and managerial occupations that require high weekly hours– are increasingly becoming dominant for highly educated workers and they are particularly hard for working mothers, which may discourage them from continuing on those career paths. Our analysis is complementary to these contributions. We take as given attitudes towards female participation, childcare costs, and gender differences in career possibilities, and focus on the endogenous response of labor supply

[2] Chiappori et al. (2018) examine a model with endogenous education and marriage that endogenies assortative matching, but they do not consider the effects of changes in the wage structure by gender on these patterns.

and its impact of lifetime wages by gender for couples who are already formed.

Our work is also related to the emerging empirical literature on household insurance. While income effects are typically estimated to be quite small, recent evidence suggests that they may play a larger role than previously thought. Specifically, at the business cycle frequency, there is extensive evidence that a perspective decline in husbands' earnings, causes wives' labor supply to increase– the so called *added worker effect*. Since the first study isolating this mechanism Lundberg (1985), a variety of contributions have confirmed the importance of this channel. Cullen and Gruber (2000) show that unemployment insurance benefits crowd out the spousal increase in labor supply associated with a spell of unemployment, while Stevens (1997) estimates the added worker effect in response to job displacement. Parker and Skoufias (2004) examine data from Mexico and find that there is a sizable added worker effect in economic downturns, and Juhn and Potter (2007) examine the evolution over time of the added worker effect in the United States. Shore (2010) examines the risk sharing of marriage over the business cycle, and finds that husbands' and wives' incomes are less positively correlated in recessions. Guner et al. (2020) measure the added worker effect with labor market flow data and find that it reduces the fraction of households with two unemployed members in recessions. In our model, the same mechanism causes wives' labor supply to decrease in response to an increase in husbands' perspective income. Ellieroth (2019) shows that the main channel through which married women offset the risk of job loss for their husbands is to reduce the rate at which they exit the labor force in recessions. Albanesi (2019) argues the added worker effect can account for the decline in the cyclicality of aggregate hours during the great moderation and the flattening of female labor force participation can explain a large fraction of the jobless recoveries in the United States since the 1990s.

These contributions are mainly empirical, though a number of recent papers develop quantitative models capturing this channel.[3] The most closely related paper in this line of work is Blundell et al. (2016), who examine the link between wage and consumption inequality using a life-cycle model incorporating consumption and family labor supply decisions. They find that family labor supply is an important insurance mechanism for smoothing temporary and permanent wage shocks.[4] Compared to this literature, we emphasize the importance of the trend growth in men's top incomes for the joint evolution of married women's wages and labor supply, on both the intensive and extensive margin, deriving implications for long run changes in the gender differences in wages and the skill premium.

Section 2 presents the empirical analysis and the main facts and Section 3 presents the model.

[3] Park et al. (2020) show that wives increase their labor supply significantly in response to increases in the variance of husbands' permanent wage shocks, reducing the welfare cost of increased earnings risk since the early 1970s. Ortigueira and Siassi (2013) examine the role of the family as a risk sharing institution in an economy with idiosyncratic labor income and unemployment risk. They find that wealth-rich households use mainly savings to smooth consumption across unemployment spells, while wealth-poor households rely on spousal labor supply. **?** build a theory of joint household search in a frictional labor market to argue that the acyclicality of the labor force is due to the added worker effect. Olsson (2019) focusses on the role of household insurance by developing an heterogeneous agent model with gender specific idiosyncratic risk, and studies labor supply responses of single and married workers as a function of asset holdings and spousal income.

[4] Wu and Krueger (2021) calibrated life-cycle two-earner household model with endogenous labor supply can rationalize the extent of consumption insurance against shocks to male and female wages, as estimated empirically by Blundell et al. (2016).

The calibration of the model and the numerical exercises are in Section 4, and Section 5 concludes.

2 Evidence

In this section, we present empirical evidence on the evolution of the labor force participation of married women by educational attainment and husband's characteristics and of the evolution of the gender skill premium. The goal of this analysis is to present disaggregated facts as evidence for our hypothesis linking earnings inequality to household labor supply decisions.

The empirical analysis presented in this section and the calibration in Section 4 uses data from the Current Population Survey (CPS) and the Panel Study of Income Dynamics (PSID). Appendix A describes the data and sample selection used for our empirical analysis, as well as how we address the issue of top-coding in the data. In our analysis, we sort individuals in two skill levels, college and high school. College individuals have completed a college degree or higher, high school individuals are those who have not obtained a college degree. Additionally, we define labor force participation annually, with participants defined as having worked or looked for work for at least 45 weeks during the year.

2.1 Labor Force Participation and Wages

Figure 2 illustrates the joint evolution of labor force participation for married women and the gender wage gap by educational attainment. As shown in Panel (A), the labor force participation of married women with a college degree has mostly stalled since the early 1990s, with a small transitory increase for college workers during the Great Recession. For high school women, the growth in participation drops substantially starting in the early 1990s, but is still mostly positive. High school women also experience a temporary surge in participation during the Great Recession, after which their participation declines. Albanesi (2019) shows that female labor supply displays a strong countercyclical component, interpreted as resulting from household insurance against the risk of earnings loss of their male partners, who are more sensitive to business cycle risk. Ellieroth (2019) finds that temporary rise in female labor force participation during recessions results from a decline in the employment to non-participation flow of married women. We focus most of our analysis on the years previous to the Great Recession, to avoid the effect of this major cyclical event.

Turning to the gender wage gap, measured as the male to female ratio of hourly earnings, Panel (A) shows that for college workers it decreased rapidly until 1992 and it stalled during the 1990s and early 2000s, only reaching values lower than those in 1992 after the Great Recession. A similar but less stark pattern occurred for high school workers, as shown in Panel (B).

As shown in figure 3, panel (A), the flattening of labor force participation starting in the early 1990s is limited to married women. Participation of single women has been mostly stable throughout the sample period. Panel (B) shows the labor force participation rates of married women by age groups. One striking observation from these figures is that prime age married women have lower participation rates than older women, suggesting that the aging of the population is

(A) College

(B) High school

Figure 2: Gender wage gap and labor force participation of married women, by educational attainment

Note: The gender wage gap is computed as the ratio between the mean wage of male full-time, full-year workers to the mean wage of female full-time, full-year workers. Labor force participation rate (LFPR) is defined as the fraction of adults in each subsample who either worked or looked for work for at least 45 weeks during the year. Panel (A) displays the gender wage gap and female labor force participation of married workers with college degree. Panel (B) displays the gender wage gap and female labor force participation of married workers with less than college degree.

Source: March Supplement of CPS

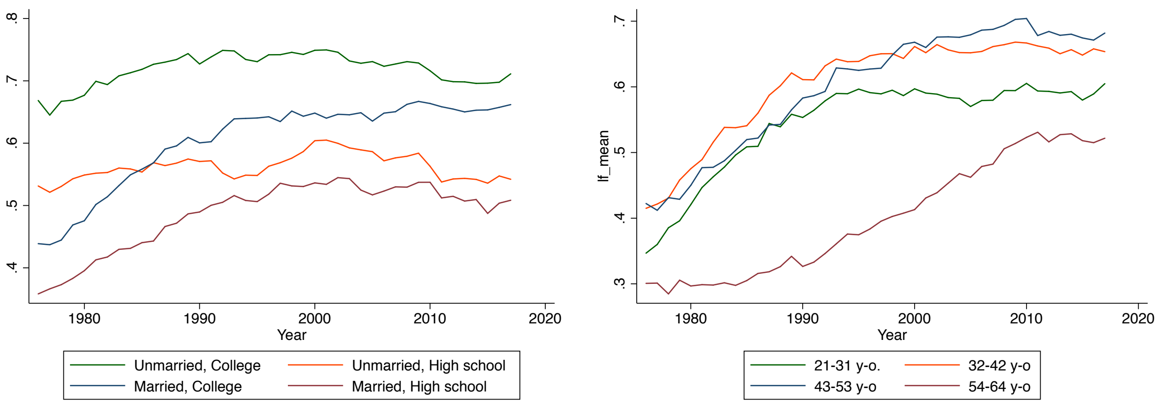
not related to this phenomenon.[5]

There are several factors that have contributed to an increasing rate of labor force participation of married women over the last few decades, such as diffusion in oral contraception (Goldin and Katz, 2002), progress in home appliances (Greenwood et al., 2005), improvements in maternal health (Albanesi and Olivetti, 2016), and cultural factors (Fogli and Veldkamp, 2011; Fernandez, 2013). We capture these varied forces by estimating a common time trend in the evolution of female participation for the period before 1993, when married women's participation stops rising, using a probit specification, in Section 2.5. We use these estimated trends to calculate the difference between actual participation and the participation that would have resulted if the pre-1993 trend had continued, which we deploy in the counterfactual analysis of our model in Section 3.

Husband's Earnings Figure 4 shows the labor force participation rate of women by their husband's decile in the male earnings distribution. The wives of higher earning husbands are much less likely to work than the wives of lower earning husbands.

We hypothesize that this pattern is driven by negative income effects on wife's participation from husbands' income, which we will refer to as cross-income effect. Appendix B presents some supportive descriptive evidence. Specifically, we calculate average household income and average husband's income in households with only male earners versus two-earners, by education. We find that average household income has risen faster for two-earner households than for male-earner

[5]See Appendix B for a comparison to the labor force participation of men during this period.



(A) Participation by marital status and education (B) Participation by age groups, married women.

Figure 3: Female labor force participation rates

Note: Labor force participation rate (LFPR) defined as the fraction of adults in each sub-sample who either worked or looked for work for at least 45 weeks during the year.

Source: Data from the monthly waves of the CPS.

only households for all education types, except for the college husband-high school wife type, for which it has grown at approximately the same rate for male-only and two-earner households. Additionally, husband's average wages are much higher in male-earner only households than in two-earner households for all years and education types. This descriptive evidence suggests that the cross-income effects within the household can be strong.

To test this hypothesis, we estimate a maximum likelihood probit model of wives' labor force participation. The controls are age, own education and cross effect of own education and husband's percentile of earnings. The estimation results in table 1 show evidence of significant cross income effects of husband's earnings on labor force participation decision of the wives.

Table 1: Sensitivity of female labor participation to husband's earnings bracket

	Coef.	Std. Err.	z	P>z	[95% Conf.	Interval]
age	0.0060	0.0002	32.11	0.00	0.006	0.006
education years	0.0900	0.0011	81.97	0.00	0.088	0.092
degree	0.1930	0.0112	17.30	0.00	0.171	0.215
degreeXperc25	-0.2111	0.0169	-12.46	0.00	-0.244	-0.178
degreeXperc50	-0.2820	0.0127	-22.12	0.00	-0.307	-0.257
degreeXperc75	-0.4821	0.0135	-35.68	0.00	-0.509	-0.456
degreeXperc90	-0.8764	0.0120	-72.78	0.00	-0.900	-0.853
constant	-1.1311	0.0157	-72.19	0.00	-1.162	-1.100

Estimated coefficients from maximum likelihood probit model. Dependent variable is wife's labor force participation. Source: Authors' calculations from Current Population Survey.

Table 2 below summarizes the information on husbands' wages for the two time periods in

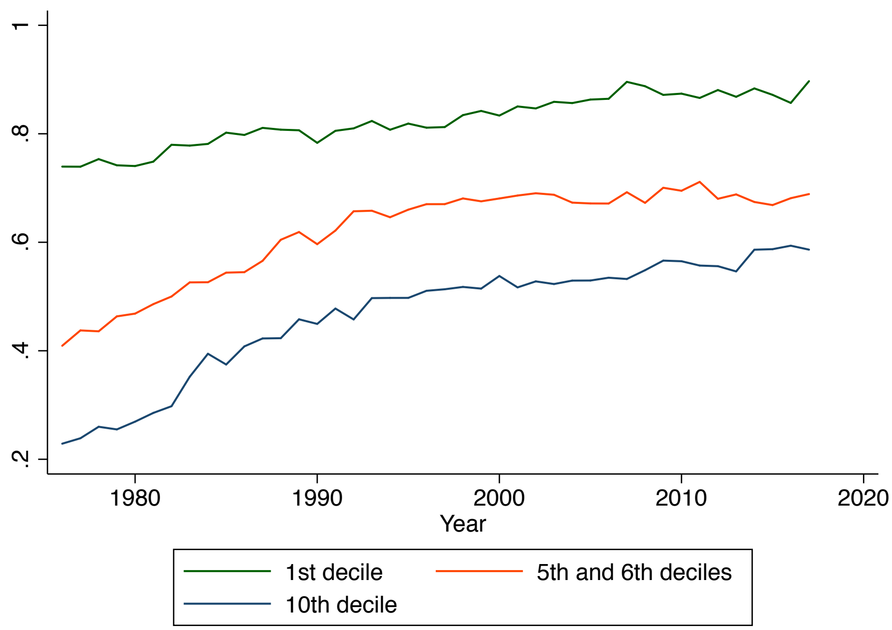


Figure 4: Labor force participation rates of married women by decile of the husband's earnings.

Note: Labor force participation rates (LFPR) defined as the fraction of adults in each sub-sample who either worked or looked for work for at least 45 weeks during the year. The groups correspond to women married to husbands with earnings in the 1st, 5th-6th, and 10th deciles of the male earnings distribution.

Source: Data from the monthly waves of the CPS.

Table 2: Average wage of husband, by household type

Period		One-earner households	Two-earner households	One-earner hh/ Two-earner hh
1976-1993	No College - No College	18.8	16.1	117%
	No Coll Husb - Coll Wife	22.1	17.1	129%
	College Husb - No Coll Wife	29.7	23.0	129%
	College - College	31.2	24.1	130%
1994-2008	No College - No College	19.4	18.0	108%
	No Coll Husb - Coll Wife	25.2	20.0	126%
	College Husb - No Coll Wife	38.5	29.0	133%
	College - College	44.7	33.1	135%

our quantitative analysis (until 1993 and after 1993). There are two salient findings. The first is that the average wage of the husband in one-earner households is higher than the average wage of the husband in two-earner households for all education pairs matchings. Second, the percentage difference between the average wage of the husband in one and two-earner households is smaller after 1994 than in the previous period for high school husbands, and larger for college husbands. This means that high school men in one and two-earner households have become less different in this last period, whereas college men in one and two earner households are further apart in the second period than what they were before 1993.

Figure 5 shows the labor force participation rates of married women, by household education types. There is a steep increase in participation until 1993, and after that there is a change in trend for all married women, regardless of education level. However, the slowdown is more pronounced for married women with a college degree, since the slope during the previous decades was steeper than for women without college. The participation of women married to college husbands stopped increasing after 1993.

2.2 Skill Premium

Figure 6 shows the evolution of the skill premium, measured as the ratio of average hourly wages of college to non-college workers, where as in the rest of the analysis, we restrict attention to full-time, full-year workers. The rise in the skill premium since the early 1990s until the Great Recession was greater for male than for female workers. The skill premium rose by 19% from 1.52 to 1.82 between 1991 and 2008 for men, while it only increased by 9% from 1.5 to 1.63 for women over the same period. This difference accelerated from the mid 1990s on, and resulted in a growing gender gap in skill premium since 1993 until the Great Recession. Even though the gender gap in skill premium decreased during the Great Recession, a positive gap still remains. Appendix B shows the evolution of the ratio between these two variables.

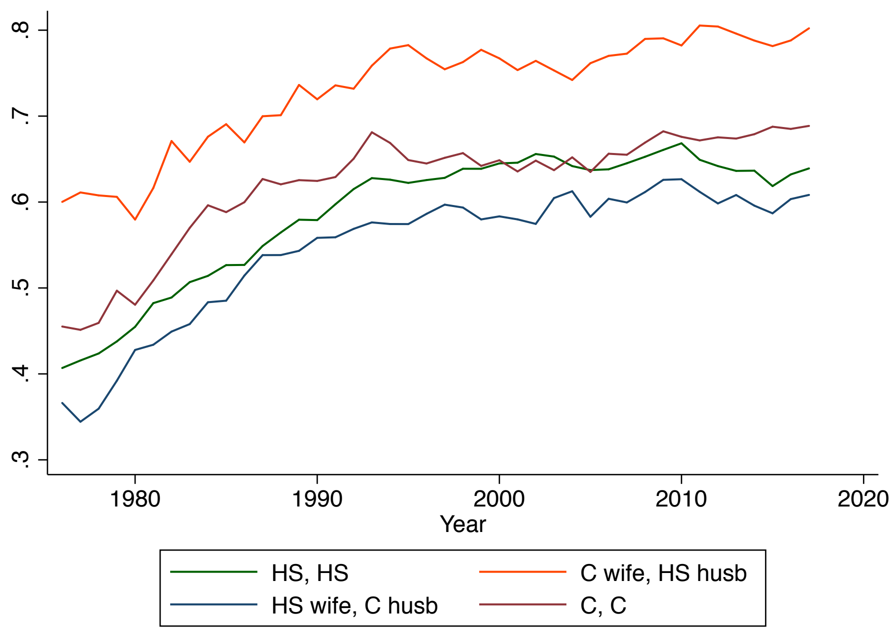


Figure 5: Evolution of labor force participation rates of married women by couple's education.

Note: The groups correspond to women in households with high school wife and husband (HS, HS), households with high school wife and college husband (HS wife, C husb), households with college wife and high school husband (C wife, HS husb), and households where both have college (C,C).

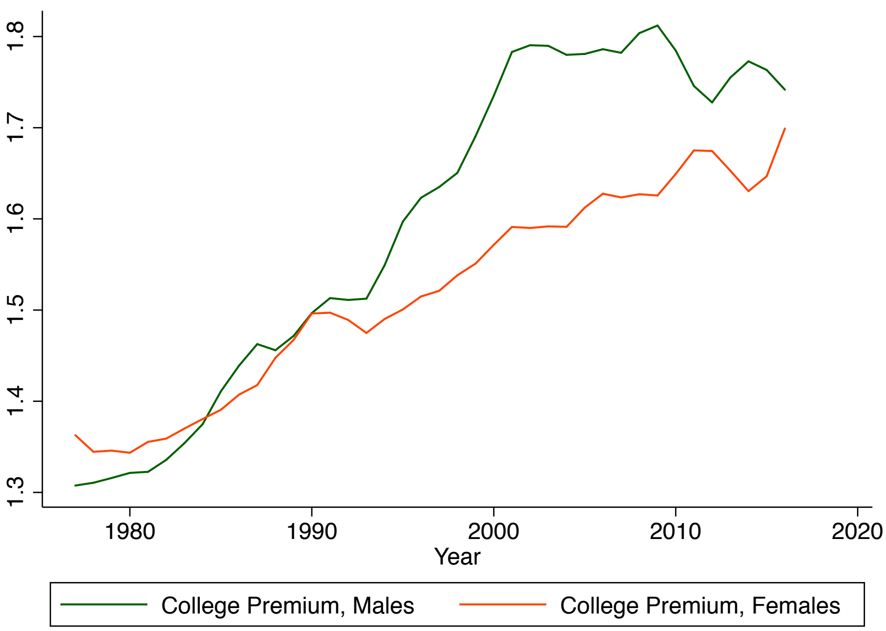
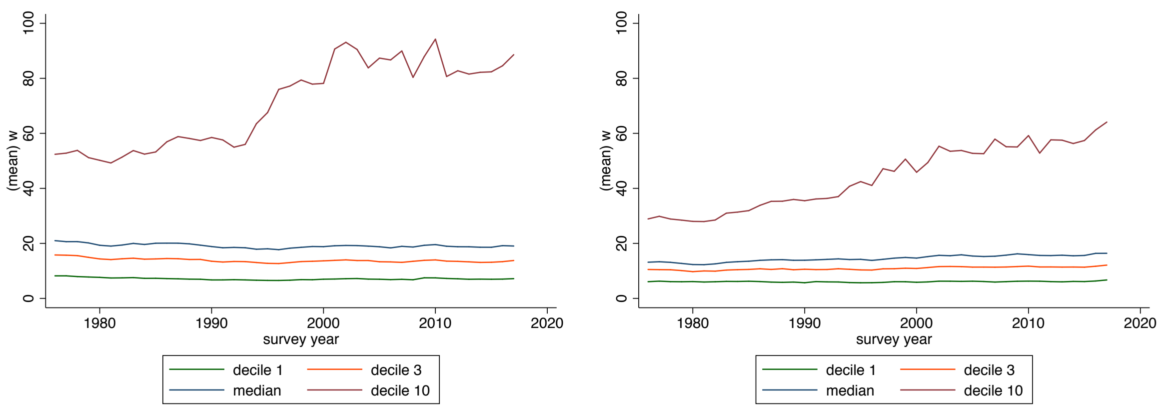


Figure 6: Evolution of skill premium by gender, full time-full year workers, regardless of marital status.

Source: March Supplement of CPS
Note: Skill premium is computed as the ratio of mean hourly wages between workers with college degree completed and those without. The data are pooled using three-year centered moving averages.

2.2.1 Real wages and male skill premium

We show that the evolution of the skill premium after the mid 1990s derives from a rise in compensation to skilled workers, as opposed to real wage loses of unskilled workers. Figure 7 shows the evolution of real average hourly wages by percentile of the wage distribution for full-time, full-year male workers (panel A) and for full-time, full-year female workers (panel B). The average real wages of male workers in the bottom half of the wage distribution fell since the beginning of the sample until the mid 1990s, and remained mostly stable since then.[6] The wages for male workers at the top of the distribution increased since the early 1990s.[7] For female workers, average wages increased over the entire sample period in most deciles, except the bottom one. The most notable change happening around the early 1990s comes from an increase in the average wages of the top earners.



(A) Male workers (B) Female workers

FIGURE 7: Real average wages of workers by deciles of the wage distribution.

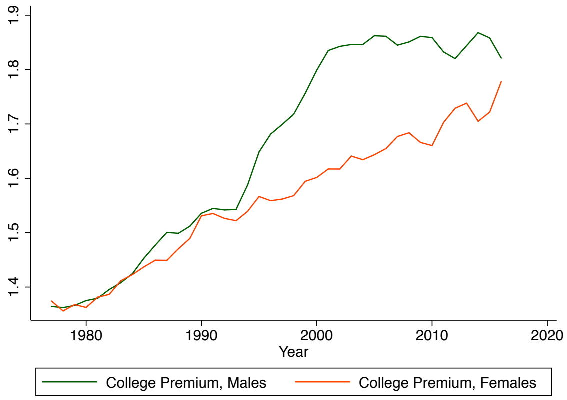
Note: 2005 US dollars. Computed for full-time, full-year workers.
Source: CPS

Skill premium by marital status

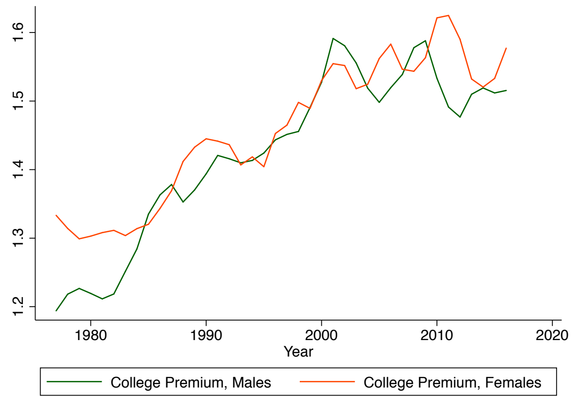
As seen in figure 6, the skill premium rose until the Great Recession, and it was always higher for male than for female workers. In particular, married male workers saw the highest growth rate in their skill premium since early 1990s. Figure 8 shows that the growth rate of the skill premium for married male workers accelerated in the early 1990s more than for married female workers. For single workers, the evolution of the skill premium seems to follow similar growth paths for both genders.

[6] The same pattern emerges when considering all workers instead of limiting the analysis to full-time, full-year workers.

[7] Autor et al. (2008) run a full analysis of trends in residual inequality during the 1980s and 1990s and find that lower-tail inequality (50/10 percentile ratio) rose sharply in the first half of the 1980s and plateaued or contracted thereafter, but upper-tail inequality (90/50 percentile ratio) increased steadily, even after adjusting for changes in labor force composition.



(A) Married workers



(B) Non-married workers

FIGURE 8: Skill premium by gender and marital status, computed as the ratio of mean hourly wages between workers with college degree and those without a college degree, for full-time and full-year workers.

2.3 Other Factors

It is important to consider changes in household characteristics or behavior in order to better understand the observed pattern in labor force participation of married women. We have shown that husband's earnings are key determinants of wives' participation in the labor force. While there has been a significant increase in dispersion of husbands' earnings, there may be other factors that also influence wives' labor force participation. In this subsection, we document the trends for several of these factors in order to rule out a major influence of any aspect other than husbands' earnings potential.

Fertility We first consider changes in fertility. Women with children are less likely to participate in the labor force, and hence increases in fertility could reduce labor force participation of married women. However, we can rule out this explanation as the only cause of the observed behavior of female labor force participation. As shown in figure 9, the decline in the growth rate of labor force participation was similar for women with and without children. Most importantly, the evolution in the labor force participation of married women depends on the characteristics of their spouse, since the decline in the rate of growth of participation was largest for women married to men in the 90th percentile of the earnings distribution, followed by those married to men in the 50th percentile and in the 10th percentile. We conclude from this pattern that changes in fertility are not the main driving force behind the observed change in participation trends.

Marriage Rates and Marital Sorting Married women represented 72.6% of the female population in 1975, and that fraction declined to 58.9% by 2008. This decline in marriage rates is driven by an increase in the fraction of never married women in the population, as the share of divorced women remained mostly stable during this period. Appendix B shows the evolution of these shares over time. With respect to the composition of the never married, Chiappori et al. (2017) show that younger cohorts of high school dropouts of both genders have shown a steep

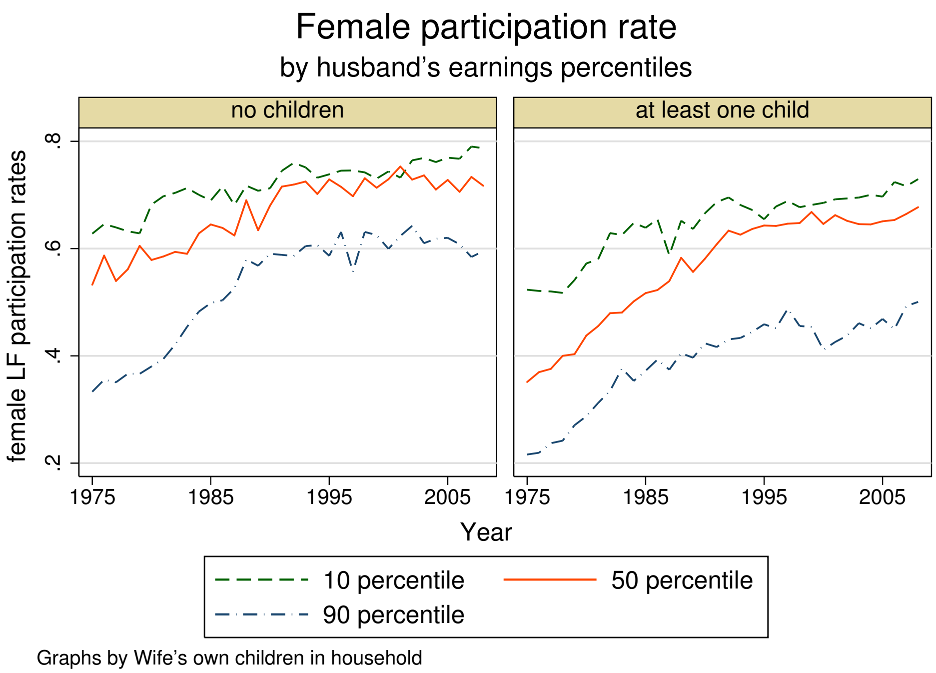


FIGURE 9: Labor force participation of married women by husband's earnings deciles and presence of children in the household

Note: The panels are divided according to whether there are any children of the wife's in the household.

decline in marriage rates compared to older cohorts, followed by high school graduates. The proportion of women born after 1967 that never married is lower for people with some college than for groups with less education.

The fraction of women in the population with college degree has increased over the entire sample period. This translates into changes of household composition in terms of education that can be seen in figure 10. The fraction of households where both partners have a college degree has increased steadily, but so has the fraction of households in which the wife has more education than the husband. The other side of this phenomenon is that now fewer men "marry down." The evidence also indicates that married women are positively selected with respect to unobservables: Eckstein et al. (2016) find that the selection of women into marriage moves from negative to positive starting with the 1965 cohort. They show that the married women of recent cohorts have higher observed and unobserved skills compared both to unmarried women and the married women of past cohorts. Taken together, the evidence suggests that there has been an increasing positive selection of women into marriage over the last several decades, which makes the deceleration in the growth of labor force participation for married women even more surprising.

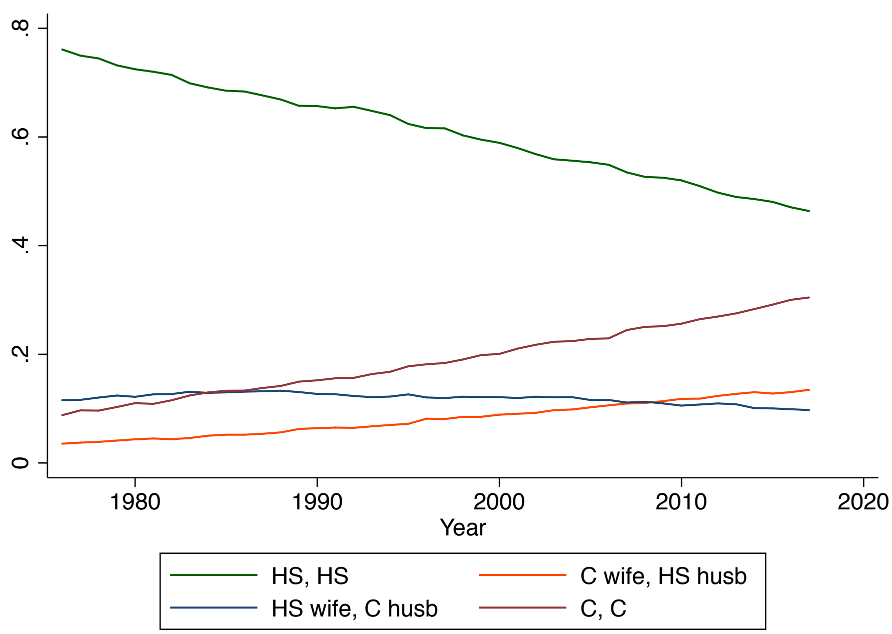
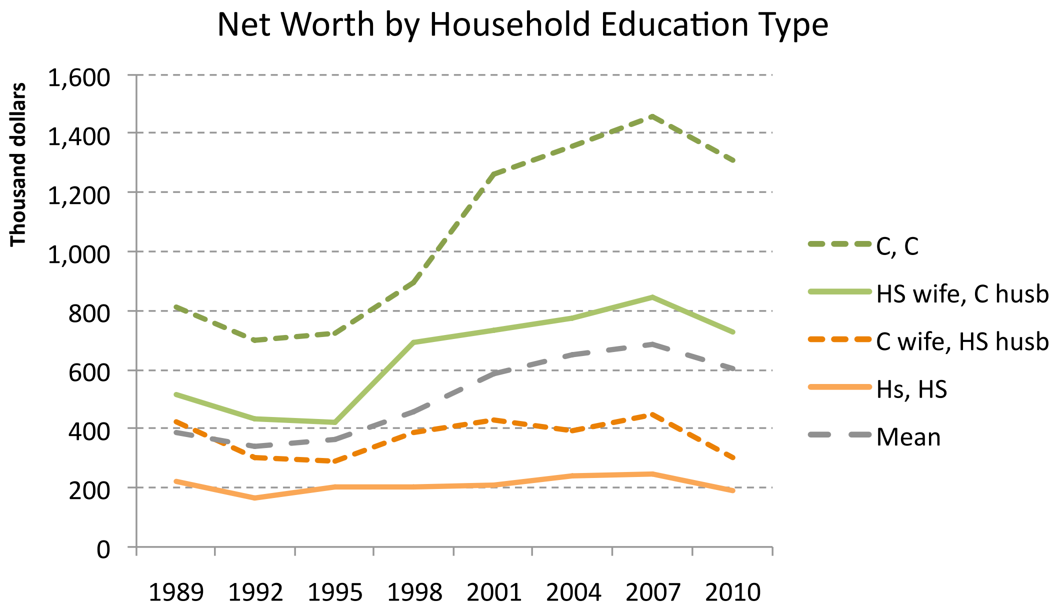


Figure 10: Fraction of households by education pairs

Note: Household type corresponds to husband-wife educational attainment.

Household Wealth Figure 11 shows the evolution of mean net worth for households by education types. It is worth noting that the only household types that display a sustained increase in net worth are those in which the husband has a college degree. In particular, asset accumulation of households where both spouses have at least college degree accelerated more than for other households since mid 1990s. The growth in net worth for households in which the husband has a college degree can be a contributing factor to the slow down in labor force participation of wives in that group.



Source: Survey of Consumer Finances

FIGURE 11: Mean Household Net Worth by Education Types

2.4 Evidence on Labor Flows

To better understand the phenomenon, we also examine the evolution of employment flows for women by household type. For this purpose, we use the PSID and examine a sample of married women selected along the same criteria as for our CPS sample. We study participation to non-participation or *exit* (E-N) flows, as well as non-participation to participation or *entry* (N-E) flows, for all married women, as well as by household type, by education, and by income percentile of the husband. The purpose of this exercise is to assess whether lack of entry or increased exit are responsible for the decline in the growth of participation.

Table 3 presents period averages of the entry and exit flows for 1984-1994 and 1995-2005 in the aggregate and by household and husband type for the married women in our sample. In the aggregate, the exit flow increased for all women from 6% to 7.3%, and the entry rate declined only modestly from 21.2% to 20.9%. Disaggregating, we find that there was a substantial rise in exit rate and decline in entry rates for college women with college husbands, as well as for all women with college husbands.

Given the aging of the population over this period and the differences in age distribution for different types of women, we also examine the effects of age on these flows. Figure 20 in Appendix B.5 reports the exit and entry flows by household type for 25-44 (core prime) year old

Table 3: Yearly transition rates between labor states for married women.

		Wife's Education			Husband's Labor Income			
		All	HS	Coll	25th	50th	75th	90th
E-N	1984-1994	0.060	0.064	0.045	0.070	0.052	0.051	0.064
	1995-2005	0.073	0.076	0.057	0.085	0.064	0.055	0.072
N-E	1984-1994	0.212	0.204	0.268	0.268	0.263	0.236	0.198
	1995-2005	0.209	0.202	0.261	0.252	0.278	0.207	0.213

		Household Type				Husband's Education	
		HS-HS	HS-C	C-HS	C-C	HS	Coll
E-N	1984-1994	0.056	0.057	0.038	0.048	0.061	0.055
	1995-2005	0.063	0.075	0.045	0.074	0.072	0.065
N-E	1984-1994	0.243	0.190	0.304	0.249	0.209	0.231
	1995-2005	0.220	0.195	0.345	0.220	0.215	0.207

Note: Proportion of women, within each subgroup of married women, who transition between states in each period. E-N: Exit flows (participation to non-participation). N-E: Entry flows (non-participation to participation). Household types: HS-HS: both spouses have high school; HS-C: high school wife and college husband; C-HS: college wife and high school husband; C-C: both spouses have college.
Source: Authors' calculations from the PSID.

women. The charts clarify that for this age group, there is a marked change in the behavior of both exit and entry rates in the mid 1990s. Specifically, exit rates start to rise while entry rates start to fall in the mid-1990s. The rise in the exit rate is most pronounced for high school women and college women with college husbands starting in the early 1990s, whereas in 2003 high school women with high school husbands also experience a rise in the exit rate. College women with high school husbands do not experience any substantial change in their exit rates over this period. Entry rates decline starting in the early 1990s, most prominently for college women with college husbands. By the early 2000s, entry rates also decline for the other household types.

To further investigate the role of age composition across groups, we calculate counterfactual flow rates by household types by changing the age distribution of each group. The resulting flow rates for the counterfactuals are shown in Appendix B.5. First, we compute counterfactual exit and entry flows by attributing high school women the same age distribution as college women. The hypothesis is that part of the difference in the behavior of flows across women of different groups is due to differences in age composition. We find that the different age composition of each skill type does not significantly affect the trends in exit and entry rates. Second, we explore the role of the changing age distribution for each group over time. As is well known, there has been generalized aging of the population, but the rate of aging likely differs by group. We compute counterfactual flow rates by using the age distribution in 1984. We find that for both flow rates and both education groups, the counterfactual rates are above the actual rates, in all periods. However, even for the counterfactual flow rates, we observe an increase in the exit rate and a decline in entry rate for college women. The effect of the change in the age distribution is most sizable starting in the early 2000s.

2.5 Quantification

To measure the differential change in growth rates in labor force participation and gender wage gaps, we estimate trends on 1975-1992 data for each of these variables, and then calculate the difference between their actual values and the ones projected based on the estimated trends for 1993-2008. For labor force participation of married women, we estimate a quadratic time trend for labor force participation by education and by household type using a probit model and controlling for age. For wages, we estimate a linear trend for the skill premium for married workers by gender. Table 4 reports the difference between the actual values of each variable for the period 1995-2005 and the predicted values, based on the estimated trend, as a measure of the change in the behavior of the variables of interest in the period 1993-2008.

The skill premium for married men in 1995-2005 was 1.86, 11 percentage points higher than predicted by its prevailing trend in the period 1975-1992, whereas the skill premium for married women, at 1.60, was only 4 percentage points higher than the predicted value. Correspondingly, the gender wage gap for college graduates was 14 percentage points higher in the data, with male/female wages at 1.46 on average in 1995-2005, then predicted from 1975-1992 behavior. Participation of married women was 61% on average during 1995-2005, while it was predicted to be 67% based on 1975-1992 data. The difference between predicted and actual values for the 1995-2005 average are higher for women with college husband than for women with high school husbands, and for women with college relative to those with high school.

Table 4: Actual and Projected Values 1995-2005

	Skill Premium		Female/Male Wages		Married Women's Participation				
	Male	Female	HS	College	Aggregate	HS Husbands	College Husbands	HS Women	College Women
Actual Average 1995-2005	1.86	1.64	1.29	1.46	0.61	0.61	0.60	0.57	0.65
Predicted Average 1995-2005	1.75	1.60	1.19	1.32	0.67	0.67	0.70	0.63	0.74
Difference between actual and predicted	0.11	0.04	0.10	0.14	-0.06	-0.06	-0.10	-0.05	-0.09
Difference between actual and predicted (as %)	6.29	2.5	8.4	10.61	-8.9	-8.9	-14.0	-9.5	-12.1

To explore the source of this divergence between actual and projected values for participation, we estimate a probit model of labor force participation of married women that allows for time dummies instead of a parametric trend, and for the effects of own education and husband's earnings to vary over time. Figure 12 shows the coefficients for dummies indicating time, college degree, and husband with earnings above the 90th percentile of the distribution.

The estimated time effects suggest that the underlying positive trend that drives female participation continues after 1992. However, after the early 1990s, both the college effect and the 'husband in the 90th percentile' effect change. The college dummy for participation dropped from an average of 0.3 in the 1980s to an average of 0.2 in the late 1990s and 2000s. The 90th percentile husband dummy always has a negative effect on wives' participation and became smaller in absolute value up until 1990, and remained stable afterwards. Therefore, both the reduction in the college effect and the discontinued attenuation of the 90th percentile effect contributed to the decline in the growth rate in labor force participation from the early 1990s onward.

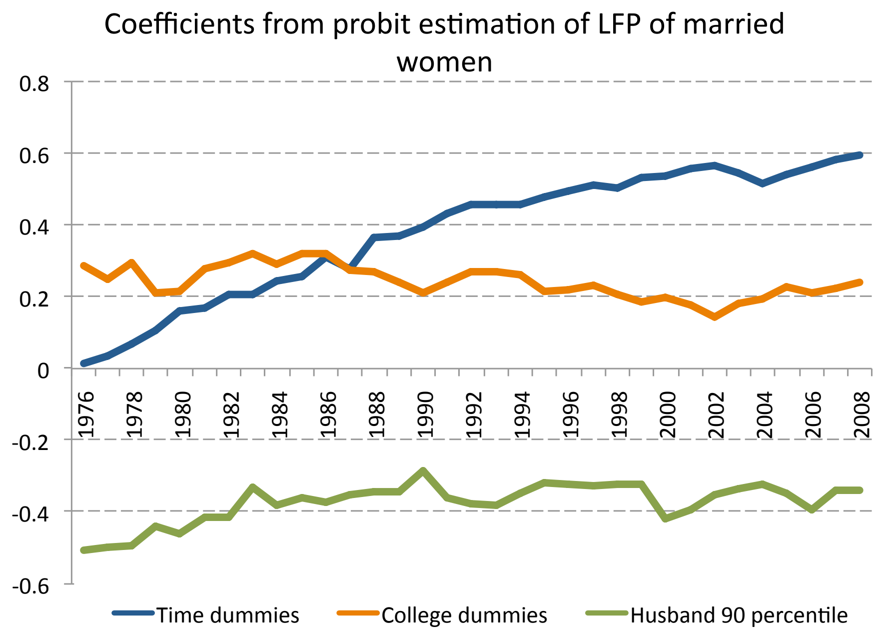


FIGURE 12: Time dummies and college and husband dummies over time from probit estimation without time trend

Note: The figure shows the coefficients corresponding to time dummies, a college dummy, and a dummy for whether husband's earnings are in the top decile of the distribution, estimated from a cross-sectional probit model of labor force participation for married women

3 Model

To quantitatively examine the impact of rising top earnings for men on the labor force participation of married women over time, we deploy a non-unitary model of household labor supply, where individuals are egoistic and have independent utility functions. We assume that the household decision-making process is cooperative, so that household decisions are Pareto efficient.[8]

There is a continuum of measure one of individuals, divided equally by gender, and organized in exogenously formed couples comprised of one man and one woman. Each individual draws a permanent productivity value θ^i from distributions that vary by gender. We consider two possible - exogenously given - education levels: less than college (we call this category high school), and college degree or more (we call this category college). Therefore, there are four kinds of households defined by the skill level of the partners: $j \in J = \{hs-hs, hs-coll, coll-hs, coll-coll\}$ (measure μ_e over the set J of household types, so that $\sum_0^1 \sum_0^1 \mu_e (e_m, e_f) = 1$). We take the evolution of μ_e over time as exogenous.

Partners make independent labor supply and consumption decisions but share a common budget constraint. The model allows for human capital accumulation in the form of learning by doing, through cumulative past work experience, and human capital is subject to depreciation. This im-

[8]The model is a particular case of the collective labor supply framework in Chiappori (1992), where we assume a fixed household welfare function and bargaining weights for all households, whereas in Chiappori's general case, the household welfare function is allowed to depend on wages and endowments.

plies that workers lose skills when they are not employed, but gain skills when employed. The wages depend on the exogenous level of education and on the endogenous level of human capital. Human capital is accumulated according to past work experience, following Imai and Keane (2004). We assume an exogenous component to the gender wage gap for high school workers entering the labor market, though the resulting gender wage gap in the model is endogenous and depends on workers' labor supply choices. Similarly, there is an exogenous component of the skill premium, which does not depend on gender. The equilibrium value of the skill premium depends on lifetime labor supply and will vary by gender.

An individual in household i is indexed by gender $s = m, f$ and age $j = 1, .., J$. Individuals derive utility from consumption, $c_j^{i,s}$, and disutility from hours worked. Individuals in the household allocate their time to market work, $l_j^{i,s}$, home production, $h_j^{i,s}$, or both. Each household must meet a required level of home production H_j by spending time producing the home good. The required level of home production varies along the lifecycle to reflect time requirements of child rearing. Labor force participation, $p_j^{i,s}$, is subject to a minimum market hours restriction:

$$l_j^{is} = \begin{cases} 0 & if\, p_j^{i,s} = 0 \\ \geq \underline{l} & if\, p_j^{i,s} = 1 \end{cases} \tag{1}$$

The variable $\underline{l} > 0$ denotes a minimum level of hours worked required for participating workers.

Individual labor earnings at time t, denoted with $y_{j,t}^{i,s}$, are a function of hours worked, a worker's stock of human capital ($k_{j,t}^{i,s}$), their intrinsic productivity ($\theta^{i,s}$), the time-dependent gender specific wages for workers without a college degree, w_t^s, as well as a worker's education. That is:

$$y_j^{i,s} = \theta^{i,s} k_j^{i,s} w_t^s l_j^{i,s} [\xi_t^s \mathbb{1}^{i,s}{}_C + (1 - \mathbb{1}^{i,s}{}_C)1] \tag{2}$$

where $\xi_t^s > 1$ is the exogenous component of the skill premium at time t, and $\mathbb{1}^{i,s}{}_C$ is an indicator variable for individuals with a college degree. We allow $w_t^f < w_t^m$ to capture gender discrimination and other factors reducing hourly wages of female workers of all education levels compared to male workers. We also allow the exogenous component of the skill premium to vary by gender. However, the gender wage gap will depend on cumulated work history, through its effect on human capital, which accumulates according to the following law of motion:

$$k_{j+1}^{i,s} = (1 - \delta)\, k_j^{i,s} + A \left(l_j^{i,s} \right)^{\alpha} k_j^{i,s} \tag{3}$$

with $\alpha \in (0, 1)$. The variable $\delta \in (0, 1)$ is the depreciation rate.

Since $w_t^f < w_t^m$, on average women will work fewer hours than men and will accumulate less human capital, amplifying the gender wage gap relative to the exogenous component. However, in individual households with $\theta^{i,f} - \theta^{i,m} > 0$ and sufficiently large, in which spouses have the same level of education, wives may have higher cumulated market hours and earn higher wages than husbands.

The utility of the household i in period j is a weighted average of the individual utilities:

$$u\left(c_j^{i,f}, c_j^{i,m}, l_j^{i,f}, l_j^{i,m}, h_j^{i,f}, h_j^{i,m}\right) = \lambda^f u\left(c_j^{i,f}, l_j^{i,f} + h_j^{i,f}\right) + \lambda^m u\left(c_j^{i,m}, l_j^{i,m} + h_j^{i,m}\right)$$

A household of type i solves the following problem. It maximizes the discounted present value of its future utility, as a function of consumption and hours worked at home and in the labor force:

$$max_{c_j^{is}, h_j^{is} \geq 0, l_j^{is} \geq \underline{l}, p_j^{i,s} \in \{0,1\}, b_{j+1}, k_{j+1}^{i,s} \geq 0} \sum_{j=1}^{J} \beta^j \sum_{s=f,m} \lambda^s u\left(c_j^{i,s}, l_j^{i,s} + h_j^{i,s}\right)$$

subject to (1), (2), (3) for $s = f, m$, its budget constraint:

$$\sum_{s=f,m} c_j^{i,s} + q b_{j+1} \leq \sum_{s=f,m} y_j^{i,s} + b_j \text{ for } j = 1, 2, ...J-1$$

the home production requirements:

$$H_j = G(h_j^f, h_j^m) \tag{4}$$

the don't-die-in-debt constraint:

$$\sum_{s=f,m} c_J^s \leq b_J$$

$$b_{j+1} \geq \underline{\mathrm{b}}_j \text{for } j = 1, 2, ...J-1$$

and the initial condition for human capital:

$$k_0^s = \overline{k^s}.$$

We assume the following functional form for the individual utility function of individual of gender s in household i and period j:

$$u\left(c_j^{is}, l_j^{is} + h_j^{is}\right) = \frac{\left(c_j^{is}\right)^{1-\sigma}}{1-\sigma} - \phi^s \frac{\left(l_j^{is} + h_j^{is}\right)^{1+\frac{1}{\gamma^s}}}{1+\frac{1}{\gamma^s}}$$

with σ, $\phi^s, \gamma^s > 0$ for $s = f, m$. This allows average work hours to differ by gender, via the parameter ϕ^s. The Frisch elasticity of labor supply can also vary by gender, via the parameter γ^s.

We adopt the following specification for the home production function:

$$G(h^f,\, h^m) = \left[\psi^f \left(h^f\right)^\rho + \psi^m \left(h^m\right)^\rho\right]^{1/\rho}$$

with ρ, $\psi^s \in (0,1)$ for $s = f, m$, $\sum_s \psi^s = 1$. Given the assumptions on ρ, ψ^s, home hours are always interior for both spouses.

3.1 Qualitative Properties

The qualitative properties of the model can be derived from the solution to the household problem. The first order necessary conditions for the household problems are reported in Appendix C.

First, for any age j, we obtain:

$$\lambda^f u_{c,j}^f = \lambda^m u_{c,j}^m$$

where we have dropped the household index i to simplify notation. Given the separability in the utility function between consumption and hours worked, implies a constant ratio of consumption across partners, and equal consumption if $\lambda_f = \lambda_m$.

The labor choice problem allows for income effects at the household level, so that a change in a partner's labor income affects the other's labor supply decisions. The income effects on labor supply can can be analyzed from the first order necessary condition for participation and market hours, captured in equations (5) and (6) below. For $s = f, m$, $p_j^s = 0$ for:

$$\beta^j \lambda^s u_{l,j}^s (\underline{l} + h_j^s) + \beta^j \lambda^s u_{cj}^s \xi_j^s + \nu_j^s A\alpha \left(\underline{l}\right)^{\alpha-1} < 0 \tag{5}$$

Instead, $p_j^s = 1$ for for $l_j^s \geq \underline{l}$, for $j = 1, 2, ..., J-1$, if:

$$\beta^j \lambda^s u_{l,j}^s + \beta^j \lambda^s u_{cj}^s \xi_j^s + \nu_j^s A\alpha \left(l_j^s\right)^{\alpha-1} = 0 \tag{6}$$

Because of the non-convexity in labor supply, that is $\underline{l} > 0$, labor force participation is zero if own wage is sufficiently low. Additionally, for given female wages, the marginal utility of consumption is lower in a household with higher male earnings or higher household wealth, making it more likely that wives will not participate. Even if wives participate, they will choose lower levels of market hours in households with high male wage or high household wealth. This is the key property driving the mechanism we want to capture. Household wealth is an important determinant of labor market decisions of the secondary earner, and it depends positively on partner's labor income. Therefore, a rise in the partner's labor income can cause market hours to drop and eventually participation to go to zero.

Given our assumptions on ρ and ψ^s, home hours will be interior and solve:

$$\frac{\lambda^f u_{l,j}^f}{G_{h_j^f}} = \frac{\lambda^m u_{l,j}^m}{G_{h_j^m}} \tag{7}$$

Equations (7) and (4), can be used to solve for h_j^s for $s = f, m$ for given l_j^s. It follows that, if wives have a comparative advantage in home production, either from relative productivity in the home production function, $\psi^f > \psi^m$, or because the husband market wage is higher than the wife's, she will choose higher home hours. Higher homes hours increase the marginal disutility of labor for the wife, making it less likely that she will participate for given own and husband's wage.

Lastly, from a dynamic point of view, the existence of returns to experience and human capital depreciation help generate diverging earnings paths for the primary and secondary earner. There's a high return for staying in the labor force, but for those who exit, there is permanent decline in earnings, which generate persistence in the non-participation state.

4 Quantitative Analysis

We calibrate the model to match statistics on aggregate participation, skill premia, gender wage gap by education, within household female/male market hours ratio in 1980. Then, we examine the effect of the rise in the skill premium on female participation and wages and other outcomes. To do so, we simulate two experiments. The first counterfactual experiment assumes that the economy is in a stationary allocation corresponding to the 1980 calibration and the exogenous component of the skill premium increases to match the average skill premium in the data in 1995-2005. We then compare the stationary allocation corresponding to this higher value of the skill premium to the original allocation. This steady state experiment provides an initial assessment of the role of the higher skill premium in the model, however, it is not realistic as the pre-1993 economy was not stationary, on the contrary was characterized by increasing female participation.

This motivates our second and main experiment in which we simulate a full transition. Specifically, we simulate the model from 1965 to 2005 adjust the disutility of labor for women to match participation for the period 1965-1990. We introduce the new process for the skill premium starting in 1995 and compare the simulated model to a version of the simulation in which the process for the skill premium remains at pre-1995 values. The results from the transition experiments largely confirm those of the steady state experiments.

4.1 Calibration

We calibrate the model to match 1980 aggregate statistics on participation, skill premia, gender wage gaps by education, and the within household female/male market hours ratio. We select some parameters directly from the data or from independent evidence and determine the remaining parameters to match model moments to the data.

We assume the four stages in life correspond to the to following age brackets: 25-39, 40-54, 55-69, 70-85 years old. Individuals work until age 69, and exogenously retire at age 70 (the intrinsic productivity of individuals ages 70 to 85 drops to zero). We set the fraction of households in each education type (husband-wife: college-college, high school-college, college-high school, high school-high school) to match empirical values in 1980, reported in Table 5. We assume the intrinsic individual productivities are drawn from a gender-specific log-Normal distribution: $\theta^s \sim logN(\bar{\theta}, \sigma^s)$ for $s = f, m$.

Table 5: Household Type Distribution

	Distribution of household types			
husband-wife	$hs - hs$	$c - hs$	$hs - c$	$c - c$
1980	73%	12%	4%	11%

The parameters that we set based on independent evidence are reported in Table 6. We set the exogenous gender wage gap for unskilled workers based on Albanesi and Olivetti (2009). In addition, we set the parameters for the human capital accumulation function based on Imai and Keane (2004) for both men and women.[9] We also set $\gamma^f = \gamma^m$ based on the estimated Frisch labor supply elasticity in Imai and Keane (2004). This implies that men and women have the same Frisch elasticity in the model, where empirical evidence suggests that women have higher elasticity, though there has been convergence over time (Blundell and MaCurdy, 1999; Keane, 2011). This is a conservative assumption and will dampen the response of women's labor supply to changes in wages.

We estimate total household-level home hours by age from the PSID and set H_s/H_1 based on these estimates, and then pin down H_1 as described below.[10] We estimate ρ from home hours by gender and gender wage gaps in the aggregate data using the first order necessary condition for the optimal allocation of home hours in equation (7). Finally, we set w^f/w^m equal to 0.9, corresponding to an unexplained gender wage gap of 10% (Blau and Kahn, 2017).

Table 6: Parameters From Independent Evidence

Preferences	$\sigma = 1.1$	$\beta = 0.978^{15}$	$\lambda^f = 0.5$
Home production	$\psi^f = 0.5$	$\rho = 0.65$	$\{H_2, H_3\} = \{1.018, 1.031\}\, H_1$
Human capital	$\delta = 0.2$	$A = 0.2$	$\alpha = 0.75$
Labor market	$\gamma^f = 3.82$	$\gamma^m = 3.82$	$w^f/w^m = 0.9$

We calibrate the remaining parameters, reported in Table 7, to match population moments in 1980 using a minimum distance approach. Specifically, we set the variance of the distribution of $\theta^f and \theta^m$ to match the dispersion of earnings by gender; $\phi^f and \phi^m$ to match the level of participation by gender, and we set H_1, the home hours requirement in the first stage of life, to match the aggregate ratio of market to home hours in the data.

Table 7: Parameters Calibrated to Match 1980 Population Moments

Utility		Home Production	θ distribution	
ϕ_t^f	ϕ_t^m	H_1	σ^m	σ^f
0.169	0.142	2.74	0.48	0.35

As shown in Table 8, the model matches participation rates and the dispersion in the earnings distribution by gender very well, though it somewhat over predicts the ratio of market to home hours in the data.

[9] The Imai and Keane (2004) are obtained from a sample of men only.

[10] The data on home hours is taken from the PSID, as reported by Albanesi and Olivetti (2009). While the measure of home hours in the PSID is imperfect (respondent reports about hours of home work for self and spouse, no time diaries are used), it is the best measure available for this period in time, as the American Time Use Survey starts in 2003.

Table 8: Data/Model Comparison

1980	Data		Model	
	Women	Men	Women	Men
Participation	0.44	0.86	0.44	0.86
Coeff. var. earnings distribution	1.34	0.84	1.34	0.84
Market/home hours	0.922		1.23	

Table 9: Response of Participation by Household Type

	Married Women's Participation by Household Type			
Husband-Wife	High School-High School	High School-College	College-High School	College-College
Calibrated model	Difference between model using 1995-2005 skill premium and baseline model			
Percent	0	-16.8	8.1	-7.3
Data	Average 1995-2005: Difference between actual and pre-1995 projection			
Percent	-10	-17	-8	-17

4.2 Experiment 1: Stationary Allocations

To assess the impact of the rise in the skill premium on female participation, we first perform a steady state experiment. That is, we presume the allocation is stationary at 1980 values and we increase the exogenous component of the skill premium so that it matches 1995-2005 values and examine the impact on model outcomes. We assume that there are no other changes to model parameters and that the new value of the skill premium persists indefinitely. This amounts to comparing to versions of the model, one with a pre-1995 skill premium and one with a 1995-2005 skill premium. To match the average skill premium in 1995-2005 by gender, we increase ξ_j^s for $j = f, m$. The results from this exercise are displayed in Tables 9-11.

Table 9 reports the response of female participation by household type. By construction, there is no response in participation of high school women married to high school husbands, as their potential wages are not affected by a change in the skill premium. The decline in participation in the model is greatest for high school women with college husbands, as in the data. However, participation of college women with high school husbands rises, contrary to the data. This is because the rise in the skill premium encourages college women to increase their labor supply in the model. For those married to college husbands, this effect is offset by the rise in labor supply and income of their husbands, leading to an overall decline in their participation, consistent with the empirical evidence. Instead, for those married to high school husbands, there is no counteracting effect. The magnitude of the response in participation is sizable. For high school wives married to college husbands, participation declines by 17% as in the data. For college women married to college husbands, participation declines by 7% whereas it declines by 17% in the data. By contrast, for college women married to high school husbands, participation rises by 8% in the simulation, while it declines by 8% in the data.

Table 10 reports the results by the wives' own education and by husbands' education separately. For high school wives, participation drops in the aggregate by 3.1% in the model, while it drops by 9.5% in the data. For college wives, participation drops by 2% in the model, while it drops by 12% in the data. For all wives married to high school husbands, participation rises by 1.3% in the model, whereas it falls by 9% in the data. For all wives married to college husbands, participation drops by 10.3% in the model, while it drops by 17% in the data.

Overall, the model captures 60% of the drop in labor supply of women with college husbands observed in the data. It also accounts for 40% of the drop in labor supply of college women with college husbands in the data. The model cannot match decline in participation of high school women with high school husbands. This is in part due to aging of the population in the data, and this factor is excluded from the model. The model is also unable to reproduce the decline in participation of college women with high school husbands. This factor may be due to in part to aging of the population and in part to changing selection for this group in the data.

Table 10: Response of Participation by Own and Husband's Education

	Married Women's Participation By Education			
	High School Wife	College Wife	High School Husband	College Husband
Model	Difference between model using 1995-2005 skill premium and baseline model			
percent	−3.1	−2	1.3	−10.3
Data	Average 1995-2005: Difference between actual and pre-1995 projection			
percent	−9.5	−12	−9	−17

Table 11 reports the response of wages and skill premia by gender. As we see in the data, the skill premium rises more for men then for women and the male/female wage ratio rises more for college workers than for high school workers. Thus, the qualitative response of these variables is in line with the data, though the magnitudes are more muted. The male skill premium rises by 2.52 times more than the female skill premium in the data, while it rises 2.27 times more in the model. The male/female wage ratio for high school workers rises by 8.4% in the data but declines by 1.3% in the model. The male/female ratio for college workers rises by 10.6% in the data but only 5.9% in the model.

Table 11: Response of Wages

	Skill Premium		Male/Female Wages	
	Male	Female	High School	College
Model	Difference between model using 1995-2005 skill premium and baseline model			
percent	25	11	−1.3	5.9
Data	Average 1995-2005: Difference between actual and pre-1995 projection			
percent	6.3	2.5	8.4	10.61

To summarize, the model predicts a large drop in the labor supply of women with college husbands in response to the rise in the skill premium, approximately 60% of the one observed in the data. The model can also produce a large drop in labor supply of women in college-college households, approximately 40% of the drop observed in the data. The model predicts that the rise in the skill premium for men larger than for women, and generates a rise in the male/female wage ratio that is higher for college workers than high school workers, as in data. However, the wages responses are considerably more muted than in the data. We will discuss the factors absent from the model that could potentially account for these discrepancies more in detail in Section 4.4.

4.3 Experiment 2: Transitional Simulation

The second experiment takes into account the transitional nature of the time period we consider. Since before the early 1990s the participation of married women was on a steep upward rise, we simulate that transition and the response to the rise in the skill premium in the subsequent period. To do so, we simulate the model every 5 years between 1965 and 2005, and examine the lifetime behavior of cohorts who are 25-39 in each simulation year. To capture the rise in participation between 1965 and the early 1990s, we allow for a stable decline in ϕ^f, to capture the forces imparting an upward trend to female labor supply for this time period. Some examples that have been considered in the literature include the availability of oral contraception (Goldin and Katz, 2002), the diffusion of home appliances (Greenwood et al., 2005), cultural factors (Fogli and Veldkamp, 2011; Fernandez, 2013), and the improvement in maternal health (Albanesi and Olivetti, 2016). The rate of decline in ϕ^f is calibrated to match aggregate participation of married women between 1965-1995, and is then projected forward to 2005, under the assumption that these forces did not stop operating after 1990. The simulations also use empirical estimates of unskilled wages by gender throughout the simulation period. These are taken as given by households who are assumed to have perfect foresight. The rise in female labor supply along this transition also causes a decline in the gender wage gap, as the resulting increase in women's cumulated work history increases their human capital.

We simulate two versions of the model, one in which the process for the skill premium is held constant for the entire simulation period, and one in which it unanticipatedly switches to the post-1995 process in 1995. Couples who in 1995 are in stage 2 and 3 of their life will re-optimize their labor supply choices based on the new process for the skill premium. Table 12 reports the skill premium parameters for the simulation. In each period, there are two components of the process for the skill premium, the level and the projected growth factor. The level determines the value of the skill premium in a given year, while the growth factor determines its evolution over time. When college educated individuals in the model make labor supply choices in each stage in life, they take into account the current value of the skill premium and its future evolution, determined by the growth factor, under perfect foresight. Higher future growth in the skill premium increases the gains from increasing their market hours for college workers in the current period. Both the level and the growth factor for the skill premium pre- and post-1995 are estimated from the data. Specifically, we estimate a process for 1965-1990 and a separate process for 1995-2005. Our estimates suggest both the level and the growth factor for the skill premium grew in the post-1995 period.

Table 13 reports the response of female labor force participation by household type. As in the previous experiment, participation drops most relative to the pre-1995 trend for women with college husbands. For high school wives with college husbands, participation drops by 12% in the model and 17% in the data. For college women married to college husbands, participation drops

Table 12: Variation in Skill Premia: Data and Parameters

Skill Premium						
1980	Level	ξ^f	0.572	ξ^m	0.662
pre − 1995	Trend (5 year growth factor)	F	1.036	M	1.054
1995	Level	ξ^f	0.74	ξ^m	0.80
post − 1995	Trend (5 year growth factor)	F	1.037	M	1.06

by 4% in the model and by 17% in the data. Participation rises for college women with high school husbands, contrary to data, as these women respond positively for the rise in the skill premium. By construction, participation does not respond for high school women married to high school husbands.

Table 13: Response of Participation by Household Type

Married Women's Participation: 1995-2005 Average by Household Type				
Husband-Wife	High School-High School	High School-College	College-High School	College-College
Model	Difference between actual and pre-1995 projection			
percent	0	−12	7	−4
Data	Difference between actual and pre-1995 projection			
percent	−10	−17	−8	−17

Table 14 reports the response of wages and the skill premium by gender. The simulation captures small fraction of the gender divergence in the skill premium and of the slowing convergence in wages by gender for skilled workers. As in the data, the male/female wage ratio rises more for college workers than for high school workers. But in the model, the skill premium for female workers rises more than for male workers due to the increases in labor supply of college women with high school husbands.

Table 14: Response of Wages and the Skill Premium by Gender

	Skill Premium		Male/Female Wages	
1995-2005 Average	Male	Female	High School	College
Model	Difference between actual and pre-1995 projection			
percent	14.6	16	1.0	2.6
Data	Difference between actual and pre-1995 projection			
percent	11.4	9.2	8.4	10.61

4.4 Discussion

Overall, our quantitative analysis suggests that income effects from the growth in top earnings for married men starting in the early 1990s exerted a sizable negative impact on the labor supply of their wives, leading to a reduction in their labor force participation and wages. This mechanism disproportionately affected married women with a college degree, due to positive assortative matching. However, our model cannot capture the reduction in the growth rate on labor force participation of women married to husbands with a high school degree– a smaller but still notable phenomenon. One factor we abstract from in our quantitative analysis is demographic change. As is well know, the working age population has been getting older, due to declining birth rates and increasing longevity. Women with high school education married to husbands who also have high school education are on average older than women in other types of households and part of the decline in their labor force participation may be driven by this effect. Krueger (2017) estimates that about 1/3 of the decline in labor force participation since the mid-1990s may be attributable to this factor, and it applies to both men and women. In addition to demographics, Abraham and Kearney (2020) find that increased import competition from China and the penetration of robots into the labor market are important factors reducing labor demand, while increased participation in disability insurance programs has played a smaller role in reducing labor supply, for prime age workers without a college degree. Another determinant may be changing selection of high school workers. As college graduation rates have increased, abilities of individuals without a college education have decreased (Hendricks and Schoellman, 2014), which may have reduced participation for those workers.

Selection may also be a factor in the decline in participation of women with a college degree married to high school husbands. While marital sorting is typically measured on observable characteristics such as education, evidence suggests positive assortative matching may occur on unobservables (Hryshko et al., 2017). If unobservable traits are correlated with educational attainment, college women married to high school husbands may be negatively selected relative to those married to college husbands, while high school men married to college wives may be positively selected relative to those married to high school wives. This may lead to a higher incidence of relatively high earnings for high school husbands married to college wives, compared to those with high school wives, and, conversely, lower incidence of high earnings for college wives married to high school husbands compared to those married with college husbands. This pattern could contribute to an observed behavior of college women married to high school husbands more similar to those of college women married to college husbands. Since marriage and marital sorting are exogenous in our framework, we do not explore this channel.

The model also fails to quantitatively capture the extent of the gender gap in the rise of the skill premium. The more muted response of gender differences in the skill premium and in wages for college workers may be due to the fact that our model abstracts for gender differences in the accumulation of human capital by gender, by assuming that the parameters governing the accumulation and depreciation of human capital are the same for men and women. In practice, gender discrimination in top professional and managerial positions (Albanesi et al., 2015) and discontinuities in human capital depreciation associated to spells on non-participation (Adda et al., 2017) may reduce the rate of accumulation of human capital and increase depreciation rates for women with a college degree compared to men. Additionally, the *motherhood penalty*–that is the negative effect on women's earnings resulting from having children– may play a sizable role (Kleven et al., 2019; Cortes and Pan, 2020). The penalty has a negative impact on both earnings conditional on observable characteristics, such as education, occupation and hours, and also influences the sorting of women into education and occupation groups, even before they have children. Finally, there has been growing dispersion of earnings for workers with college degrees (Autor, 2014; Hershbein et al., 2020). This growing dispersion may drive part of the gender differences in measured skill premium, if women are still underrepresented in the occupations and positions that have tended to exhibit the fastest growth in earnings.

5 Concluding Remarks

This paper examines the factors behind the discontinued growth of married women's labor force participation and the lack of convergence in wages by gender since the early 1990s in the United States. We show that the phenomenon is mainly driven by a decline in participation of women married to college educated or high income husbands. We posit that the mechanism driving this pattern is the sharp rise in the skill premium and top earnings for men in the early 1990s. Our hypothesis is that the growth in wages for highly educated men generated a negative income effect on the labor supply of their female spouses, reducing their participation, market hours and their wages relative to men. To evaluate this hypothesis, we develop a model of household labor supply that generates this prediction and is consistent with evidence on the behavior of skill premia and wages by gender. A calibrated version of the model accounts for more than half of the decline relative to trend in married women's participation in 1995-2005, and more than two thirds of the decline for college women. The model can also account for one third of the rise in the gender wage gap for college graduates relative to trend in the same period.

Other factors could also be jointly contributing to the decline in the growth rate of participation, particularly for married women with a college degree. Ramey and Ramey (2009) argue that the increase in the skill premium increased the competitiveness of college admissions in the 1990s, causing a rise in the time parents of teenage children spend with them. The additional time demands on parents of teenage children would be greatest for those households who intend to send their offspring to college, and therefore be concentrated among high income/high education parents. If husband's income and/or household wealth is high enough, mothers who are secondary earners would be expected to reduce their labor supply to meet these additional needs.

Another factor potentially playing a role is changes in income taxes. The Tax Reform Act of 1993 created a 36% and 39.6% marginal tax bracket for filers, increasing marginal taxes on top earners and effectively reversing the 1980s tax reforms that reduced top marginal rates in the United States. Eissa (1996) and Eissa (1995) find that the 1980s reforms contributed to the rise in married women's participation over that period. Top marginal tax rates disproportionately affect married women as they tend to be secondary earners and married couples are taxed at a rate that depends on their joint income. Many European countries have higher marginal tax rates than the United State, however, married individuals are taxed separately, so that their marginal rate does not depend on their marital status or their spouse's income. Bick and Fuchs-Schündeln (2017) evaluate the effects of taxing married women at the same rate as single women with the same wage, by switching to a system of separate taxation from joint taxation in a number of European countries and find that it would lead to a substantial increase in married women's labor supply.

Guner et al. (2012) evaluate the quantitative implications of taxing women at a lower rate than men in the United States, and find that setting lower taxes on women increases output and female labor force participation. Bick and Fuchs-Schündeln (2018) quantify the contribution of international differences in non-linear labor income taxes and consumption taxes to the international differences in hours worked in the data. They find that taxes, together with wages and the educational composition, account for a significant part of the small differences in married men's and the large differences in married women's hours worked in the data. Taken together, the evidence suggests that the rise in marginal income taxes starting in 1993 may have contributed to a decline in the growth rate of participation of married women, particularly those in higher income households. However, the 1993 reform was effectively reversed in 2001 and 2003, when the top four marginal tax rates were reduced by 3-4.5 percentage points. This did not lead to a resumption in the growth in labor force participation of married women, particularly at the top of the education and income distribution, suggesting that the 1993 reform did not play a pivotal role in the change in the trend for married women's participation.

The link between rising incomes at the top for men and flattening participation of married women is based on a simple economic mechanism that we expect to hold in other countries. Many advanced economies have experienced an acceleration in the growth of top earnings and the skill premium, and it is instructive to consider the joint behavior of female participation in those countries. The international evidence suggests that income effects may play a role in the participation of married women and should be considered when examining questions related to labor market performance by gender and household level inequality.

Figure 13 reports data on the labor force participation rate of prime age women and income inequality in eight OECD economies for which the both variables are available at least since the early 1980s. As a measure of inequality, we use the ratio of income for the top 10% of the population to average income, to focus on the growth in top earnings. In addition to the United States, Australia, Canada and Sweden experience a sizable rise in income dispersion in the early 1990s. In all these countries, we observe a flattening of female labor force participation in the subsequent period. For the UK we also observe a rise in inequality in the early 1990s, and a decline in the rate of growth in female participation, but the pre-1990 data series is too short to establish the slowing trend conclusively. In Spain, a reduction in income inequality starting in the early 1990s is associated with an acceleration of the rise in female labor force participation over the same period. In Germany, earnings dispersion is stable over the sample period and participation grows at a constant rate.[11]

[11] The discontinuity in 1989 corresponds to German unification.

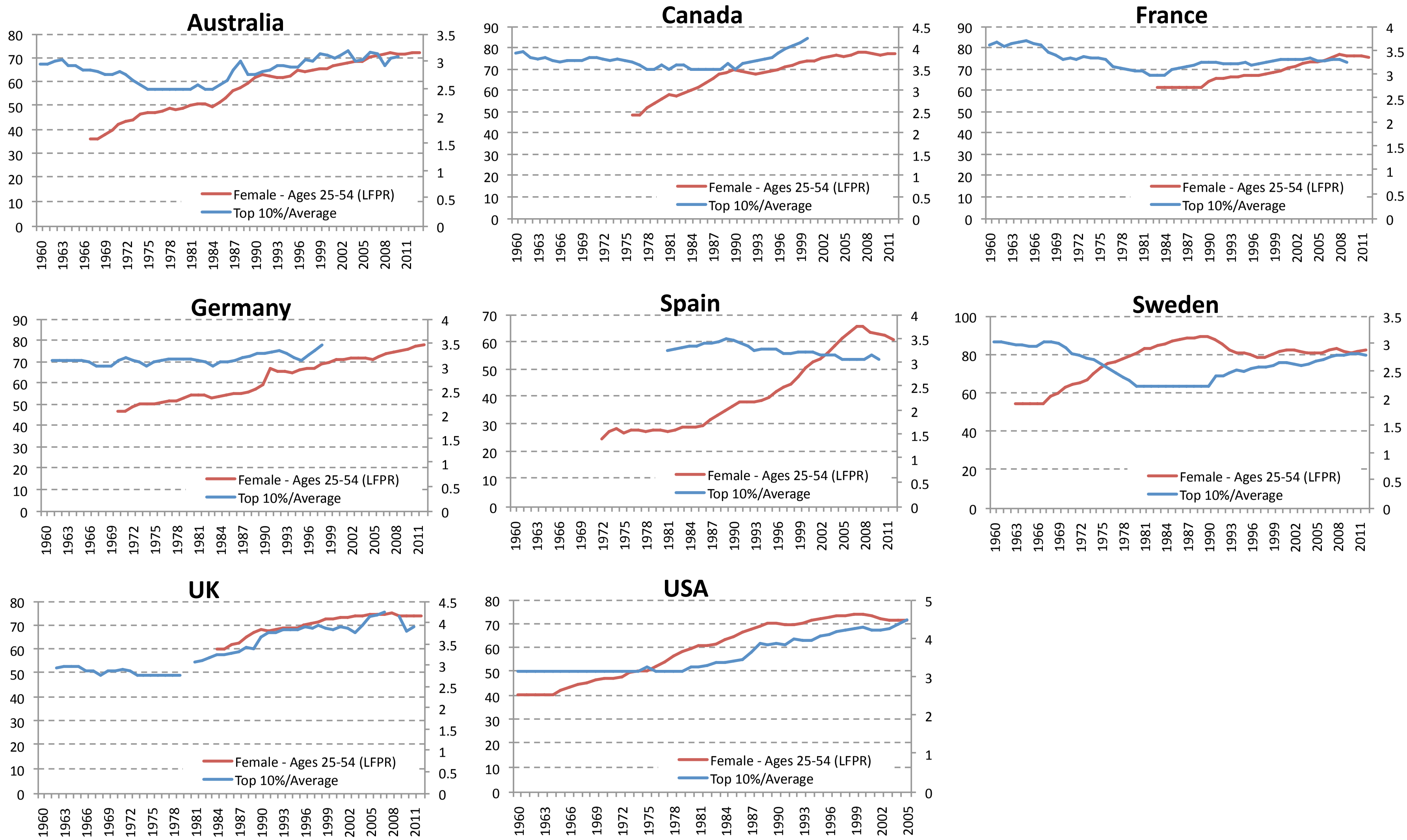


FIGURE 13: Participation and top 10%/average income ratio. Source: OECD

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Appendix A Data and sample

We use monthly waves of the Current Population Survey (CPS) from 1975-2011 and matched waves from the March Supplement of the CPS from IPUMS. The public use CPS is a large nationally representative sample of households. Our sample focuses on adults aged between 21 and 65, all races, and comprises approximately from 23,000 to 35,000 households per year (which translates into 45,700 to 70,600 observations per year).

To study different aspects of the data, we use sub-samples where we condition on marital status and work status. The *married* category includes everyone who declares to be married with spouse present. In the motivational evidence, we show monthly data on labor force participation. Elsewhere in the empirical analysis and calibration, we use a measure of labor force participation that accounts for participation in the workforce throughout the year. For this measure, we define people as participating in the labor force if they have been employed and/or actively seeking employment during at least 45 weeks that year.

We divide the population in two education categories: *high school* indicates all education levels less than college degree, and *college* includes those who obtained a college degree or higher.

Topcoding To protect the confidentiality of its respondents, the U.S. Census Bureau censors the income of individuals above specified topcoded levels in the public use March CPS data. This peculiarity of the data must be taken into account when using the CPS to address questions regarding earnings dispersion, since inconsistent topcode levels lead to artificial increases or decreases in mean incomes as different fractions of the population are subject to topcoding each year. The CPS has introduced different topcodes during the sample period, and the methodology about the treatment of topcoded observations has changed a few times. Namely, the 1990 IPUMS is topcoded at $140,000 with higher earnings amounts replaced with state medians. After 1995, instead of one uniform value for all topcoded observations, the most recent topcode categories replace topcoded earnings with average earnings across gender-race-work experience cells. These changes in methodology complicate the estimation of properties of the distribution of earnings over time. To address this concern, for surveys before 1995, we replace the topcoded values with the gender-race-work status cell means estimated by Larrimore et al. (2008). This way, we use their cell means series in conjunction with cell means provided by the Census Bureau for later years to create a complete set of cell means from 1976-2008.

Appendix B Additional empirical evidence

B.1 Skill premium

The rise in the skill premium for men is also associated with a sharp rise in earnings dispersion in the top 50% of the earnings distribution over the same period, as can be seen in figure 14. The smaller rise in earnings dispersion for women over the same period has resulted in a growing gender gap in earnings dispersion up until the 2008 recession.

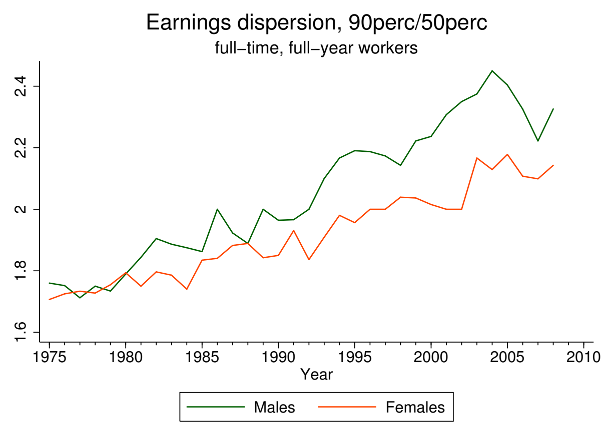

FIGURE 14: Earning dispersion at the top half of the earnings distribution, by gender.
Note: Three-year centered moving averages.

Figure 6 shows the sharp rise in the male to female ratio of the skill premium starting in 1993. Even though the male skill premium decelerated after the Great Recession (as shown in Figure 6), Figure 15 shows that the ratio of male to female skill premium after the Great Recession went down but still remains higher than its level during the 1980s and early 1990s.

B.2 Labor force participation of men

Figure 16 shows the evolution of the labor force participation by gender. There is a decline in male labor force participation rates since the beginning of the sample until the mid 1990s, and it

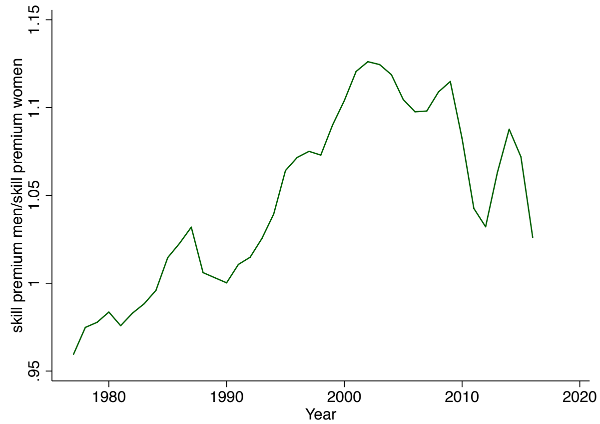

FIGURE 15: Evolution of male to female skill premium ratio, full time-full year workers, regardless of marital status.

Source: March Supplement of CPS
Note: Skill premium is the ratio of mean hourly wages between workers with college degree completed and those without. The data are pooled using three-year centered moving averages.

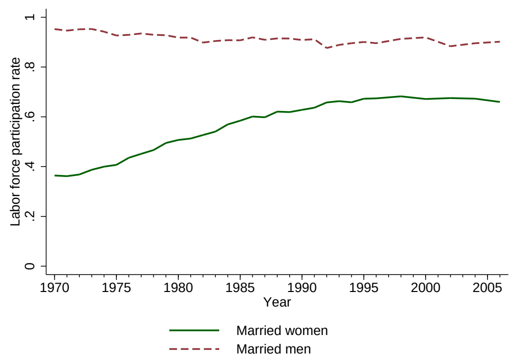

FIGURE 16: Labor force participation by gender, married individuals. Source: PSID

remains stable after that. The decline was a few percentage points and is not such a big break in trend as the flattening of the female participation rates after the mid 1990s.

B.3 Male only earner versus two-earner households

Figure 17 shows the average household income by the education type of the household, for male-only earner households (left panel) and for two-earner households (right panel). For most education types, the average household income has risen faster for two-earner households than for male-earner only households. Only for college husband-high school wife households, average household income has grown at approximately the same rate for one- and two-earner types of households.

Figure 18 shows the average wage of the husband for the same groups of households as figure 17. Husband's average wages are much higher in male-earner only households than in two-earner households for all years and education types.

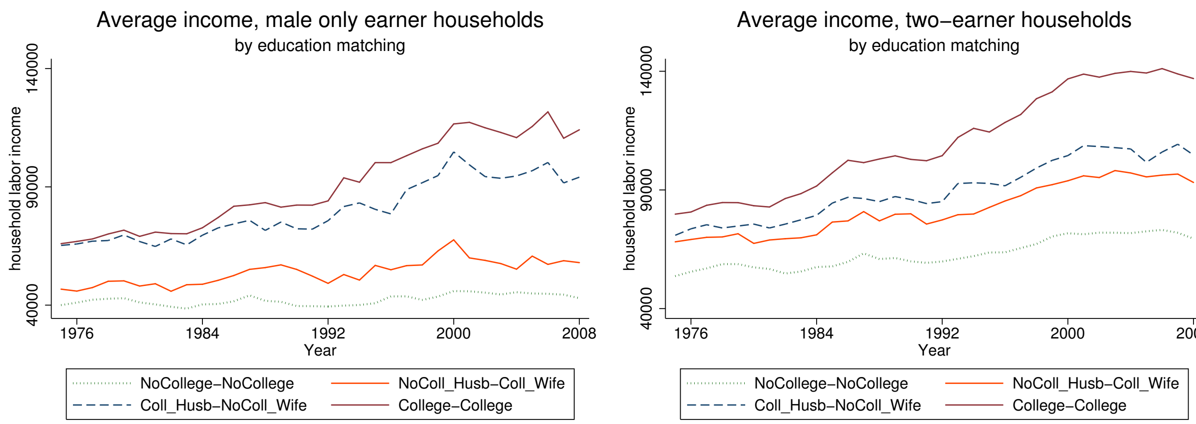

Figure 17: Average family incomes by household type

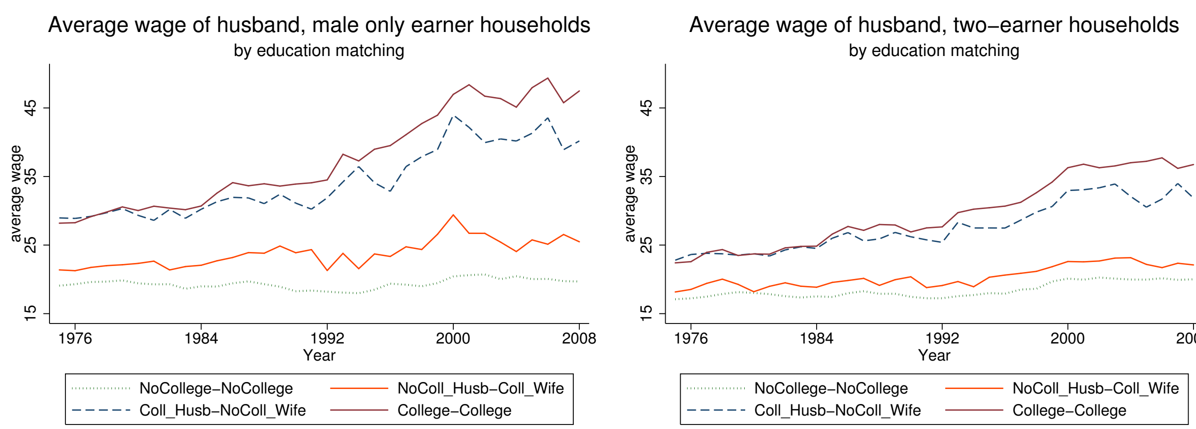

Figure 18: Average wage of husbands by household types

B.4 Marriage rates

Figure 19 shows the evolution of the shares of women by marital status over time. Married women represented 72.6% of the female population in 1975, and that fraction went down to 58.9% by 2008, The fraction of separated or divorced women in the population stayed approximately constant during these years, varying between a minimum of 16.6% in 1975 and a maximum of 19.6% in 1996, declining back again to 18.5% by 2008. The fraction of women who have never been married has increased from 10.7% in 1975 to 22.4% in 2008.

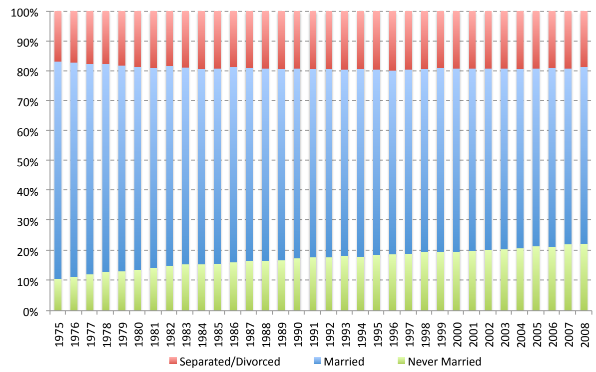

FIGURE 19: Marriage rates in the population

B.5 Entry and exit labor flows

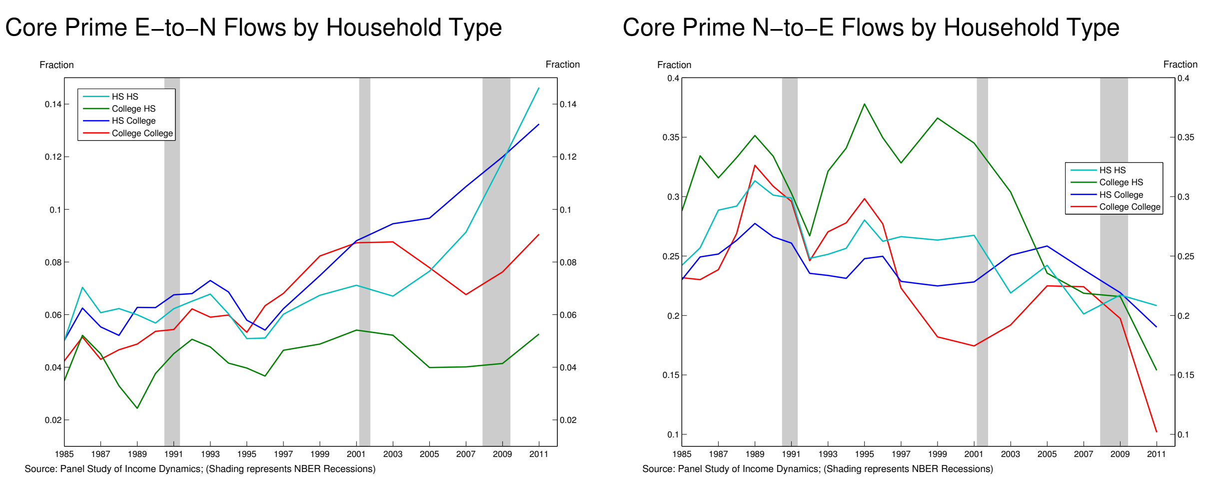

FIGURE 20: Annual exit and entry rates for participation, core prime women.

Note: Core prime encompasses 25-44 year olds. Household composition by educational attainment: *HS HS* are households with high school husbands and wives, *College HS* are college wives and high school husbands, *HS College* are high school wives and college husbands, and *College College* are households were both partners have a college degree.
Source: Authors' calculations from the PSID.

We compute counterfactual entry and exit labor flows by changing the age distribution of women by education type. The first counterfactual assigns high school women the age distribution of college women. The resulting flows are displayed in figures 21 and 22. The figure shows that exit rates for high school women would have been lower if they had the same age composition of college women, but the difference between the actual and counterfactual exit rates are small and virtually disappear after the mid 1990s. Similarly, entry rates would have been higher for high school women in the counterfactual, but the difference with the actual entry rate is small and disappears by the mid 1990s.

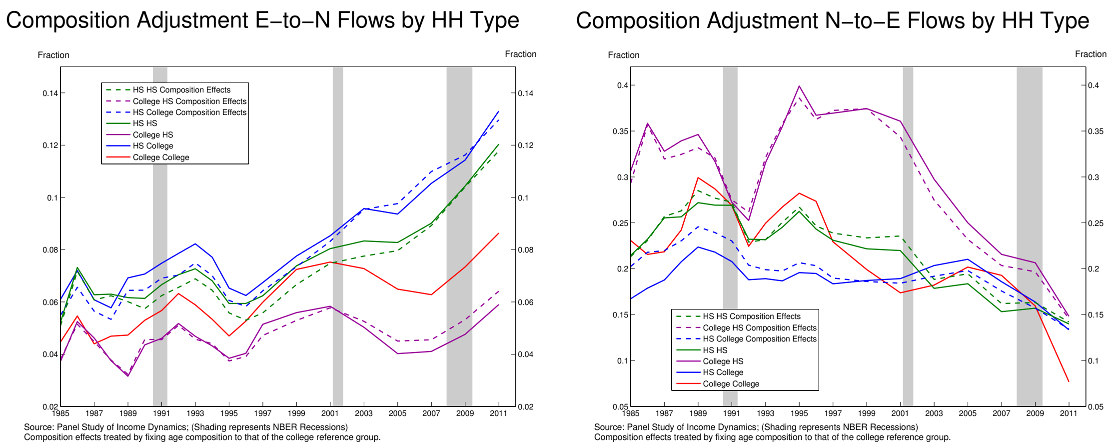

FIGURE 21: Annual exit and entry rates by household type, actual and with C-C women's age composition. Source: Authors' calculations from the PSID.

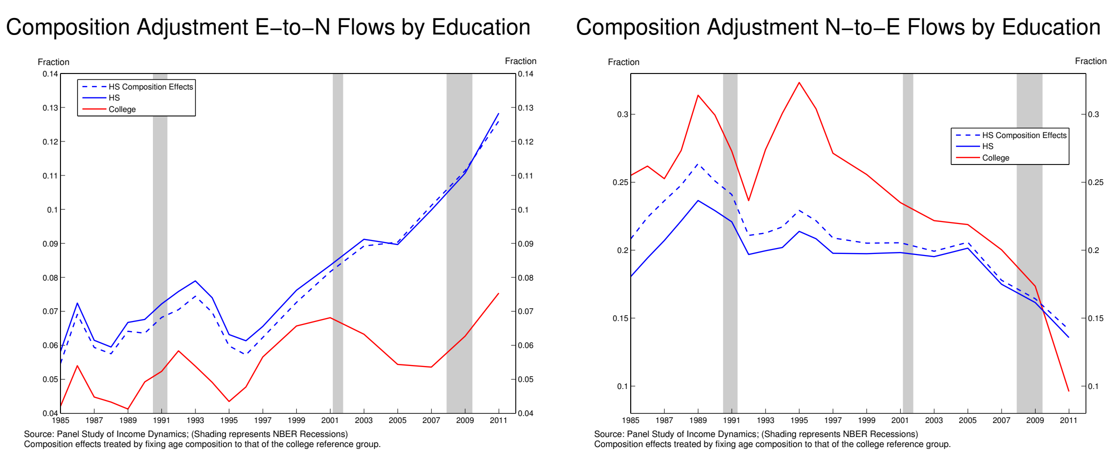

FIGURE 22: Annual exit and entry rates by education, actual and with college women's age composition. Source: Authors' calculations from the PSID.

In the second counterfactual, we explore the role of changing age distribution for each group over time. As is well known, there has been generalized aging of the population, but the rate of aging likely differs by group. We compute counterfactual flow rates by using the 1984 age distribution. The resulting flows are presented in figures 23, 24 and 25. For both flow rates and both education groups, the counterfactual rates are above the actual rates, in all periods. However, even for the counterfactual flow rates, we observe a rise in the exit rate and a decline in entry rate for college women. The effect of the change in the age distribution is most sizable starting in the early 2000s.

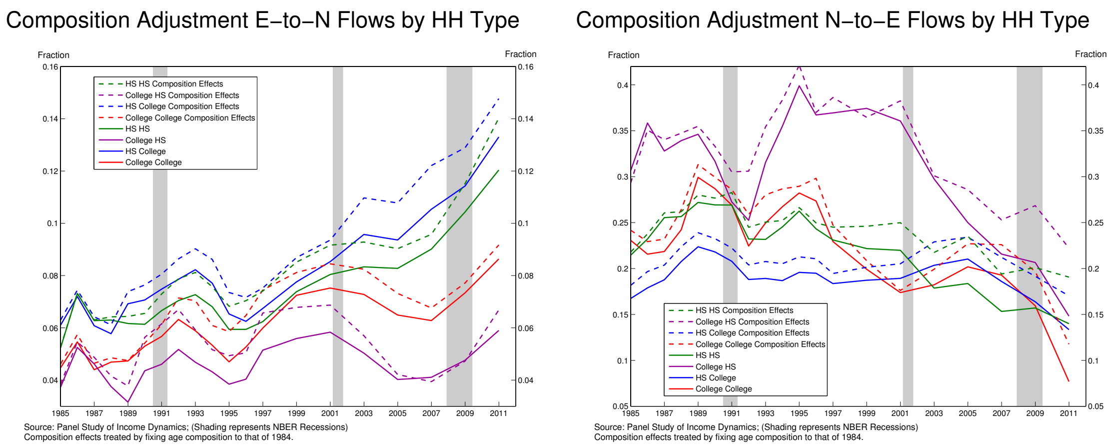

FIGURE 23: Annual exit and entry rates for participation by household type, actual and with 1984 age composition. Source: Authors' calculations from the PSID.

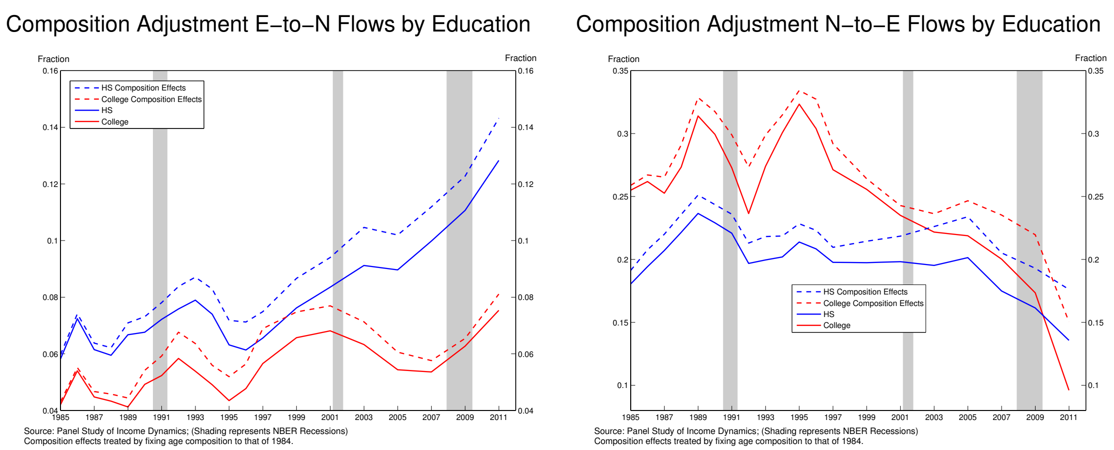

FIGURE 24: Annual exit and entry rates for participation by education, actual and with 1984 age composition. Source: Authors' calculations from the PSID.

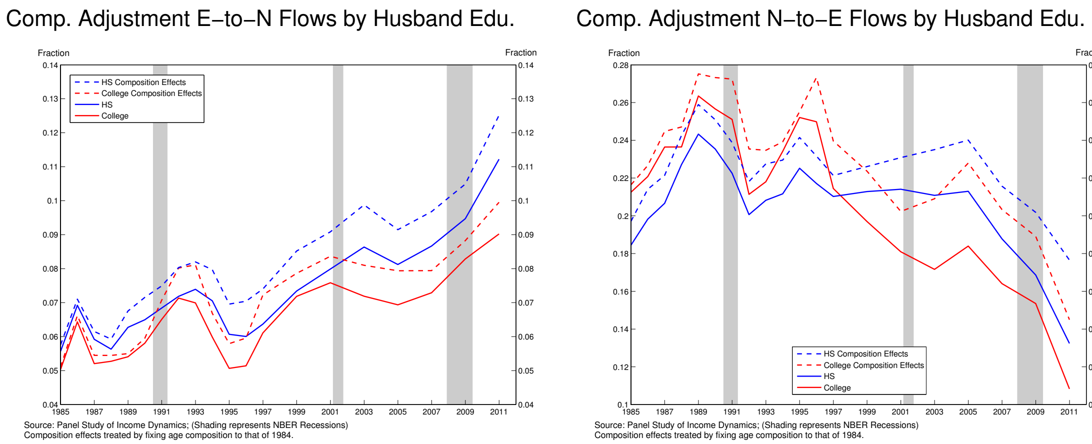

FIGURE 25: Annual exit and entry rates for participation by husband's education, actual and with 1984 age composition.
Source: Authors' calculations from the PSID.

Appendix C Model

C.1 Solution

The following are the first order necessary conditions for the household problem, where we drop the household index i for ease of notation. For consumption:

$$\beta^j \lambda^s u^s_{cj} = \mu_j \tag{8}$$

for $j = 1, 2, ...J$, where μ_j is the multiplier on the household budget constraint in period j.

For $s = f, m$, $p^s_j = 0$ for:

$$\beta^j \lambda^s u^s_{l,j} (\underline{l} + h^s_j) + \beta^j \lambda^s u^s_{cj} \xi^s_j + \nu^s_j \alpha \left(\underline{l}\right)^{\alpha-1} < 0 \tag{9}$$

Instead, $p^s_j = 1$ for for $l^s_j \geq \underline{l}$, for $j = 1, 2, ..., J-1$, if:

$$\beta^j \lambda^s u^s_{l,j} + \beta^j \lambda^s u^s_{cj} \xi^s_j + \nu^s_j \alpha \left(l^s_j\right)^{\alpha-1} = 0 \tag{10}$$

If $p^s_j = 1$, then we can combine the first order necessary condition for consumption and market hours to obtain:

$$\beta^j \lambda^s u^s_{l,j} + \beta^j \lambda^s u^s_{c,j} \xi^s_j + \nu^s_j \alpha \left(l^s_j\right)^{\alpha-1} = 0, \tag{11}$$

for $s = f, m$ and $j = 1, 2, ...J - 1$.

For a two earner households, equations (7) and (11) define a system that can be used to solve for h_j^s and l_j^s as a function of ${c_j}^s$.

For one earner households, assuming that male participation is positive and that hours are interior, the following will hold:

$$\beta^j \lambda^m u_{l,j}^m + \beta^j \lambda^m u_{c,j}^m \xi_j^m + \nu_j^m \alpha \left(l_j^m\right)^{\alpha-1} = 0, \tag{12}$$

while $l_j^f = 0$. Then, equation (12) jointly with equation (7) can be used to solve for h_j^s and l_j^s as a function of ${c_j}^s$.

For home hours:

$$\beta^j \lambda^s u_{l,j}^s + \pi_j G_{h^s,j} \leq 0 \tag{13}$$

with equality for $h_j^s > 0$, for $j = 1, 2, ..., J - 1$. For the evolution of assets:

$$-q\mu_j + \mu_{j+1} = 0,$$

For the evolution of human capital:

$$-\nu_j^s + \beta V_{k^s}(b, k_{j+1}^f, k_{j+1}^m, j) = 0,$$

for $j = 1, 2, ..., J - 1$.

The envelope conditions for this problem are:

$$V_b(b, k^f, k^m, j) = \mu_j = u_c(\overline{c}_j),$$

where $\overline{c_j} = u_c^{-1}(\lambda^s u_c(c_j^s))$,

$$V_{k^s}(b, k^f, k^m, j) = \nu_j^s(1 - \delta) + \mu_j w_j^s \theta^s l_j^s,$$

for $s = f, m$.

Finally, combining the first order necessary condition for home and market hours for each partner in the labor force at an interior solution, we obtain for $j = 1, 2, ...J-1$:

$$- \pi_j G_{h^s,j} + \mu_j \xi_j^s + \nu_j^s \alpha \left(l_j^s\right)^{\alpha-1} = 0. \tag{14}$$

Using the Euler equation:

$$u_{c,j}^s q + \beta u_{c,j+1}^s = 0,$$

for $j = 1, 2, ...J$. Combining the Euler equation for k_j^s with the corresponding envelope condition, we obtain:

$$- \nu_j^s + \beta \left[\nu_{j+1}^s (1-\delta) + \mu_{j+1} w_{j+1}^s \theta^s l_{j+1}^s\right] = 0, \tag{15}$$

for $j = 1, 2, ..., J-1$, with $\nu_J^s = 0$ for $s = f, m$. This implies automatically that $\nu_{J-1}^s = 0$. Then, we can solve iteratively backwards from the last period:

$$-\nu_{J-2}^s + \beta \left[\mu_{J-1} w_{J-1}^s \theta^s l_{J-1}^s\right] = 0,$$

$$-\nu_{J-3}^s + \beta \left[\nu_{J-2}^s (1-\delta) + \mu_{J-2} w_{J-2}^s \theta^s l_{J-2}^s\right] = 0,$$

and so on for j going to 0 according to (15).

C.2 Numerical Computation

We solve the household problem computationally through backwards induction. We approximated the distribution of productivity types θ using a Gaussian approximation with 8 nodes for each of the four distributions by gender and education. We discretize the spaces of assets and human capital levels and the choice of hours worked. In each period except the last one, we take as given the continuation value obtained at the previous step and solve the current period's optimization problem by grid search.

In the transitional simulation, households take as given the current and future paths of w_t^s and ξ_t^s for $s = f, m$ under perfect foresight.