Female Labor Supply and Jobless Recovery

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Abstract

Female labor force participation rose steadily over the U.S. post-war era until the late 1980s. Since then, the upward trend has largely subsided. Concurrent with this leveling off, starting in 1990, recessions in the U.S. have featured jobless recoveries. This paper considers the connection between these two recent patterns, examining both empirically and through the lens of a general equilibrium macroeconomic model, the extent to which the weakened trend contributes to slower recoveries. My empirical analysis shows that young, married women with children were the primary drivers of aggregate employment recoveries prior to 1990. These findings inform the development of a theoretical model that I use to study the interaction between female and male labor supply at the household and at the aggregate level. My model predicts that post-1990 aggregate employment recoveries were significantly slower than pre-1990 recoveries due to the weakened trend for young married women with children and is thus consistent with my empirical evidence both in the aggregate and in which individual groups show these changes. Decomposing the relative contributions of several underlying factors responsible for this pre-1990s rise, the model predicts that the narrowing gender wage gap is the most important factor in the overall increase. However, until the mid-1980s, when the upward trend in female labor supply was the strongest and recoveries in aggregate employment were brisk, a reduction in the number of young children for married women was the most crucial factor. With this insight, I use my framework to discuss policy implications for mitigating jobless recoveries.

Keywords: Female labor supply, jobless recovery, heterogeneous households, time use

JEL Classification: E32, E24, J22, E21

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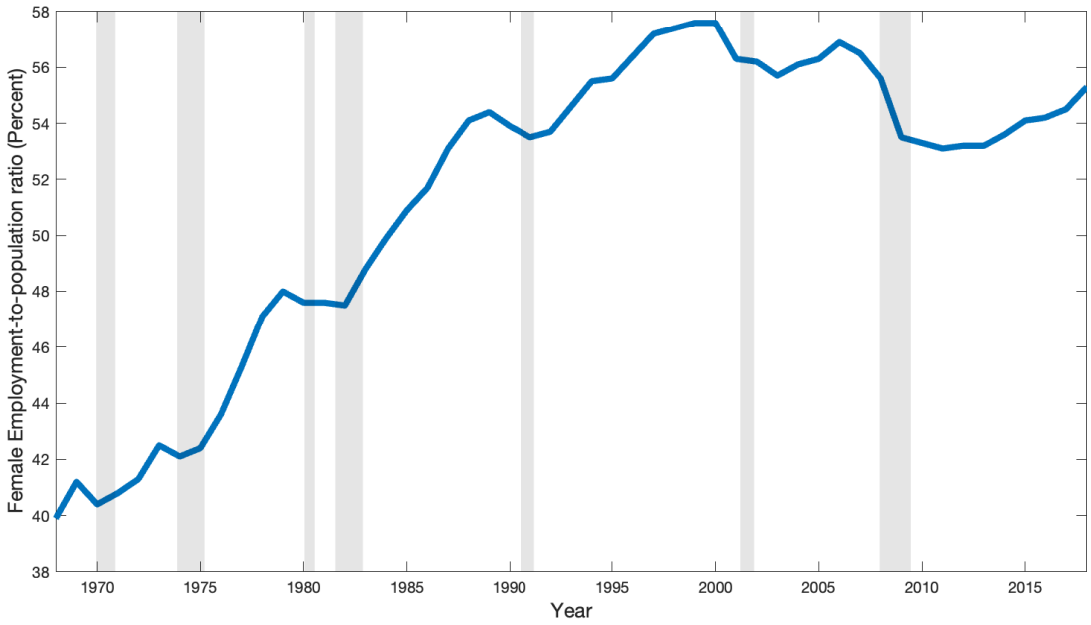
1 Introduction

The demographic composition of the U.S. labor market has changed significantly over the past several decades, and one crucial aspect of this has been a change in labor force participation among women. From the end of World War II until the late 1980s, female labor force participation rose steadily; since then, the trend has weakened and largely subsided. Another macroeconomic feature of this decade has been a jobless recovery phenomenon in the U.S. recessions since 1990, which features a weak aggregate employment recovery that lags the rebound in aggregate production. In this paper, I study the connection between these two recent patterns, examining both empirically and through the lens of a general equilibrium macroeconomic model the extent to which the weakened secular trend in female labor supply has contributed to jobless recoveries. I identify the subgroups of women who were the primary drivers of the upward trend and investigate the underlying demographic factors that these women responded to. The findings from my analysis provide insight into the type of government policies that can be effective in mitigating jobless recoveries, the impact of which I examine using my framework.

Figure 1 graphs the evolution of the employment-to-population ratio for female workers in the U.S.[1] There was a secular increase from 39.9% in 1968 to 54.4% in 1989; however, since then there has been a decline in the growth rate of the employment-to-population ratio. Underlying factors which are plausible contributors to explaining the trend include a decrease in marriage rates, an increase in divorce rates, a narrowing of the gender wage gap, changes in fertility rates among women, and technological progress in home production, among several others. In what follows, I use empirical analysis to select several of these as leading contributors, then develop a fully articulated model consistent with key patterns in the data to quantify the relative contribution of each of these changing factors to the secular trend in female labor supply at different points along the transition over the last few decades.

Figure 2 looks at recoveries in prime-age employment over the last five recessions. As is apparent from panel (a), recoveries have slowed down for the recessions post-1990 as compared to the ones before. To understand whether this change in employment recoveries has affected the entire population or specific subgroups, I decompose the series by gender. Panel (b) shows that, apart from the Great Recession of 2007-2009, recovery patterns have always been similar for men. However, for women, recoveries have significantly slowed since the recession in 1990

[1] Patterns are consistent if we look at labor force participation (Appendix, Figure B1) or average hours worked instead (Appendix, Figure B2)



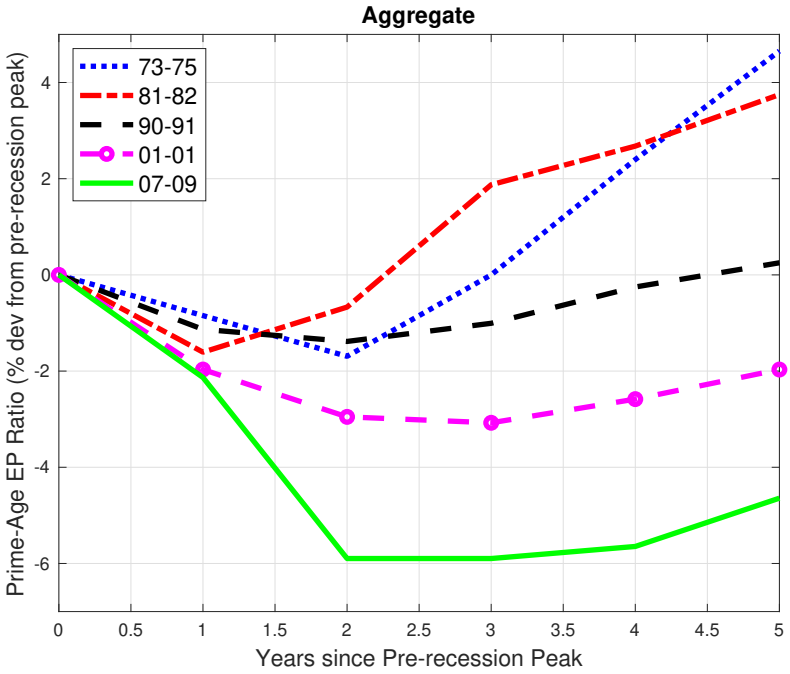
Notes: This series comes from the Current Population Survey (Household level) and has been retrieved from FRED, Federal Reserve Bank of St. Louis. This data is seasonally adjusted and aggregated at the annual level. The population comprises of all individuals above the age of 16.

Figure 1: Secular trend in Female Employment-to-Population ratio

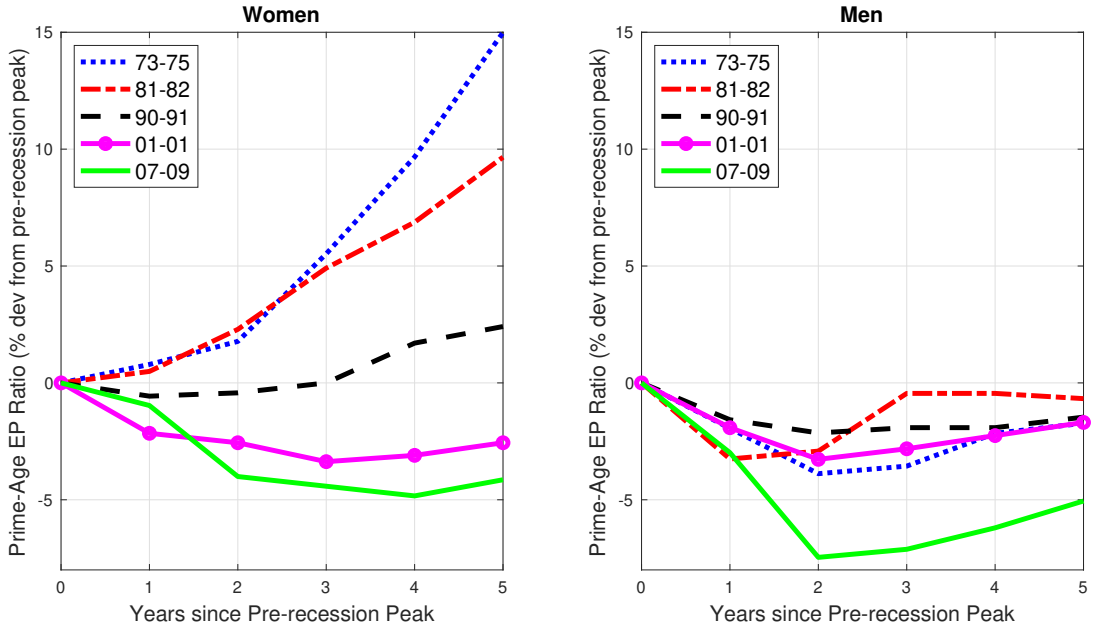
and are qualitatively identical to the aggregate patterns observed.

Motivated by the observations above, I conduct an empirical investigation to establish whether the change in employment recovery patterns for women and the absence of change for men have been homogeneous across all subgroups of these two populations. To do that, I segregate individuals based on age, marital status, gender, presence of children, and education. Among these subgroups, I find that it was the strong recovery patterns of young married women with children that drove the strong post-recession recoveries in total employment prior to 1990. Each of these three individual characteristics is identified as a key source of formerly robust and now anemic aggregate employment recoveries. Perhaps surprisingly, conditioning on the factors above, I find little evidence for educational differences among women as a significant factor behind the changing employment recovery patterns over the five recessions shown in Figure 2. I examine the trend in employment for each of these subgroups and find that consistent with the recovery patterns, young, married women with children are the largest contributors to the strong upward trend in female employment before 1990.

The findings from my empirical analysis inform the specification of a theoretical framework I develop to gain insight into the possible links between the secular trend in female labor supply and the advent of jobless recoveries. My model allows for persistent heterogeneity across



(a) All workers



(b) Male and Female workers

Notes: This figure graphs the employment-to-population of prime age workers aged 25-54 during the last five recessions (pre-recession peaks defined as per NBER) prior to the pandemic and the subsequent recoveries. We ignore the recession in 1980 due to the subsequent recession that soon followed. This series comes from the Current Population Survey (Household level) and has been retrieved from FRED, Federal Reserve Bank of St. Louis. This data is seasonally adjusted and aggregated at the annual level. Figure $B3$ in the Appendix shows the employment recoveries for all workers aged 16-65.

Figure 2: Slowing Recoveries for Prime-Age Workers

households along five dimensions: age, marital status, gender, number of children, and asset holdings. Each household faces marriage or divorce shocks conditional on their age and marital

status and decides how much to save and how much labor each adult member will supply to the economy's firms. Conditional on the number of children, members also choose how much labor will be provided at home for non-market work and childcare. I use this framework to examine the interaction between female and male labor supply both at the household level and at the aggregate level.

My dynamic stochastic general equilibrium model is distinguished by an endogenously evolving distribution of households over asset holdings. That evolving distribution affects the expected lifetime utility from marriage not only for single individuals but also for married individuals through divorce and subsequent re-marriage. This endogenous wealth distribution is essential to accurately quantify the contribution of changes in underlying demographic factors to the changes in aggregate employment patterns and to correctly assess the overall effectiveness of government policies targeted at the labor supply choices within specific subgroups of the population. For example, if effectively narrowing the gender wage gap or introducing a childcare policy incentivizes single women to increase their labor supplied to the market, it will also change their asset accumulation decisions and, thus, the future distribution of assets over this group. To the extent that this raises or lowers their expected discounted value of being married, single men will alter both their labor supply and their asset accumulation. That, in turn, will influence the decisions of single women through their valuation of marriage, and it will affect those of other groups depending on the magnitudes of the resulting wage and interest rate changes. Thus, an important contribution of my work is to study the feedback from equilibrium changes in the asset distribution, not only to assess policy effectiveness but also to correctly quantify the labor supply responses to underlying changes in demographic factors.

As the lines above suggest, a general equilibrium framework allowing the response of one section of the population to have implications for the rest of the population is imperative if we are to correctly assess the impact of a changing demographic factor or a policy intervention. For example, an increase in female labor supply increases household income, raising demand for consumption and savings. The resulting rise in aggregate output demand, in turn, increases aggregate demand for labor and capital. Economy-wide labor supply may rise or fall depending on the extent to which male labor supply is crowded out within households. The resulting wages and rental rates will then have a feedback effect on households' asset accumulation and labor supply decisions, which will then determine equilibrium employment and equilibrium prices. A policy designed to increase labor supply among married women with children may sufficiently

increase the demand for market-provided childcare among wealthy households to raise the price of that service above the reservation price for poorer, younger households and thereby offset the effectiveness of the policy. A general equilibrium analysis is necessary to account for such unintended consequences.

I simulate my model economy starting from an initial set of conditions calibrated to reflect the U.S. in 1968, and I examine the predicted aggregate and subgroup employment changes at various points along the path from then until 2014. Jones, Manuelli, and McGrattan (2015) and Heathcote, Storesletten, and Violante (2017) argue that the narrowing of the gender wage gap was a significant contributor to the sharp increase in female labor force participation over the years prior to 1990. Therefore, I allow for changes in the gender wage gap over time. As discussed above, my empirical evidence on employment recoveries underlines the role of age and marital status differences and the presence of young children in households. We also know that there have been significant changes over the past five decades in marriage rates, divorce rates, and fertility rates in U.S. households (Doepke & Tertilt, 2016). With this in mind, and given the evidence that family composition plays a significant role in determining the labor supply of women (Bloom, Canning, Fink, & Finlay, 2009; Papps, 2006), I also allow for time variation in each of these demographic rates. Consistent with my empirical evidence, the model results show that the largest increase in labor supply over the last fifty years was driven by young married women with children.

Next, I consider the relationship between changes in female labor supply and jobless recovery by examining, along the transition episode, employment changes during and after recessions, driven by negative aggregate productivity shocks. Comparing the downturn and recovery over a pre-1990 recession, in the presence of an upward trend in female labor force participation, to those over a post-1990 recession when the trend has subsided, my model is consistent with the data in predicting significantly slower aggregate employment recoveries in the case of the latter. Consistent with the findings in my empirical analysis, the model predicts that it is the pre-versus post-1990s recovery patterns among married women, not men or single women, that drive these changes. Thus my model confirms the hypothesis that the leveling off in the secular trend is a significant contributing factor to the emergence of jobless recoveries over recent U.S. recessions.

Next, I use my theoretical framework to decompose the relative contributions of several leading proposed causal factors underlying the long run labor supply changes described above.

In undertaking this decomposition analysis, I examine the relative contributions of each factor not only in the aggregate but also in the responses of specific male and female subgroups. Comparing steady states, my model suggests that the most relevant contributor to the changes in labor supplied by married individuals between 1968 and 2014 is the narrowing of the gender wage gap. However, this quick before versus after comparison masks important information. Along the path between these two dates, the relative contributions of each of the four underlying factors to the secular trend in labor supply shift. In the early part of the transition, it is not the gender wage gap but a reduction in the number of young children among married women that is the most important driving factor. Given that those early dates were when the strongest growth in female labor supply took place, subsequently contributing to strong employment recoveries, I infer from this result that it is essential to consider the relationship between time spent on non-market work, childcare, and female labor supply when formulating policies aimed at strengthening aggregate employment or reshaping its cyclical movements.

I use my theoretical framework to discuss fiscal policies aimed at increasing the labor supply of young, married women with children with the intent of mitigating jobless recoveries. As noted above, my general equilibrium environment allows one to investigate not only the labor and savings decisions of the targeted subsection of the population but also the decisions of untargeted subsections. I allow households to choose how much time to devote to non-market work and childcare at home and how much to buy at a market-provided service. The government subsidy comes as a reduction in the purchase price of this market service that substitutes the labor supplied at home. I find that the introduction of the countercyclical subsidy results in faster post-recession recoveries through an increase in the labor supplied by married women with children, as it leads them to substitute away from home-produced to market-produced childcare. For the other groups, the effects are muted in comparison, leading to an increase in aggregate labor supplied. Increased demand for the market-produced service induces a rise in the demand for labor in that sector, which absorbs a part of the increased labor supply, thus resulting in an increase in aggregate employment.

1.1 Related Literature

My paper is closely related to two strands of literature, one investigating the sources of jobless recoveries and the other examining secular changes in female labor supply. Several explanations have been proposed to account for jobless recoveries, including theories of generous unemploy-

ment insurance extensions (Mitman & Rabinovich, 2019), structural change (Jaimovich & Siu, 2020), wage rigidities (Shimer, 2012) and access to credit (Herkenhoff, 2019). I explore here the contribution of an alternative explanation arising from secular changes in the labor supply of U.S. population subgroups, most notably young married women with children.

A large literature has devoted itself to explaining the secular trend in female employment. Some leading theories propose sources, including the narrowing of the gender gap (Jones et al., 2015; Heathcote et al., 2017; Blau & Kahn, 2017) and improvements in household technology (Greenwood, Seshadri, & Yorukoglu, 2005). Others emphasize medical advances affecting female health (Albanesi & Olivetti, 2016; Goldin & Katz, 2000), changes in childcare costs (Attanasio, Low, & Sánchez-Marcos, 2008), cultural changes (Fernández, Fogli, & Olivetti, 2004) and the rise of the service sector (Ngai & Petrongolo, 2017; Buera, Kaboski, & Zhao, 2019). Some papers attribute the post-1990 slowdown and subsequent decline in female employment in the U.S. relative to other countries to the lack of family-friendly policies (Blau & Kahn, 2013; Black, Schanzenbach, & Breitwieser, 2017). I include several competing factors together in my model to consider the relative importance of each over time and investigate business cycle recoveries in the presence and absence of the trend. Model results reveal that steady state comparisons present an incomplete picture regarding the importance of these competing factors; the relative weights have changed over time, so it is essential to study the contribution of each factor along a transition.

My paper is most closely related to the works of Albanesi (2019), Fukui, Nakamura, and Steinsson (2018) and Olsson (2018) in that these papers also discuss changes in female labor market outcomes and their role in jobless recoveries. The first two papers mentioned above use a large representative household framework, whereas my model allows for heterogeneous labor supply and consumption responses to changes in aggregate conditions across multiple subgroups of the population differing by age, assets, marital status, and the number of children in the household, in a general equilibrium environment. Based on my empirical exploration, alongside the predictions of my model, I argue that the inclusion of each of these dimensions of heterogeneity is crucial for robust quantitative predictions because the underlying factors driving changes in one population subgroup's employment outcomes can have a differential effect on those of others. Olsson (2018) incorporates households that are heterogeneous with respect to marital status, productivity, and employment status in a general equilibrium framework. However, her stochastic aging framework does not allow for age distinctions within the working-

age population; neither does her paper account for the role of children, both of which, I find, are critical omissions for the analysis in question.

As compared to all these three papers, my work is distinguished by the fact that I allow for changes in marital status and have consistency between the expectation of the wealth distribution of future household partners and the actual equilibrium distribution of wealth that the households' labor supply and consumption decisions generate. Further, none of these papers consider the relative contribution of changes in underlying demographic factors barring the narrowing of the gender wage gap. Therefore they are unable to evaluate the most important factor, changes in the number of young children in married households, during the late 1960s to the mid-1980s, when the upward trend in female labor supply was the strongest and employment recoveries were brisk, especially since they do not account for heterogeneity with respect to children. My paper is also the first to examine the role of government policies targeted at increasing female labor supply to mitigate jobless recoveries. Since my model accommodates general equilibrium feedback effects through endogenous changes in base wages and interest rates, it is a suitable environment in which we can analyze the aggregate implications of government policies targeted at the labor supply choices in one segment of the population without running the risk of overlooking unintended consequences for other groups.

The remainder of the paper is organized as follows. Section 2 examines the data and provides empirical evidence to isolate the dimensions of household heterogeneity that matter most for jobless recovery. Section 3 describes the theoretical framework, the specification of which is informed by the findings in Section 2. Section 4 describes the model solution and discusses its parameterization. Section 5 presents and explains key results of the model, including the decomposition of factors driving the run-up in female labor supply and their effects on specific male and female subgroups. Section 6 discusses policy implications and alternative specifications. Section 7 concludes.

2 Empirical Evidence

2.1 Data Description and Sample Selection

In this paper, to study labor market outcomes, I use the Annual Social and Economic Supplement (ASEC) of the Current Population Survey (CPS) as available through the Integrated

Public Use Microdata Series (IPUMS)[2]. The CPS is administered jointly by the U.S. Census Bureau and the U.S. Bureau of Labor Statistics at both the household and the individual level and is considered the primary source of official labor force statistics for the U.S. government.

For my analysis, I consider individual-level observations pertaining to the working-age population (aged 16-65). I drop those who reside in institutionalized quarters such as prisons and psychiatric wards or are in the armed forces. I then calculate the employment-to-population ratios for subgroups of the population which vary by gender, age, marital status, presence of children, and education. The goal is to identify how these subgroups' recoveries from recessions changed over the past 50 years. In particular, the recessions considered are 1973-1975, 1981-1982, 1990-1991, 2001-2001, and 2007-2009 (as defined by the NBER). I count individuals as employed if they either reported having worked for pay or for profit or worked for at least fifteen hours in a family business or farm the preceding week. Those who reported being temporarily absent from work due to illness, vacation, bad weather, or a labor dispute are also considered employed.

2.2 Decomposition Analysis: Cycle

In this section, I discuss the patterns observed from my empirical analysis when the female population is further subdivided into groups that differ by age, marital status, presence of children, and education. I focus on women because, as observed in Figure 2, recoveries for men have always been jobless; women have shown changes in their recoveries over the recessions.

2.2.1 Age

To analyze changes in employment recovery patterns for different age groups, I divide the population into two age groups: 16-44 (young) and 45-65 (old). Figure 3 displays deviations in the average employment-to-population ratio from the pre-recession business cycle peak for each of these groups. I find that the younger women were the primary drivers of the strong recoveries following early recessions. Over time, employment recovery has slowed down for this group. Apart from the 1990-1991 recession, recoveries have always been slow for older women. The strong recovery in 1990-1991 could partially reflect a cohort effect, as a fraction of the young women who recovered strongly in the previous two recessions would now belong to the

[2]Sarah Flood, Miriam King, Renae Rodgers, Steven Ruggles, and J. Robert Warren. Integrated Public Use Microdata Series, Current Population Survey: Version 6.0 [dataset]. Minneapolis, MN: IPUMS, 2018. https://doi.org/10.18128/D030.V6.0

older group.

Figure 3: Employment Recoveries for Women by Age Groups

2.2.2 Marriage

Next, I examine whether the recovery patterns observed for younger women vary with respect to their marital status. In this case, single households consist of all individuals who are divorced, separated, widowed, or never married. The results in Figure 4 suggest that the strong employment recoveries in the pre-1990 recessions were primarily driven by married women, which indicates that marriage is a dimension of heterogeneity that is relevant for examining jobless recoveries.

2.2.3 Children

Once age and marriage are accounted for, I further investigate whether the presence of young children at home matters when analyzing jobless recoveries. To do this, I restrict the population to only married women aged 16-44. I compare the employment recoveries of those with at least one child aged less than five to those with no young children at home. Figure 5 shows that although women without children have also undergone changes in their recovery patterns over the last recessions, the changes are starker for those who have young children at home[3]. I

[3]I conduct a similar exercise for women with and without children (aged less than 18) and the results are shown in Figure B4 in the Appendix. The patterns are consistent. However, recoveries pre-1990 are relatively

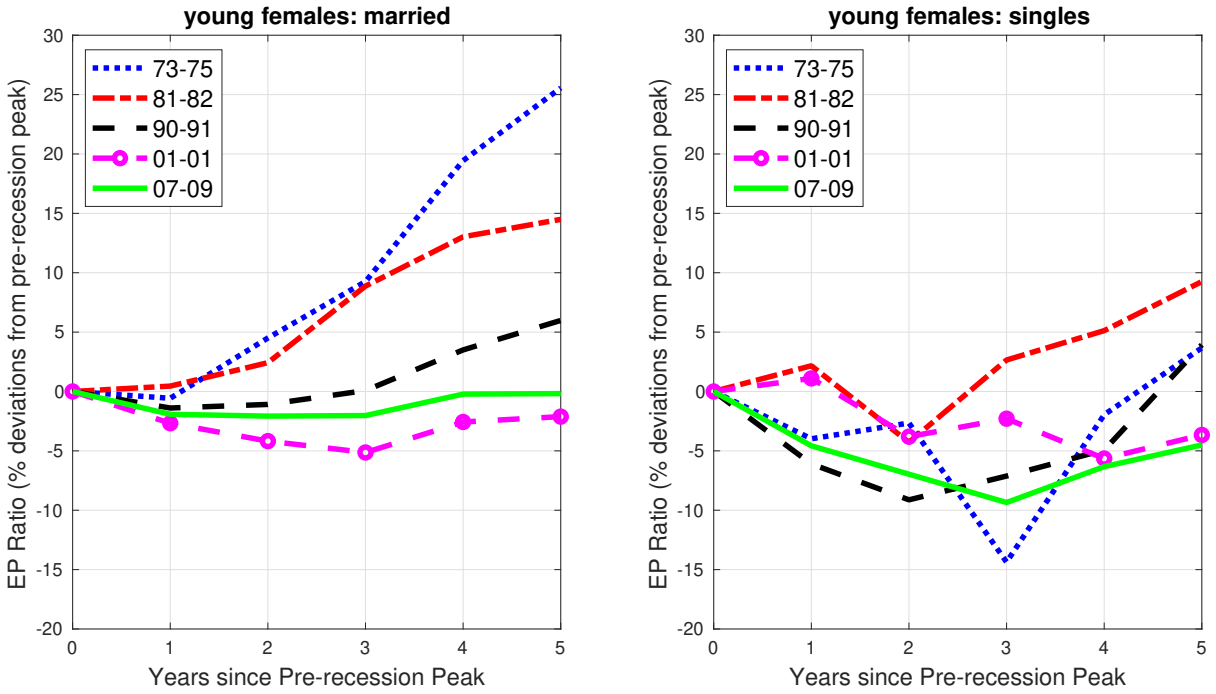


Figure 4: Employment Recoveries for Young Women by Marital Status

speculate that some of the young married women with no young children could have expectations of having children, which could make them behave similarly to those who have children at home.

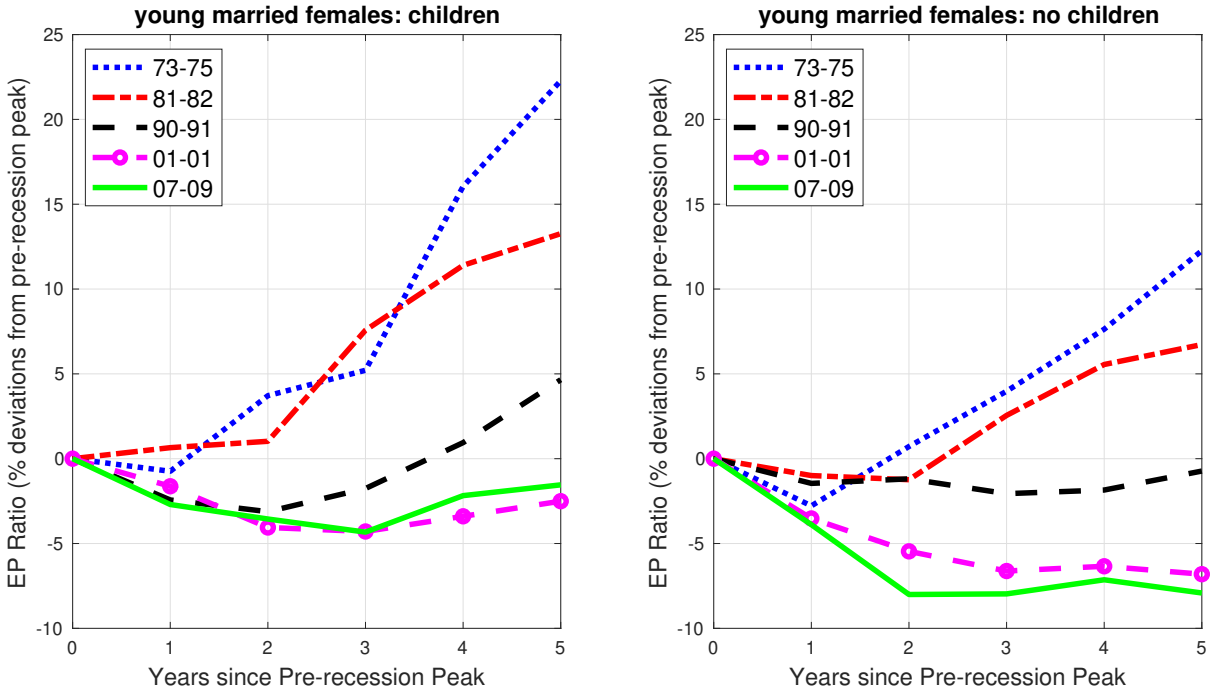


Figure 5: Employment Recoveries for Young Married Women by presence of Children

stronger for those with young children

2.2.4 Education

I conduct my last decomposition based on education levels. I divide the population of young, married women with young children into two groups: those with at least a four-year college degree and the rest of the population[4]. Figure 6 suggests that once age, marriage, and the presence of children are accounted for, there is not enough evidence to suggest that differences across education levels translate into different employment recoveries for women. For both groups, those with and without a college degree, the recoveries were stronger in the pre-1990 recessions and have slowed down significantly since then.

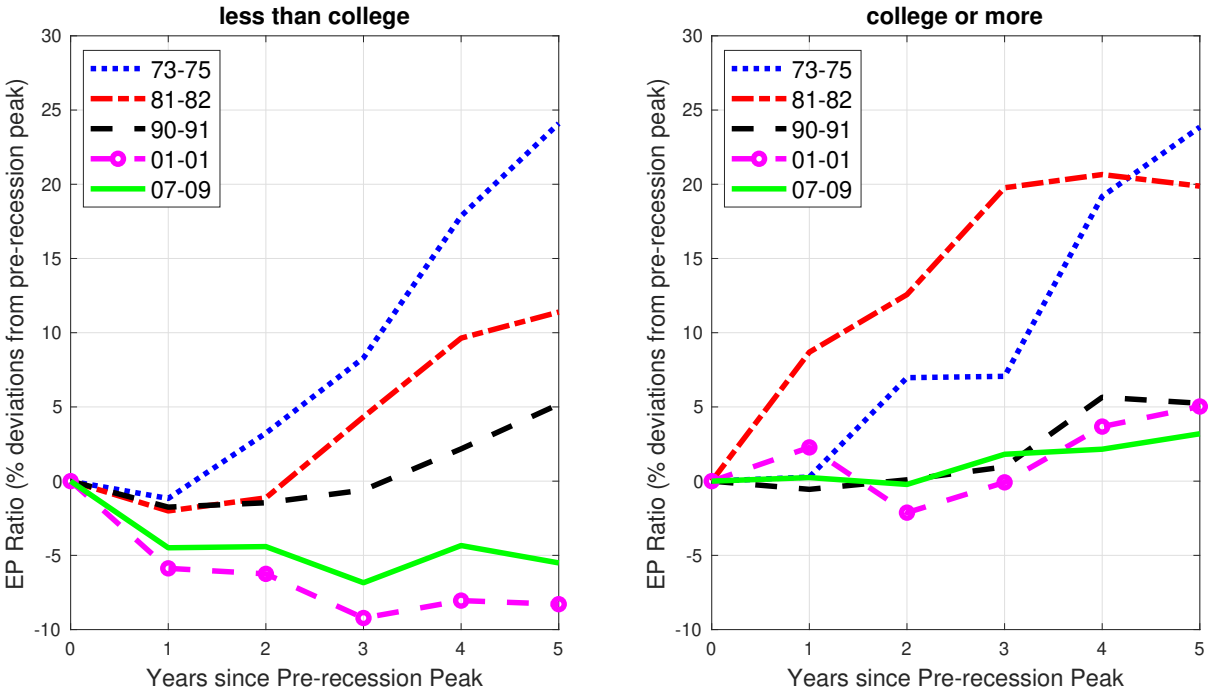


Figure 6: Employment Recoveries for Young Married Women with Children by Education

Thus, to summarize the findings from this subsection, the changing recovery pattern is more pronounced among young married women with young children. I do not find enough evidence to suggest that education difference is an important dimension of heterogeneity to be considered once age, marital status, and children are accounted for.

[4]An alternative decomposition was also considered that divides the population into four groups: less than a high school (HS) degree, a HS degree, some college education, and those with at least a college degree. Figure *B*6 in Appendix B shows the results for the different education groups.

2.3 Decomposition Analysis: Trend

In this subsection, I discuss the patterns observed with respect to the trend in female employment when the female population is further subdivided into groups that differ by marital status, age, and the presence of young children.

Figure 7 shows the trend in employment for men and women of different marital statuses. As is seen in the left panel, the change has primarily been driven by married women. Till 1990, married women's employment-to-population ratio rose 2.2 times more than that of single women. For men, there has been a decrease in the employment-to-population ratio for both married and single individuals. However, the fall in married men's employment-to-population ratio is only 40% of the rise for married women, implying that the rise in married women's employment was not completely offset by the decrease in employment for married men.

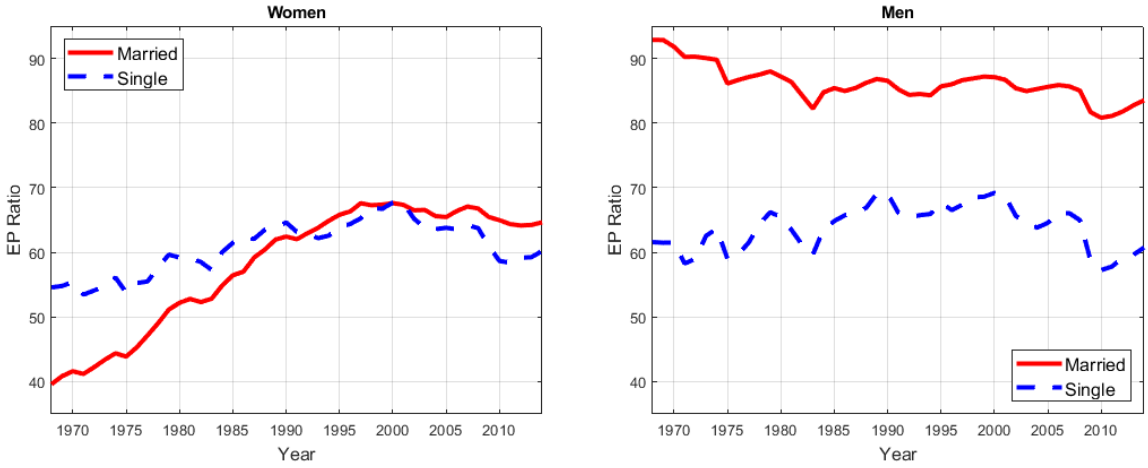


Figure 7: Secular trend in male and female employment by marital status

Since the change in female employment was primarily driven by married women, we further subdivide the population to understand better which groups of married women contributed to that trend. Figure 8 illustrates the patterns. As is evident from the left panel of Figure 8, which looks at married women with and without young children, the trend exists for both groups. However, the trend is stronger for married women with children. On further dividing this group by age groups, as seen from the right panel, we find that the trend is stronger for young married women with children.

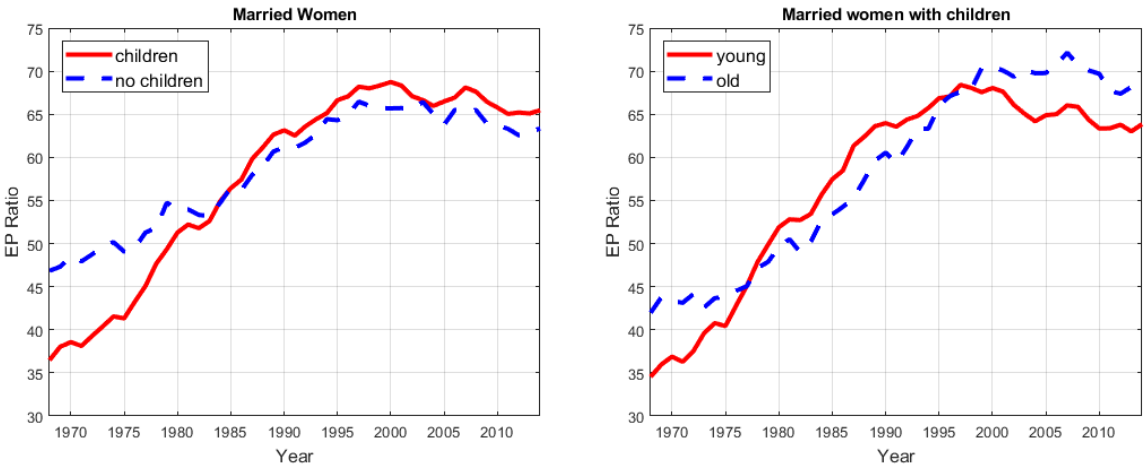


Figure 8: Secular trend among groups of married women

3 Model

3.1 Overview

The economy is populated by agents who are heterogeneous along the following dimensions: gender ($g = \{m, f\}$), age (j), marital status (single, s or married, p), assets, k, and the number of children. I assume there is a unit measure of both men and women. The number of children in a household varies with the age and marital status of the adults in the household.

Agents live and work for J periods and discount the future at the rate of β. Married households face divorce shocks, and single households face marriage shocks. Individuals derive utility from the consumption of a market-produced good, c, home-produced good, c^h (includes childcare), and leisure, l. Utility from c and c^h are subject to equivalence scales, χ, and χ^h, respectively, to account for the consumption needs of different family sizes[5]. Each individual is endowed with 1 unit of time. Every period, households take the gender-specific market wages $w(g)$ and rental rate r as given and make consumption-savings and time-allocation decisions for their members. A production technology converts the time spent working at home into the home-produced good. There is a representative firm that employs labor and uses capital for production. Wages and rental rates are determined in equilibrium. The gender wage gap is modeled as a discrimination tax, that female workers have to pay for every unit of labor supplied[6].

[5] As shown in Figures $B10$ and $B11$ in Appendix B, I find that both non-market work time and childcare time increases with the number of children, therefore the home-produced good takes both into consideration

[6] Several explanations (such as productivity differences, occupational and sectoral choice, employer discrimination among others) have been provided in the literature to explain the gender wage gap (Blau & Kahn, 2000, 2017; Becker, 1957). In this framework it is assumed to be exogenous and purely distortionary

3.2 Single Households

At each period, t[7], single households decide on their market consumption c, home-good consumption, c^h, savings k', labor supply to the market n[8], and labor supply at home, n^h. We interpret n^h as the sum of non-market work and home-produced childcare time that cannot be outsourced. Households are constrained by their budget, which is the sum of their labor income, $w_t(g)n$, and asset income, $(1+r_t)k$. They are not allowed to borrow ($k' \geq 0$).

At the start of the next period, with an exogenous probability, p_{t+1}, singles receive a marriage shock. Conditional on receiving a marriage shock, the probability of getting matched to a single of the opposite gender, $\tilde{g}$, with next period assets equal to $\tilde{k'}$ is given by $\theta_{t+1}(\tilde{g}, \tilde{k'}, j+1)$ which is determined in equilibrium and is described by equation (12) later. For simplicity, I assume that matches take place between same-aged individuals. $V_{s,t}(g,k,j)$, which describes the lifetime utility of a single individual of gender g and age j with assets, k, is defined below:

$$\begin{aligned} V_{s,t}(g,k,j) = \max_{\Omega_{s,t}} U\Big(\frac{c}{\chi_{s,t}(g,j)}, \frac{c^h}{\chi^h_{s,t}(g,j)}, 1-n-n^h\Big) \\ + \mathbb{1}_{j<J}\beta\Big\{p_{t+1}\int_{\tilde{k'}} \theta_{t+1}(\tilde{g},\tilde{k'},j+1)\hat{V}_{p,t+1}(g,k'+\tilde{k'},j+1)d\tilde{k'} \\ + (1-p_{t+1})V_{s,t+1}(g,k',j+1)\Big\} \end{aligned} \tag{1}$$

subject to:

$$c + k' \leq w_t(g)n + (1+r_t)k \tag{2}$$

$$c^h \leq A^h_t n^h \tag{3}$$

$$c, c^h, k' \geq 0; n, n^h \in [0,1]; n + n^h \in [0,1] \tag{4}$$

$$\Omega_{s,t} = \{c, c^h, n, n^h, k'\}; k' = h_{s,t}(g,k,j)$$

Here $\hat{V}_{p,t+1}(g, k' + \tilde{k'}, j+1)$ refers to the lifetime utility of the agent when married to an individual with next period assets equal to $\tilde{k'}$ and is described by equation $(9-10)$ later. Equation (3) describes the technology of home production. It is assumed to be linear in the time spent working at home, and A^h_t is the productivity parameter.

The optimal policy rules for the problem described by equations $(1-4)$ are given by $\Omega^*_{s,t} =$

[7] the aggregate state of the economy is summarized by t

[8] In my model I do not distinguish between the extensive and intensive margin of labor choice. Therefore, in the context of my theoretical framework, I use the following terms interchangeably: labor supplied to the market, hours worked, employment, and market work.

$\{c^*_{s,t}(g,k,j), {c^h}^*_{s,t}(g,k,j), n^*_{s,t}(g,k,j), {n^h}^*_{s,t}(g,k,j), h^*_{s,t}(g,k,j)\}$.

3.3 Married Households

Married (or partnered) households comprise one male and one female adult living together. We assume cooperative bargaining where ζ_f and ζ_m represent the welfare weights for the wife and husband respectively, with $\zeta_f + \zeta_m = 1$. At each period, t, these households decide on their joint consumption of the market good c, the home-produced good, c^h, savings k', labor supplied to the market by the male and female member, n_m and n_f respectively, and the labor supplied at home, n^h_f. Based on empirical evidence that married women spend a significantly larger fraction of their time towards home production relative to married men (Ramey, 2009), I assume that married men divide their time only between market work and leisure. Households are constrained by their budget, which is the sum of their labor income, $w_{m,t}n_m + w_{f,t}n_f$, and asset income, $(1+r_t)k$. They are not allowed to borrow ($k' \geq 0$).

At the start of the next period, with exogenous probability, d_{t+1}, married households receive a divorce shock. In the event of divorce, household assets are split equally between the two adults, consistent with the equal division regime. A divorced individual's problem is assumed to be identical to that of single individuals. $V_{p,t}(k,j)$, which describes the lifetime utility of a couple aged j with assets k, is described below:

$$\begin{aligned} V_{p,t}(k,j) = \max_{\Omega_{p,t}} \zeta_m U\Big(\frac{c}{\chi_{p,t}(j)}, \frac{c^h}{\chi^h_{p,t}(j)}, 1-n_m\Big) + (1-\zeta_m) U\Big(\frac{c}{\chi_{p,t}(j)}, \frac{c^h}{\chi^h_{p,t}(j)}, 1-n_f-n^h_f\Big) \\ + \mathbb{1}_{j<J}\beta\Big\{ d_{t+1}\{\zeta_m V_{s,t+1}(m, \frac{k'}{2}, j+1) + (1-\zeta_m) V_{s,t+1}(f, \frac{k'}{2}, j+1)\} \\ + (1-d_{t+1}) V_{p,t+1}(k', j+1)\Big\} \end{aligned} \tag{5}$$

subject to:

$$c + k' \leq w_t(m)n_m + w_t(f)n_f + (1+r_t)k \tag{6}$$

$$c^h \leq A^h_t n^h_f \tag{7}$$

$$c, c^h, k' \geq 0; n_m, n_f, n^h_f \in [0,1]; n_f + n^h_f \in [0,1] \tag{8}$$

$$\Omega_{p,t} = \{c, c^h, n_m, n_f, n^h_f, k'\}; k' = h_{p,t}(k,j)$$

The optimal policy rules for the problem described by equations $(5-8)$ is given by $\Omega^*_{p,t} = \{c^*_{p,t}(k,j), {c^h}^*_{p,t}(k,j), n^*_{p,m,t}(k,j), n^*_{p,f,t}(k,j), {n^h}^*_{p,f,t}(k,j), h^*_{p,t}(k,j)\}$.

The lifetime utility of a female and a male in a marriage is described below respectively:

$$\hat{V}_{p,t}(f,k,j) = U\Big(\frac{c^*_{p,t}}{\chi_{p,t}}, \frac{c^{h*}_{p,t}}{\chi^h_{p,t}}, 1 - n^*_{p,f,t} - n^{h^*}{}_{p,f,t}\Big) + \mathbb{1}_{j<J}\beta\Big\{d_{t+1}V_{s,t+1}\Big(f, \frac{k'^*}{2}, j+1\Big) + (1-d_{t+1})\hat{V}_{p,t}(f,k'^*,j+1)\Big\} \quad (9)$$

$$\hat{V}_{p,t}(m,k,j) = U\Big(\frac{c^*_{p,t}}{\chi_{p,t}}, \frac{c^{h*}_{p,t}}{\chi^h_{p,t}}, 1 - n^*_{p,m,t}\Big) + \mathbb{1}_{j<J}\beta\Big\{d_{t+1}V_{s,t+1}(m, \frac{k'^*}{2}, j+1) + (1-d_{t+1})\hat{V}_{p,t}\Big(m,k'^*,j+1\Big)\Big\} \quad (10)$$

3.4 Firms

There is a representative firm in the economy which rents capital K_t, at the rental rate r_t, and hires labor N_t at the wage rate, w_t to produce output Y_t each period according to the technology $Y_t = A_t K_t^\alpha N_t^{1-\alpha}$. Here A_t is the total factor productivity, and α is the capital share of output. I assume male and female labor, $N_{m,t}$ and $N_{f,t}$ respectively, are perfect substitutes, such that $N_t = N_{m,t} + N_{f,t}$. As discussed before, female wages are subject to a discrimination tax, $\Delta_t \in (0,1)$, such that $w_f = \Delta_t w_{m,t} = \Delta_t w_t$. Thus the gender wage gap, which is defined as the ratio of female wage to male wage, is represented by Δ_t.

Given w_t and r_t, the firm chooses its optimal factor demand to maximize its total profits. The firm's problem is given by:

$$max_{K_t,N_t} A_t K_t^\alpha N_t^{1-\alpha} - w_t N_t - (r_t + \delta)K_t. \quad (11)$$

where δ is the depreciation rate.

3.5 Distribution of households

The distribution of single households is represented by $\mu_{s,t}(g,k,j)$, whereas $\mu_{p,t}(k,j)$ denotes the distribution of married households. The probability of getting matched to a single of the opposite gender, $\tilde{g}$, with next period assets equal to $\tilde{k'}$, is $\theta_{t+1}(\tilde{g},\tilde{k'},j+1)$, which is defined as:

$$\theta_{t+1}(\tilde{g},\tilde{k'},j+1) = \frac{\mu_{s,t+1}(\tilde{g},\tilde{k'},j+1)}{\int_{k'}\mu_{s,t+1}(\tilde{g},k',j+1)dk'} \quad (12)$$

Aggregate distributions evolve according to the following rule:

$$\mu_{s,t+1}(g,k,j+1) = \{1-p_{t+1}(j+1)\}\int_{\{\hat{k}|k=h_{s,t}(g,\hat{k},j)\}}\mu_{s,t}(g,\hat{k},j)d\hat{k} + d_{t+1}(j+1)\int_{\{\hat{k}|k=\frac{\hat{k}}{2}\}}\mu_{p,t}(\hat{k},j)d\hat{k} \tag{13}$$

$$\mu_{p,t+1}(k,j+1) = \{1-d_{t+1}(j+1)\}\int_{\{\hat{k}|k=h_{p,t}(\hat{k},j)\}}\mu_{p,t}(\hat{k},j)d\hat{k} + \frac{1}{2}p_{t+1}(j+1)\sum_{g}\int_{\tilde{k}}\int_{\{\hat{k}|k=h_{s,t}(g,\hat{k},j)+h_{s,t}(\tilde{g},\tilde{k},j)\}}\mu_{s,t}(g,\hat{k},j)\theta_{t+1}(\tilde{g},\tilde{k},j+1)d\hat{k}.d\tilde{k} \tag{14}$$

3.6 Equilibrium

A competitive equilibrium is a set of sequences,

$$\{c_{s,t}, c^h_{s,t}, n_{s,t}, n^h_{s,t}, h_{s,t}, V_{s,t}, c_{p,t}, c^h_{p,t}, n_{p,m,t}, n_{p,f,t}, n^h_{p,f,t}, h_{p,t}, V_{p,t}, \hat{V}_{p,t}, \mu_{s,t}, \mu_{p,t}, \theta_t, w_t, r_t\}_{t=1}^{\infty}$$

for given $\mu_{s,0}, \mu_{p,0}$, that solve the households' and firm's problems and clear markets for labor, assets and output such that the following conditions are satisfied:

1. $V_{s,t}$ solves the problem for single households which is defined by equations (1)-(4) and $(c_{s,t}, c^h_{s,t}, n_{s,t}, n^h_{s,t}, h_{s,t})$ are the associated policy rules.
2. $V_{p,t}$ solves the problem for partnered households which is defined by equations (5)-(8) and $(c_{p,t}, c^h_{p,t}, n_{p,m,t}, n_{p,f,t}, n^h_{p,f,t}, h_{p,t})$ are the associated policy rules.
3. $\hat{V}_{p,t}$ is calculated using equations (9)-(10).
4. $\mu_{s,t}$ and $\mu_{p,t}$ describe the aggregate distribution over single and partnered households respectively and are calculated using equations (13-14). Subsequently θ_t is calculated using (12).
5. w_t and r_t are determined competitively and the labor market and asset market clears.

$$w_t = (1-\alpha)A_t K_t^{\alpha} N_t^{-\alpha}. \tag{15}$$

$$r_t = \alpha A_t K_t^{\alpha-1} N_t^{1-\alpha} - \delta \tag{16}$$

$$N_t = N_{m,t} + N_{f,t} \tag{17}$$

$$N_{m,t} = \sum_j \int_k \{n_{s,t}(m,k,j)\mu_{s,t}(m,k,j) + n_{p,m,t}(k,j)\mu_{p,t}(k,j)\}dk \tag{18}$$

$$N_{f,t} = \sum_j \int_k \{n_{s,t}(f,k,j)\mu_{s,t}(f,k,j) + n_{p,f,t}(k,j)\mu_{p,t}(k,j)\}dk \tag{19}$$

$$K_t = \sum_j \int_k \{\sum_g k\mu_{s,t}(g,k,j) + k\mu_{p,t}(k,j)\}dk \tag{20}$$

Thus, incorporating the gender wage gap, $w_{m,t} = w_t$ and $w_{f,t} = \Delta_t w_{m,t}$.

6. Goods market clears by Walras Law.

4 Solution and Calibration

Quantitative assessment of this framework to study the economy's business cycle responses requires the use of numerical methods to solve the model. The first step of the algorithm is to calibrate parameters so that the model's steady state matches the key moments from the data. I calibrate my parameters for my benchmark model to match a steady state corresponding to 1968. I chose 1968 as the starting year because it is the first year for which CPS March ASEC collected data on the number of young children for every individual starting 1968. The model period is one year.

Table 1 lists the parameter choices made in this framework. Since I consider workers aged 16-65, there are 50 age cohorts in the model economy. Following Knowles (2013) I assume separability in consumption of the market good, home-produced good, and leisure and the utility derived by an individual of gender g takes the functional form: $U_g(c, c^h, l) = \frac{c^{1-\sigma}}{1-\sigma} + \eta_h \frac{(c^h)^{1-\sigma^h}}{1-\sigma^h} + \eta_g \frac{l^{1-\phi}}{1-\phi}$. I assume that agents are risk averse and their coefficient of relative risk aversion with respect to market good, $\sigma = 1$, which is standard in the literature [9]. The parameter ϕ impacts the Frisch elasticity of labor supply and is assumed to equal 3, consistent with Heathcote et al. (2017). The utility curvature parameter for the home produced good, $\sigma^h = 1.5$, is taken from Knowles (2013). The choice of $\sigma^h > \sigma$ ensures that the marginal utility of the home-produced good diminishes faster than that of the market-produced good (Greenwood, Guner, & Vandenbroucke, 2017). As is standard in the literature [10], the total factor productivity, A, is normalized to 1 in steady state.

Seven parameters in this framework are calibrated. The capital depreciation rate, δ, is set to match the aggregate investment-to-capital ratio of 6.9%. The remaining parameters are jointly chosen, and the discussion below links parameters with the targets they most influence. The discount factor, $\beta = 0.9771$ and the capital's share of aggregate output, $\alpha = 0.255$ imply an annual real interest rate of 4% and aggregate capital-output ratio of 2.34 respectively. The fraction of time spent in non-market work and childcare on aggregate in 1965, equal to 0.155, is used to calculate $\eta_h = 0.0335$, the utility weight for the home-produced good. This measure

[9] See Heathcote et al. (2017) for example

[10] See Hansen (1985) for example

Pre-set	Source	Values
σ	Heathcote et al. (2017)	1
ϕ	Heathcote et al. (2017)	3
σ^h	Knowles (2013)	1.5
A	Hansen (1985)	1
Calibrated	**Targets**	**Values**
β	Annual Rate of interest	0.977
α	Capital-Output ratio	0.255
δ	Investment-Capital ratio	0.069
η_h	Fraction of time in non-market work & childcare, 1965	0.0335
η_m	Fraction of hours worked by married men, 1968	1
η_f	Fraction of hours worked by single women, 1968	1.53
ζ_m	Fraction of hours worked by married women, 1968	0.67

Table 1: Parameter choices

is calculated using the American Heritage Time Use Study (AHTUS)[11], as available through IPUMS[12]. The aggregate fraction of hours worked by married men, married women, and single women in 1968, equal to $0.333, 0.109$, and 0.198, respectively, are used as targets to evaluate the preference parameters for male and female leisure, $\eta_m = 1$ and $\eta_f = 1.53$, respectively, and the Pareto weight to the male's utility in the married household's problem, $\zeta_m = 0.67$.

Household needs increase with an increase in family size, but not proportionately due to shared expenditure. χ and χ^h are used to scale households' consumption needs of the market good and home-produced good, respectively, with changes in family size. In both cases, for single households, the adult is assigned a value of 1, whereas, for married households, the couple is assigned a value of 1.7, in accordance with the OECD equivalence scale (also known as the Oxford scale [13]). For the market good, each child is assigned a value of 0.5. For the

[11]Kimberly Fisher, Jonathan Gershuny, Sarah M. Flood, Joan Garcia Roman, and Sandra L. Hofferth. American Heritage Time Use Study Extract Builder: Version 1.2 [dataset]. Minneapolis, MN: IPUMS, 2018. https://doi.org/10.18128/D061.V1.2

[12]Time spent by individuals caring for, educating, or playing with their children is classified under childcare, consistent with Aguiar and Hurst (2007); total non-market work time includes core activities (meal preparation, clean-up, laundry, ironing), activities related to home-ownership (repairs, exterior cleaning, gardening), obtaining goods and services (grocery shopping, shopping for other items), and care for other adults (supervising and caring for other adults, preparing meals, shopping for others). Our measure of total time spent in home production is the sum of childcare time and non-market work time. This is then divided by 1440 to calculate the fraction of time spent in home production. Since we do not have data on time use in 1968, we use the data from 1965 as a proxy

[13]See Quality review of the OECD database on household incomes and poverty and the OECD earnings database, 2012

home-produced good, which includes childcare, young children are assigned a higher weight, and the fraction of time spent by households in non-market work and childcare in 1975 is used as a target.

Next, I incorporate changes in factors that have impacted the composition and behavior of families over the years as possible contributors to the secular trend in female labor supply: the narrowing of the gender wage gap, decreases in marriage rates, increases in divorce rates, and changes in the number of young children at home. I assume that agents in the model have perfect foresight with respect to transitions in each of these factors over time. I study the responses of the economy along the transition path until they reach the final steady state, which in this framework corresponds to 2014. I use the endogenous grid method[14] to solve for decision rules for each type of household at every time period. Further, I use a perfect foresight environment to study business cycle dynamics, where A_t fluctuates and represents shocks to total factor productivity.

I use the ratio of the median income of female to male full-time workers, published by the United States Census Bureau from 1968-2014, as the gender wage gap [15]. Micro-data on the number of young children aged less than five from the CPS March ASEC data from 1968-2014 is used to calculate the yearly average for a household of every age and marital status. The average calculated includes households with no children[16]. I use data from the United States Census Bureau on household type to calculate the fraction of married households for every year between 1968-2014. I use a combination of two data sources to calculate the divorce rate for the entire period of interest. First, I use data reported by Doepke and Tertilt (2016), which is available for every year until 1990[17]. Next, I use data reported by the National Center for Family and Marriage Research (NCFMR) for 2000 and every year between 2008-2014. In both cases, the divorce rate is calculated as the number of divorces per 1000 married women older than 15. I use interpolation to approximate the divorce rates between 1991-1999 and 2001-2007 by using the rates in 1990, 2000, and 2008.

The marriage rate is calculated as the ratio of the number of marriages to the number of unmarried women aged 15 and above in a given year. The NCFMR reports data on marriage rates for the years 1970, 1980, 1990, 2000, and 2008-2014. Again I use interpolation to approximate

[14] See Carroll (2006) for a detailed discussion on the solution method

[15] US Census Bureau, Historical Income Tables, Table P-36

[16] For married households, I use information reported by married women, since information on young children provided by married men is missing for three years in the data

[17] Doepke and Tertilt (2016) in turn use this data from Clarke (1995)

the marriage rates for every year in between. I assume that the marriage rates in 1968-1969 were the same as in 1970. Figures $B7$, $B8$, and $B9$ in the Appendix illustrate these changes graphically. As documented before, we find a narrowing of the gender wage gap, a decrease in the marriage rate, and a slight increase in the divorce rate till the early 1980s. There has been a substantial decline in the average number of young children for young married households aged less than 30, particularly till the late 1970s. In contrast, there has been a slight increase for older married households in the later years. A similar pattern emerges for single-women households. For single-men households, however, the average number of young children has increased for individuals of almost all ages.

5 Results

In this section, I describe three sets of results obtained from my quantitative model. Firstly, I compare the benchmark model results to their counterparts in the data. In this subsection, I analyze both the model predictions for the steady state in 1968 (targeted) and the transition of the economy to 2014 (un-targeted) as a response to the changing gender wage gap, the number of young children, marriage rates, and divorce rates. The initial steady state is characterized by low female labor supply, while the ending steady state reproduces the recent labor force participation of females. After validating that the model replicates the aggregate patterns in the data, I next study the economy's response to aggregate shocks. To understand the effect of the trend on jobless recoveries, I compare the economy's response to a common total factor productivity shock during a period with rising female labor supply to a later period when the trend has weakened. I find that the economy shows brisk recoveries in total hours worked in the presence of the trend, whereas the recoveries are jobless when the trend weakens. Finally, through the lens of this general equilibrium model, I investigate the role of each underlying causal factor in explaining the trend in female labor, which in turn led to brisk employment recoveries prior to 1990. This analysis provides insights into cyclical policies that can be introduced during episodes of jobless recoveries that would be effective in improving labor market outcomes.

5.1 Benchmark

5.1.1 Steady State

First, I discuss the model results for aggregate labor allocations at the initial (1968) and final (2014) steady state. I allow agents in the framework to respond to the changes in the gender wage gap, marriage and divorce rates, and family sizes, calculated from the data, as described in Section 4.

Table 2 shows the model performance in terms of its targeted moments from the initial steady state. The results on the average fraction of hours worked by married men, married women, single men, and single women for the benchmark model (1968) are listed. I use a measure of the average weekly hours worked by each group (this includes all those who work 0 hours) from CPS (ASEC) and divide it by 120 (total available hours in a week) to get the data counterpart. The table also lists the model results for the time spent by households on aggregate in non-market work and childcare in 1968 (our initial steady state) and in 1975. I use time use surveys to calculate these measures in the data. Since time use data for 1968 is unavailable, I use AHTUS for 1965 as a proxy for 1968. The model predicts quantitatively accurate labor allocations, as seen in the data, both in terms of targeted and un-targeted moments.

	Data	Model
Fraction of hours worked by married women, 1968	0.109	0.109
Fraction of hours worked by married men, 1968	0.333	0.332
Fraction of hours worked by single women, 1968	0.198	0.196
Fraction of hours worked by single men, 1968[1]	0.273	0.278
Fraction of hours worked on aggregate[1]	0.222	0.223
Fraction of time in non-market work & childcare, 1968	0.155	0.156
Fraction of time in non-market work & childcare, 1975	0.138	0.146

Note: [1] denotes Untargeted successes

Table 2: Calibration Targets and Overidentifying Success

Next, I compare the percentage changes in labor allocations across the two steady states. The results are illustrated in Table 3. My model performs quantitatively well in replicating the data in 2014, none of which I target. As is seen in the data, I find that aggregate labor supplied by women, both married and single increases, with a greater change by the former. Average hours worked by both married and single men decreases. I calculate the time spent by households in non-market work and childcare in 2014 using the American Time Use Survey

(ATUS) data from 2014[18][19]. Consistent with the data, time spent in non-market work and childcare on aggregate in the model also falls. My model captures more than 85% of the rise in labor supplied by married women, the group which is the most relevant in this period. Further, within married households, the increase in labor supplied by women is not entirely offset by a decrease by men, which is consistent with the evidence that substantial crowding out does not take place among couples (Fukui et al., 2018).

	Data	Model
Fraction of hours worked by married women	74.31	63.6
Fraction of hours worked by married men	-13.51	-7.59
Fraction of hours worked by single women	5.05	7.97
Fraction of hours worked by single men	-16.48	-3.15
Fraction of hours worked on aggregate	3.45	8.28
Fraction of time in non-market work & childcare	-21.58	-12.03

Table 3: Percentage change in Steady State Values from 1968 to 2014 (Untargeted)

5.1.2 Secular Trend in Labor Supply

I run my model economy forward starting from an initial set of conditions reflecting the U.S. in 1968, and I examine the labor supply changes in the aggregate as well as for each subgroup, at various points in time along the path. I assume that agents in the model have perfect foresight concerning changes in the gender wage gap, marriage rates, divorce rates, and the number of children for every year between 1968 and 2014. Figure 9 compares the implied path for aggregate labor supply that the model predicts to that seen in the data. My model performs reasonably well in predicting the trend in total labor supply. The deviations from the data occur, particularly during periods of recessions.

Further, I test the path predicted by the model for subgroups of the population: married women, married men, single women, and single men. The results are shown in Figure 10. My model-implied trend for labor supply matches well with that seen in the data for married women, married men, and single women, with deviations representing business cycle movements. For married women, the growth in labor supply was strong until the 1990s, post which the trend

[18] I use the same classifications as discussed before for AHTUS.

[19] Sarah M. Flood, Liana C. Sayer, and Daniel Backman. American Time Use Survey Data Extract Builder: Version 3.1 [dataset]. College Park, MD: University of Maryland and Minneapolis, MN: IPUMS, 2022. https://doi.org/10.18128/D060.V3.1

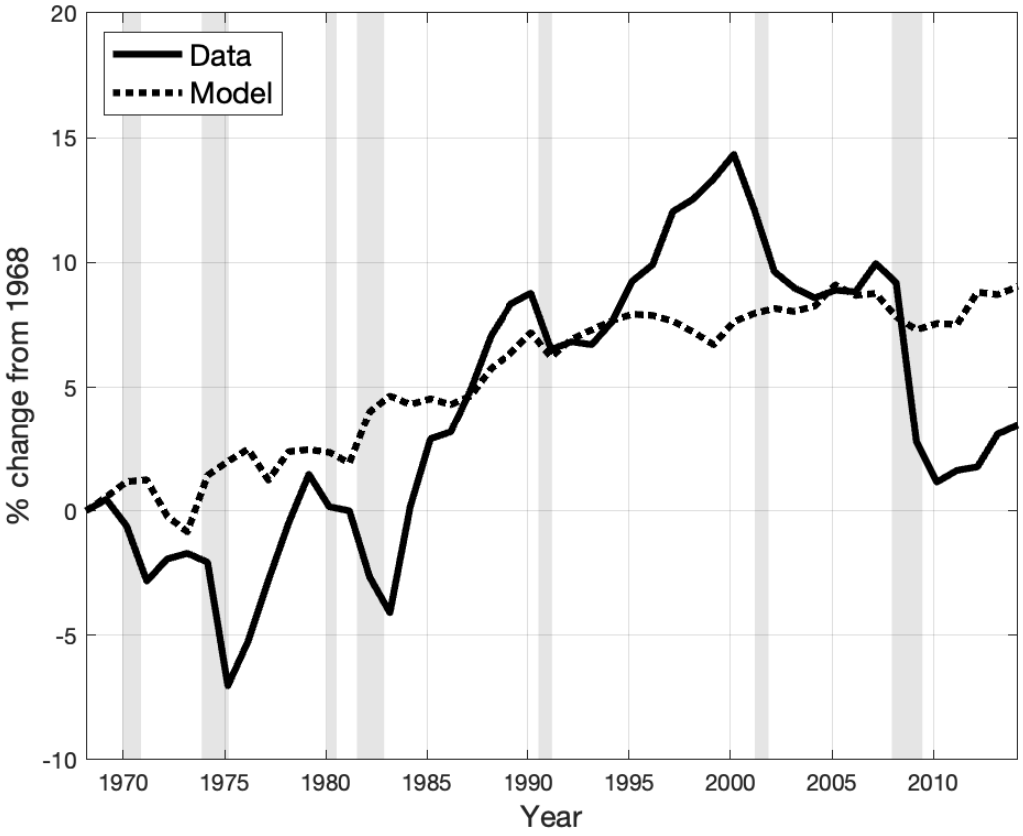


Figure 9: Aggregate labor supply: model and data

weakens consistent with the data[20]. For single men, similar to the data, the model predicts a gradual decline in their labor supply. This model validation allows us to use it to conduct relevant counterfactual exercises.

The mechanisms in the model are described as follows. As the gender wage gap decreases, the opportunity cost of not supplying labor to the market increases for women. As a result, married women switch from home production to market production, thereby increasing their labor supply. For younger cohorts, a decrease in the number of young children at home reduces demand for market goods, which has an opposite effect on labor supply. A corresponding reduction in the demand for non-market work and home-produced childcare further encourages substitution from home to market labor and leisure. For older groups, the slight increase in the number of children has an offsetting effect; however, the change is small as compared to the younger cohorts. Further, the reduction in the gender wage gap dominates. The income effect

[20]Cultural changes in preferences towards work (Fernández et al., 2004) and technological progress in home production (Greenwood et al., 2005), both factors not accounted for in the model due to a lack of a direct data measure, could help explain the small gap between the model's predictions and the data.

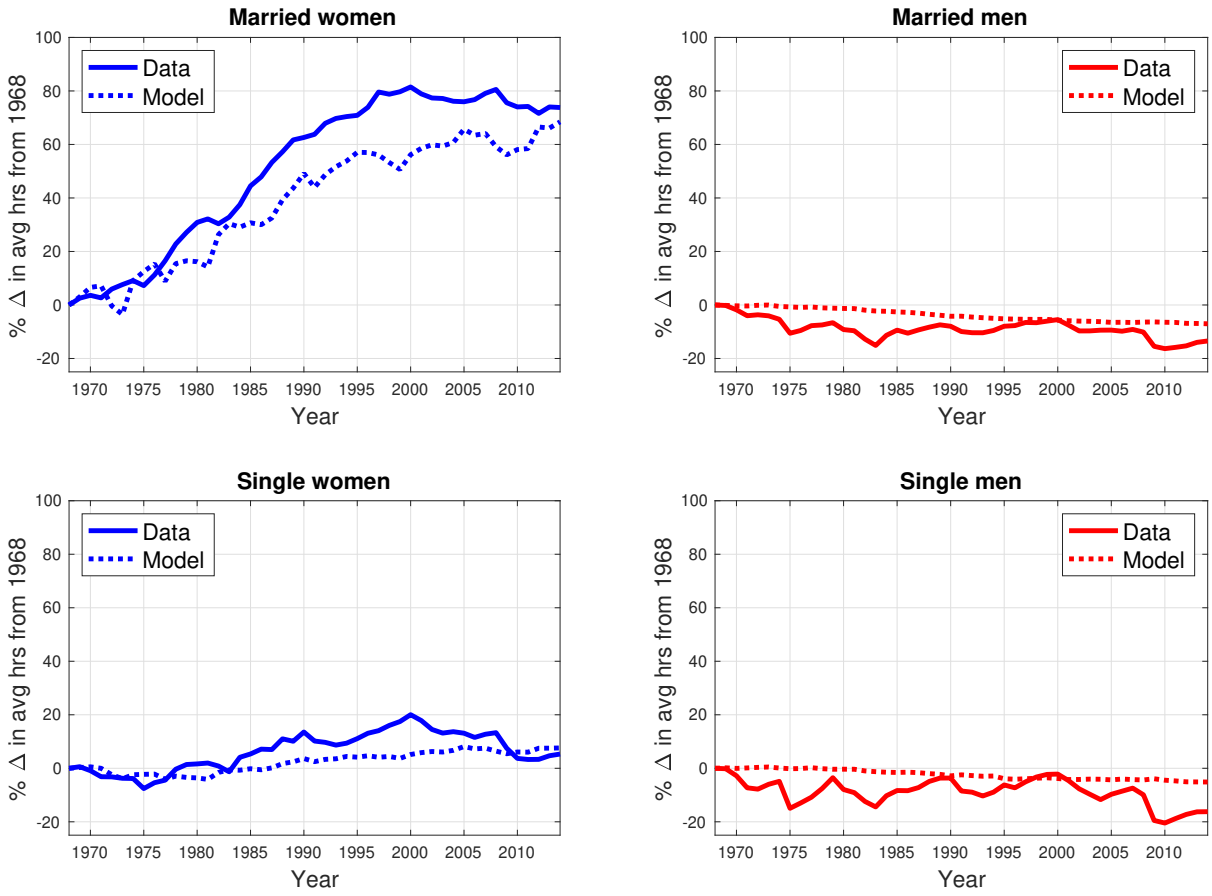


Figure 10: Aggregate labor supply for married and single, women and men

due to higher female wages results in a decrease in labor supplied by married men; since women substitute home production for market production, this effect is not very strong, as a result of which the decrease in married men's labor supply is not large.

For single women, the decrease in marriage rates incentivizes them to increase their labor supply. Since they are less likely to have a spouse with whom to pool income, single women are more likely to depend on the income they earn to finance consumption. Further, a decrease in the labor supplied by single men implies lower expected future wealth for the single women through marriage, which amplifies the negative wealth effect. An increase in household income, mainly attributed to the increased labor supply of married women, increases demand for consumption and savings of households, which in turn increases the output produced by firms and increases the wages earned by both men and women, which induces a positive wealth effect. A fall in the gender wage gap has a stronger wealth effect on single women as compared to married women, as a result of which, the overall increase in labor supplied by them is low. For single men, an increase in the average number of children between 1968 and 2014 makes it costly for them to supply labor in the market in the model, decreasing their hours worked. My model

underpredicts the overall decline in hours worked as seen in the data. I hypothesize that this is because, in the data, younger men are more likely to be single and as discussed by Aguiar and Hurst (2007), their leisure preferences have changed over time, which the model does not allow for.

5.2 Jobless Recoveries

Next, I investigate the main question in the paper: whether the weakening of the secular trend in female labor supply contributed to the emergence of jobless recoveries. To do this, I compare the response of the economy to a one-time negative aggregate productivity shock when (a) there is an upward trend in aggregate female labor supply (Pre-1990) (b) when the trend has weakened (Post-1990). For the Pre-1990 case, I assume the shock hits the economy in 1973, whereas post-1990, I assume the shock hits the economy in 2001. Agents do not anticipate the arrival of the shocks; however, they can observe the future path of the shocks after it hits the economy. I assume that the underlying process for the aggregate TFP is standard and is given by:

$$\log A_{t+1} = \rho \log A_t + \varepsilon_{t+1} \tag{21}$$

where ρ is the persistence of the process and ε is a standard normal shock. Following Boppart, Krusell, and Mitman (2018), I choose quarterly persistence of 0.95 and standard deviation of 0.007, which in annual terms translates into $\rho = 0.815$, with standard deviation equal to 0.026. The rest of the analysis shows the labor supply responses of the economy to a one standard deviation negative shock.

Figure 11 demonstrates the responses implied by the model for aggregate labor supply. We measure the percentage deviation in labor supply from the impact date (or start of a recession). As is evident, total labor supply recovers faster in a pre-1990 recession as compared to a post-1990 one. In the pre-1990 recession, in one year, the economy shows full recovery in aggregate labor (with the initial fall of 1.3%, whereas in the post-1990 recession, the economy recovers 49.6% of the initial drop (of 1.2%).

In Figure 12, the aggregate labor supply recoveries for females and males make it evident that it is the recovery in female labor supply that drives the strong recovery at the aggregate level for the pre-1990 recession. This result confirms the hypothesis that the trend in female

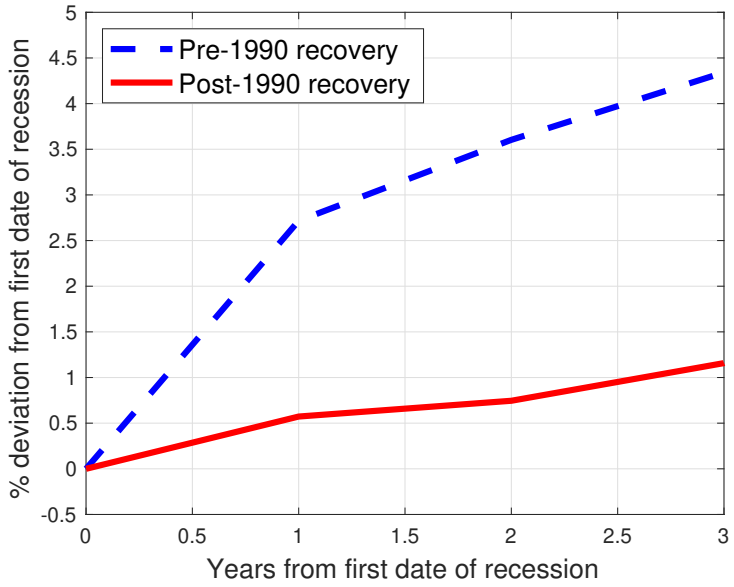


Figure 11: Cyclical response in Labor Supply: Aggregate

labor supply leveling off leads to jobless recoveries[21].

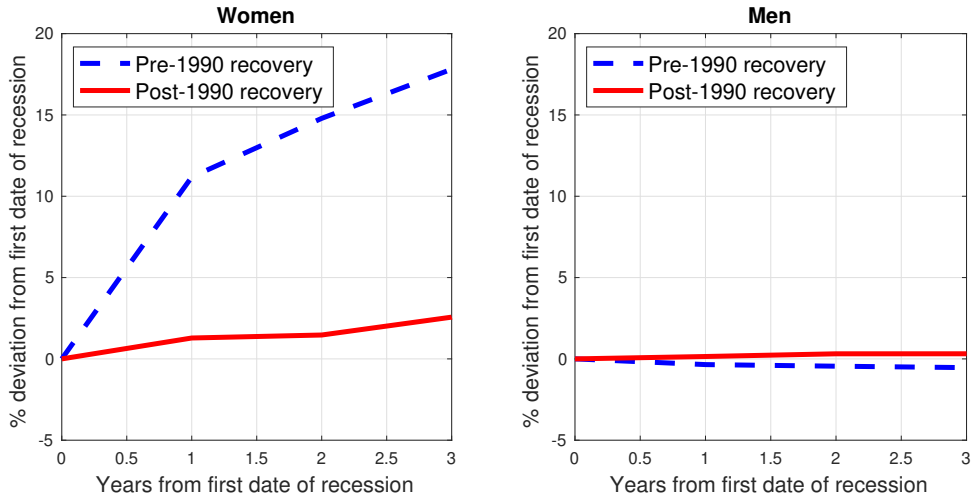


Figure 12: Cyclical response in Labor Supply: Women and Men

I further subdivide the women population based on their marital status and look at the cyclical response in labor supply for married and single women separately. Figure 13 shows that married women were the primary drivers during the pre-1990 recoveries. These results are consistent with the empirical evidence in Section 2. It is the secular trend in the labor supply of married women with children, which drives the strong recovery following the pre-1990 recession.

[21]It has been documented that men show a larger drop in employment during recessions relative to women due to gender differences across sectors (Albanesi & Şahin, 2018) and spousal insurance provided by the married (Mankart & Oikonomou, 2017; Olsson, 2018). My model is unable to capture these differences at the onset of the recessions due to the absence of sectoral composition and gender-specific income risk; however, the focus of my analysis is not on the impact but on the recovery thereafter, the model predictions of which are consistent with empirical evidence

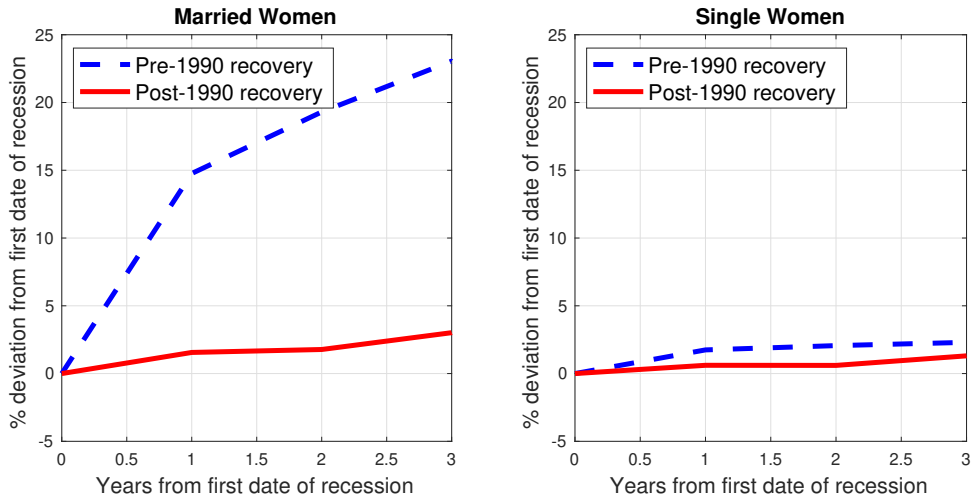


Figure 13: Cyclical response in Labor Supply: Married and Single Women

5.3 Decomposition of Factors

To identify the relative contribution of a change in each of the factors, I conduct counterfactual experiments where I allow all but one of the factors to change from 1968 to 2014.

5.3.1 Understanding steady state changes

The results from this exercise for the steady state changes are listed in Table 4. Each column describes the percentage change in outcomes from 1968 to 2014 that remains unexplained if we fix the (1) gender wage gap, (2) the marriage rate, (3) the divorce rate and (4) the number of young children at home respectively to its 1968 level. The results suggest that for married men and women, the most significant contributor has been a narrowing of the gender wage gap, which makes it more favorable for women to increase their labor supply and men to decrease theirs. For single men, the increase in the average number of young children at home across all age cohorts is the primary contributor towards a decrease in the labor supplied in the market. For single women, the decline in marriage rates is the largest contributor towards increasing labor supply.

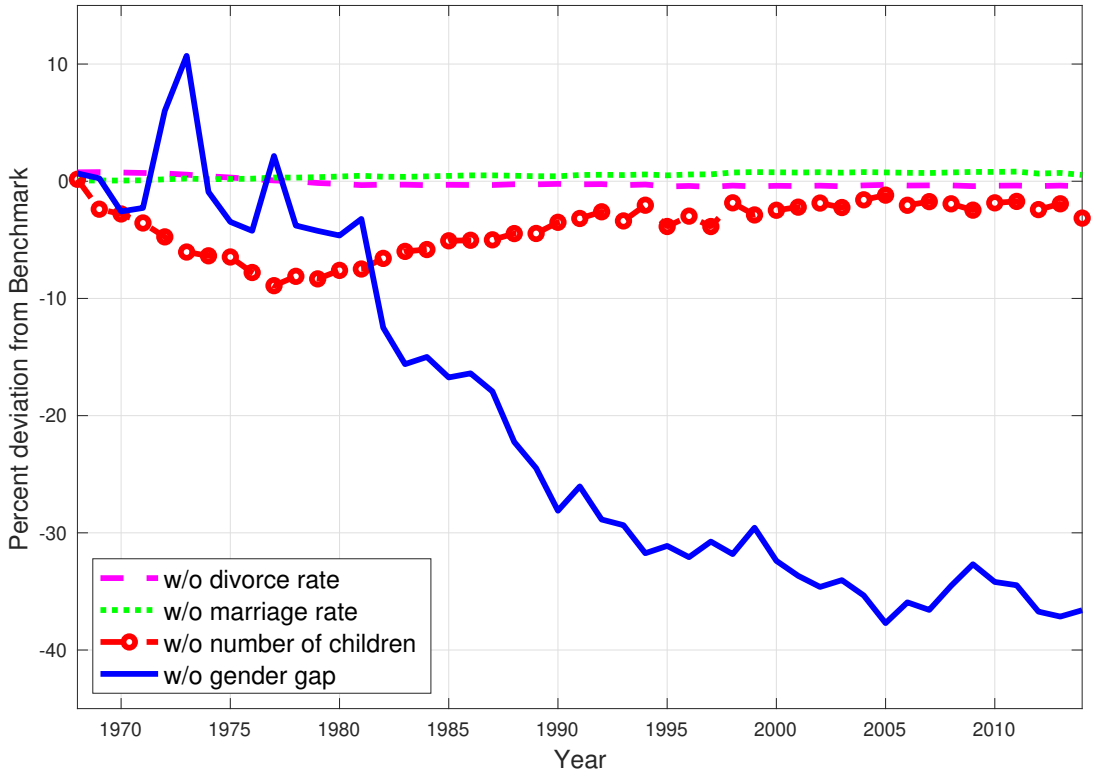
5.3.2 Understanding Secular Trend in Labor Supply

Next, to identify the importance of each of these underlying factors along the trend, I conduct counterfactual exercises, where I allow all but one of these factors to change over time. The results for married and single women are illustrated in Figures 14 and 15, respectively. The corresponding results for men are shown in Figures $B12$ and $B13$ in Appendix B.

	(1)	(2)	(3)	(4)
Fraction of hours worked by married women	-36.38	0.76	-0.32	-2.94
Fraction of hours worked by married men	8.16	-0.03	-0.34	0.38
Fraction of hours worked by single women	-2.4	-5.65	1.21	-0.10
Fraction of hours worked by single men	0.46	-1.18	0.78	1.61
Fraction of hours worked on aggregate	-5.78	-0.33	0.08	-0.29
Fraction of time in non-market work & childcare	9.73	-2.13	-0.55	2.32

Notes: Each column describes the percentage deviation from the benchmark (when all factors are allowed to change) if we fix the (1) gender wage gap, (2) the marriage rate, (3) the divorce rate and (4) the number of young children at home respectively to their 1968 level. Positive numbers imply that the labor allocation would have been higher than the benchmark if the corresponding factor had not changed over time. Similarly, negative numbers imply that the labor allocation would have been lower than the benchmark.

Table 4: Contributions of leading causal factors to labor allocation changes

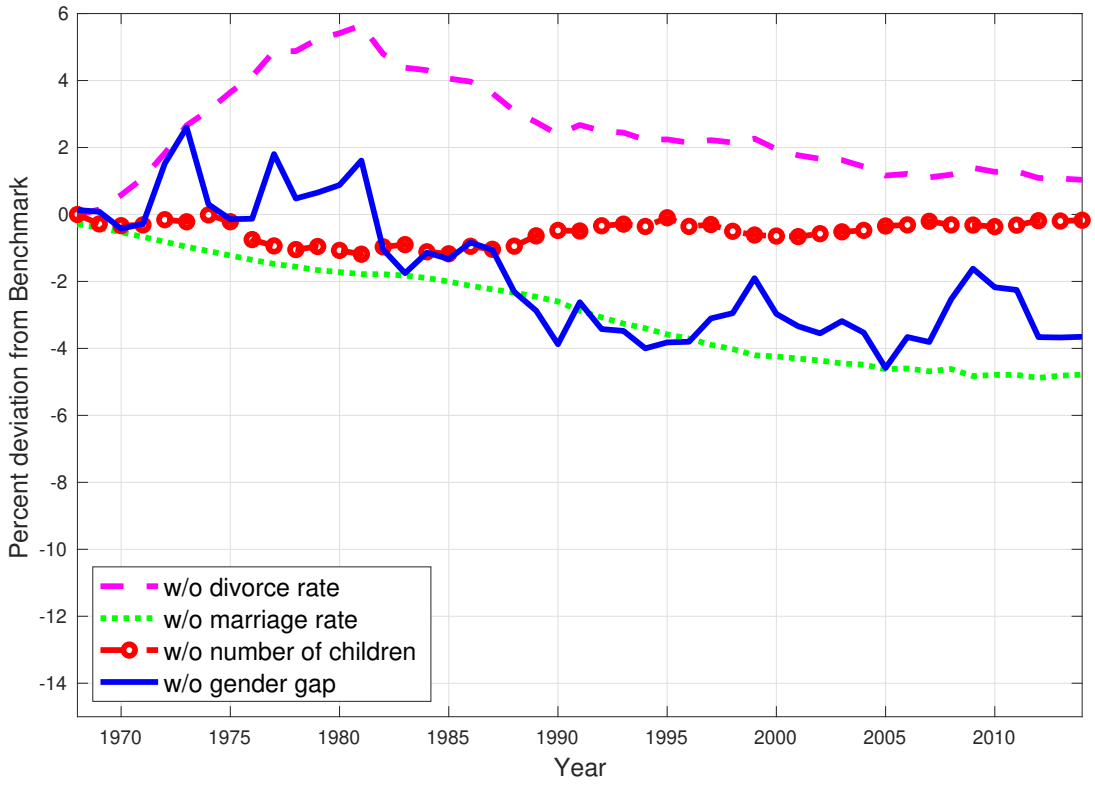


Note: The y-axis measures the percentage deviation from the benchmark model, where all of the underlying factors are allowed to change. The resulting difference measures the relative contribution of each factor.

Figure 14: Decomposition into factors underlying married women's trend in labor supply

For married women, the results indicate that from 1968 to the early 1980s (the years that coincide with the brisk employment recoveries), the most important factor that is associated with the upward trend in labor supply is a fall in the number of young children at home. After that, the gender wage gap is the primary driving force. This decomposition highlights

the association between female labor supply and children, mainly because the strongest upward trend in married women's labor supply existed in the early part of the transition. Further, as can be seen from Figure $B9$ in Appendix B, the younger married households saw the largest decline in the number of young children. This corroborates the empirical evidence that employment recoveries in the pre-1990s recessions were different for young, married women with young children. This decomposition exercise over the transition path highlights the importance of children in a way that could not be captured by the comparison of the two steady states (Table 4).



Note: The y-axis measures the percentage deviation from the benchmark model, where all of the underlying factors are allowed to change. The resulting difference measures the relative contribution of each factor.

Figure 15: Decomposition into factors underlying single women's trend in labor supply

For single women, the decline in marriage rates is the primary contributor towards an increasing labor supply both across steady states as well as along the trend. The model further predicts that if divorce rates had not changed, the labor supply increase would have been higher. As discussed earlier, marriage allows for income pooling, which decreases women's incentive to supply market labor since men's wages are higher. However, it is to be noted here that the overall change in the labor supplied by single women is substantially smaller than their married counterparts, as was illustrated in Figure 14. As a result, the contribution of each of these

factors to explain is also substantially smaller in magnitude.

6 Further Discussion

6.1 Policy Implications

In this paper, we have established that the trend in female labor supply contributed to brisk employment recoveries during the recessions prior to 1990. During this time, married women increased their labor supply in response to changes in several underlying demographic factors, among which a decrease in the number of young children in households played the most important role. Less young children at home reduced the time women needed to spend at home doing housework and childcare. Using this insight, we can discuss policy experiments to mitigate jobless recoveries during episodes of low female employment by reducing the cost of raising children during recessions. The general equilibrium framework in this paper is ideally suited to conduct these counterfactual exercises.

One such experiment is discussed in detail in Appendix A. I study the impact of a countercyclical government subsidy that reduces the per-unit cost of buying a market service that substitutes the labor supplied at home (for example, market-provided childcare). The benchmark model is extended to account for a second sector that produces this service using labor as its input. Workers in this sector are compensated at the equilibrium wage rate. Households have the additional option of buying this market-provided service at a price determined in equilibrium. Next, I analyze the employment recovery in a post-1990 recession (where the trend in female labor force participation has subsided) in the presence of this policy and compare it to an environment where no such provision is available.

The results from this exercise show that in the presence of the childcare subsidy, the fall in market work in response to an unanticipated negative aggregate TFP shock is lower, and recovery is faster relative to the benchmark. In the presence of a countercyclical subsidy, the effective cost of the market-provided service falls during a recession, which increases its quantity demanded. Subsequently, the demand for workers in this sector rises which helps to dampen the fall in equilibrium wages. The subsidy induces both a wealth effect as well as a substitution effect on the labor supply of individuals. For women (particularly married women), the substitution effect well dominates the wealth effect as a result of which there is an overall increase.

6.2 Endogenous Fertility

In this model, we assume that fertility is exogenous and the number of children in the different households is measured from the data. While extending this model to incorporate endogenous fertility decisions in response to changing labor market conditions for women could be an interesting exercise, it is not of first-order importance for our main results. As illustrated in Figure $B9$ in Appendix B, both married and single female-headed households saw a decline in the number of young children from 1968 until the early 1980s. As shown in Section 5.3, this change was the most significant contributor to labor supply changes for married women, who were the drivers of the strong trend in female labor force participation and subsequent brisk employment recoveries during this period. As illustrated in Figure $B8$, the gender wage gap, which reflects the labor conditions for women, starts to fall after 1982, thus playing an important role afterward. The fertility decline during this period could be the household's response to exogenous factors such as a reduction in child mortality rates (Murphy, Simon, & Tamura, 2008) or the pill revolution (Goldin & Katz, 2002). The assumption of exogenous fertility may be a potential shortcoming of the cyclical policy experiments discussed above[22]; however, endogenizing it in this environment will be non-trivial and due to the computational costs involved, are left for future exploration.

7 Conclusion

In this paper, I study the connection between the weakened secular trend in female labor supply and jobless recoveries. I examine this question, both empirically and through the lens of a general equilibrium macroeconomic model. In my empirical analysis, I study the employment recoveries of different demographic groups over the last five recessions. On segregating the population based on age, marital status, gender, presence of children, and education, I find that young married women with children were not only the primary drivers of aggregate employment recoveries in recessions but also showed the strongest growth in labor supply before 1990.

The results from my empirical analysis inform the specification of my theoretical framework, using which I study the interaction between female and male labor supply both at the household level and at the aggregate level. To examine the contribution of this secular trend towards jobless recovery, I compare my model's economic downturn and recovery over a pre-1990 recession, in

[22] fertility has been shown to exhibit cyclical behavior (Coskun & Dalgic, 2022; Jones & Schoonbroodt, 2016)

the presence of an upward trend in female labor force participation, versus the responses to the same aggregate shock over a post-1990 recession when the trend has flattened. The model predicts significantly slower aggregate employment recoveries post-1990 as compared to the pre-1990 era, confirming the hypothesis that the weakened secular trend has contributed to the emergence of jobless recoveries over recent U.S. recessions.

Next, I investigate the relative contribution of several underlying factors that give rise to the secular trend in the labor force participation of young, married women with children, which in turn contributed to the strong employment recoveries prior to 1990. Although the gender wage gap is the most important factor in the overall increase, I find that over early dates, when the upward trend in female labor supply is the strongest, a lower number of young children reduces the time cost associated with household production and is the most crucial factor.

Based on my findings that there is an association between strong female labor supply growth and a reduction in the number of children and that the leveling off in the trend contributes towards jobless recoveries, I study the effect of a countercyclical childcare subsidy. I find that married women show an increase in labor supplied and a faster recovery during recessions, which dominates the negative effect on the labor supply responses of other groups, which results in a faster aggregate employment recovery.

A possible extension of this analysis would account for educational differences across groups of women. One of the factors that have contributed to the narrowing of the gender wage gap is the increase in the average educational attainment of women over time. Given that this is a substantial contributor towards the secular change in female labor supply, it would be interesting to explore the implications for jobless recoveries if I account for endogenous human capital investment decisions for women. Further, given the results that I obtain, I could examine the effectiveness of alternative government policies, which are aimed at increasing the educational attainment for women.

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Appendix

A Policy experiment

I use an extension of my framework to examine the effectiveness of a countercyclical government subsidy, τ_c, that reduces the per-unit cost of buying a market service that substitutes the labor supplied at home (for example, a childcare subsidy). A (childcare) sector produces this service using labor-intensive technology, and the production function is given by $Y_t^h = \gamma A_t N_t^h$, where N^h denotes the number of workers and γ measures the relative productivity in this sector. Workers are paid the market equilibrium wage rate such that they are indifferent between working here and in the final goods sector. Thus aggregate labor, $N_t = N_t^y + N_t^h$, where N_t^y represents workers in the final goods firm.

Households have the additional option of buying this service: φ from the market at the equilibrium price, q. There is a required amount of the home-produced good, c_s^h and c_p^h that needs to be consumed by single and married households respectively[23]. Thus the constraints for single households are given by

$$c + (1 - \tau_{c,t}) q_t \varphi + k' \leq (1 - \tau_w) w_t(g) n + (1 + (1 - \tau_r) r_t) k \tag{22}$$

$$c^h \leq (n^h)^\psi + \varphi \tag{23}$$

[23]This is equivalent to the outcome that we solve in our benchmark model. For simplicity, we assume that all households of a particular age and marital status need to consume a fixed c^h, which is equal to the median c^h that we calculate for that group.

and that for married households are given by

$$\begin{aligned} c + (1-\tau_{c,t})q_t\varphi + k' \leq & (1-\tau_w)w_t(m)n_m + (1-\tau_w)w_t(f)n_f \\ & + (1 + (1-\tau_r)r_t)k \end{aligned} \tag{24}$$

$$c^h \leq (n_f^h)^\psi + \varphi \tag{25}$$

The policy is funded using taxes on wage (τ_w) and rental income (τ_r), and Government spending G. Thus,

$$\text{Total Subsidy}_t = \tau_w \sum_g w_{g,t}N_{g,t} + \tau_r r_t K_t - G_t \tag{26}$$

Next, I compare the recoveries in the post-1990 recessions (when the trend in female labor force participation leveled off) in the presence and absence of this countercyclical government subsidy. I solve for the steady state in this model corresponding to 2014 and introduce unanticipated aggregate shocks, keeping the demographic factors constant at their 2014 levels (which, in the absence of shocks, would lead to no change in the labor supply responses). To conduct this numerical exercise, I assume the following parameter values: $\tau_w = \tau_r = 10\%$. I discuss the results under a subsidy that starts at 2.5% when the recession hits the economy and has the same persistence as aggregate productivity. This parametric choice ensures that $G_t > 0$, $\forall t$[24].

Figure $A1$ illustrates the results. In the presence of a countercyclical subsidy, in response to the unanticipated negative TFP shock, aggregate labor supply falls by 0.5%, whereas in the absence of the policy, there is an initial fall of 1.4%. Further, the economy recovers faster in the case of the former, with a half-life of 1 year. The half-life of the recession in the absence of the policy is close to 2 years.

To investigate the role of gender, I next examine the policy's effect on the cyclical changes in labor supply for men and women. Figure $A2$ displays the results. I find that the policy is effective in more than compensating the initial drop in labor supply for women and leads to a subsequent increase. This is because women bear the bulk of the childcare responsibilities in this economy, and the subsidy allows them to increase their labor supply even during a recession. We find that men also benefit from the policy in terms of the initial impact, but it does not

[24]Parametric choices of $\gamma = 2$ and $\psi = 0.8$ ensure that the implied q, which in this framework is determined by the equilibrium wage rate (since production in this sector is linear in N) allows at least some households to afford the market-produced service and shows variation over time

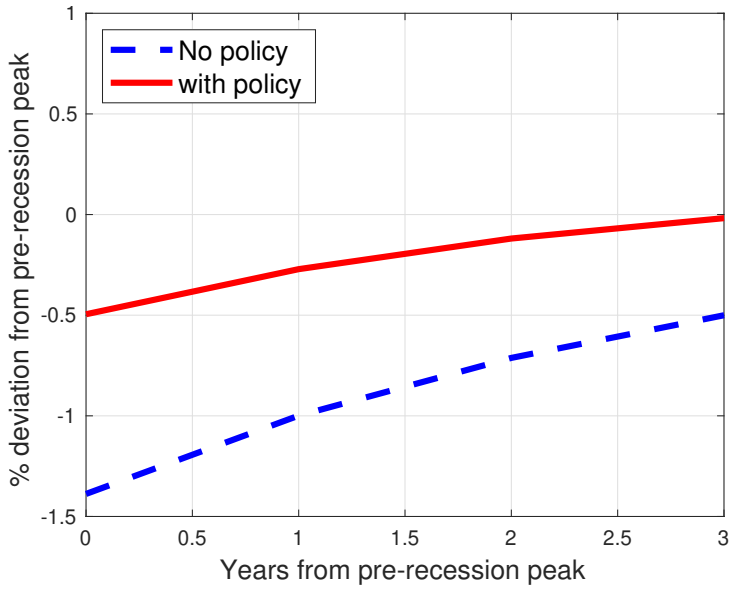


Figure A1: Aggregate Labor Supply response to Countercyclical Subsidy

affect their recovery. Since the change is greater for women, it is reflected in aggregate labor supply responses.

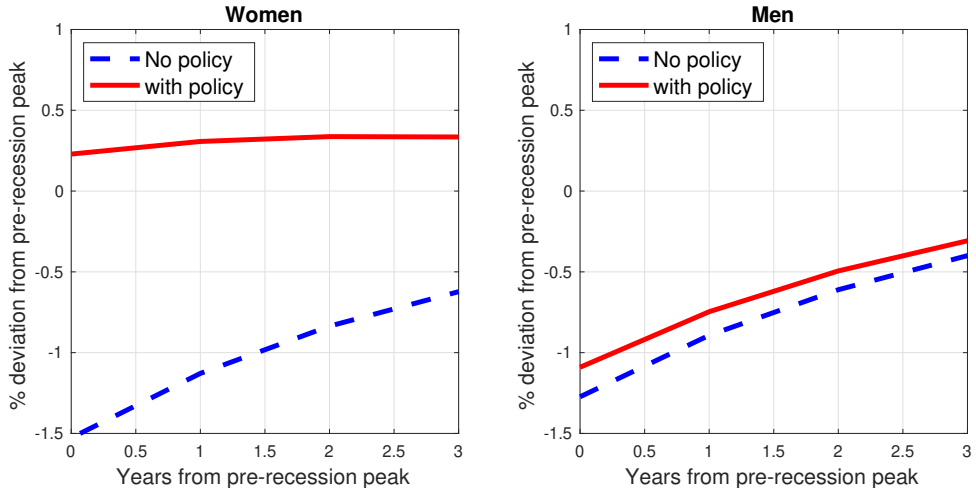


Figure A2: Responses to Countercyclical Subsidy by Gender

The results from this exercise show that in the presence of the childcare subsidy, the fall in market work in response to an unanticipated negative aggregate TFP shock is lower, and recovery is faster relative to the benchmark. In the presence of a countercyclical subsidy, the effective cost of the market-provided service falls during a recession, which increases its quantity demand. Subsequently, the demand for workers in the childcare sector rises, which helps to dampen the fall in equilibrium wages. The subsidy induces both a wealth effect as well as a substitution effect on the labor supply of individuals. For women (particularly married

women), the substitution effect well dominates the wealth effect, as a result of which there is an overall increase.

B Additional Figures

B.1 Female market work over time

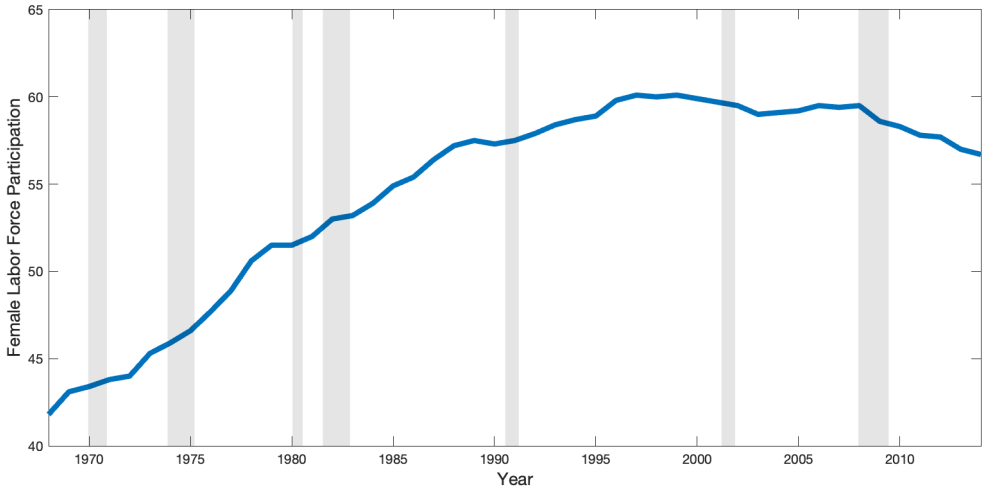


Figure B1: Secular trend in Female Labor Force Participation

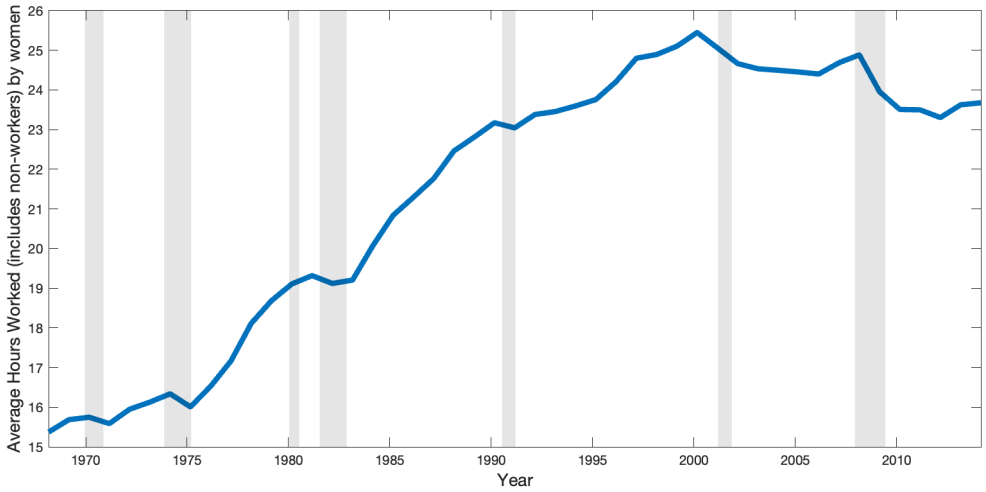
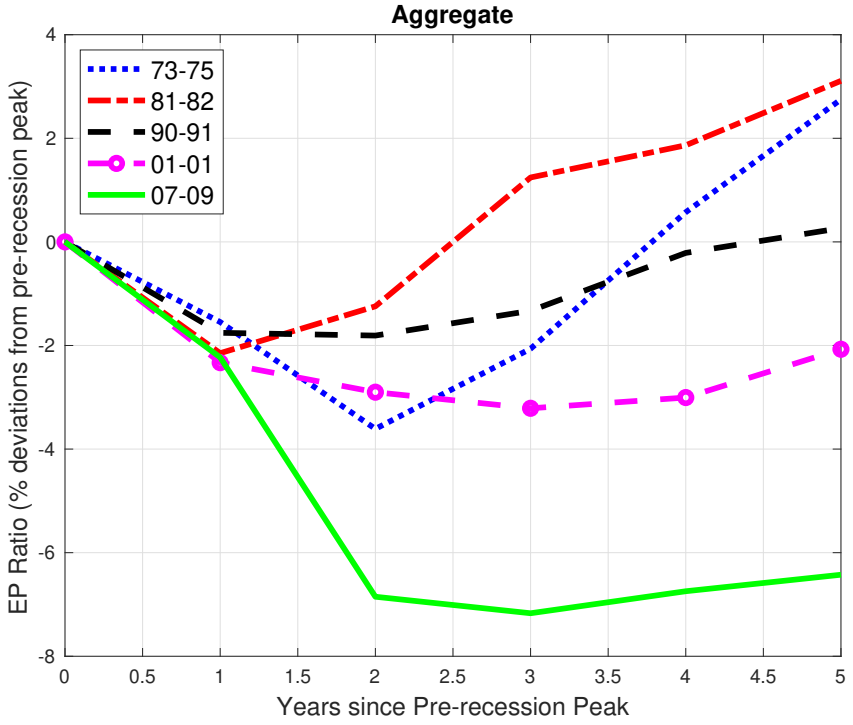


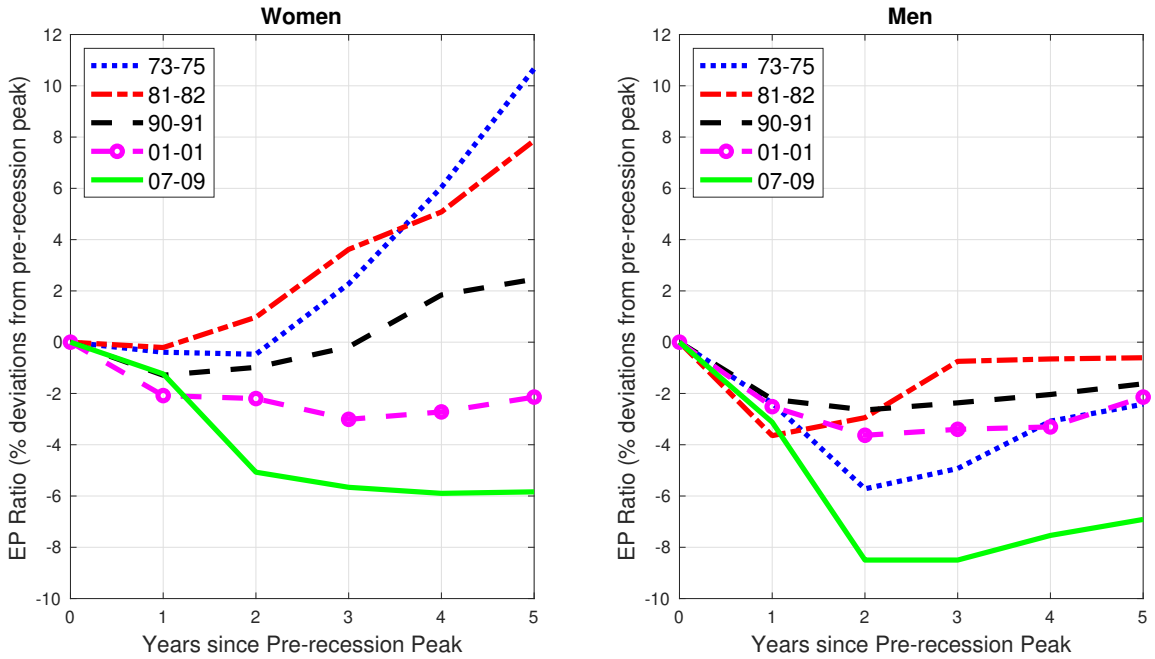
Figure B2: Secular trend in Average Hours Worked

Notes: The labor force participation series comes from the Current Population Survey (Household level) and has been retrieved from FRED, Federal Reserve Bank of St. Louis. This data is seasonally adjusted and aggregated at the annual level. Average hours worked have been calculated using disaggregated data from ASEC of CPS.

B.2 Employment Recoveries



(a) All workers



(b) Male and Female workers

Notes: This figure graphs the employment-to-population ratio of all workers aged 16 and above during the last five recessions (pre-recession peaks defined as per NBER) prior to the pandemic and the subsequent recoveries. We ignore the recession in 1980 due to the subsequent recession that soon followed. This series comes from the Current Population Survey (Household level) and has been retrieved from FRED, Federal Reserve Bank of St. Louis. This data is seasonally adjusted and aggregated at the annual level.

Figure B3: Slowing Recoveries for Workers

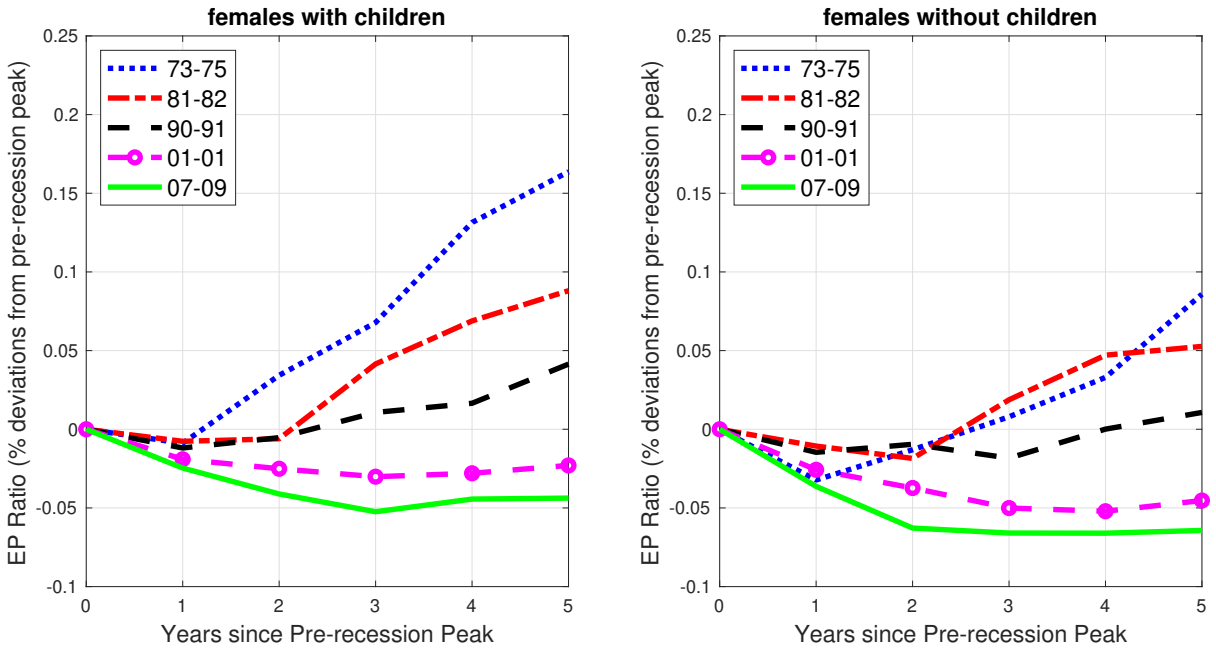
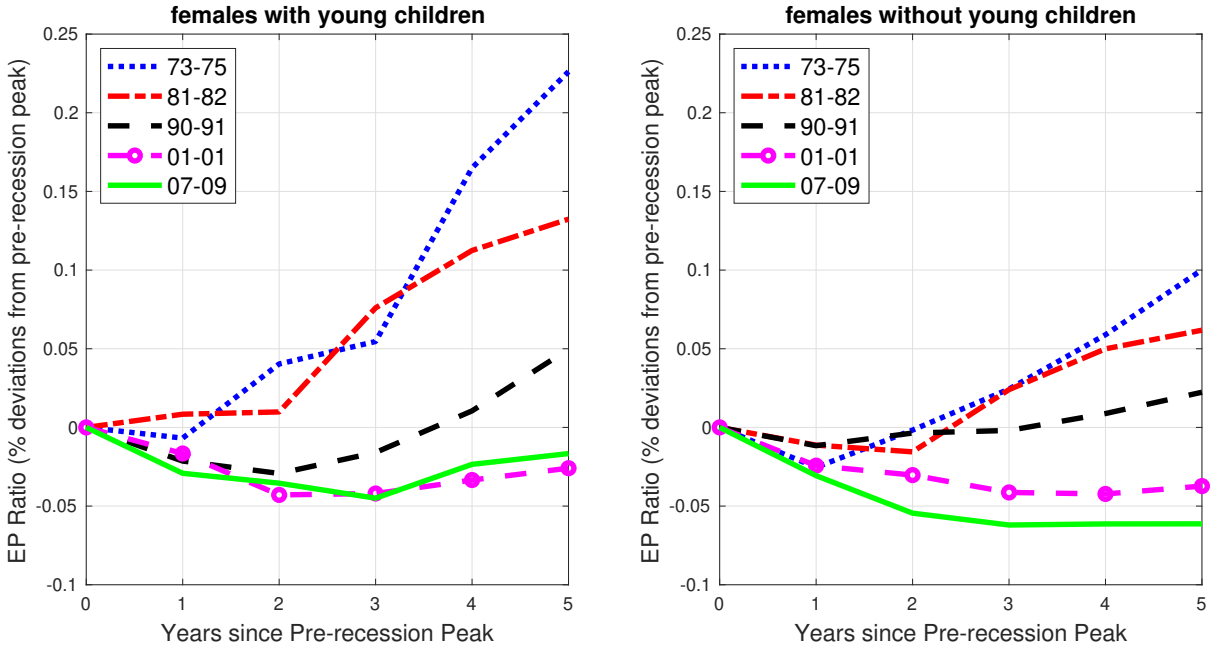
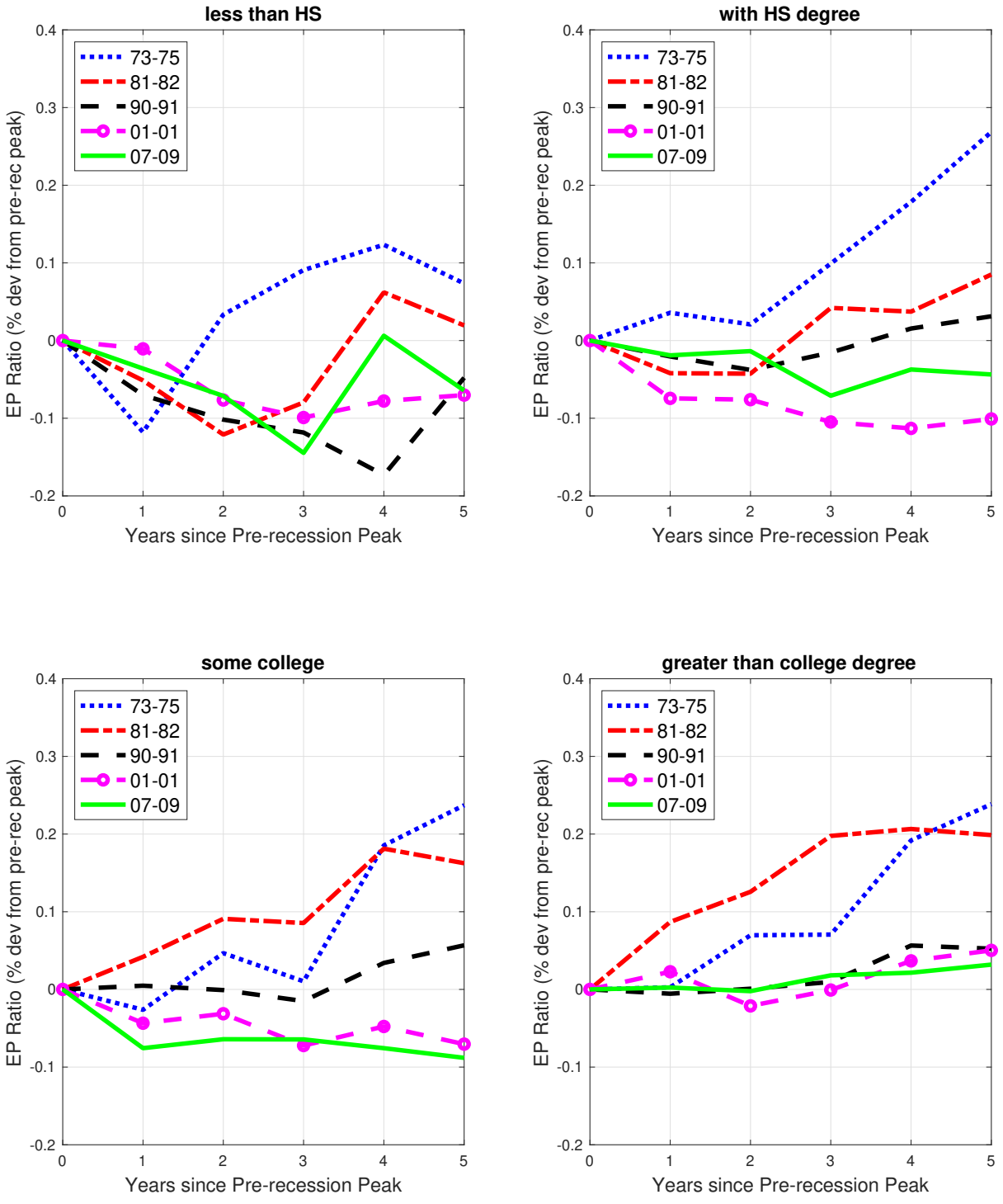


Figure B4: Employment recoveries for women by presence of children



Notes: Young children implies those aged less than five

Figure B5: Employment recoveries for Women by presence of young children



Notes: Population restricted to those aged between 16-44 and have at least one child younger than five

Figure B6: Employment recoveries for young married mothers by education

B.3 Changes in demographic factors

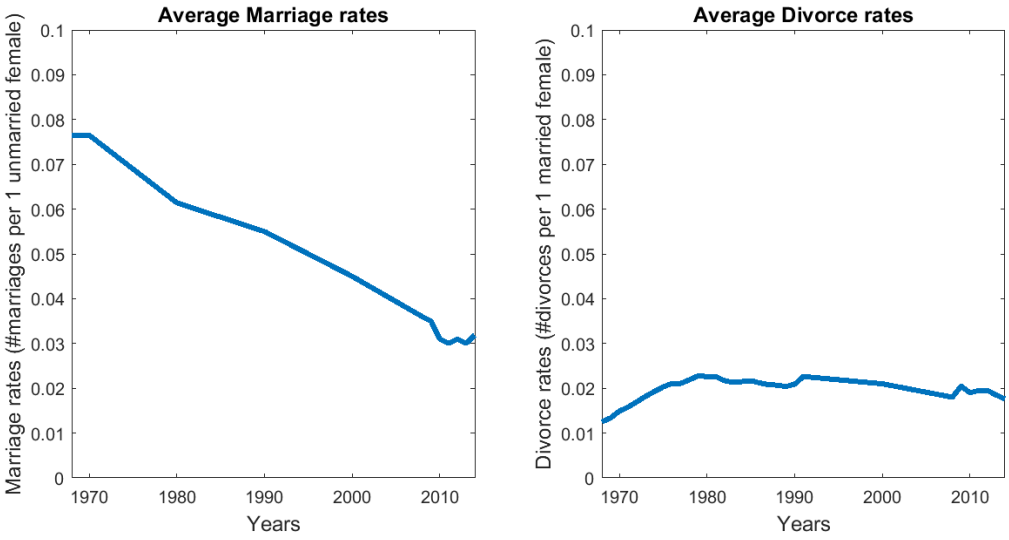


Figure B7: Marriage and Divorce rates over the years

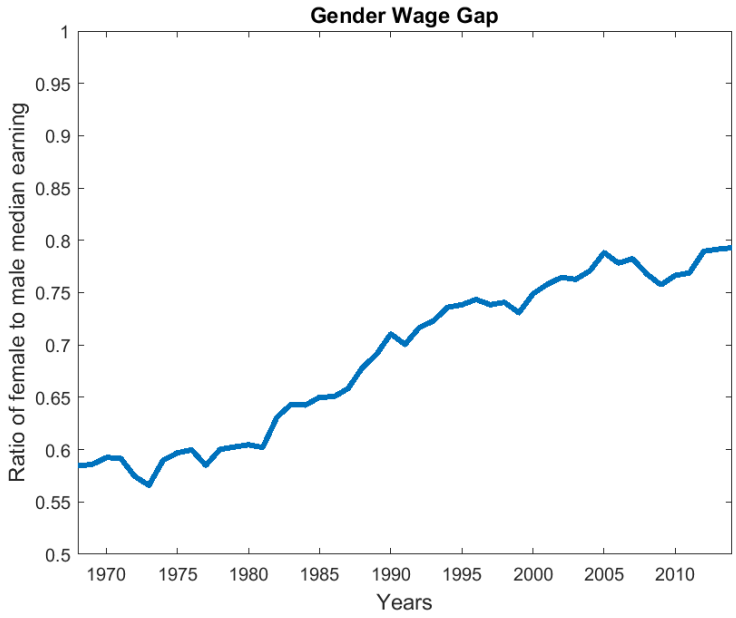
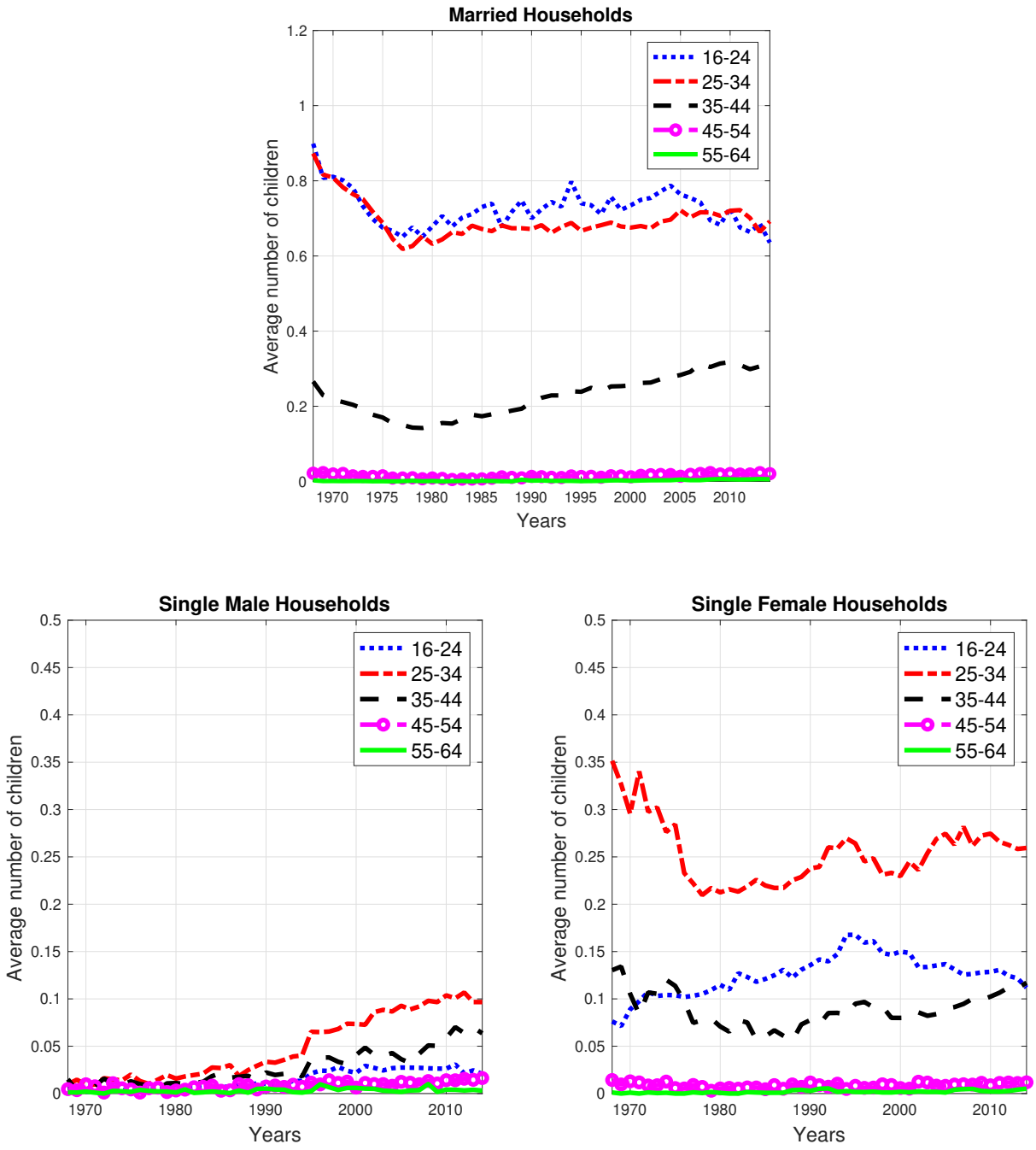


Figure B8: Changes in the Gender Wage Gap



Note: These averages have been calculated from the CPS (March ASEC) and include all households with zero children.

Figure B9: Average number of young children by household type

B.4 Time Use with children

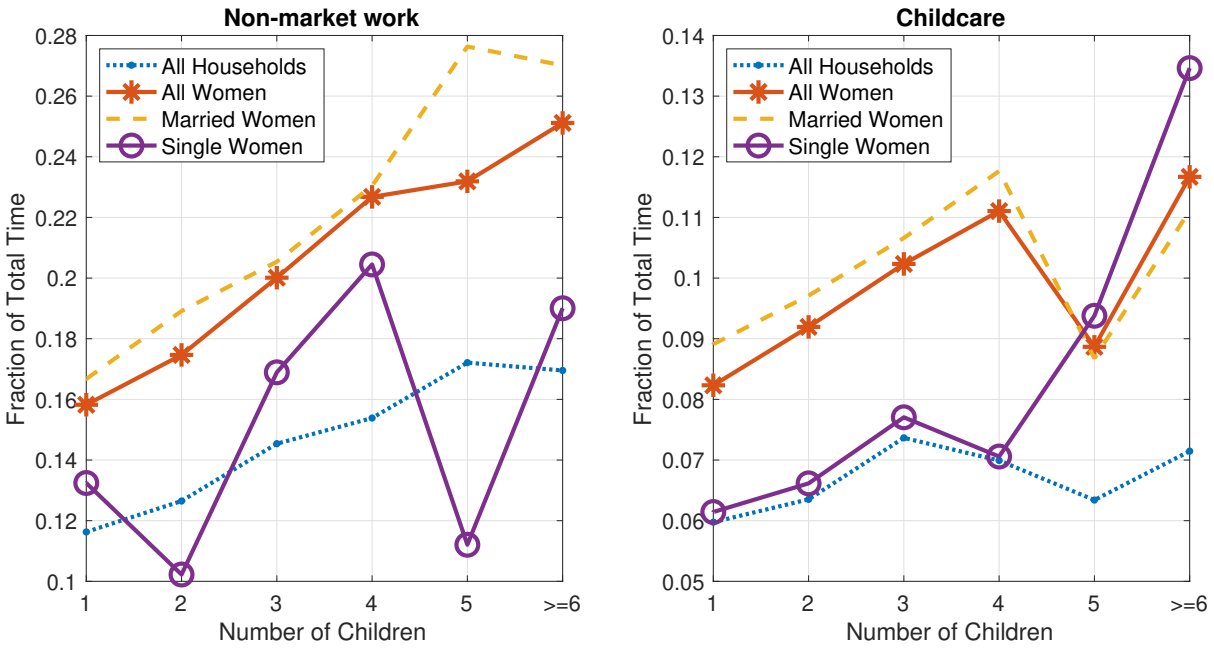


Figure B10: Time spent in non-market work increases with the number of children

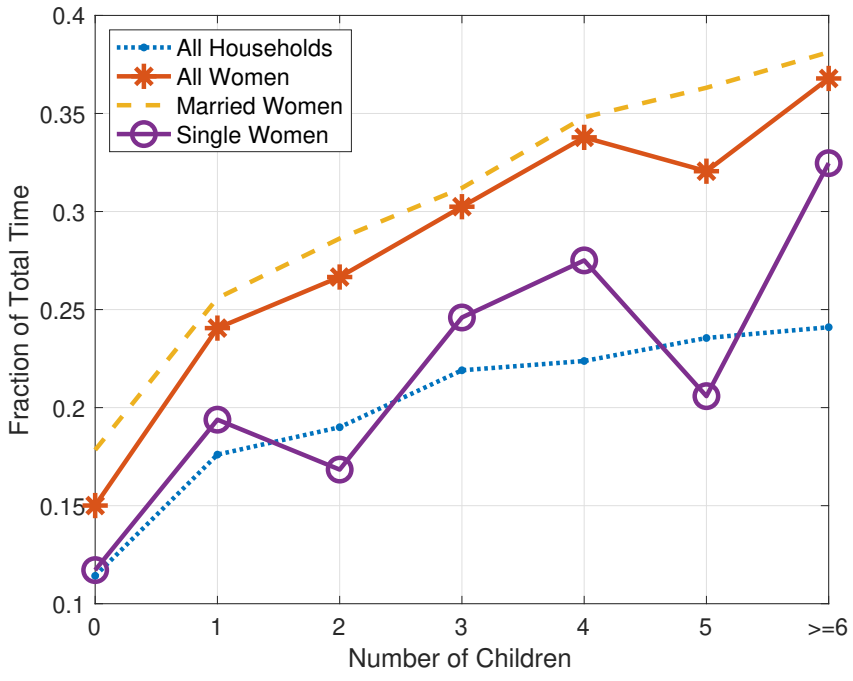


Figure B11: Non-market work and childcare time increases with the number of children

B.5 Decomposition of Factors for Men

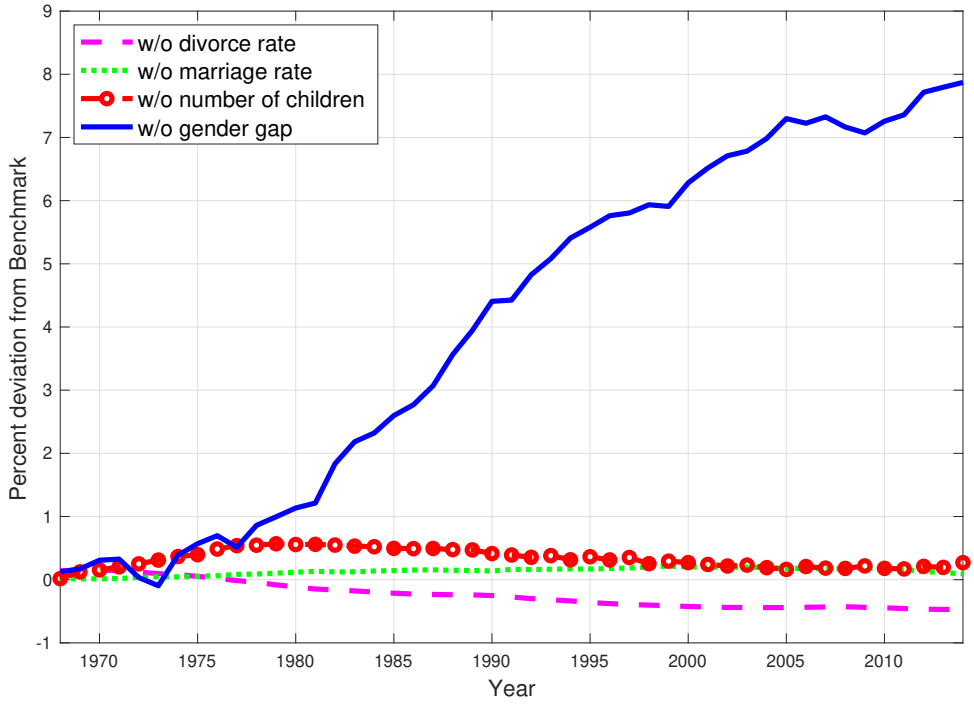


Figure B12: Decomposition into factors underlying married men's trend in labor supply

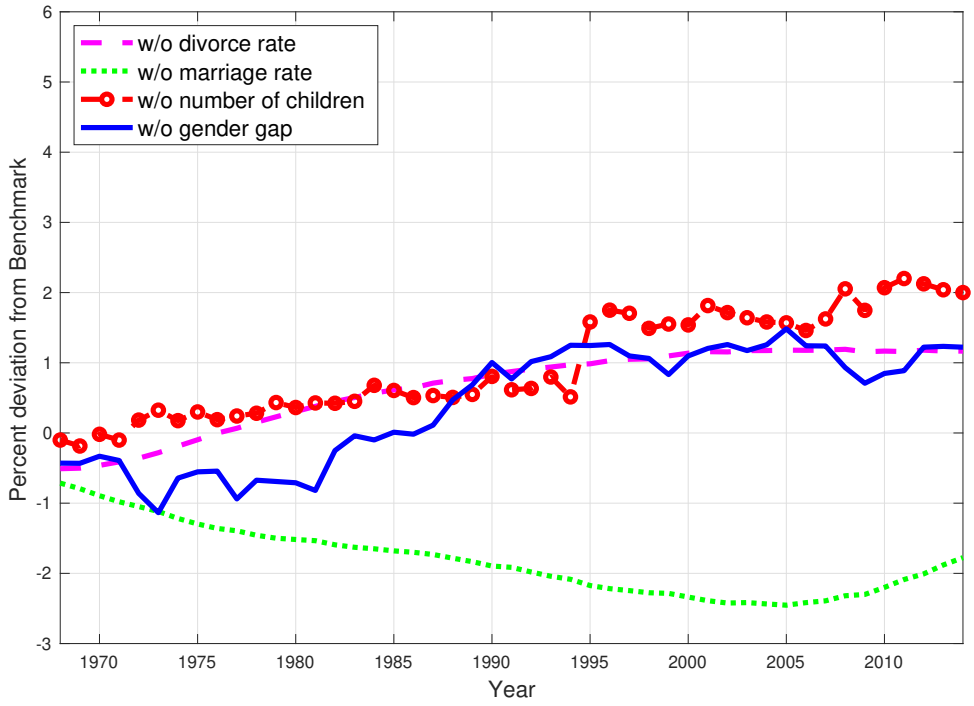


Figure B13: Decomposition into factors underlying single men's trend in labor supply

B.6 Cyclical Response Comparison for Men

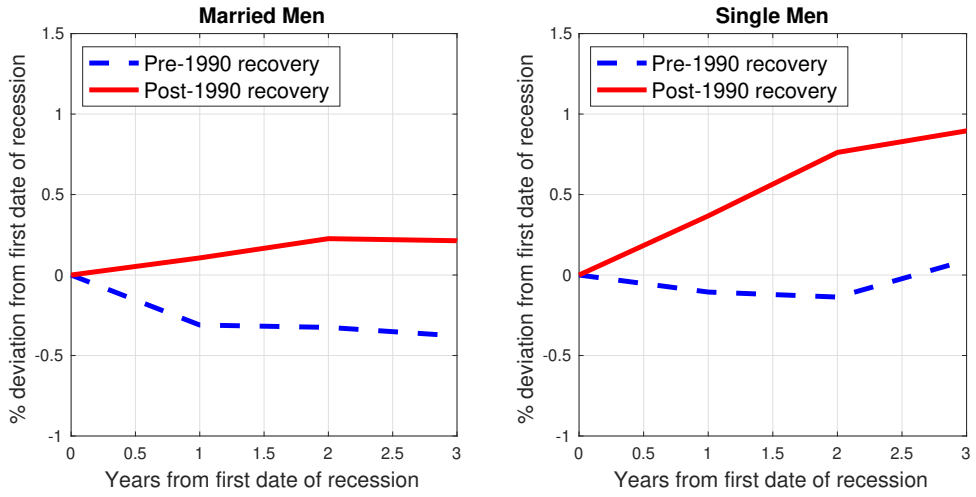


Figure B14: Cyclical response in Labor Supply: Married and Single Men