# Female Labor Supply and Jobless Recovery

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**Abstract**

The first strand of my research explores the role of gender in affecting macroeconomic outcomes. In one of my papers, titled "Female Labor Supply and Jobless Recovery," I examine the extent to which a weakened trend in female labor force participation contributes to jobless recoveries in the recessions post-1990. I document that 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 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, 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.

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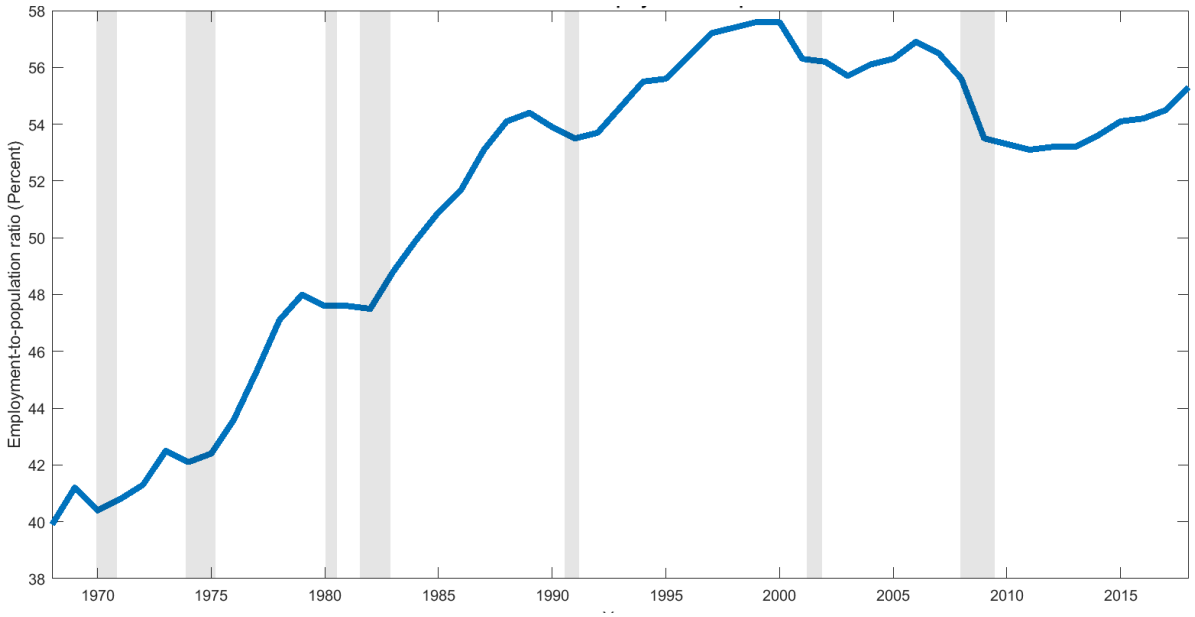
†See: https://github.com/PubaliC/JMP/blob/master/Pubali_JMP.pdf

# 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 towards mitigating jobless recoveries, the impact of which I examine using my framework.

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




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.

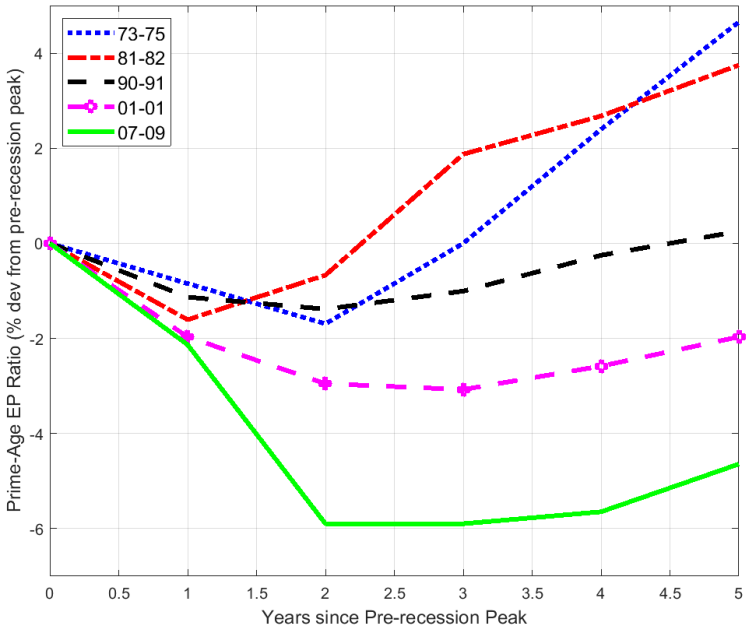
Figure 1 graphs the evolution of the employment-to-population ratio for female work-

ers in the U.S. 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 towards explaining the trend include a decrease in marriage rates, an increase in divorce rates, 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.

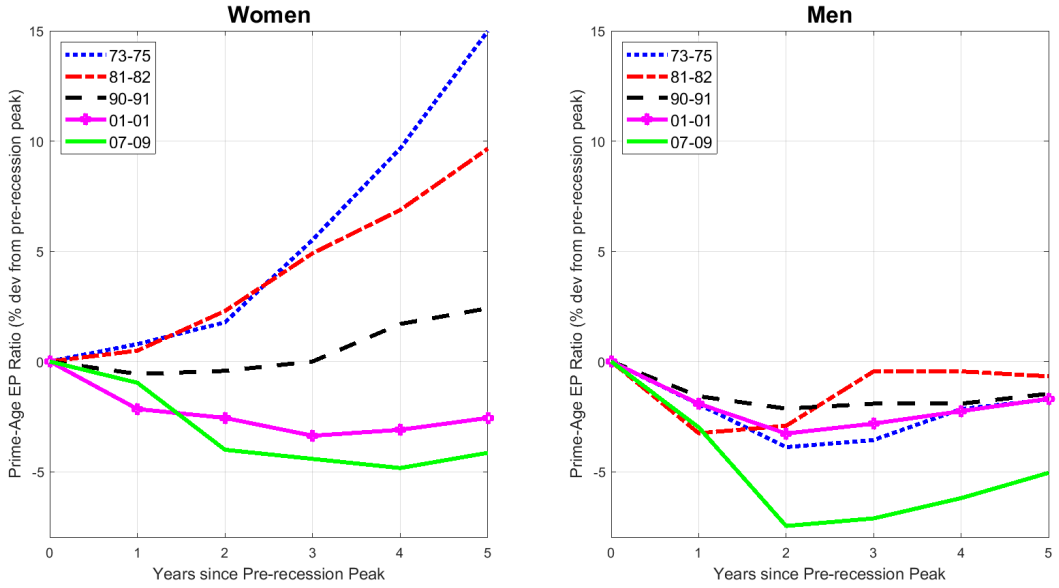
Figure 2 looks at recoveries in prime-age employment over the last five recessions. As is apparent from panel (a), recoveries have slowed down for the recessions post-1990 as compared to the ones before. To understand whether this change in employment recoveries has affected the entire population or specific subgroups, I proceed to 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 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.

Figure 2: Slowing Recoveries for Prime-Age Workers




(a) All workers




(b) Male and Female workers

Notes: This figure graphs the employment-to-population of prime age workers (25-54) during the last 5 recessions and the subsequent recoveries. The x-axis measures years since pre-recession peak whereas the y-axis measures the percentage change in employment-to-population ratio since the pre-recession peak. Each series is calculated by aggregating microdata from the March ASEC of the CPS.

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 hetero-

geneity across 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 having children, members also choose how much labor will be provided at home to produce child care. I use this framework to examine the interaction between female and male labor supply both at the household level and 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 child care 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 child care among wealthy households as 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. Consistent with my empirical evidence, the model results show that the largest increase in labor supply was driven by young married women with children. Next, I use my theoretical framework to decompose the relative contributions of several leading proposed causal factors underlying the labor supply changes described above. 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. We also know that there have been significant changes over the past five decades in marriage rates, divorce rates, and the number of children that households have in the U.S. (Doepke & Tertilt, 2016). With this in mind, and given my evidence that family composition plays a significant role in determining the labor supply of women[1], I also allow for time variation in each of these demographic rates. 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.

[1]See, for example, Bloom, Canning, Fink, and Finlay (2009); Papps (2006)

Comparing across 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 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, I infer from this result that it is essential to consider the relationship between time spent towards child care and female labor supply when formulating policies aimed at strengthening aggregate employment or reshaping its cyclical movements.

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.

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 child care to provide at home and how much to buy at a market provided service. The government subsidy comes as a reduction in the purchase price of market child care. I

find that the introduction of the countercyclical child care 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 child care. However, for all the other groups, the wealth effect of this subsidy exceeds the substitution effect, leading to a slight reduction in their labor supply. Increased demand for market-produced child care induces a rise in the demand for labor in the child care 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 unemployment insurance extensions (Mitman & Rabinovich, 2014), 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)) and improvements in household technology (Greenwood, Seshadri, & Yorukoglu, 2005). Others emphasize medical advances affecting female health (Albanesi and Olivetti (2016); Goldin and Katz (2000)), cultural changes (Fernández, Fogli, & Olivetti, 2004) and the rise of the service sector (Ngai & Petrongolo, 2017). I include several competing factors together in my model to consider the relative importance of each over time. 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. I extend this analysis to then study business cycle recoveries in the

presence and absence of the trend.

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 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, as 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 is the strongest, 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 to increase 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. The insights from that decomposition are used to discuss policy experiments targeted at increasing female labor supply. Section 6 concludes.

# 2 Empirical Evidence

## 2.1 Data Description and Sample Selection

In this paper, I use the Annual Social and Economic Supplement (ASEC) of the Current Population Survey (CPS) as available through the Integrated Public Use Microdata Series[2]. The CPS is administered jointly by the U.S. Census Bureau and the U.S. Bureau of Labor Statistics at both the household as well as individual level and is considered to be 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 (that is, 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 proceed to 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

[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

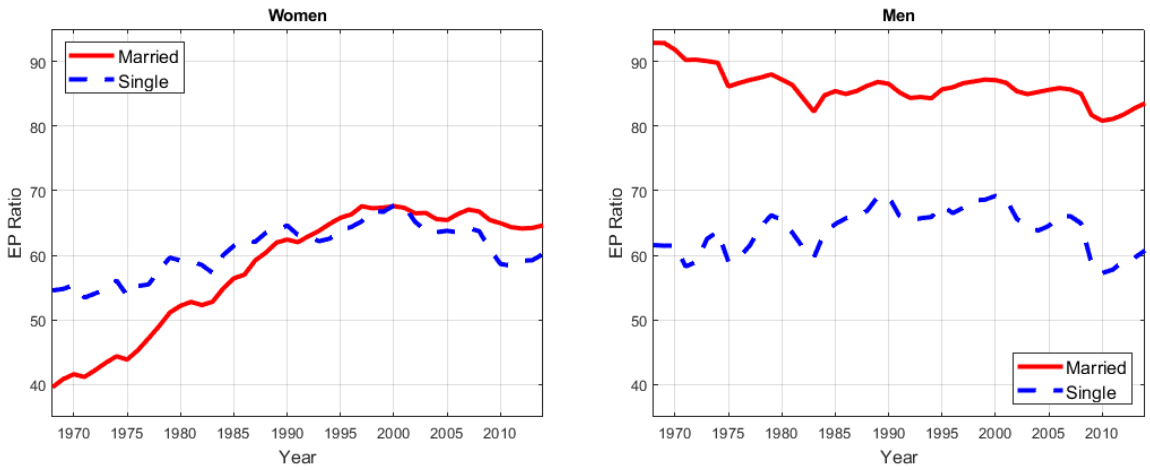
identify how these subgroups' recoveries from recessions changed over the past 50 years. In particular the recessions considered are 1973-1975, 1981-1982, 1990-1991, 2001-2001 and 2007-2009 (as defined by the NBER). I count individuals as employed if they either reported to have worked for pay or for profit, or worked for at least fifteen hours in a family business or farm in the preceding week. Those who reported to be temporarily absent from work due to illness, vacation, bad weather or a labor dispute are also considered to be employed.

## 2.2 Decomposition Analysis: Trend

In this section, I discuss the patterns observed with respect to the trend in female employment from my empirical analysis when the female population is further subdivided into groups which differ by marital status, age and the number of children.

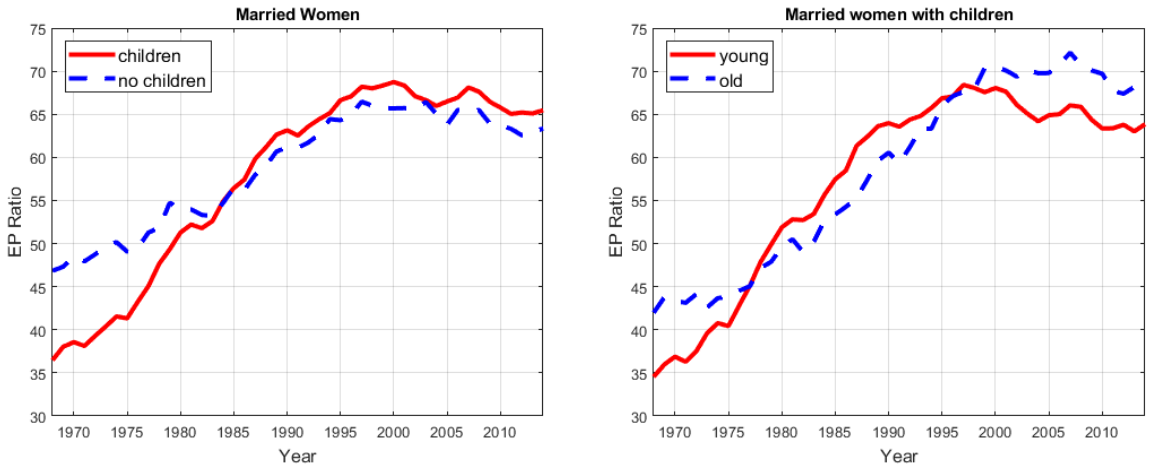
Figure 3 shows the trend in employment for men and women of different marital status. As is seen in the left panel, the change has primarily being driven by married women. Till 1990, married women's employment-population ratio rises 2.2 times more than that of single women. For men, there has been a decrease in their employment-population ratio for both married and single men. However, the fall in married men's employment-to-population ratio is only 40% of the rise for married women. This implies that the rise in married women's employment was not completely offset by the decrease in employment for married men.

Figure 3: 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 their population to understand better which groups of married women were contributing to that trend. Figure 4 illustrates the patterns.

Figure 4: Secular trend among groups of married women




As is evident from the left panel of Figure 4, which looks at married women with and without 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 can be seen from the right panel, we find that the trend is stronger for young married women with children.

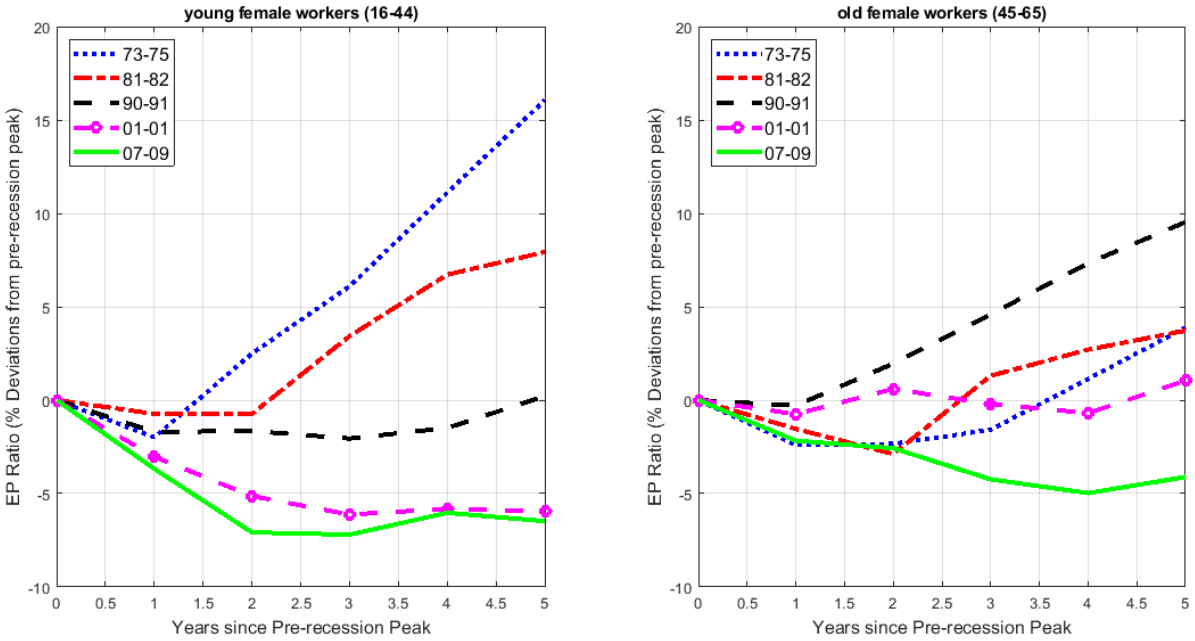
## 2.3 Decomposition Analysis: Cycle

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

### 2.3.1 Age

To analyze changes in employment recovery patterns for different age groups, I divide the population into 2 age groups: 16-44 (young) and 45-65 (old). [3] Figure 5 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 strong recoveries post early recessions were primarily driven by younger women. Over time, employment recovery has slowed down for this group. For older women, apart from the 1990-1991 recession, recoveries have always been slow. 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 older group.

Figure 5: Employment Recoveries for Women by Age Groups



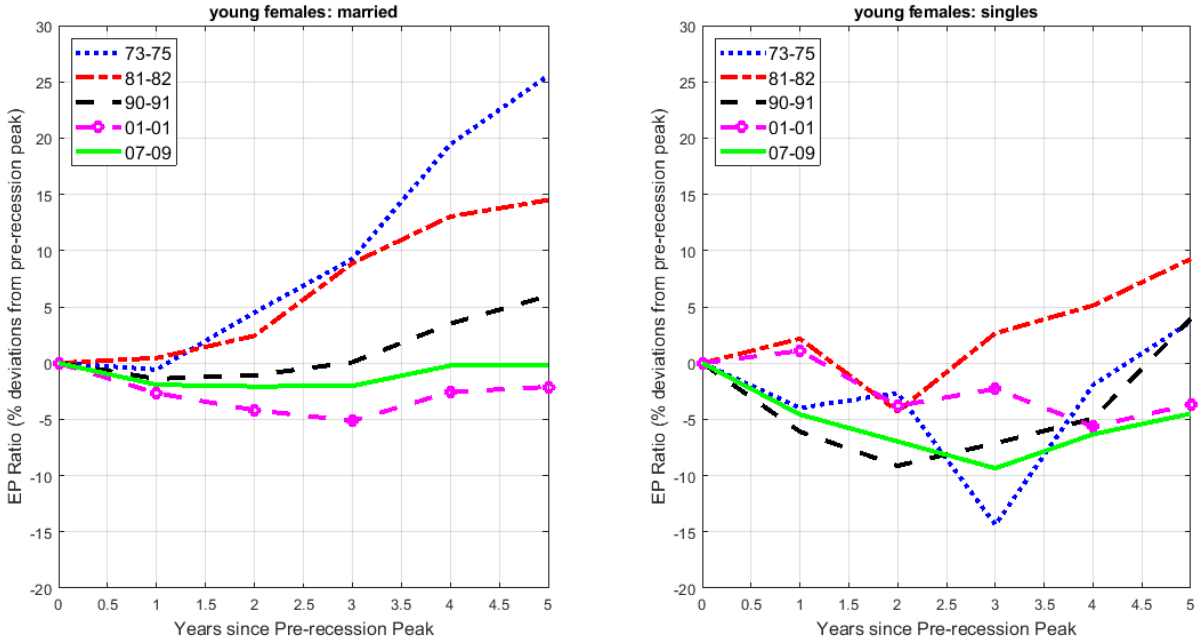

Notes: This figure graphs the employment-to-population of women workers during the last 5 recessions and the subsequent recoveries. The x-axis measures year since pre-recession peak whereas the y-axis measures the percentage change in employment-to-population ratio since the pre-recession peak. Each series is calculated by aggregating microdata from the March ASEC of the CPS.

[3] In the Appendix B, I report results obtained by dividing the population into 5 age bins: 16-24, 25-34, 35-44, 45-54, 55-65.

### 2.3.2 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 6 suggest that the strong employment recoveries in the pre-1990 recessions were primarily driven by married women. This indicates that marriage is a dimension of heterogeneity that is relevant for examining jobless recoveries.

Figure 6: Employment Recoveries for Young Women by Marital Status



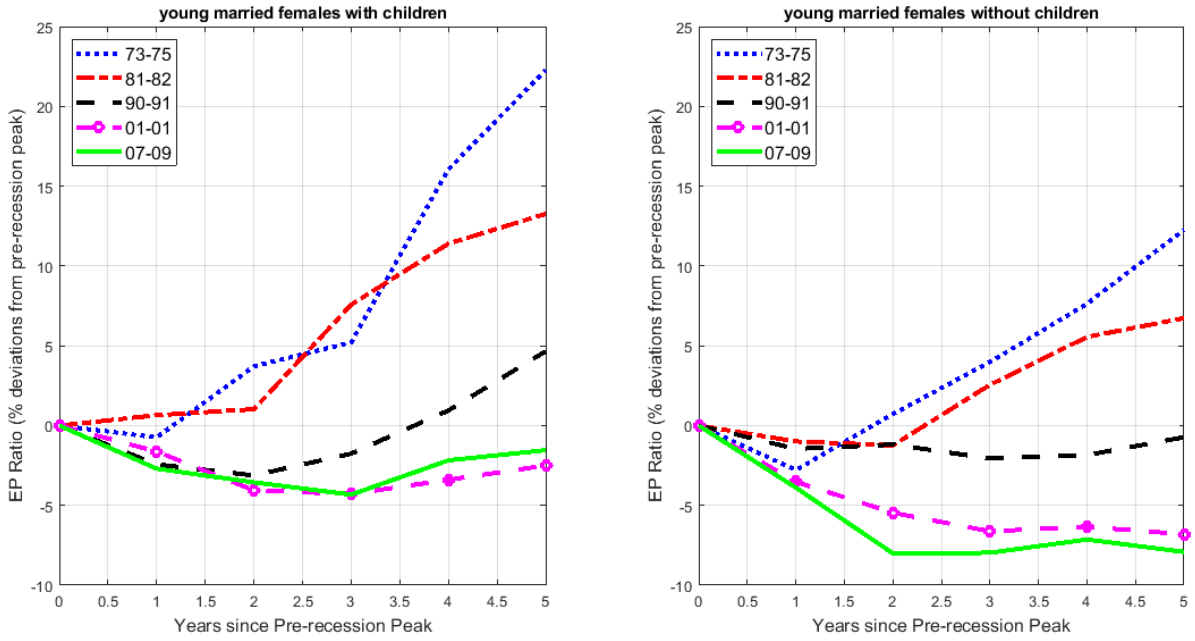

Notes: This figure graphs the employment-to-population of young women workers (aged 16-44) during the last 5 recessions and the subsequent recoveries. The x-axis measures year since pre-recession peak whereas the y-axis measures the percentage change in employment-to-population ratio since the pre-recession peak. Each series is calculated by aggregating microdata from the March ASEC of the CPS.

### 2.3.3 Children

Once age and marriage is 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 include only married women who are aged 16-44. I compare the employment recoveries of those who have at least one child aged less than 5 to those who have no young children at home. Figure 7 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. I speculate that some of the young married women with no young children could have expectations of having children which could make them behave in a similar way to those who have children at home.

Figure 7: Employment Recoveries for Young Married Women by presence of Children




Notes: This figure graphs the employment-to-population of young (aged 16-44) married women workers during the last 5 recessions and the subsequent recoveries. The x-axis measures year since pre-recession peak whereas the y-axis measures the percentage change in employment-to-population ratio since the pre-recession peak. Each series is calculated by aggregating microdata from the March ASEC of the CPS. I subdivide the population into 2 groups: all those who have at least one child at home aged less than 5 and all those who have no children at home aged less than 5.

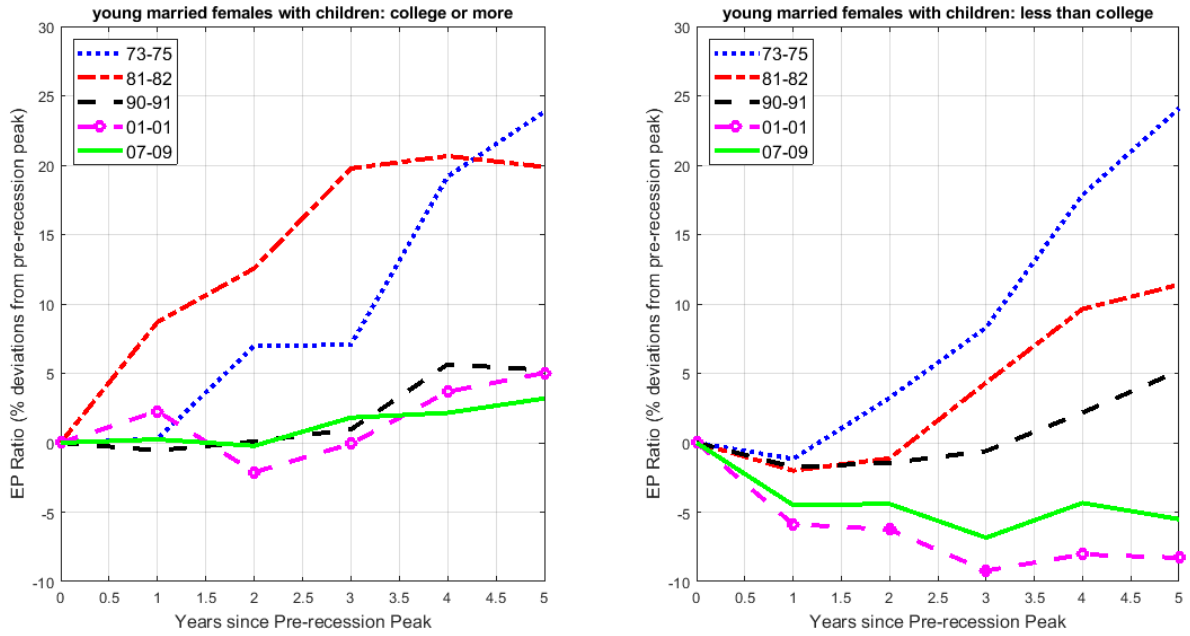
### 2.3.4 Education

I conduct my last decomposition based on education levels. I divide the population of young, married women with young children into 2 groups: those with at least a 4-year college degree; the rest of the population. [4] Figure 8 suggests once age, marriage and 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.

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

For both the 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 8: Employment Recoveries for Young Married Women with Children by Education




Notes: This figure graphs the employment-to-population of young (aged 16-44) married women workers having at least 1 child aged less than 5 at home, during the last 5 recessions and the subsequent recoveries. The x-axis measures year since pre-recession peak whereas the y-axis measures the percentage change in employment-to-population ratio since the pre-recession peak. Each series is calculated by aggregating microdata from the March ASEC of the CPS. I subdivide the population into 2 groups: all those who have attained at least a 4-year college degree and those who have not.

Thus, to summarize the findings from this section, 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.

# 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 $\beta$. 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, $\chi$, and $\chi^h$, respectively, to account for the consumption needs of different family sizes. 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.

## 3.2 Single Households

At each period, $t$[5], single households decide on their market consumption $c$, home-good consumption, $c^h$, savings $k'$, labor supply to the market $n$, 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

[5]the aggregate state of the economy is summarized by $t$

$j$ with assets, $k$, is defined below:

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

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

## 3.3 Married Households

Married (or partnered) households comprise one male and one female adult living together. We assume cooperative bargaining where $\zeta_f$ and $\zeta_m$ 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 supply 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:

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

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 respec-

tively:

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

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

## 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 $\alpha$ 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 $\Delta_t$.

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:

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

where $\delta$ 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:

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

Aggregate distributions evolve according to the following rule:

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

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

## 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 $\theta_t$ is calculated using (12).

5. $w_t$ and $r_t$ are determined competitively and the labor market and asset market clears.

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

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

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

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

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

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

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

Table 1: Parameter choices

| Pre-set | Source | Values |
|---|---|---|
| $\sigma$ | Heathcote et al. (2017) | 1 |
| $\phi$ | Heathcote et al. (2017) | 3 |
| $\sigma^h$ | Knowles (2013) | 1.5 |
| $A$ | Hansen (1985) | 1 |
| **Calibrated** | **Targets** | **Values** |
| $\beta$ | Annual Rate of interest | 0.977 |
| $\alpha$ | Capital-Output ratio | 0.255 |
| $\delta$ | Investment-Capital ratio | 0.069 |
| $\eta_h$ | Fraction of time in non-market work & childcare, 1965 | 0.0335 |
| $\eta_m$ | Fraction of hours worked by married men, 1968 | 1 |
| $\eta_f$ | Fraction of hours worked by single women, 1968 | 1.53 |
| $\zeta_m$ | Fraction of hours worked by married women, 1968 | 0.67 |

in the literature [6]. The parameter $\phi = 3$ 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 [7], the total factor productivity, $A$, is normalized to 1 in steady state.

Seven parameters in this framework are calibrated. The capital depreciation rate, $\delta$, 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 is calculated using the American Heritage

[6] See Heathcote et al. (2017) for example
[7] See Hansen (1985) for example

Time Use Study (AHTUS) [8]. 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. $\chi$ and $\chi^h$ 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 [9]). For the market good, each child is assigned a value of 0.5. For the 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 child care 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[10] 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. Micro-data on

[8]The definition of childcare time is consistent with that used by Aguiar and Hurst (2007). To calculate total non-market work time, we combine time spent in home production and time spent obtaining goods. Since we do not have data on time use in 1968, we use the data from 1965 as a proxy

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

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

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[11]. 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. 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 the marriage rates for every year in between. I assume that the marriage rates in 1968-1969 were the same as in 1970. Figures (20), (21), and (22) in the Appendix B 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.

[11]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

# 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,

Table 2: Calibration Targets and Overidentifying Success

| | 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 | 0.197 |
| Fraction of hours worked by single men, 1968[1] | 0.273 | 0.278 |
| Fraction of time in non-market work & childcare, 1968 | 0.155 | 0.156 |
| Fraction of time in non-market work & childcare, 1975 | 0.138 | 0.143 |

Note: [1] denotes Untargeted successes

married women, single men, and single women for the benchmark model (1968) are listed. I use a measure of the average number of hours worked by each group (this includes all those who work 0 hours) from Doepke and Tertilt (2016) 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 does well quantitatively in replicating the labor allocations, as seen in the data, both in terms of targeted and un-targeted moments.

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

| | Data | Model |
|---|---|---|
| Fraction of hours worked by married women | 74.31 | 63.28 |
| Fraction of hours worked by married men | -13.51 | -7.589 |
| Fraction of hours worked by single women | 5.05 | 7.852 |
| Fraction of hours worked by single men | -16.48 | -3.068 |
| Fraction of hours worked on aggregate | 3.45 | 8.9 |
| Fraction of time in non-market work & childcare | -19.35 | -12.07 |

Next, I compare the percentage changes in labor allocations across the two steady states. The results are illustrated in Table 3. My model does well quantitatively in replicating the data in 2014, none of which I explicitly 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. Time spent in non-market work and childcare on aggregate 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 data that substantial crowding out does not take place among couples (Fukui et al., 2018).

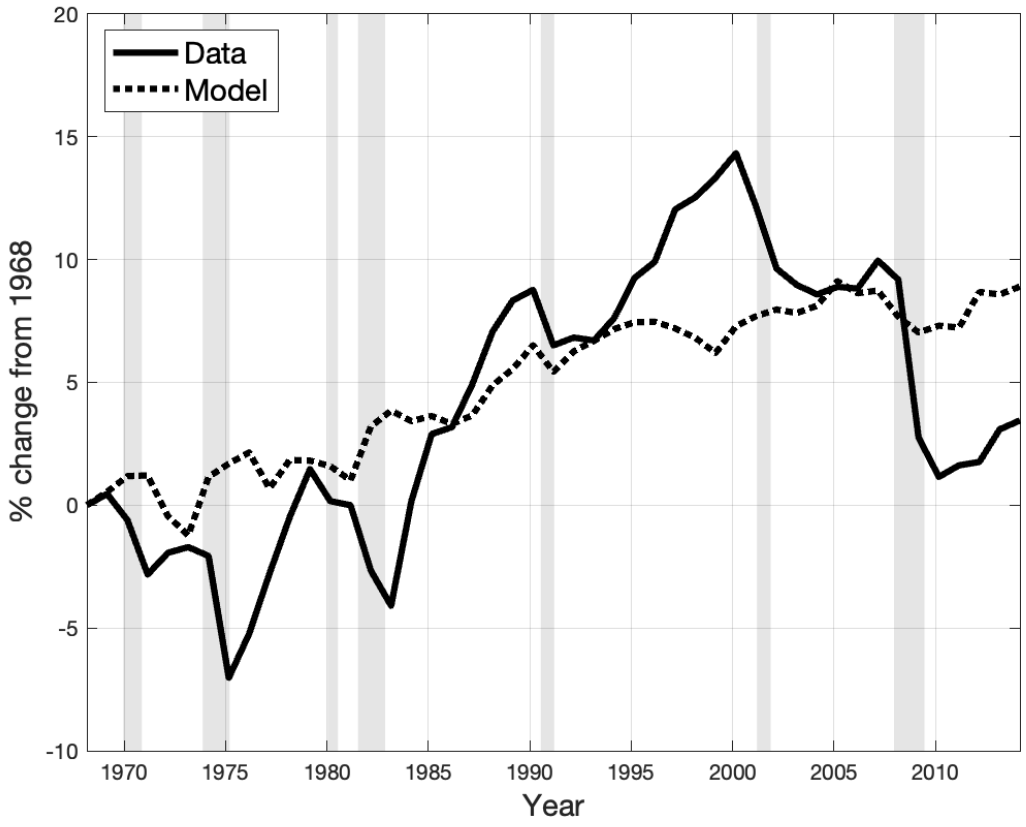
### 5.1.2 Secular Trend in Labor Supply

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 does 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, single women. 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. 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 the 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-

Figure 9: Aggregate labor supply: model and data

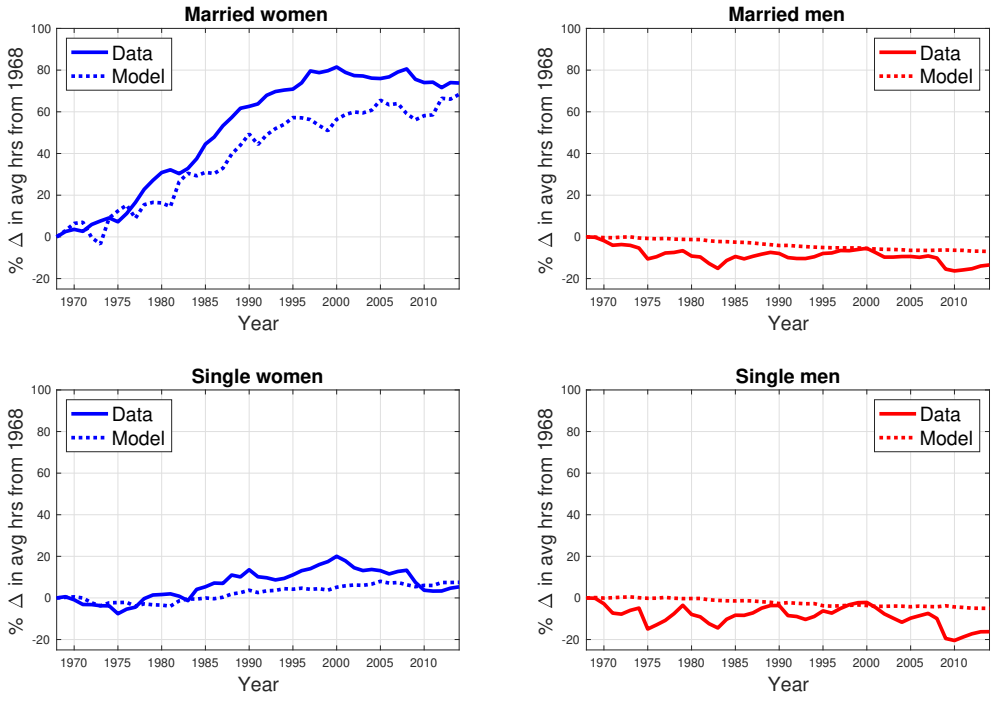



Notes: I use the measure of average number of hours worked by the population (includes all those who work 0 hours) from Doepke and Tertilt (2016) and divide it by 120 to get the data counterpart of aggregate labor supply.

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 reduction in the gender wage gap dominates. The income effect 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 will be more likely to depend on the income they earn to finance consumption. 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

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




Notes: I use the measure of average number of hours worked by the population (includes all those who work 0 hours) from Doepke and Tertilt (2016) and divide it by 120 to get the data counterpart of labor supplied by each group. The y-axis plots the percentage change in labor supplied by each of these groups from their 1968 values. Here single households include all those who are never married, divorced, separated or widowed.

turn increases the output produced by firms and increases the wages earned by both men and women. 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, decreasing their hours worked. The levels predicted in my model are higher than that in the data for both the steady states. I hypothesize that this is because, in the data, younger men acquiring higher education are more likely to be single. Since my model does not account for heterogeneity in education levels, it fails to capture the magnitude correctly.

## 5.2 Jobless Recoveries

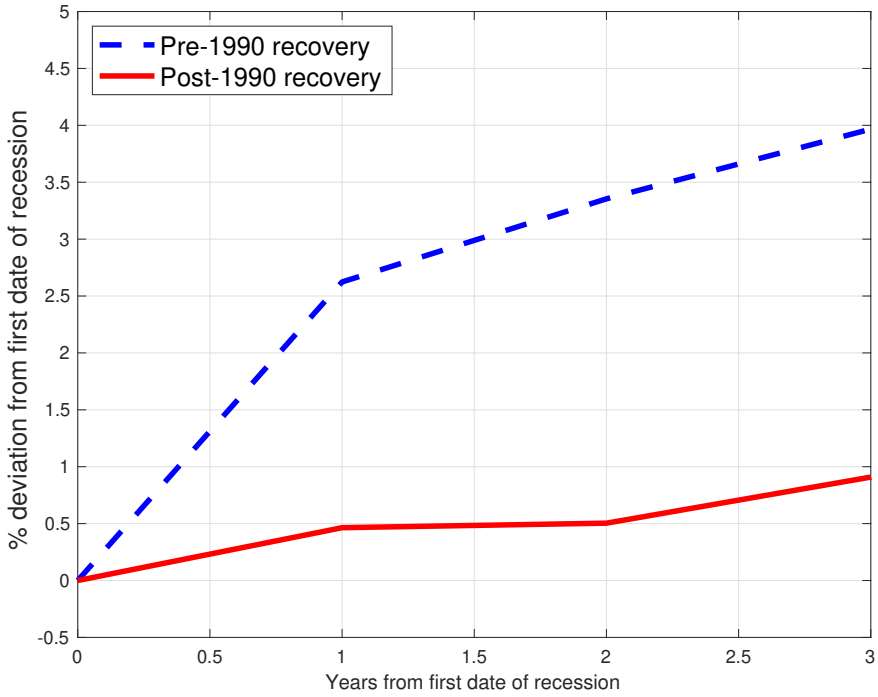
Next, I investigate the main question in the paper: whether the weakening of the secular trend in female labor supply contributed to the emergence of jobless recoveries. To do this, I compare the response of the economy to a 2% negative aggregate productivity

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. I assume that agents do not anticipate the arrival of the shocks; however, they can observe the future path of the shocks after it hits the economy. The underlying process for the aggregate TFP is given by:

$$A_{t+1} = \rho A_t + (1-\rho)A \tag{21}$$

where $\rho = 0.90$ is the persistence of the processes whereas $A$ is the steady state values.

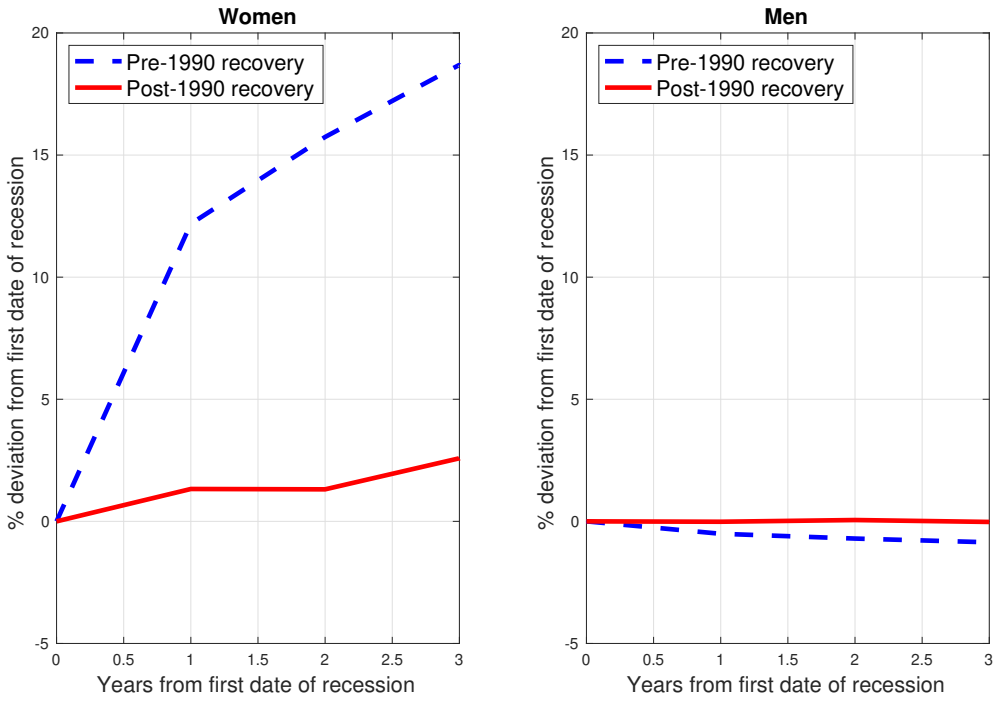
Figure 11: Cyclical response in Labor Supply: Aggregate




Notes: This graph measures the cyclical response in aggregate labor supply in the presence of an upward trend (Pre-1990) and in the absence of an upward trend (Post-1990). The y-axis measures the percentage deviation in labor supply from the impact date (or start of a recession)

Figure 11 demonstrates the responses implied by the model for aggregate labor supply. As is evident in the first panel, total labor supply recovers faster in a Pre-1990 recession as compared to a post-1990 one. The former has a half-life of 4 years whereas for the latter it is 6 years.

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




Notes: This graph measures the cyclical response in labor supplied by men and women in the presence of an upward trend (Pre-1990) and in the absence of an upward trend (Post-1990). The y-axis measures the percentage deviation in labor supply from the impact date (or start of a recession)

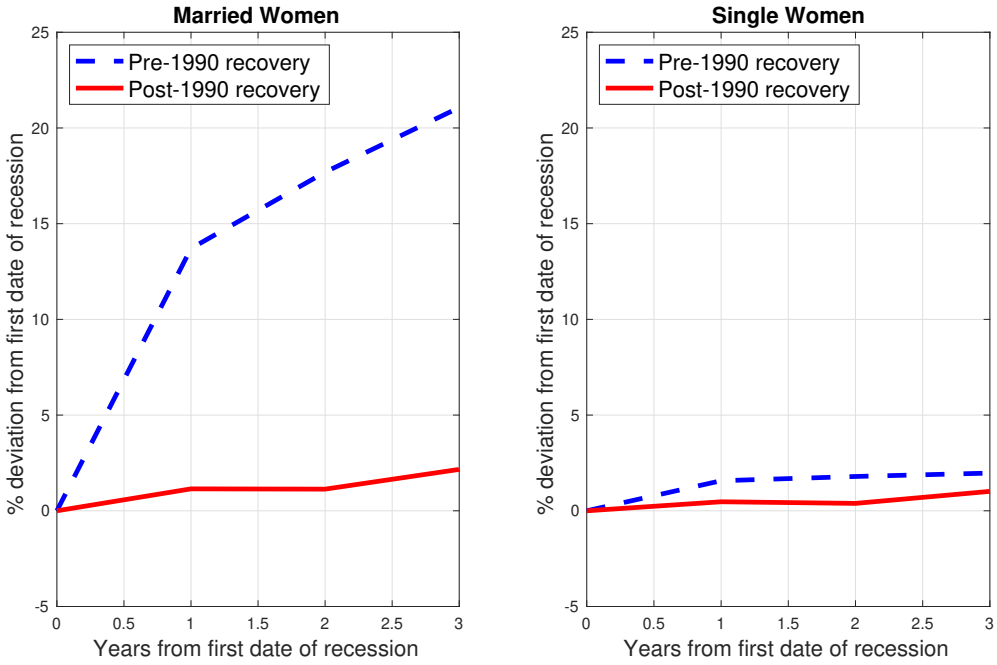
In Figure 12, the aggregate labor supply recoveries for females and males make it evident that it is the recovery in female labor supply that drives the strong recovery at the aggregate level for the pre-1990 recession. This result confirms the hypothesis that leveling off the trend in female labor supply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

I further subdivide women based on marital status and look at the cyclical response in labor supply for married and single women separately. Figure 13 shows that married women were 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 post pre-1990 recessions.

## 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.

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




Notes: This graph measures the cyclical response in labor supplied by married women and single women in the presence of an upward trend (Pre-1990) and in the absence of an upward trend (Post-1990). The y-axis measures the percentage deviation in labor supplied by each group from the impact date (or start of a recession)

### 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 partnered 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.

Table 4: Contributions of leading causal factors to underlying Labor Allocation Changes

| | (1) | (2) | (3) | (4) |
|---|---|---|---|---|
| Fraction of hours worked by married women | -36.07 | 0.67 | -0.32 | -2.91 |
| Fraction of hours worked by married men | 8.23 | -0.07 | -0.34 | 0.40 |
| Fraction of hours worked by single women | -2.16 | -5.69 | 1.16 | -0.07 |
| Fraction of hours worked by single men | 0.56 | -1.26 | 0.75 | 1.63 |
| Fraction of hours worked on aggregate | -7.21 | 0.78 | 0.44 | -0.60 |
| Fraction of time in non-market work & childcare | 9.67 | -2.06 | -0.54 | 2.33 |

Notes: 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. Positive numbers imply that the labor allocation would have been higher than the benchmark if the corresponding factor was fixed. Similarly, negative numbers imply that the labor allocation would have been lower than the benchmark.

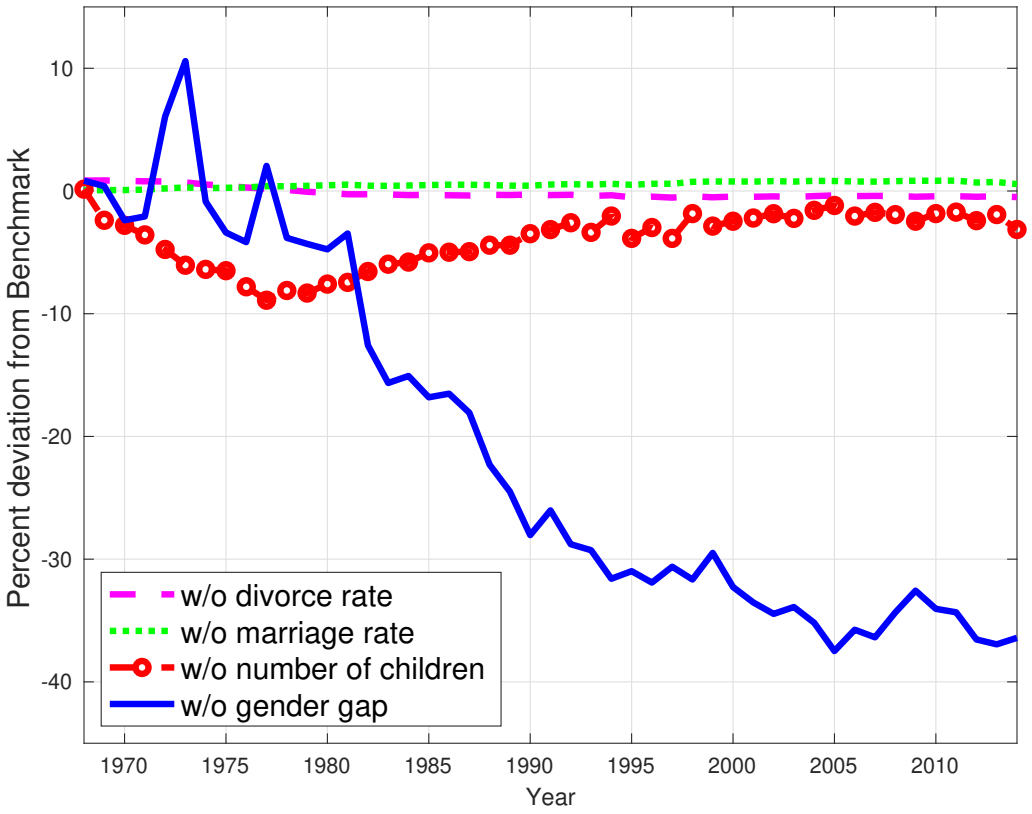
### 5.3.2 Understanding Secular Trend in Labor Supply

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 25 and 26 in the Appendix $B$.

For married women, the results indicate that from 1968 to the early 1980s, the most important factor that is associated with the upward trend in labor supply is the reduction in the number of children for younger cohorts. 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. 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). This result suggests that the government should implement policies targeted towards reducing the cost associated with providing child care at home to increase female 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

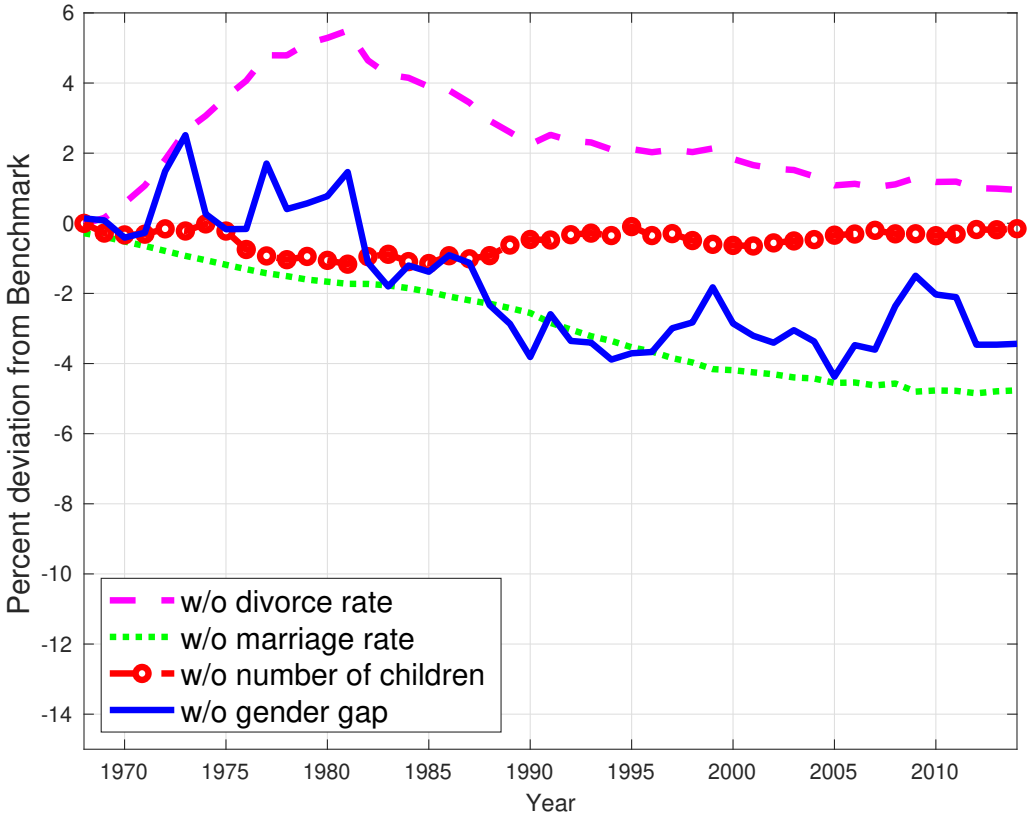
Figure 14: Decomposition into factors underlying married women's trend in labor supply




Note: This graph measures the relative contribution of each of the factors towards explaining the trend in labor supply for married women from 1968 to 2014. For each of the series, I fix only one of the underlying factors and study the implied trend in labor supply. 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.

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.

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




Note: This graph measures the relative contribution of each of the factors towards explaining the trend in labor supply for single women from 1968 to 2014. For each of the series, I fix only one of the underlying factors and study the implied trend in labor supply. 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.

## 5.4 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. Married women increased their labor supply in response to a decrease in the number of young children at home as the time cost of raising children reduced. Using this insight, we can discuss policy experiments to mitigate jobless recoveries characterized by 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. I extend the model and now introduce a market sector that produces the good that earlier could only be produced at home (let us call this the

childcare sector for simplicity [12]). The production function in this sector is linear in its labor input and pays the equilibrium wage rate to its workers. Households now have the additional option of buying childcare from the market 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 benchmark case and compare it to an environment where there is a government provision of a counter-cyclical subsidy to households for every unit of childcare that they purchase from the market.

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. The subsidy completely offsets the initial decline in labor supply for married women and facilitates stronger growth thereafter. For single women, the policy does not affect their labor supply. For men, employment recovery is slower in the presence of a subsidy; however, the effect is weaker compared to women. In the presence of a countercyclical child care subsidy, the effective cost of market-provided child care falls during a recession, which increases its quantity demand. Subsequently, the demand for workers in the childcare sector rises. The subsidy induces both a wealth effect and a substitution effect on individuals' labor supply. For men, the wealth effect dominates, as a result of which there is a decrease in their labor supply. For single women, the two effects almost negate each other. However, for married women, the substitution effect dominates. The policy experiment is described in detail in the Appendix *A*.

# 6 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,

[12]The analysis however corresponds to the home good

and education, I find that young married women with children were the primary drivers of aggregate employment recoveries in recessions 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. I investigate the relative contribution of several underlying factors that give rise to this secular trend in the labor force participation of young, married women with children. I find although the gender wage gap is the most important factor in the overall increase, over early dates, when the upward trend in female labor supply is the strongest, reduction in the number of young children is the most crucial factor.

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 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.

Based on my findings that there is an association between strong female labor supply growth and 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 a smaller decline 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.

For future work, I want to extend my analysis further to 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.

# References


Aguiar, M., & Hurst, E. (2007). Measuring trends in leisure: The allocation of time over five decades. *The quarterly journal of economics*, *122*(3), 969–1006.

Albanesi, S. (2019). *Changing business cycles: The role of women's employment* (Tech. Rep.). National Bureau of Economic Research.

Albanesi, S., & Olivetti, C. (2016). Gender roles and medical progress. *Journal of Political Economy*, *124*(3), 650–695.

Bloom, D. E., Canning, D., Fink, G., & Finlay, J. E. (2009). Fertility, female labor force participation, and the demographic dividend. *Journal of Economic growth*, *14*(2), 79–101.

Borella, M., De Nardi, M., & Yang, F. (n.d.). Are marriage-related taxes and social security benefits holding back female labour supply? *The Review of Economic Studies*.

Carroll, C. D. (2006). The method of endogenous gridpoints for solving dynamic stochastic optimization problems. *Economics letters*, *91*(3), 312–320.

Doepke, M., & Tertilt, M. (2016). Families in macroeconomics. In *Handbook of macroeconomics* (Vol. 2, pp. 1789–1891). Elsevier.

Fernández, R., Fogli, A., & Olivetti, C. (2004). Mothers and sons: Preference formation and female labor force dynamics. *The Quarterly Journal of Economics*, *119*(4), 1249–1299.

Fukui, M., Nakamura, E., & Steinsson, J. (2018). *Women, wealth effects, and slow recoveries* (Tech. Rep.). National Bureau of Economic Research.

Goldin, C., & Katz, L. F. (2000). Career and marriage in the age of the pill. *American Economic Review*, *90*(2), 461–465.

Greenwood, J., Guner, N., & Vandenbroucke, G. (2017). Family economics writ large. *Journal of Economic Literature*, *55*(4), 1346–1434.

Greenwood, J., Seshadri, A., & Yorukoglu, M. (2005). Engines of liberation. *The Review of Economic Studies*, *72*(1), 109–133.

Hansen, G. D. (1985). Indivisible labor and the business cycle. *Journal of monetary Economics*, *16*(3), 309–327.

Heathcote, J., Storesletten, K., & Violante, G. L. (2017). The macroeconomics of the quiet revolution: Understanding the implications of the rise in women's participation for economic growth and inequality. *Research in Economics*, *71*(3), 521–539.

Herkenhoff, K. F. (2019). The impact of consumer credit access on unemployment. *The Review of Economic Studies*, *86*(6), 2605–2642.

Jaimovich, N., & Siu, H. E. (2020). Job polarization and jobless recoveries. *Review of Economics and Statistics*, *102*(1), 129–147.

Jones, L. E., Manuelli, R. E., & McGrattan, E. R. (2015). Why are married women working so much? *Journal of Demographic Economics*, *81*(1), 75–114.

Knowles, J. (2013). Why are married men working so much? an aggregate analysis of intra-household bargaining and labour supply. *Review of Economic Studies*, *80*(3), 1055–1085.

Mitman, K., & Rabinovich, S. (2014). Unemployment benefit extensions caused jobless recoveries!?

Ngai, L. R., & Petrongolo, B. (2017). Gender gaps and the rise of the service economy. *American Economic Journal: Macroeconomics*, *9*(4), 1–44.

Olsson, J. (2018). Structural transformation of the labor market and the aggregate economy. *Work, wealth, and well-being*, 5.

Papps, K. L. (2006). The effects of divorce risk on the labour supply of married couples.

Ramey, V. A. (2009). Time spent in home production in the twentieth-century united states: New estimates from old data. *The Journal of Economic History*, *69*(1), 1–47.

Shimer, R. (2012). Wage rigidities and jobless recoveries. *Journal of Monetary Eco-*

*nomics*, *59*, S65–S77.

# A Policy Experiment

I use an extension of my framework to examine the effectiveness of a countercyclical childcare subsidy. I conduct a counterfactual exercise, wherein households with children have the additional option of buying child care: $\varphi$ from the market at a price, $q$. There is a required amount of the home-produced good (or child care), $c_s^h(g,k,j)$ and $c_p^h(k,j)$ that needs to exist for every single and married household respectively [13]. There is a firm that now produces childcare using labor that it hires at the market wage rate using the following technology $Y^h = \gamma N^h$. Thus aggregate labor supply, $N = N^y + N^h$, where $N^y$ is the labor demanded by the final goods firm. The policy is funded using taxes on wage ($\tau_w$) and rental income ($\tau_r$) and Government spending $G$. Thus,

$$\text{Total Subsidy}_t = \tau_w \sum_g w_{g,t} N_{g,t} + \tau_r r_t K_t - G_t \tag{22}$$

I compare the recoveries in the post-1990 recessions (when the trend in female labor force participation has leveled off) in the presence and absence of these countercyclical government subsidies.

The government provision of a subsidy to households for every unit of child care that they purchase from the market is given by ($\tau_s$). The model environment remains the same as described in Section 3, apart from the following changes. For single households, equations (2)-(3) are rewritten as:

$$c + (1-\tau_{c,t}) q_t \varphi + k' \leq (1-\tau_w) w_t(g) n + (1 + (1-\tau_r) r_t) k \tag{23}$$

$$c^h \leq A_t^h (n^h)^\psi + \varphi \tag{24}$$

[13] This is equivalent to the outcome that we solve in the benchmark case of no policy

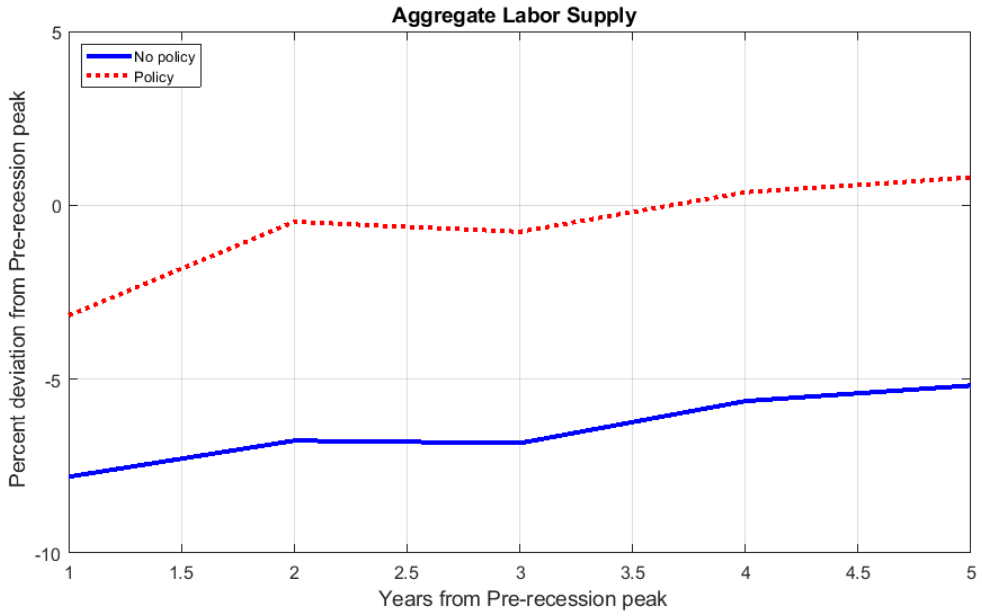
For partnered households, equations (6)-(7) are rewritten as:

$$c + (1 - \tau_{c,t})q_t\varphi + k' \leq (1 - \tau_w)w_t(m)n_m + (1 - \tau_w)w_t(f)n_f + (1 + (1 - \tau_r)r_t)k \tag{25}$$

$$c^h \leq A_t^h(n_f^h)^\psi + \varphi \tag{26}$$

I assume the following parameter values: $\tau_w = \tau_r = 10\%$ whereas $\gamma$ is normalized to 1. I discuss the results under a subsidy that starts at 30% when the recession hits the economy and has the same persistence ($\rho$) as aggregate productivity. Figure 16 illustrates the results. In the presence of a countercyclical child care subsidy, in response to the unanticipated negative TFP shock, aggregate labor supply falls by 3.2%, whereas in the absence of the policy, there is an initial fall of 7.8%. 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 5 years.

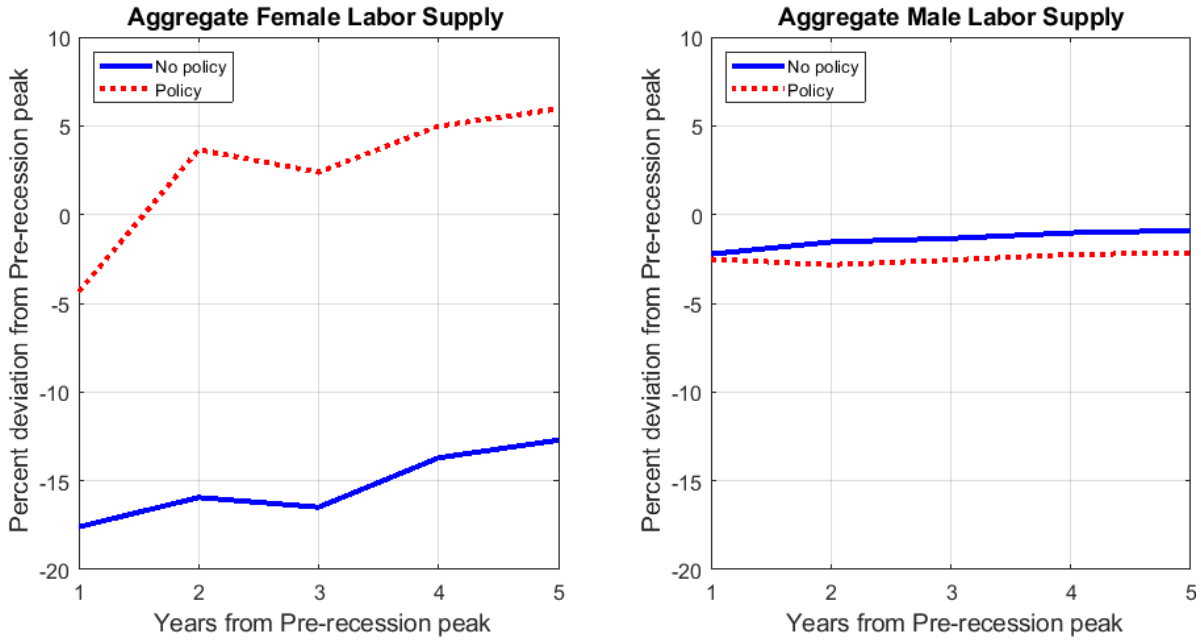
Figure 16: Aggregate Labor Supply response to Countercyclical Child Care subsidy




To study the response of the different demographic groups to the policy, I next examine the cyclical changes in labor supply for men and women. Figure 17 displays the results. I find that the policy is effective in dampening the cyclical response in labor supply for

women. On the contrary, for men, the policy results in a slower recovery. Since the effect is stronger for women, it is reflected in aggregate labor supply responses.

Figure 17: Responses to Countercyclical Child Care Subsidy by Gender




Next, I investigate whether there is heterogeneity in the effectiveness of the policy between different groups of women. Figure 18 shows that the countercyclical child care subsidy completely offsets the initial decline in labor supply for married women and facilitates stronger growth thereafter. For single women, the policy does not have any effect on their labor supply. I conduct a similar exercise for different groups of men. Figure 19 illustrates the results for the same.

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.

Figure 18: Responses to Countercyclical Child Care Subsidy by Women's Marital Status

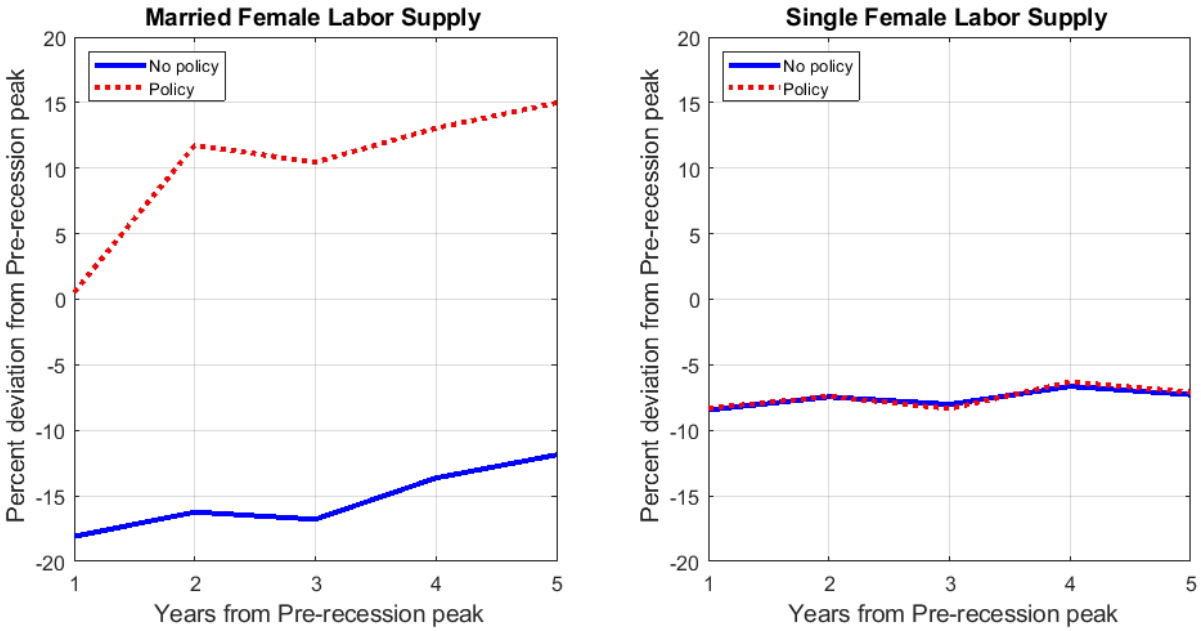
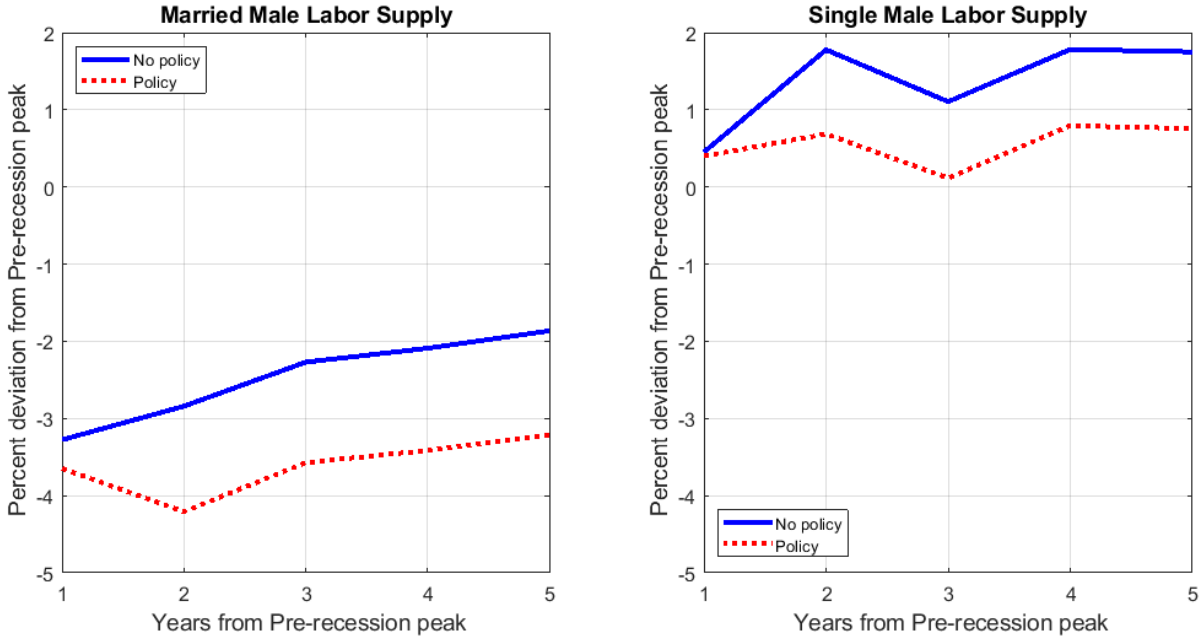



Figure 19: Responses to Countercyclical Child Care Subsidy by Men's Marital Status

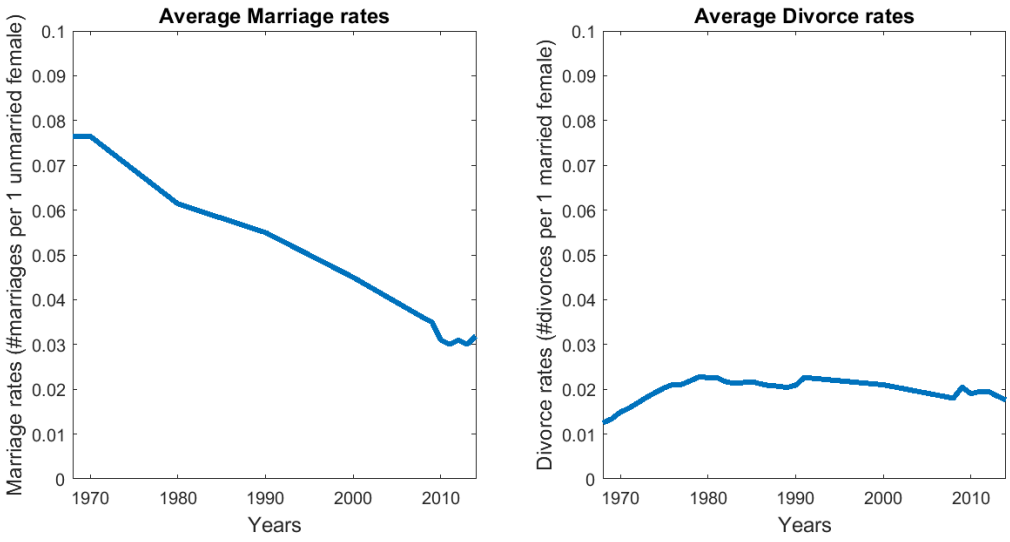



# B Additional Figures

The average marriage and divorce rates are described in Figure 20. Marriage rates have fallen substantially whereas there has been a rise and then a decline in the divorce rates.

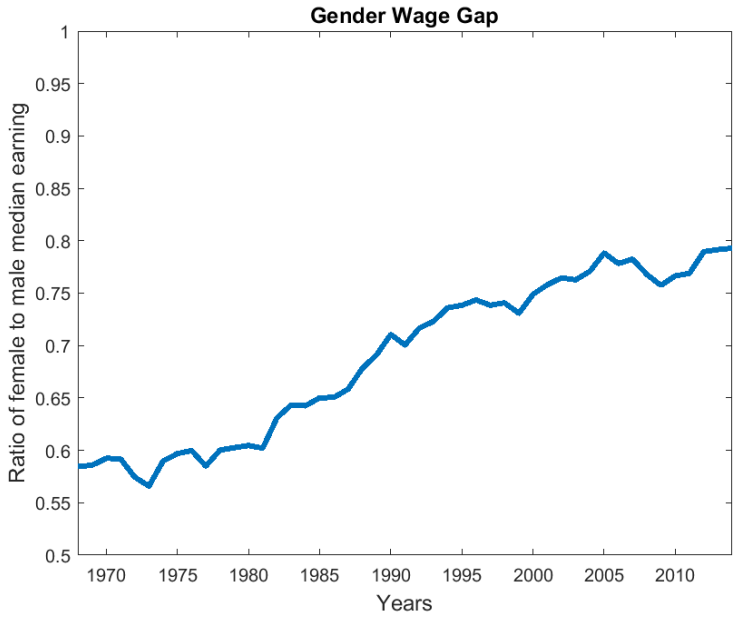
The gender wage gap has narrowed over the years with a decline in the ratio of female

Figure 20: Marriage and Divorce rates over the years




and male wages. It has been described in Figure 21. In this graph, only full time workers have been considered.

Figure 21: Changes in the Gender Wage Gap




Changes in the number of young children for households of each type for different age groups are illustrated in Fig 22.

Figure 22: Average number of young children by household type

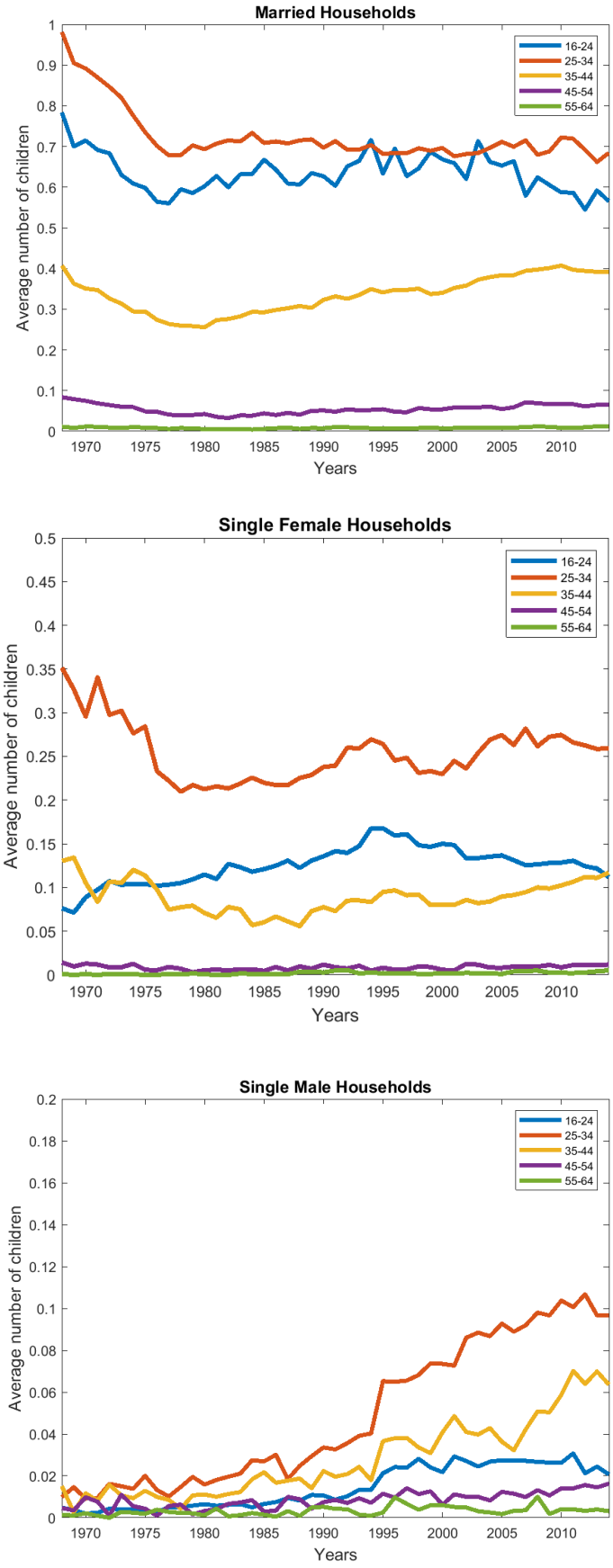


Figure 23: Time spent in non-market work increases with the number of children

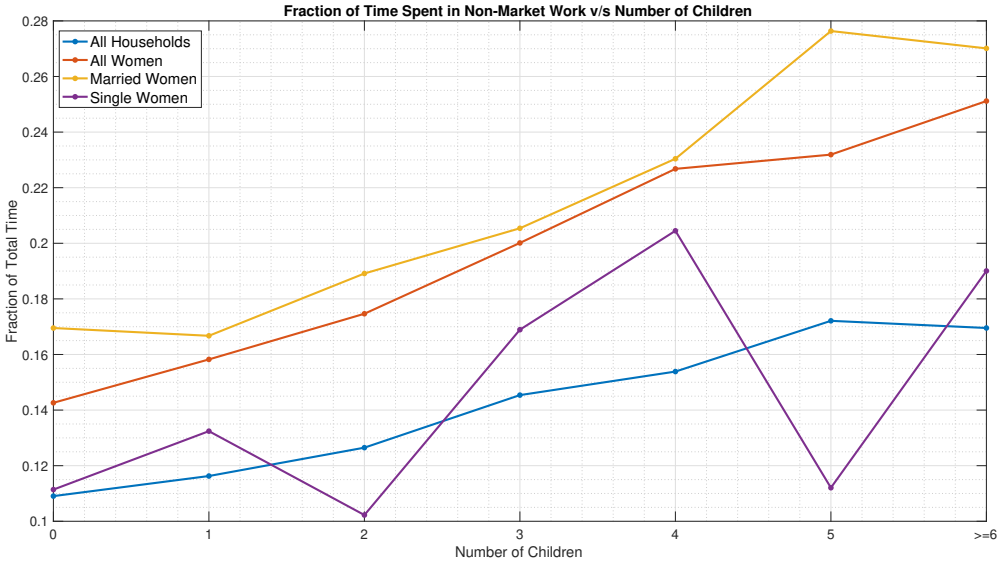
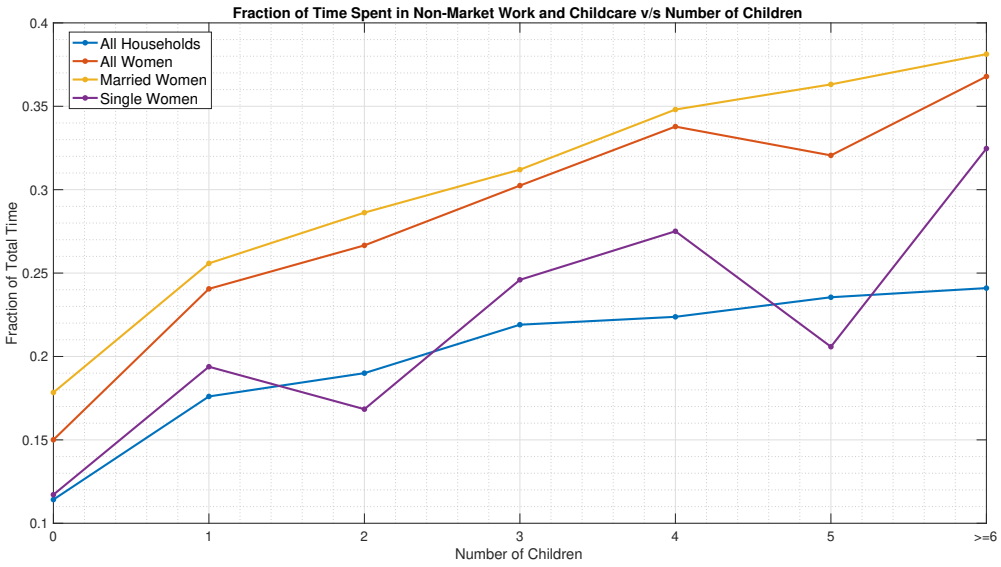
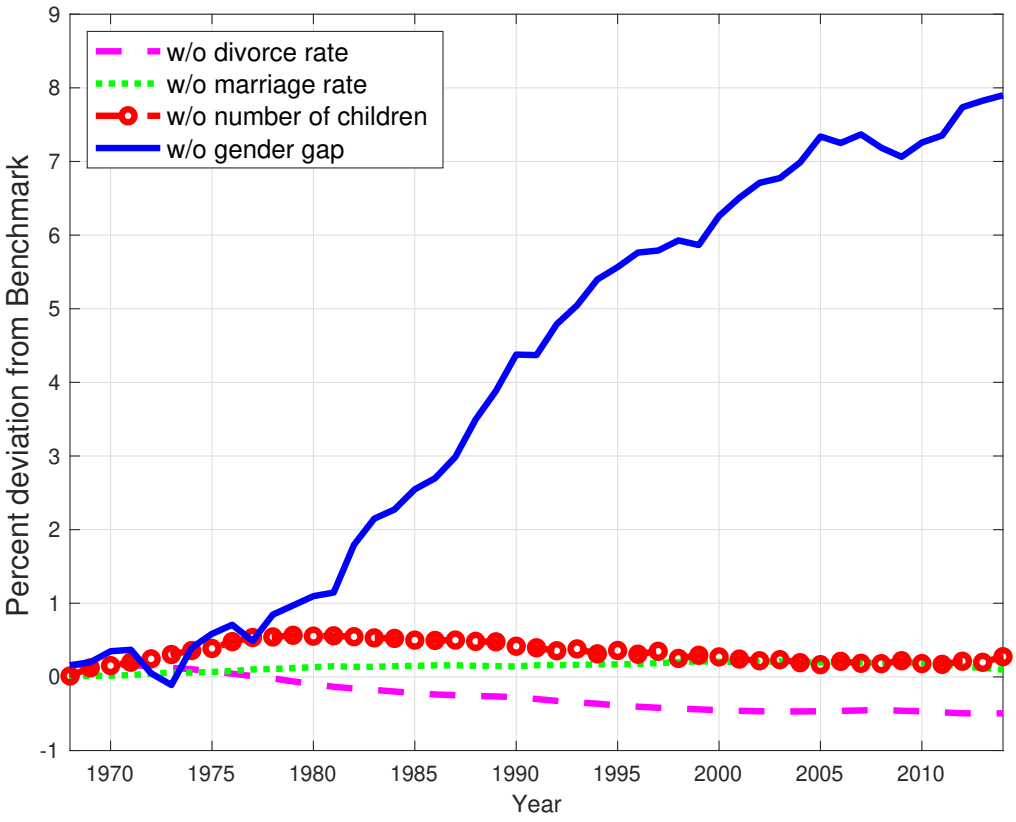



Figure 24: Non-market work and childcare time increases with the number of children



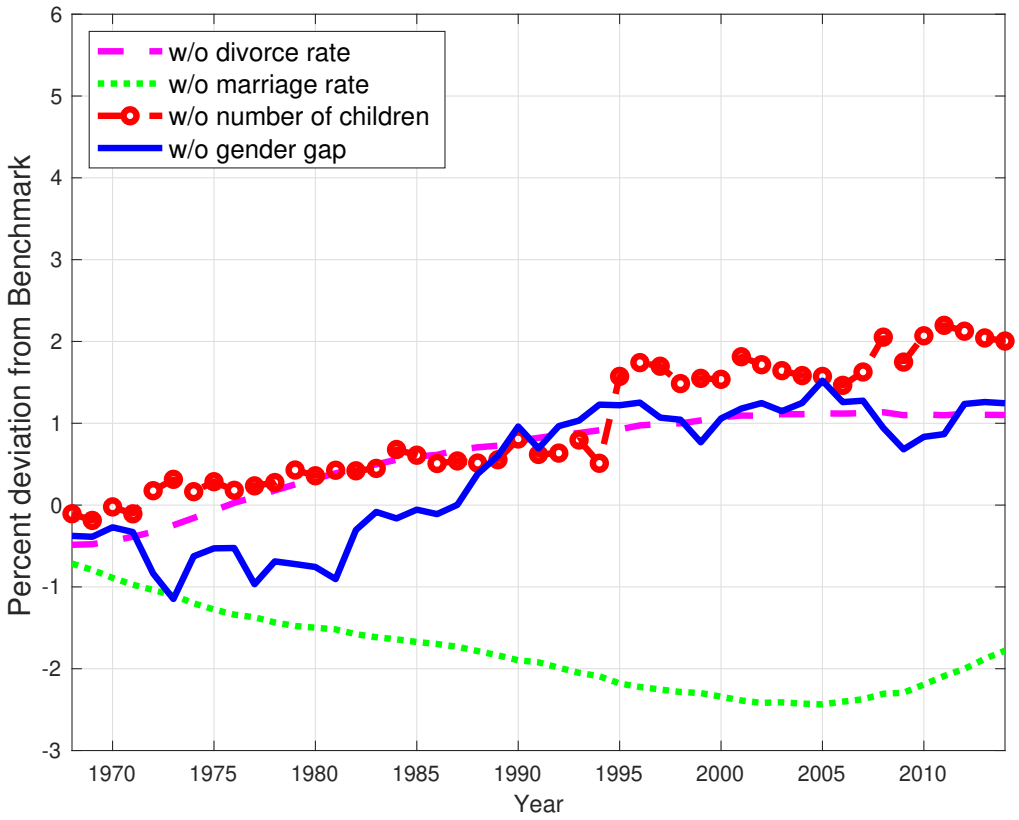

Source: AHTUS 1965, 1975, 1985, 1995, 1998 and ATUS 2003-2014

Figure 25: Decomposition into factors underlying married men's trend in labor supply




Note: This graph measures the relative contribution of each of the factors towards explaining the trend in labor supply for married women from 1968 to 2014. For each of the series, I fix only one of the underlying factors and study the implied trend in labor supply. 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 26: Decomposition into factors underlying single men's trend in labor supply




Note: This graph measures the relative contribution of each of the factors towards explaining the trend in labor supply for married women from 1968 to 2014. For each of the series, I fix only one of the underlying factors and study the implied trend in labor supply. 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.