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 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 of the gender wage gap is the most important factor in the overall increase. However, till 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 is the most crucial factor. With this insight, I use my framework to examine the relative effectiveness of a countercyclical child-care subsidy and a countercyclical income tax break for married women with children towards mitigating jobless recoveries. Preliminary results suggest that per-unit government expenditure, a countercyclical child-care subsidy is more effective.

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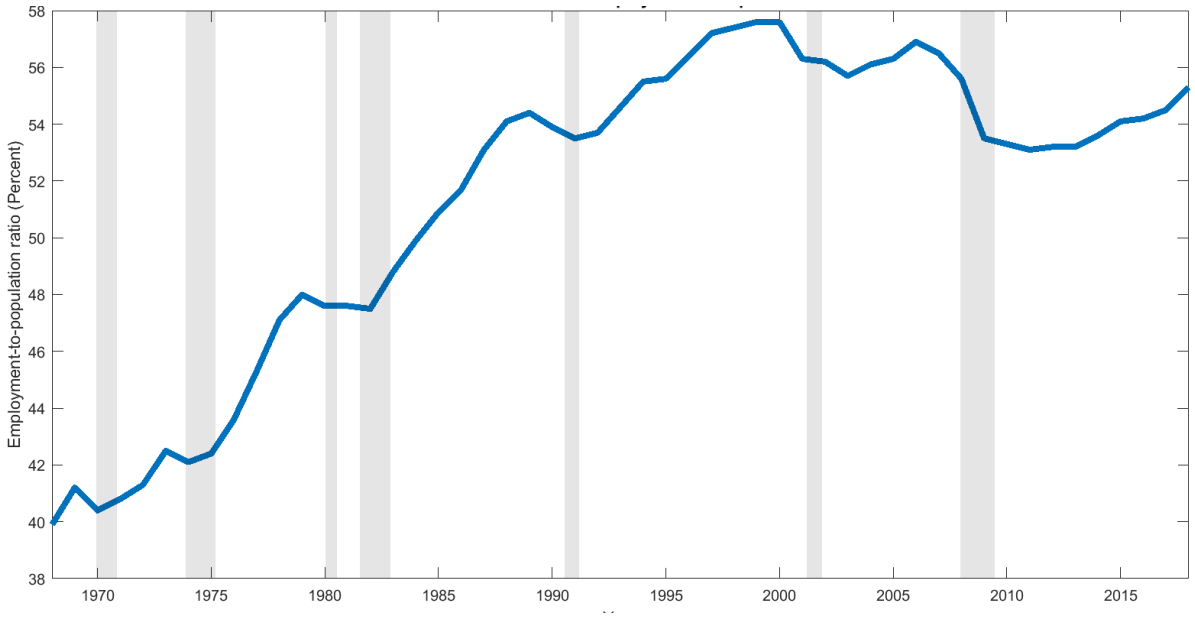
†See: https://github.com/PubaliC/JMP/blob/master/Pubali_JMP.pdf

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.

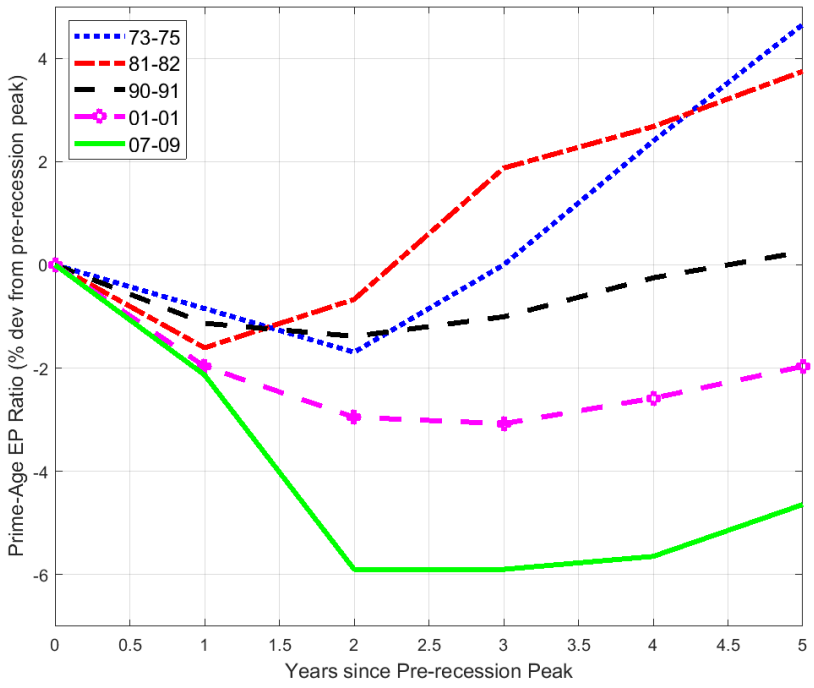
Figure 1 graphs the evolution of the employment-to-population ratio for female work-

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.

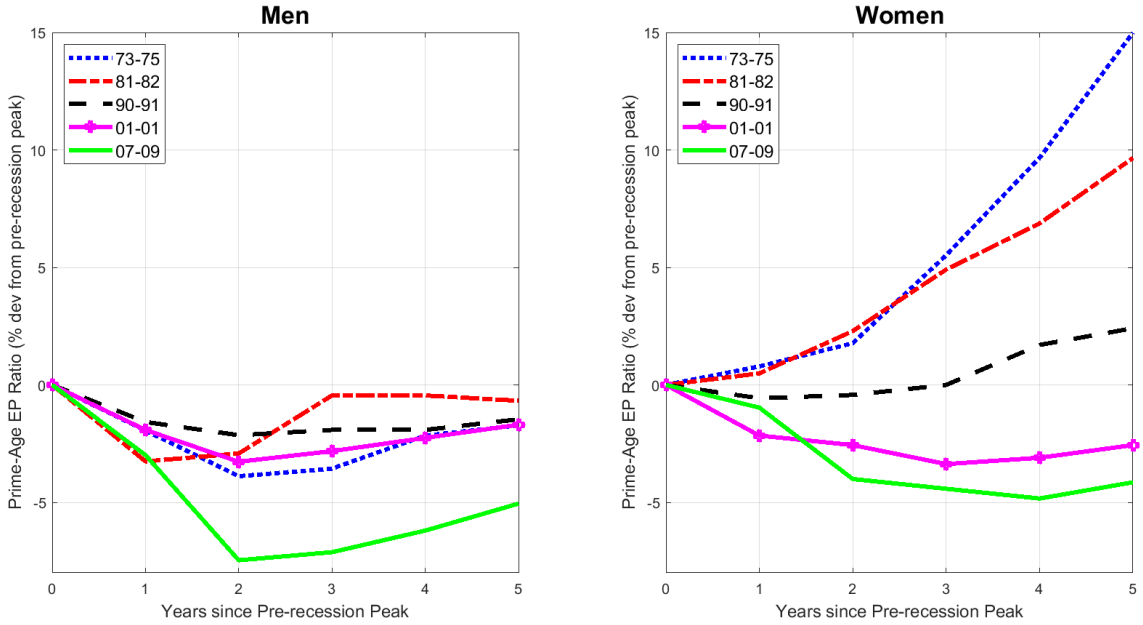
Figure 2 looks at recoveries in prime-age employment over the last five recessions. As is apparent from panel (a), recoveries have slowed down for the recessions post-1990 as compared to the ones before. To understand whether this change in employment recoveries has affected the entire population or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

[1]See, for example, Bloom et al. (2009); Papps (2006)

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.

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.

Finally, I use my theoretical framework to consider the effectiveness of alternative fiscal policies aimed at increasing the labor supply of young, married women with children with the intent of mitigating jobless recoveries. I discuss the results obtained under a countercyclical child care subsidy and a countercyclical wage income tax break for married

women. 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. In each of these policy scenarios, as well as in a control economy with neither policy, 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 either as a reduction in the purchase price of market child care or a reduction in the labor income tax rate paid by married women with children.

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.

The results are similar in the case of the alternative policy. When the tax rate for married women with children decreases, the substitution effect dominates the wealth effect, as a result of which the labor supplied by this group increases. This, in turn, increases the demand for consumption and market produced child care, which increases labor demand. The increase in labor supply exceeds the increase in labor demand, as a result of which there is a decline in the equilibrium wage rate. The other groups respond by decreasing their labor supply; however, this only partially offsets the initial increase. Thus this policy also results in an increase in equilibrium aggregate employment. Further, per-unit government expenditure, the child-care subsidy, is more effective in mitigating jobless recoveries than the income tax break. This result is consistent with my finding that changes in the number of children were the most important factor when the slope of the secular trend in female labor supply was the steepest.

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 and Rabinovich, 2014), structural change (Jaimovich and Siu, 2012), wage rigidities (Shimer, 2012) and access to credit (Herkenhoff, 2017). 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, Manuelli and McGrattan, 2015; Heathcote, Storesletten and Violante, 2017) and improvements in household technology (Greenwood, Sheshadri and Yorokoglu, 2005). Others emphasize medical advances affecting female health (Albanesi and Olivetti, 2016; Goldin and Katz, 2002), cultural changes (Fernandez, Fogli and Olivetti, 2004) and the rise of the service sector (Ngai and 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 (2019) and Olsson (2019) 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 (2019) 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. Section 6 draws insights from that decomposition in discussing the results of model policy experiments targeted at increasing female labor supply. Section 7 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 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]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

2.2 Decomposition Analysis

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. The corresponding results for men are discussed in the Appendix.

2.2.1 Age

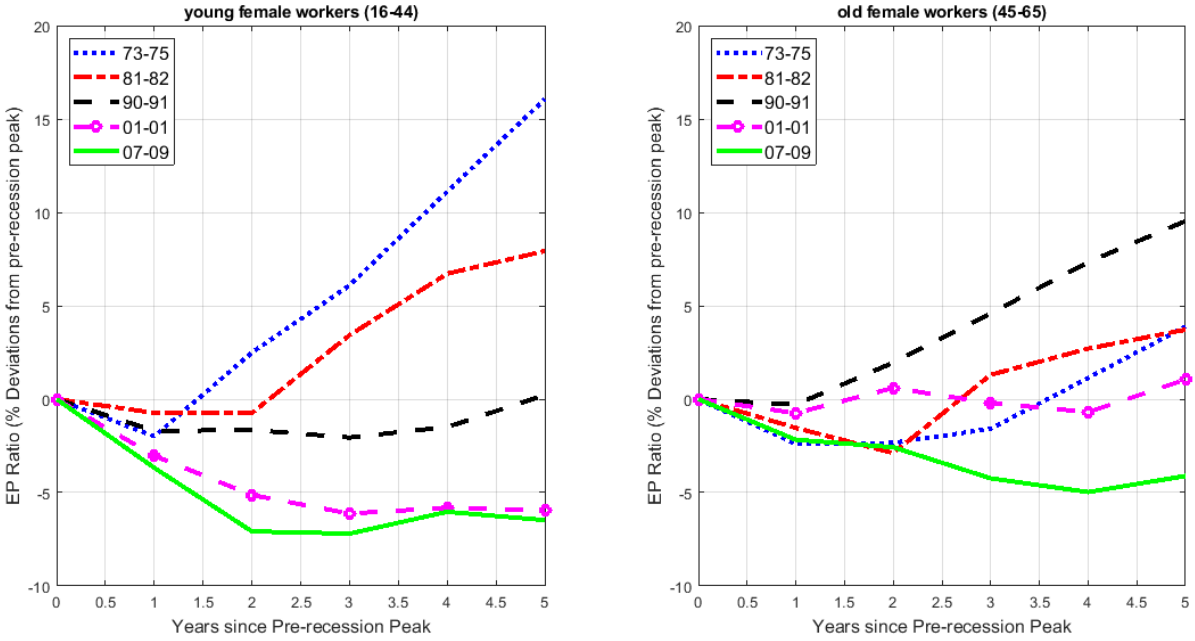
To analyze changes in employment recovery patterns for different age groups, I divide the population into 2 age groups: 16-44 (young) and 45-65 (old). [3] Figure 3 displays deviations in the average employment-to-population ratio from the pre-recession business cycle peak for each of these groups. I find that the 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.

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. This indicates that marriage is a dimension of heterogeneity that is relevant for examining jobless recoveries.

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

Figure 3: 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.

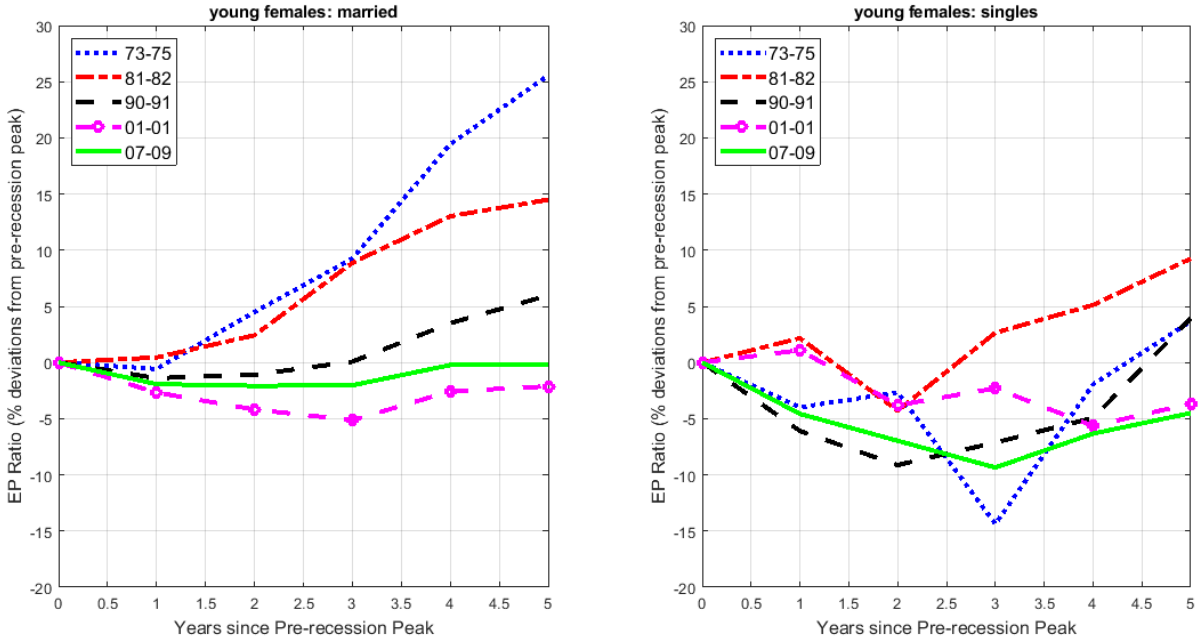
2.2.3 Children

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 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. 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.

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 2 groups: those with at least a 4-year

Figure 4: Employment Recoveries for Young Women by Marital Status



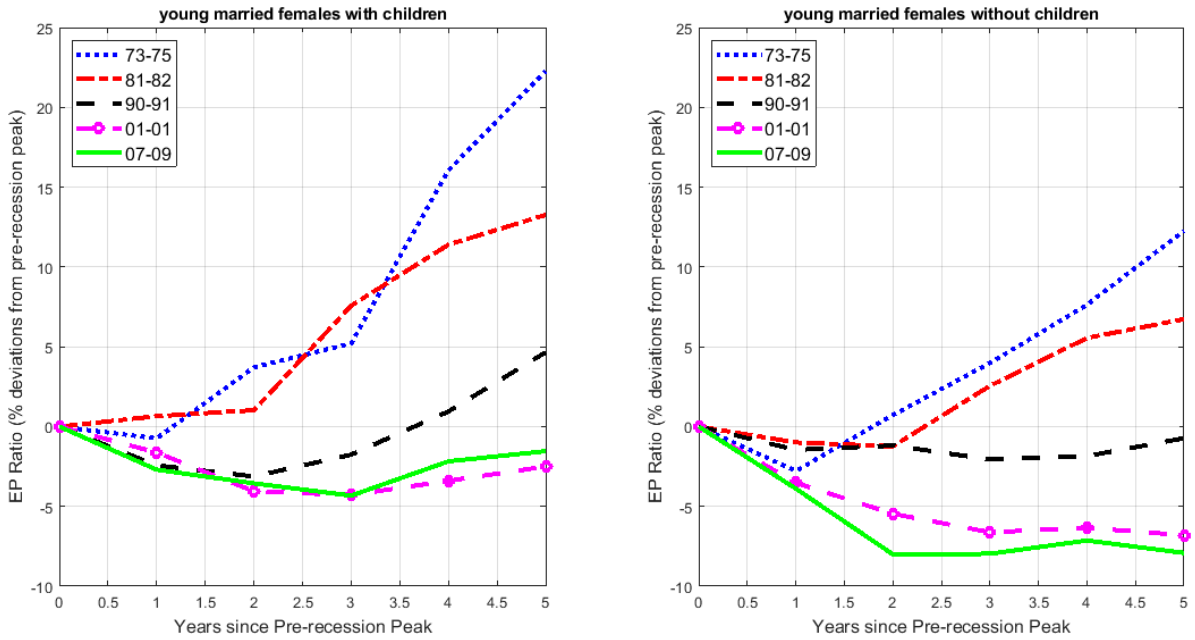
Notes: This figure graphs the employment-to-population of young women workers (aged 16-44) during the last 5 recessions and the subsequent recoveries. The x-axis measures year since pre-recession peak whereas the y-axis measures the percentage change in employment-to-population ratio since the pre-recession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

college degree; the rest of the population. [4] Figure 6 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. 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.

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.

[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 31 in the Appendix shows the results for the different education groups.

Figure 5: 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.

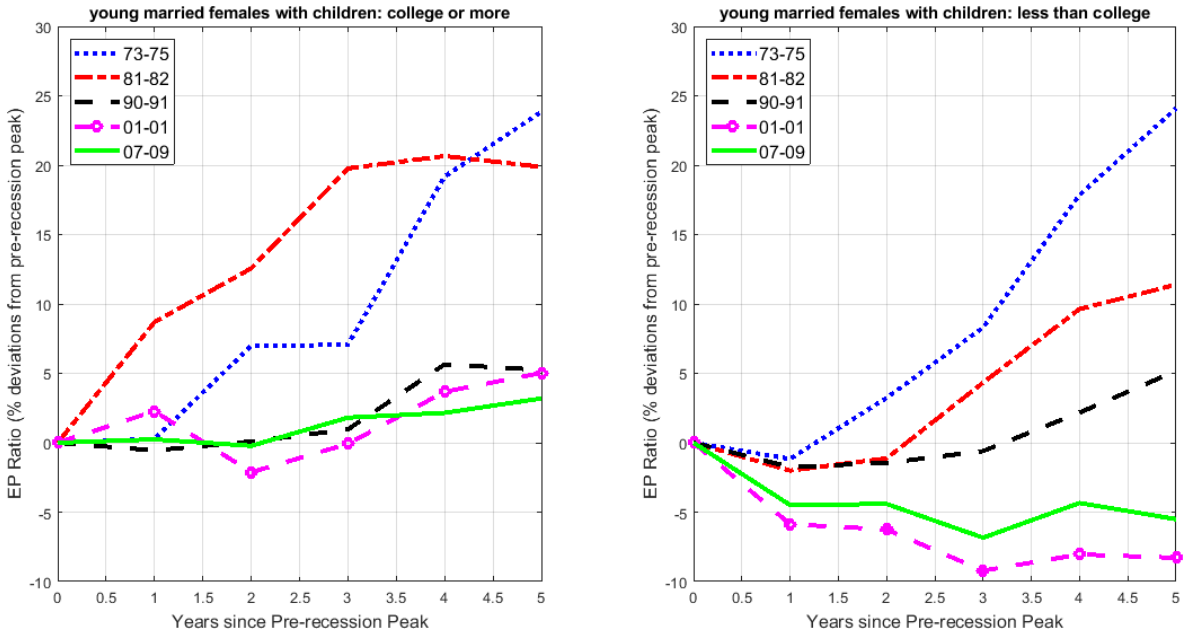
3 Model

3.1 Overview

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

The model period is one year long. Agents live for J periods and discount the future at the rate of β. In every period, both single and partnered households decide how much to save, how much to work in the market and how much to work at home. Households face gender-specific market wages $w_t(g)$ and rental rate r_t. There is a home production technology that uses the time spent at home as an input and produces a good that gives utility to households. This can be interpreted as home-produced child care that cannot

Figure 6: 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.

be outsourced. Partnered households face age-specific divorce shocks, whereas single households face age-specific marriage shocks.

There is a representative firm which employs labor and uses capital for production. Wages and rental rates are determined in equilibrium. Female wages are subject to an exogenous discrimination tax which gives rise to a gender wage gap.

3.2 Single Households

At each time period, t, single households of gender g, with assets k and age j have a time endowment of 1 and face gender specific market wages $w_t(g)$ and rental rate r_t. Agents choose own consumption c, savings k', labor to be supplied to the market n and labor to be supplied at home, n^h. Expenditures are subject to their budget constraint, which is the sum of their labor income, $w_t(g)n$, and asset income, $(1 + r_t)k$. Wages are subject to a distortionary labor wedge, τ_t. The assumption of the wedge would allow me to fit a

typical recession during the post-war era. It has no role in changing the recovery speed before or after 1990. Agents are not allowed to borrow ($k' \geq 0$).

A home production technology converts the time spent at home to produce child care c^h. Agents derive utility from own consumption, child care production and own leisure, which is equal to $1-n-n^h$. Utility from child care production is subject to an equivalence scale $\chi^h_{s,t}$ which depends on the number of children at home. I assume that $\chi^h_{s,t}$ varies with age and gender.

At the beginning of the next period, singles face an exogenous age-specific probability of marriage, which is denoted by $p_{t+1}(j+1)$. 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 agents get matched to other agents of the same age only. Agents maximize their lifetime utility as a single, $V_{s,t}$, which is defined below:

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

subject to:

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

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

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

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

where $\hat{V}_{p,t+1}(g, k'+\tilde{k'}, j+1)$ refers to the lifetime utility of the agent if married to an individual with next period assets equal to $\tilde{k'}$ and is defined by equation $(9-10)$ later.

Here equation (3) describes the technology of home production. I assume decreasing

returns to scale ($\psi < 1$). A_t^h is the parameter that governs technological progress in home production.

The optimal policy rules for the problem described by equations $(1-4)$ are given by $\Omega_{s,t}^* = \{c_{s,t}^*(g,k,j), n_{s,t}^*(g,k,j), n^{h^*}{}_{s,t}(g,k,j), h_{s,t}^*(g,k,j)\}$

3.3 Married Households

At each time period, t, married (or partnered) households with household assets k and age j consist of 1 male and 1 female who are of working-age. Each individual has a time endowment of 1 unit. Agents choose joint household consumption c, which is subject to an equivalence scale parameter given by χ, savings k', labor to be supplied to the market by each individual n_m, n_f and labor to be supplied at home by the female, n_f^h. Expenditures are subject to their budget constraint, which is the sum of their labor income, $w_{m,t}n_m + w_{f,t}n_f$, and asset income, $(1+r_t)k$. Wages are subject to a distortionary labor wedge, τ_t. Agents are not allowed to borrow ($k' \geq 0$).

A home production technology converts the time spent at home by the female to produce child care c^h. I assume that married men do not devote time at home towards child care production. This is an extreme assumption. However there is evidence that married women relative to married men spend a significantly larger fraction of their time towards home production (Ramey, 2009).

Each individual derives utility from joint consumption, child care production and own leisure, which is equal to $1-n_m$ for men and $1-n_f-n_f^h$ for females. child care production is subject to an equivalence scale $\chi_{p,t}^h$, which depends on the number of children at home. I assume that $\chi_{p,t}^h$ varies with the age of the household.

At the beginning of the next period, partnered households face exogenous age-specific probabilities of divorce, which is denoted by $d_{t+1}(j+1)$. In the event of divorce, I assume that their is an equal division of household assets between the individuals. The household maximizes the sum of individual lifetime utilities weighted by fixed shares, ζ_m

and $\zeta_f = 1 - \zeta_m$, represented by $V_{p,t}$ as described below:

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

subject to:

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

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

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

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

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

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

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

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

3.4 Firms

There is a representative firm in the economy which at every period t, 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 according to the technology $Y_t = A_t K^{\alpha}_t N^{1-\alpha}_t$. 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, to

be perfect substitutes, such that $N_t = N_{m,t} + N_{f,t}$. I assume that the 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:

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

where δ is the depreciation rate.

3.5 Distribution of households

Let the distribution of single households of gender g, age j and assets k be given by $\mu_{s,t}(g,k,j)$. Let the distribution of partnered households of age j and assets k be given by $\mu_{p,t}(k,j)$. The probability of getting matched to a single of the opposite gender, $\tilde{g}$, with next period assets equal to $\tilde{k'}$, given by $\theta_{t+1}(\tilde{g},\tilde{k'},j+1)$, 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:

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

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

3.6 Equilibrium

A competitive equilibrium is a set of sequences,

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

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 $(c_{s,t}, n_{s,t}, n^h_{s,t}, h_{s,t})$ are the associated policy rules.

2. $V_{p,t}$ solves the problem for partnered households which is defined by equations (5)-(8) and $(c_{p,t}, n_{p,m,t}, n_{p,f,t}, n^h_{p,f,t}, h_{p,t})$ 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 Parameter Choices

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. For my benchmark model, I calibrate my parameters to match a steady state corresponding to 1968. I choose 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.

Next, I incorporate changes in factors identified by the literature as possible contributors to the secular trend in female labor supply: the narrowing of the gender wage gap, technological advancements in home production, decreases in marriage rates, increases in divorce rates and changes in the number of young children at home[5]. 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[6] to solve for decision rules for each type of household at every time period. Further, to study business cycle dynamics, I use a perfect foresight environment, where A_t fluctuates which represents shocks to total factor productivity.

Since I consider workers aged 16-65, there are 50 age cohorts in the model economy. I assume that utility derived by an individual of gender g takes the following functional form: $U_g(c, c^h, 1-n) = \frac{c^{1-\sigma}}{1-\sigma} + \frac{(c^h)^{1-\sigma^h}}{1-\sigma^h} + \eta_g \frac{(1-n)^{1-\phi}}{1-\phi}$. Table 1 lists the parameter choices made in this framework. 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 and with respect to home produced good, $\sigma^h = 1.5$. I assume separability in consumption of the home-produced good and the market good because the former is interpreted as child care in my framework, which cannot be substituted by own consumption if agents have children. The equivalence scale parameter, χ, which is used to

[5]See for example: Heathcote, Storesletten, Violante (2018), Goldin (2014), Jones, Manuelli, McGrattan (2015), Greenwood et al (2005)

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

Table 1: Parameter Choices

Parameter	Description	Value
Pre-set		
ϕ	Curvature parameter in utility from leisure	4
A^h	Home production technology parameter	0.5
σ^h	CRRA coefficient for child care	1.5
ψ	Curvature parameter in home production technology	0.2
χ^h	Equivalence scale for children	1.5
Common Values	*Source*	
A	Hansen (1985)	1
σ	Heathcote, Storesletten, Violante (2017)	1
χ	OECD Tables	1.7
τ	Shimer (2009)	0.40
Calibrated internally	*Targets*	
β	Annual Rate of interest (=0.048)	0.98
α	Capital-Output ratio (=2.31)	0.27
δ	Investment-Capital ratio (=0.069)	0.069
η_m	Average Hours worked by married men, 1968	0.62
η_f	Average Hours worked by single women ,1968	1.134
ζ_m	Average Hours worked by married women, 1968	0.65

scale married households' consumption of the market good is chosen to be the OECD equivalence scale corresponding to couple households [7]. The parameters that govern the home production function, ψ, A^h, χ^h will be disciplined further by using moments from the American Time Use Survey.

The preference parameter for leisure for males and females, η_m and η_f respectively and the Pareto weight associated with the male utility, ζ_m, in a married household are jointly calibrated to match the average labor supplied by married men, married women and single women in 1968 [8]. The parameter choices for capital share of output, α, depreciation rate,

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

[8] ϕ which governs the curvature in the utility function from leisure will be disciplined using a measure of Frisch elasticity of labor supply for households. Heathcote, Storesletten and Violante (2017) use a

δ, and discount factor β result in steady state values of $\frac{K}{Y} = 2.31$, $\frac{I}{Y} = 0.16$ and an annual interest rate, $r = 4.76\%$. The total factor productivity, A, is normalized to 1 and the labor wedge, $\tau = 0.4$ in steady state.

I use the ratio of the median income of full-time year-round female to male workers, which is published by the United States Census Bureau from 1968-2014, as the gender wage gap for that time period. I use micro-data on the number of young children, aged less than 5, from the CPS March ASEC data and calculate the average number for a household of every age and marital status for every year between 1968-2014. The average calculated includes households with no children[9]. 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. To calculate the divorce rate for the entire time period of interest, I use a combination of two data sources. 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 for every year between 2008-2014. In both cases, the divorce rate is calculated as the number of divorces per 1000 married women aged above 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. Data on marriage rate is reported by the NCFMR for the years 1970, 1980, 1990, 2000, 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. At this point, marriage rates and divorce rates used are not age-specific. The next step of my analysis would involve using a panel data structure to estimate age-specific marriage and divorce rates for individuals over the entire time period of interest.

value of 3 for the same. My choice of ϕ is not very different.

[9]For married households, I use information reported by married women, since information on young children provided by married men is missing for 3 years in the data

5 Results

In this section, I describe three sets of results obtained from my quantitative model. Firstly, I compare the steady state results obtained from the model to their counterparts in the data and then study the relative contribution of each of the underlying causal factors influencing labor supply changes, as discussed in the previous section. Secondly, to understand the trend in labor supply, I compare a transition from an initial to a final steady state. The initial steady state is characterized by low female labor supply, while the ending steady state reproduces the recent labor force participation of females. I explore the importance of each factor along the transition. Finally, to understand the effect of the trend on jobless recoveries, I compare the response of the economy to an aggregate productivity shock during a period with rising female labor supply to a later period when the trend has weakened. I further investigate the role of each underlying causal factor towards influencing the cyclical response in labor supply for each group under the two scenarios.

5.1 Steady State

Here, I discuss results for aggregate labor supplied by each subgroup of the population at the initial (1968) and final (2014) steady state. The changes that take place across the two steady states include a narrowing of the gender wage gap, a decrease in marriage rates, an increase in divorce rates, and a change in the average number of young children across households. I allow agents in the framework to respond to these changes, which are directly measured from the data, as described in Section 4. In particular, there has been a substantial decline in the average number of young children for young married households of ages less than 30, whereas there has been a slight increase for older married households. 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. These patterns are illustrated in the Appendix in Figures 22, 23, 24.

The results on aggregate labor supplied by married women, married women, single

Table 2: Calibration Targets and Overidentifying Successes

	Data 1968	Model 1968
Gender wage gap	0.415	0.415
Marriage rates	0.077	0.077
Divorce rates	0.013	0.013
Num. of Children	'68 values	'68 values
Aggregate: N	0.222	0.221[1]
Married Women: $N_{f,p}$	0.109	0.109
Married Men: $N_{m,p}$	0.333	0.333
Single Women: $N_{f,s}$	0.198	0.198
Single Men: $N_{m,s}$	0.273	0.311[1]

Note: I use values on the gender wage gap, marriage rates, divorce rates and the number of young children directly from the data to solve my model. The number of young children at home differ across ages and across marital status and hence cannot be summarized by a single number here. The upper panel describes the values used. The lower panel compares the results obtained on aggregate labor supply N, aggregate labor supplied by partnered and single individuals of gender g, $N_{g,p}$ and $N_{g,s}$ respectively to their counterparts in the data in 1968. I use the measure of average number of hours worked by each group (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 of labor supply. [1] denotes Untargeted successes

men, and single women for the benchmark model (1968) are listed in Table 2. The model does well quantitatively in replicating the labor supplied by each of these groups, as seen in the data, both in terms of targeted as well as untargeted moments.

Next, I compare the changes in labor supplied by each group across the two steady states. The results are illustrated in Table 3. My model does well in quantitatively replicating the data counterparts 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. Labor supplied by both married and single men decreases. My model captures 74% 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 (55.05%) is not entirely offset by a decrease by men (6.31%), which is consistent with the data that substantial crowding

out does not take place among couples.

Table 3: Percentage change in Steady State Values of Labor Supply from 1968 to 2014

	Data	Model
Gender wage gap	-50.12	-50.12
Marriage rates	-58.44	-58.44
Divorce rates	38.46	38.46
Num. of Children	–	–
Aggregate	3.60	8.14
Married Women	74.31	55.05
Married Men	-13.51	-6.31
Single Women	5.05	12.12
Single Men	-16.48	-5.47

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. The results from this exercise are listed in Table 4. 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.

As the gender wage gap decreases, the opportunity cost of not supplying labor to the market increases for women. As a result, 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 home-produced child care, further encouraging substitution from home to market labor. 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

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

	Gender wage gap	Marriage rates	Divorce rates	Num. Children
Aggregate	95.7	1.79	-2.43	-1.75
Married Women	95.0	-1.90	0.55	4.72
Married Men	87.4	1.07	-5.79	2.29
Single Women	15.81	47.2	-13.11	-0.68
Single Men	7.18	28.7	12.4	63.2

Notes: Each column describes the percentage of the total change in labor supplied by each group from 1968 to 2014 explained by the gender wage gap, the marriage rate, the divorce rate and the number of young children at home respectively.

men's labor supply is not large.

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, as a result of which there is a decrease in the labor supplied. 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 who are acquiring 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.

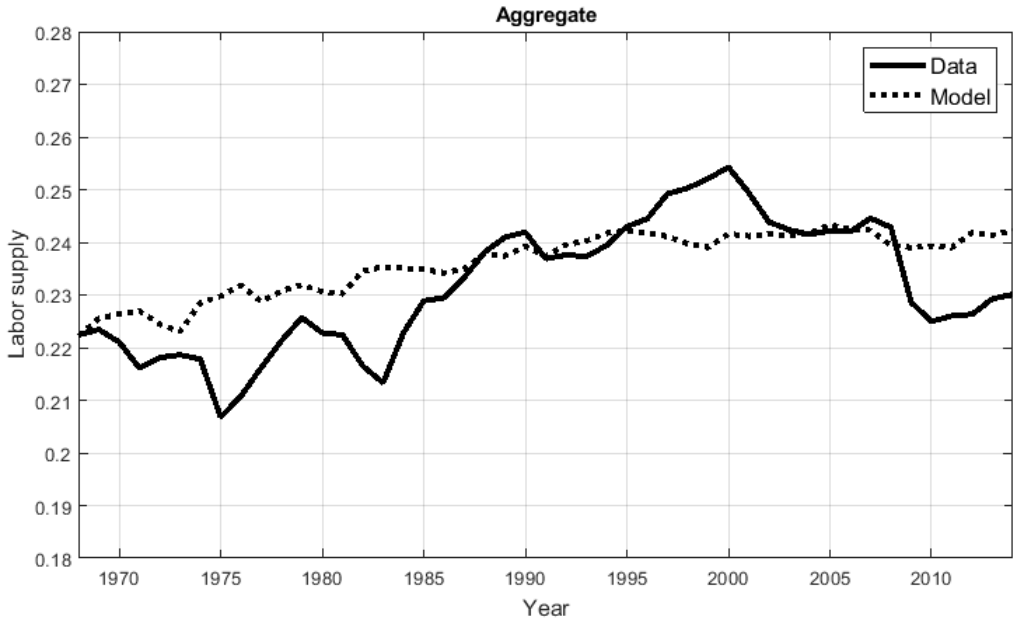
For single women, the decrease in marriage rates results in increasing the labor supplied by them the most. Since they are less likely to have a spouse with whom to pool income, single women will more likely need to depend on the income they earn to finance consumption. An increase in household income, mainly attributed to the increased labor supply of married women, increases demand for consumption and savings of households, which in turn increases the output produced by firms and increases the wages earned by both men and women.

5.2 Understanding 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 7 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.

Figure 7: Aggregate labor supply: model and data



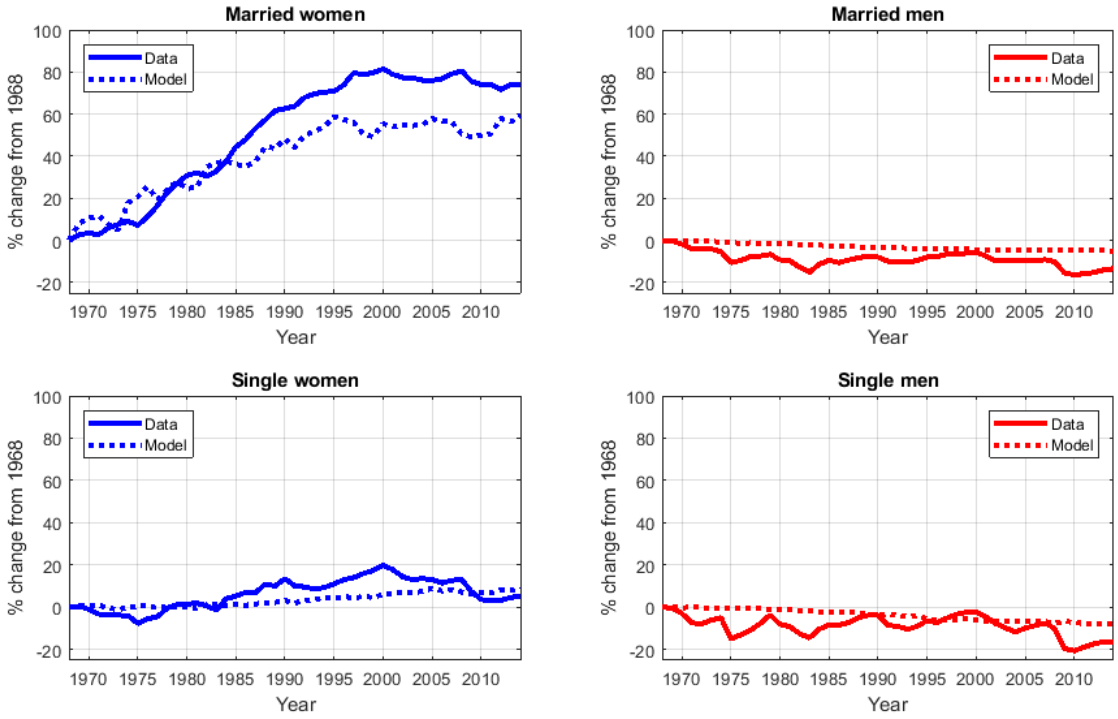
Notes: I use the measure of average number of hours worked by the population (includes all those who work 0 hours) from Doepke and Tertilt (2016) and divide it by 120 to get the data counterpart of aggregate labor supply.

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 8. 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.

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 9 and 10, respectively. The corresponding results for men are shown in Figures 25 and 26 in the Appendix.

For married women, the results indicate that from 1968 to the early 1980s, the most

Figure 8: Aggregate labor supply for married and single, women and men

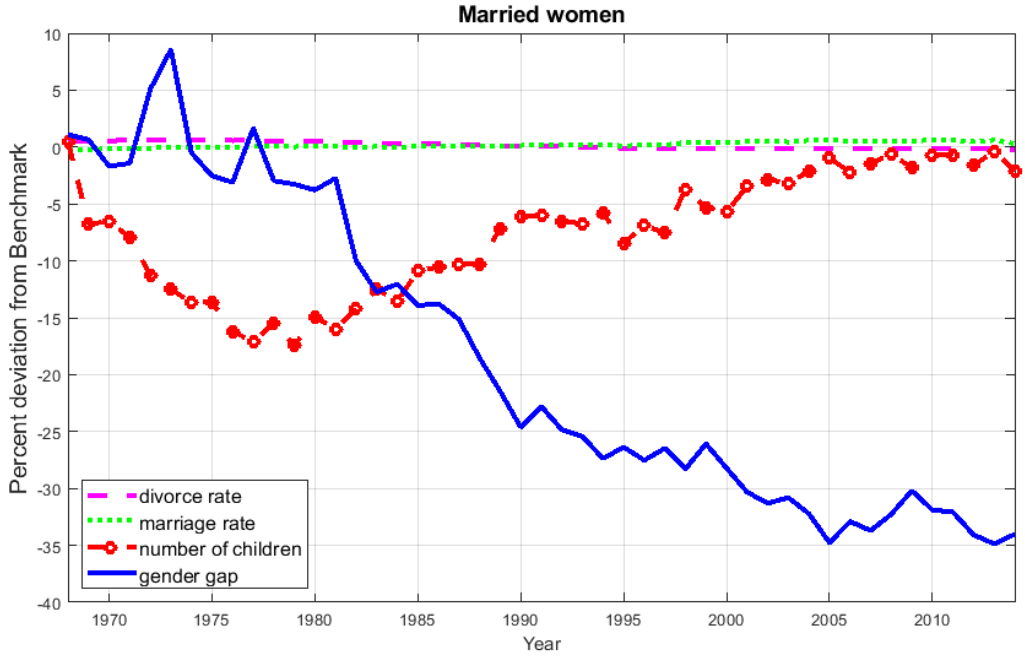


Notes: I use the measure of average number of hours worked by the population (includes all those who work 0 hours) from Doepke and Tertilt (2016) and divide it by 120 to get the data counterpart of labor supplied by each group. The y-axis plots the percentage change in labor supplied by each of these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

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 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 de-

Figure 9: Decomposition into factors underlying married women's trend in labor supply



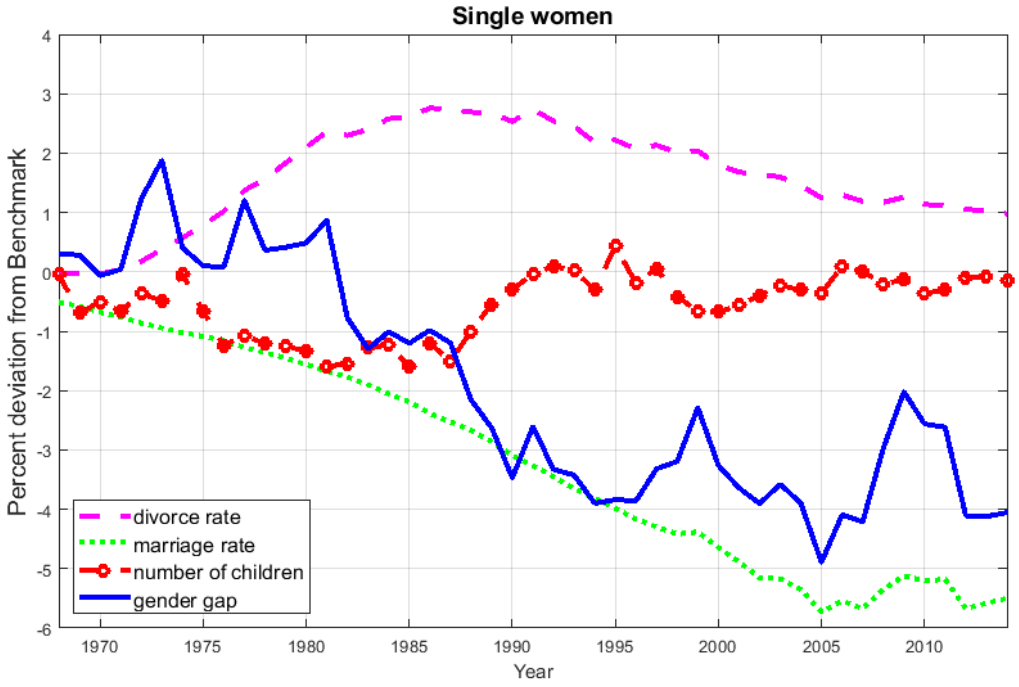
Note: This graph measures the relative contribution of each of the factors towards explaining the trend in labor supply for married women from 1968 to 2014. For each of the series, I fix only one of the underlying factors and study the implied trend in labor supply. The y-axis measures the percentage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

creases 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 9. As a result, the contribution of each of these factors to explain is also substantially smaller in magnitude.

5.3 Understanding Jobless Recoveries

In this section, I investigate the interaction between the secular trend in female labor supply and jobless recoveries. To do this, I compare the response of the economy to the combined effect of a 5% negative aggregate productivity shock and a 20% positive labor wedge 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

Figure 10: 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.

in 2007. 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. Specifically, the underlying processes for aggregate TFP and the labor wedge are respectively given by:

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

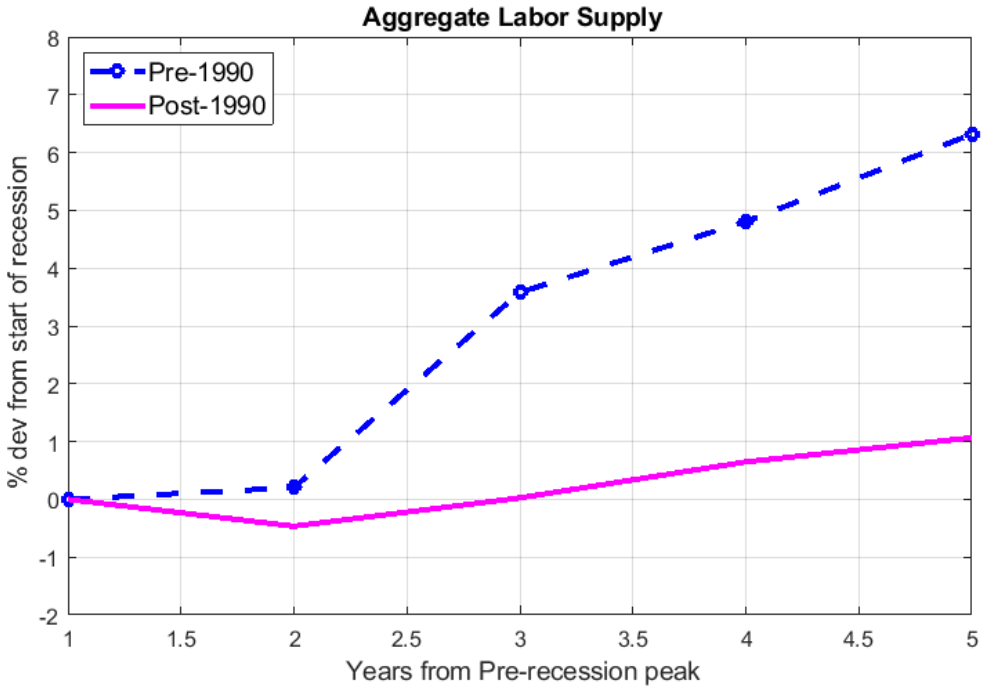
$$\tau_{t+1} = \rho \tau_t + (1-\rho)\tau \tag{22}$$

where $\rho = 0.95$ is the persistence of the processes whereas A and τ are the steady state values.

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.

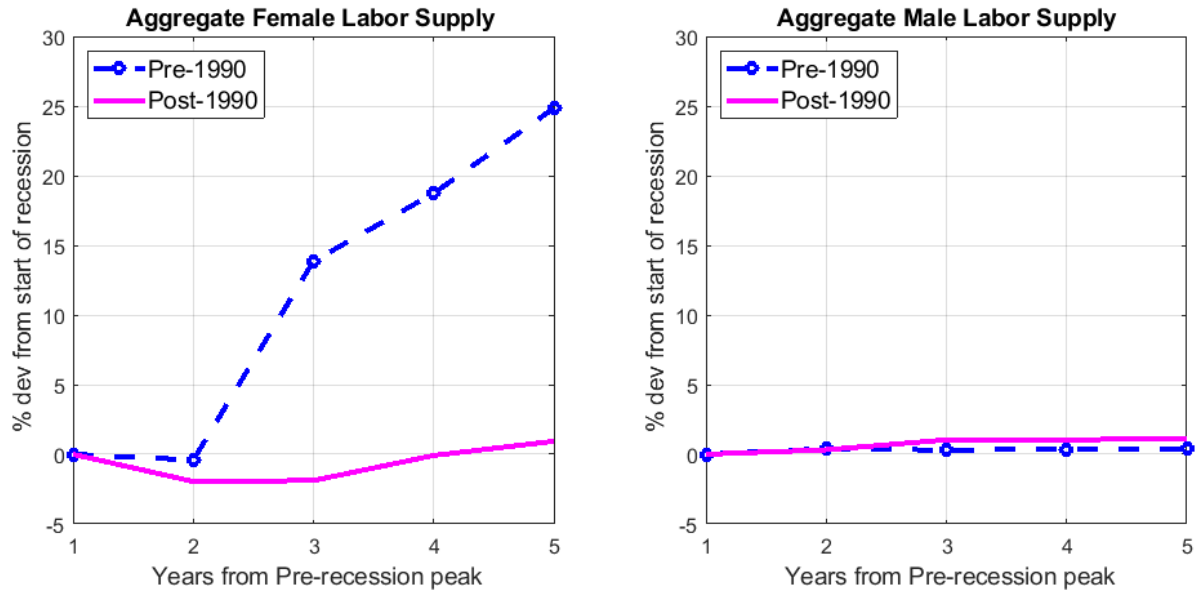
In Figure 12, the aggregate labor supply recoveries for females and males make it

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 12: Cyclical response in Labor Supply: Men and Women

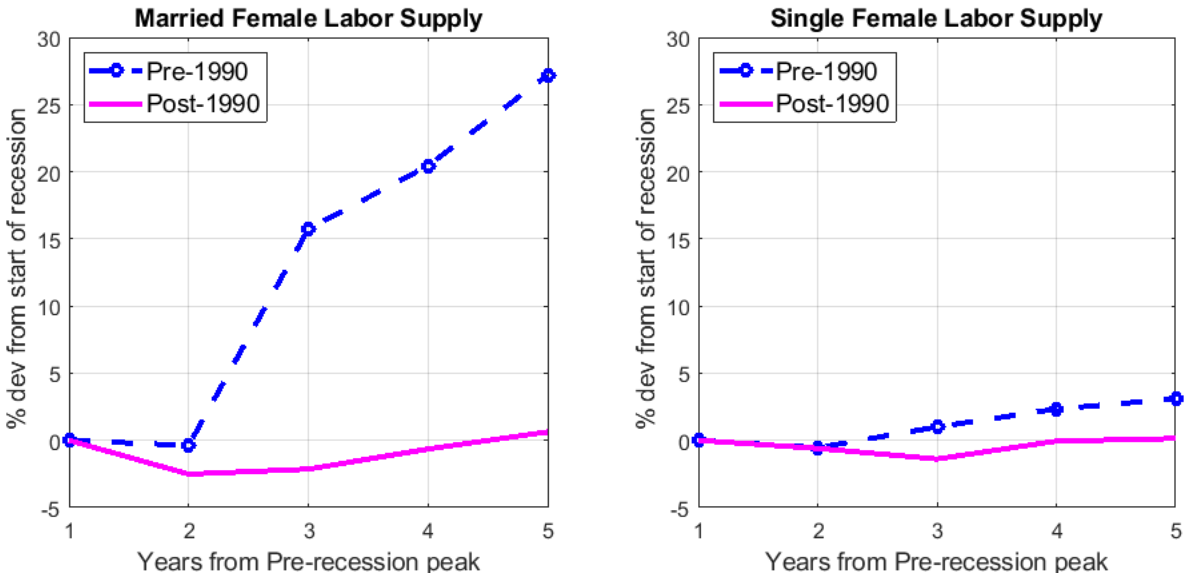


Notes: This graph measures the cyclical response in labor supplied by men and women in the presence of an upward trend (Pre-1990) and in the absence of an upward trend (Post-1990). The y-axis measures the percentage deviation in labor supply from the impact date (or start of a recession)

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.

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)

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.

I then investigate the contribution of each of the underlying demographic changes on the cyclical response of labor supply for different groups of women. To do this, I conduct counterfactual exercises in which I fix one of the factors at a time at its pre-recession level and observe the labor supply response over the cycle. The results are shown in Figure 14. I find that for married women in the pre-1990 recession, change in the number of young children is the biggest contributor towards explaining their cyclical response in labor supply as well. For this group, the narrowing of the gender wage gap has the least effect during this era. During the post-1990 recessions, all the factors seem to have similar contributions towards affecting the cyclical response in labor supply. For single women, however, during the pre-1990 recession, all factors contribute equally. In the post-1990

Figure 14: Role of underlying factors in the cyclical response in women's labor supply

Notes: The Y-axis plots the percentage deviation in the cyclical response in labor supply for each of the series from the benchmark case where all the factors are allowed to change.

recession, the gender wage gap and change in the number of young children affect the cyclical responses the most. I do a similar decomposition for men. The results are shown in Figure 33 in the Appendix.

6 Targeted Policy Intervention

In this section, I discuss policy experiments that are aimed at mitigating jobless recoveries. I use my framework to examine the effectiveness of each of these policies. I conduct a counter-factual exercise, wherein households with children have the additional option of buying child care: φ from the market at a price, q. However, there is a required amount of total 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. There is a firm that now produces child care 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.

In the following subsections, I study the labor supply choices during business cycles under alternative policies, which are funded using taxes on wage (τ_w) and rental income (τ_r) and Government spending G. Thus,

$$\text{Total Subsidy}_t = \tau_w \sum_g w_{g,t} N_{g,t} + \tau_r r_t K_t - G_t \tag{23}$$

I compare the recoveries in the post-1989 recessions (when the trend in female labor force participation has leveled off) in the presence and absence of these countercyclical government subsidies.

6.1 Per-unit Child Care Subsidy

Here I consider the government provision of a subsidy (τ_s) to households for every unit of child care that they purchase from the market. 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:

$$c + (1 - \tau_{c,t}) q_t \varphi + k' \leq (1 - \tau)(1 - \tau_w) w_t(g) n + (1 + (1 - \tau_r) r_t) k \tag{24}$$

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

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

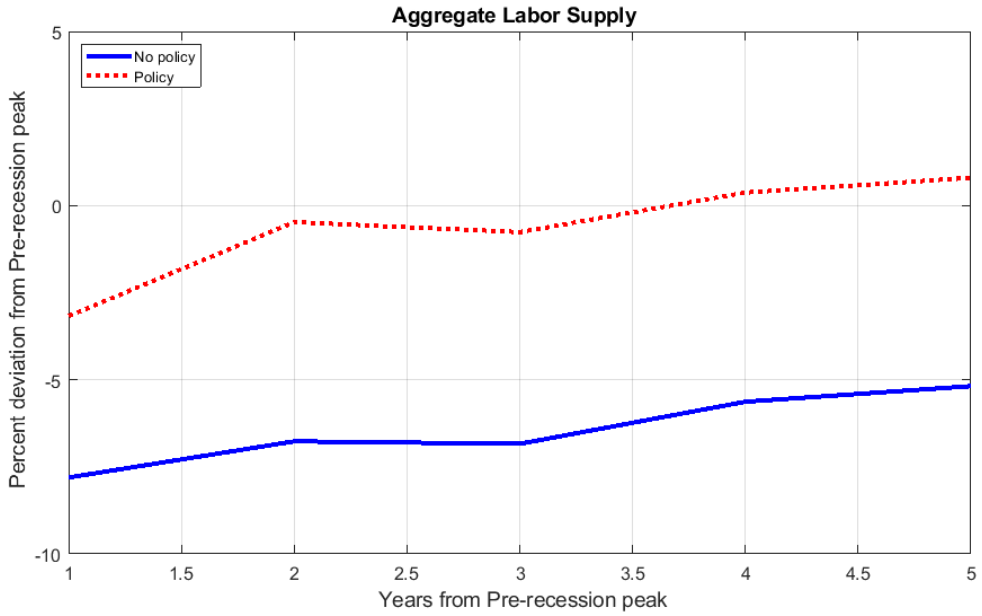
$$\begin{aligned} c + (1 - \tau_{c,t}) q_t \varphi + k' \leq & (1 - \tau)\{(1 - \tau_w) w_t(m) n_m + (1 - \tau_w) w_t(f) n_f\} \\ & + (1 + (1 - \tau_r) r_t) k \end{aligned} \tag{26}$$

$$c^h \leq A_t^h (n_f^h)^\psi + \varphi \tag{27}$$

For the preliminary version of this exercise, I assume the following parameter values: $\tau_w = \tau_r = 10\%$ whereas γ 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 (ρ) as aggregate productivity. Figure 15 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 15: 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 16 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.

Next, I investigate whether there is heterogeneity in the effectiveness of the policy between different groups of women. Figure 17 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 34 in the Appendix illustrates the results for the same.

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 child care sector rises. The subsidy induces both

Figure 16: Responses to Countercyclical Child Care Subsidy by Gender

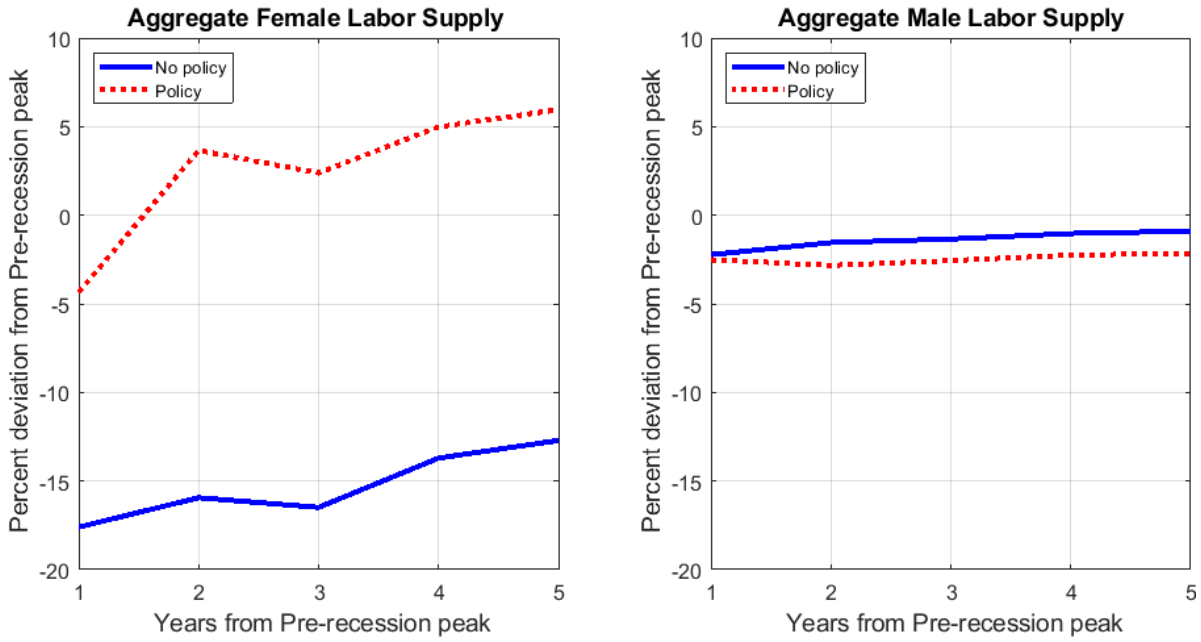
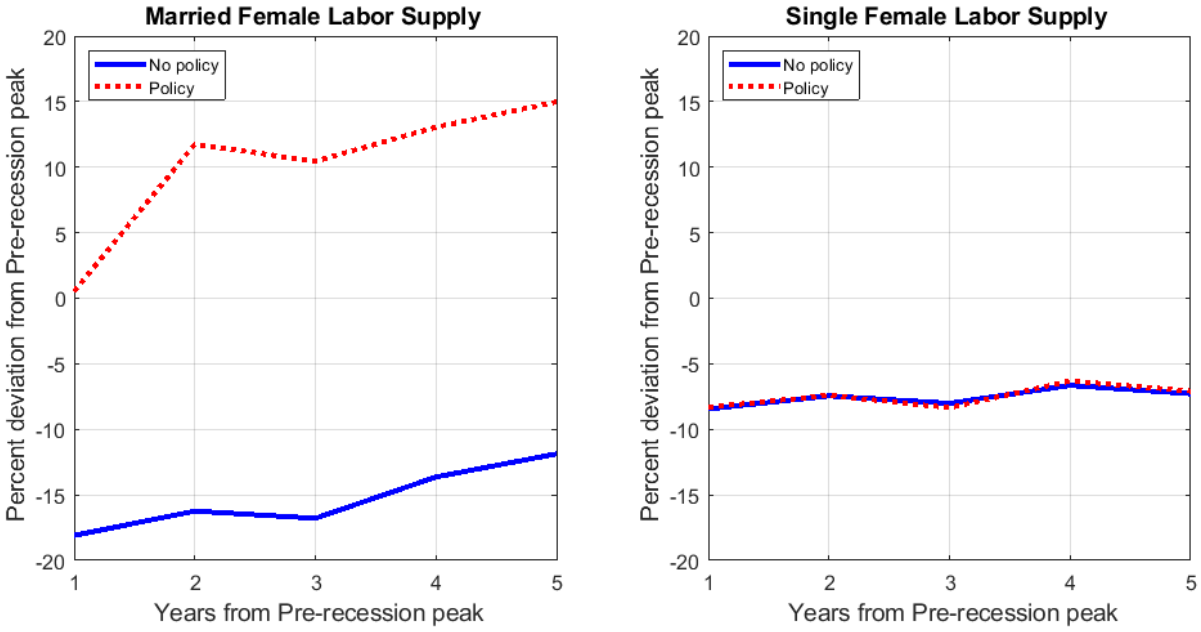


Figure 17: Responses to Countercyclical Child Care Subsidy of Women by marital status



a wealth effect as well as a substitution effect on the labor supply of individuals. 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.

6.2 Tax Break for Married Women with Children

Next, instead of a child care subsidy, I examine the effectiveness of a countercyclical tax break on wage income for married women with young children. In this case, during recessions, this group is taxed at the rate of $\hat{\tau}_{w,t} < \tau_w$. 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:

$$c + q_t\varphi + k' \leq (1-\tau)(1-\tau_w)w_t(g)n + (1+(1-\tau_r)r_t)k \tag{28}$$

$$c^h \leq A_t^h(n^h)^\psi + \varphi \tag{29}$$

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

$$\begin{aligned} c + q_t\varphi + k' \leq & (1-\tau)\{(1-\tau_w)w_t(m)n_m + (1-\hat{\tau}_{w,t})w_t(f)n_f\} \\ & + (1+(1-\tau_r)r_t)k \end{aligned} \tag{30}$$

$$c^h \leq A_t^h(n_f^h)^\psi + \varphi \tag{31}$$

For the preliminary version of this exercise, I assume that $\tau_w = \tau_r = 10\%$ as in the previous case. However, at the start of the recession, $\hat{\tau}_{w,t} = 0$, and it mean-reverts to equal τ_w with the same persistence (ρ) as aggregate productivity. The effect of this policy on the cyclical response in aggregate labor supply is shown in Figure 18. I find that in the presence of this policy, aggregate labor supply decreases by 5.2% as opposed to 7.8% when no such policy is in place. Further, labor supply recovers faster, with a half-life of 6 years as opposed to 7 years in the case of the former.

Next, I investigate the response of men and women to this policy; the results are shown in Figure 19. I find that women benefit from this tax break, with a lower decline and a faster recovery in their labor supply during recessions. Men show a greater reduction in their labor supply in the presence of this policy. However, the net positive effect on women's labor supply dominates the negative impact on men's labor supply in terms of magnitude, which is then reflected in the aggregate.

Figure 18: Aggregate Labor Supply response to Countercyclical Income Tax Break

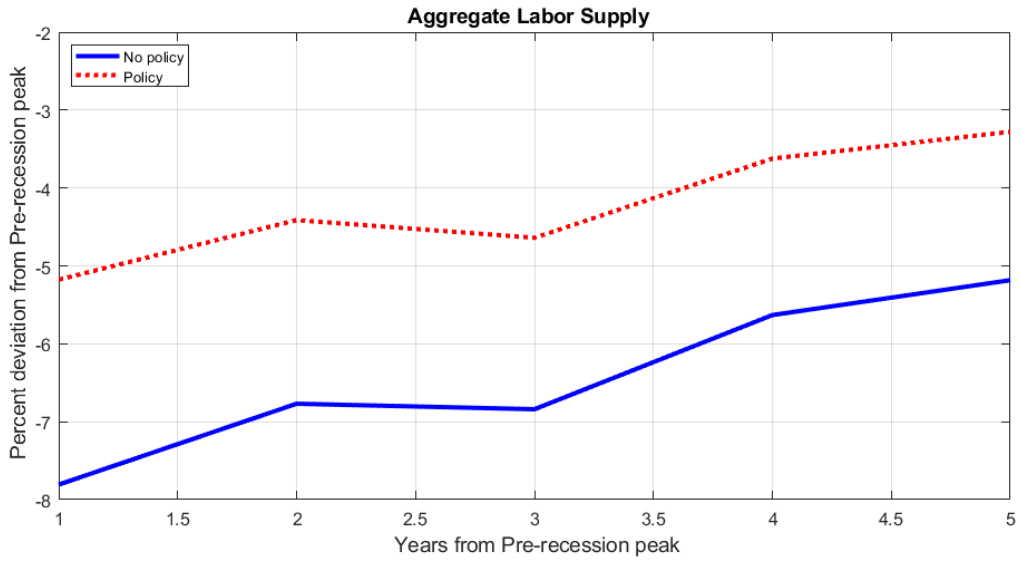
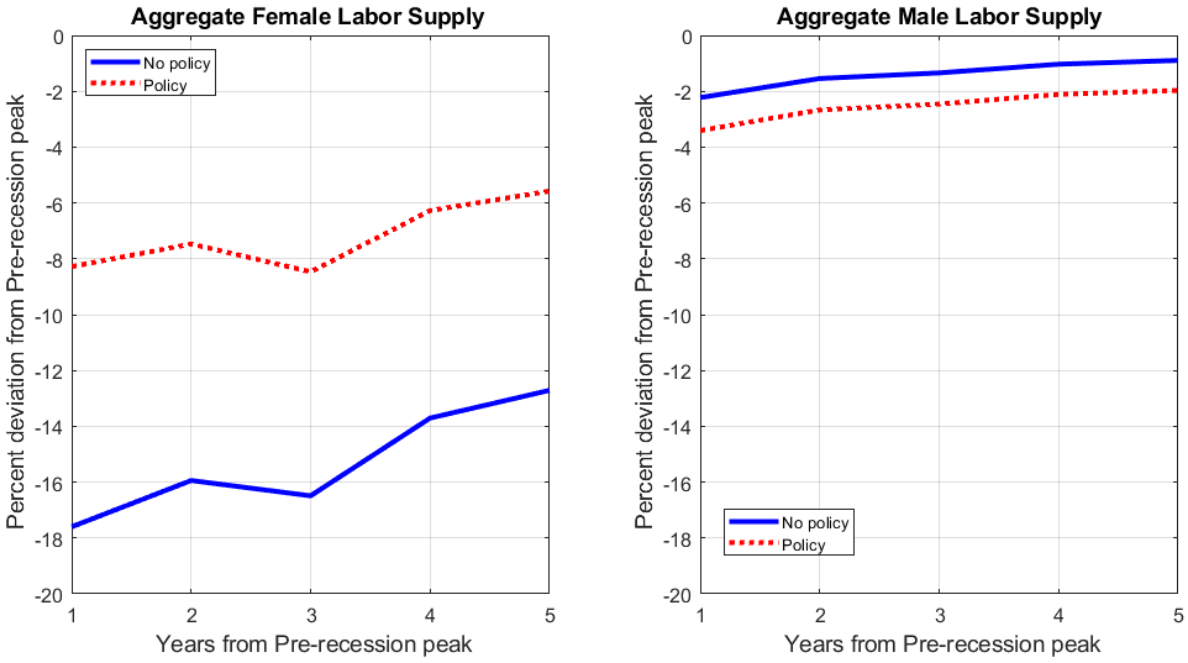
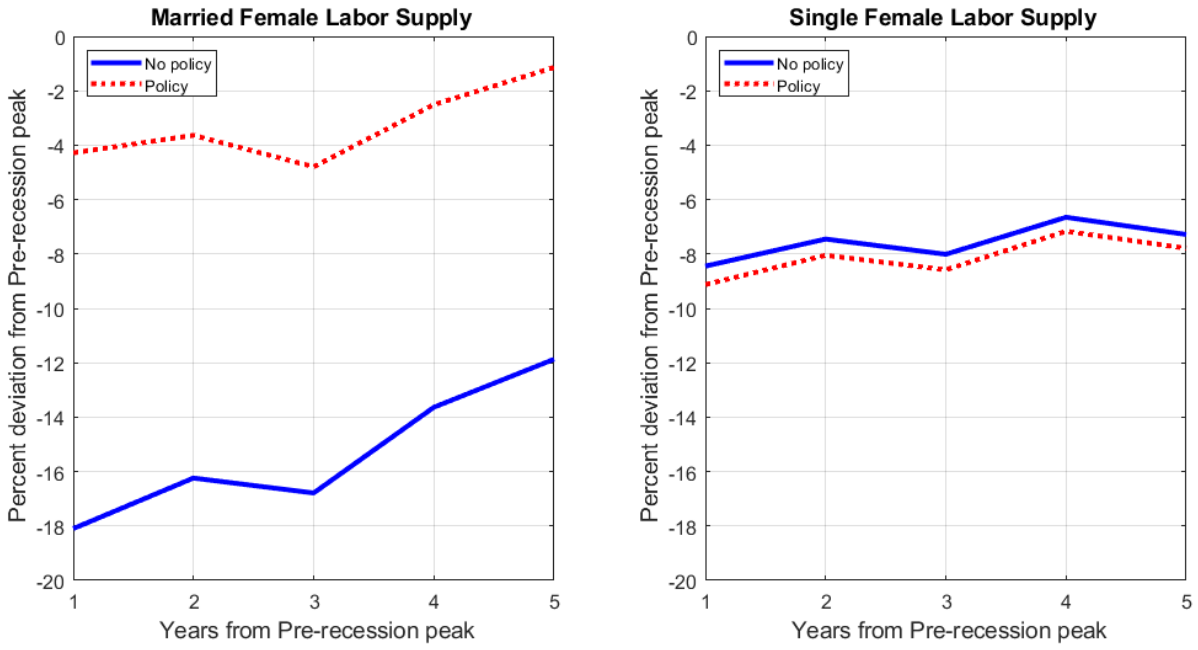


Figure 19: Responses to Countercyclical Income Tax Break by Gender



I then proceed to explicitly analyze the effect of this policy on the labor supply responses of married and single women. Not surprisingly, I find that married women respond substantially to this policy, which is reflected in a lower decline and faster recovery in their labor supply. Single women show a slight decrease in their labor supply when this policy is implemented. I do a similar decomposition for men, the results for which are illustrated in Figure 35 in the Appendix.

Figure 20: Responses to Countercyclical Income Tax Break of Women by Marital Status

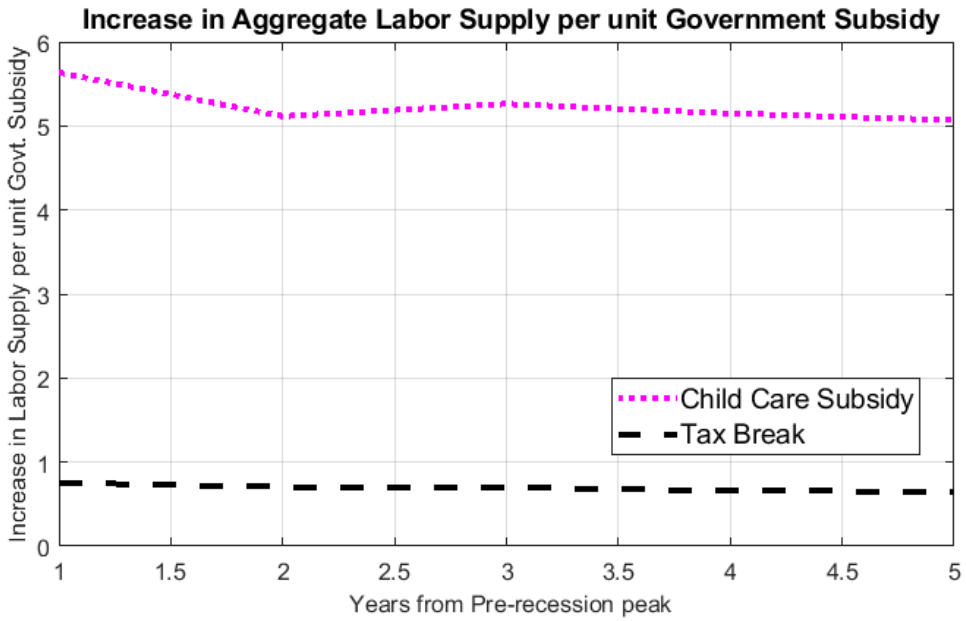


As the tax break is introduced, married women increase their labor supply to the market. This is because there is an increase in their effective wage rate, and the resulting substitution effect dominates the wealth effect. This policy is qualitatively similar to a narrowing of the gender wage gap and hence induces a comparable response in labor supplied by women. As married women work more, there is an increase in demand for consumption as well as demand for market-provided child care, which in turn increases the demand for labor. The result is an increase in aggregate equilibrium employment. However, for the current specification, the increase in labor supply exceeds the rise in labor demand, as a result of which there is a slight decrease in equilibrium wages. As wages decline, all the other groups respond by decreasing their labor supplied to the market. However, this decline is not quantitatively sufficient to completely offset the initial increase in labor supply by married women.

Next, to compare the effectiveness of the two policies discussed above in mitigating jobless recoveries, I compute the change in the cyclical response of aggregate labor supply due to each of these policies per unit of the total government spending towards these policies. The results are illustrated in Figure 21. I find that for every dollar spent by the government on policies, the child care subsidy is almost eight times more effective

in increasing labor supply as compared to a tax break for married women. A targeted tax break effectively reduces the gender wage gap, whereas the child care subsidy reduces the cost of child care. These results further illustrate the importance of accounting for children when examining factors influencing female labor supply.

Figure 21: Comparison of Policies on Cyclical Response in Aggregate Labor Supply



Notes: This figure shows a comparison in the effectiveness of the countercyclical policies considered. I compute, for each policy, the difference between aggregate labor supply in the presence and absence of the policy and then divide it by the total cost incurred by the Government to fund the corresponding policy. The results for the first five year post the pre-recession peak are plotted here.

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 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 con-

tribution 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 two countercyclical policies: a subsidy to market-provided child care and a tax break for married women with children. I find that in both these cases, 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. Further, per-unit government expenditure, the child-care subsidy, is more effective in mitigating jobless recoveries than the income tax break. This result is consistent with my finding that changes in the number of children were the most important factor when the slope of the secular trend in female labor supply was the steepest.

For future work, I want to extend my analysis 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.

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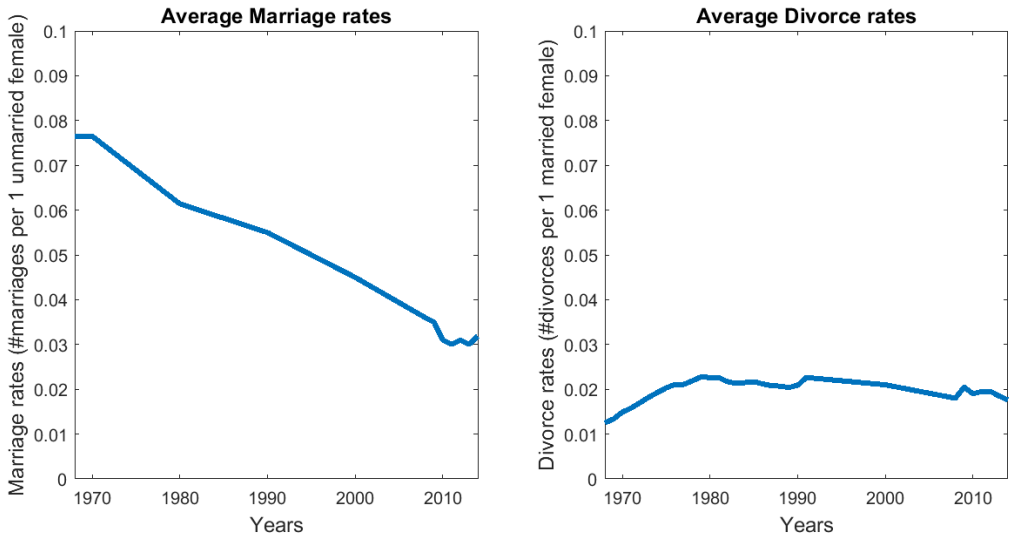
A Appendix

The average marriage and divorce rates are described in Figure 22. Marriage rates have fallen substantially whereas there has been a rise and then a decline in the divorce rates.

Figure 22: Marriage and Divorce rates over the years



The gender wage gap has narrowed over the years with a decline in the ratio of female and male wages. It has been described in Figure 23. In this graph, only full time workers have been considered.

Changes in the number of young children for households of each type for different age groups are illustrated in Fig 24.

Figure 23: Changes in the Gender Wage Gap

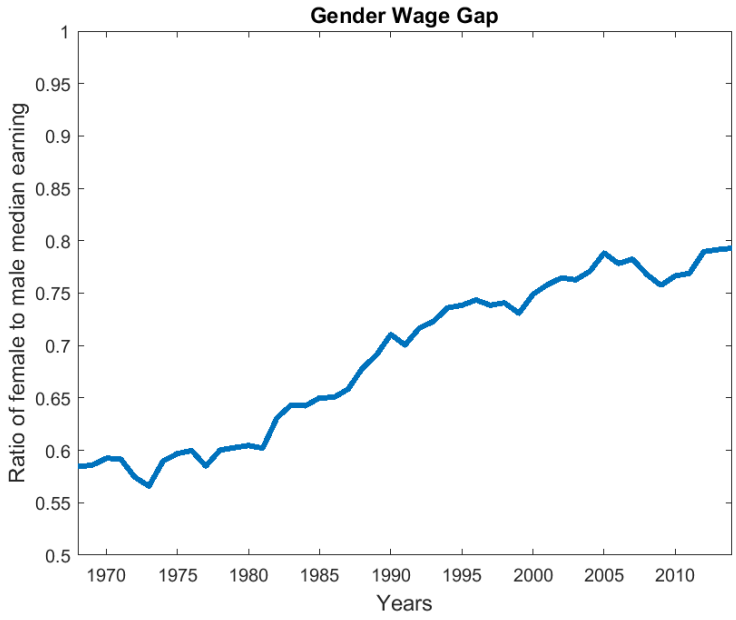


Figure 24: Average number of young children by household type

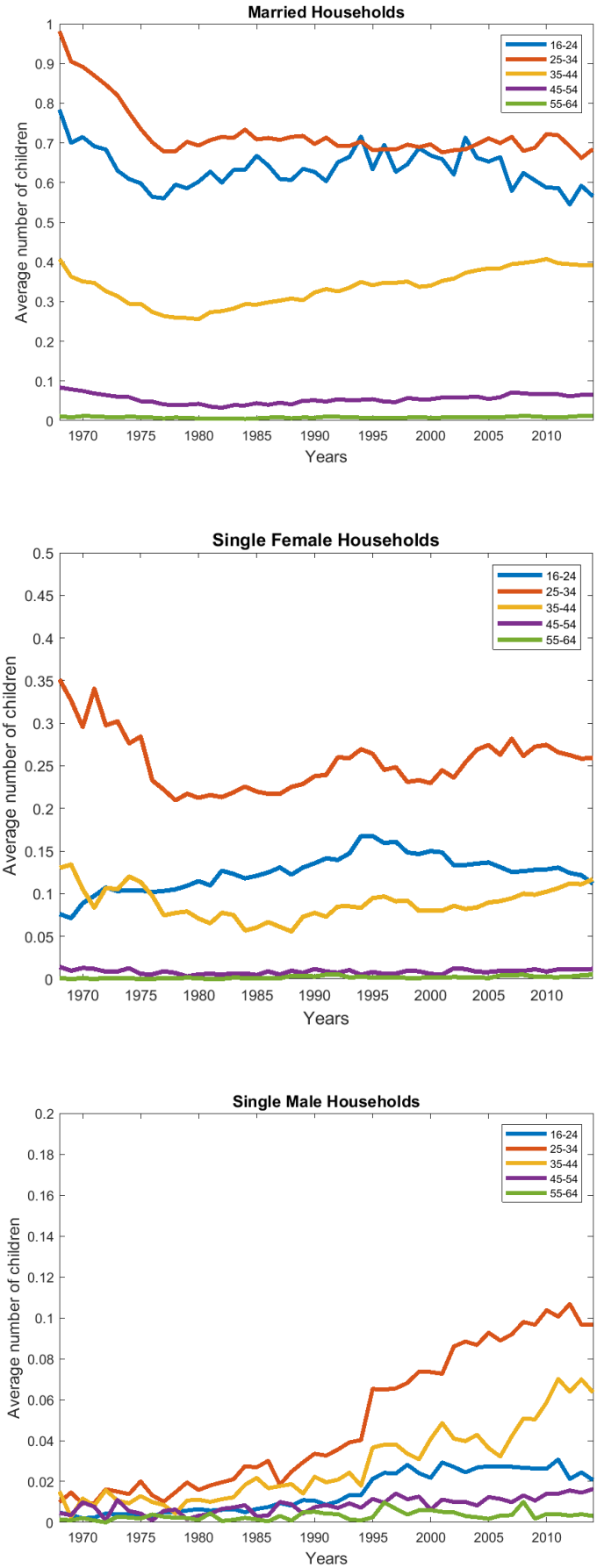


Figure 25: Decomposition into factors underlying married men's trend in labor supply

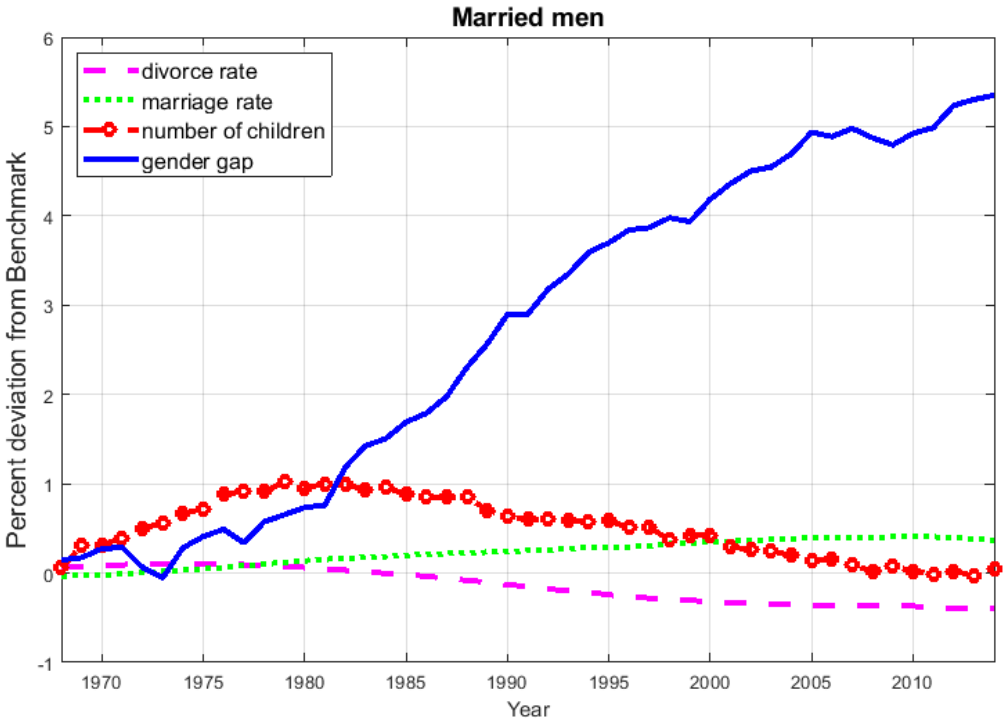


Figure 26: Decomposition into factors underlying single men's trend in labor supply

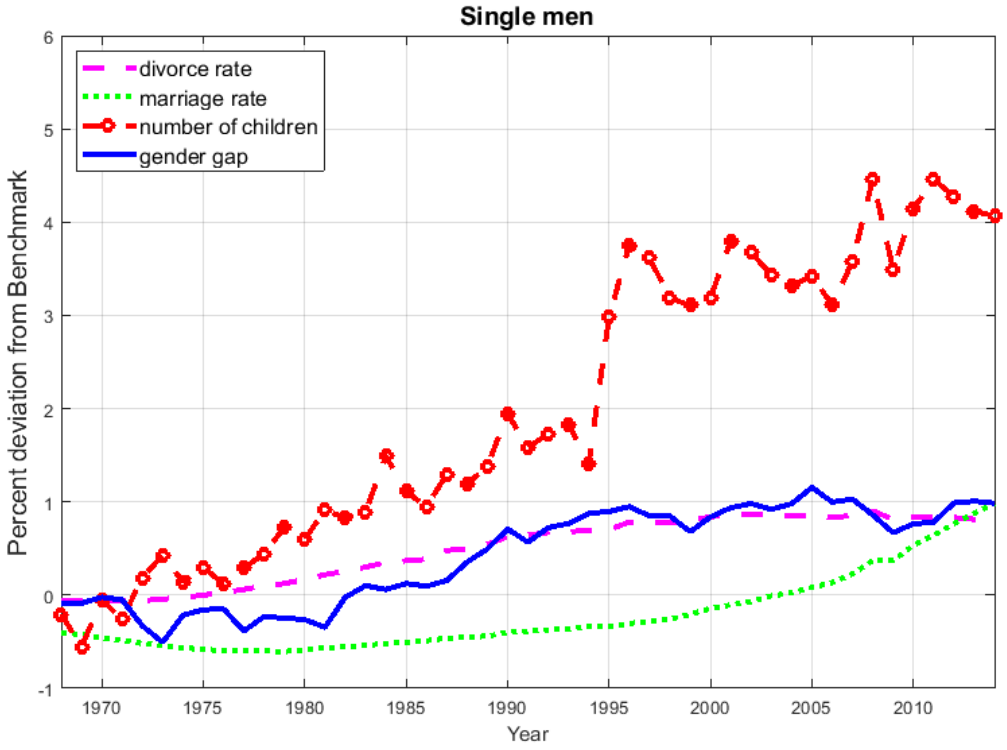
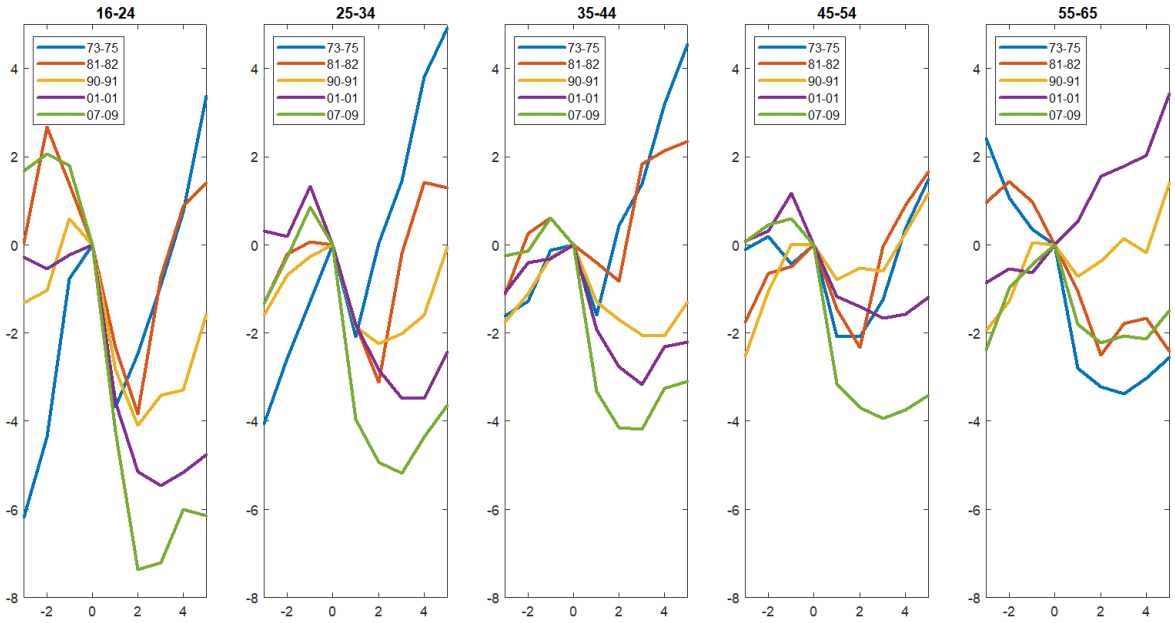
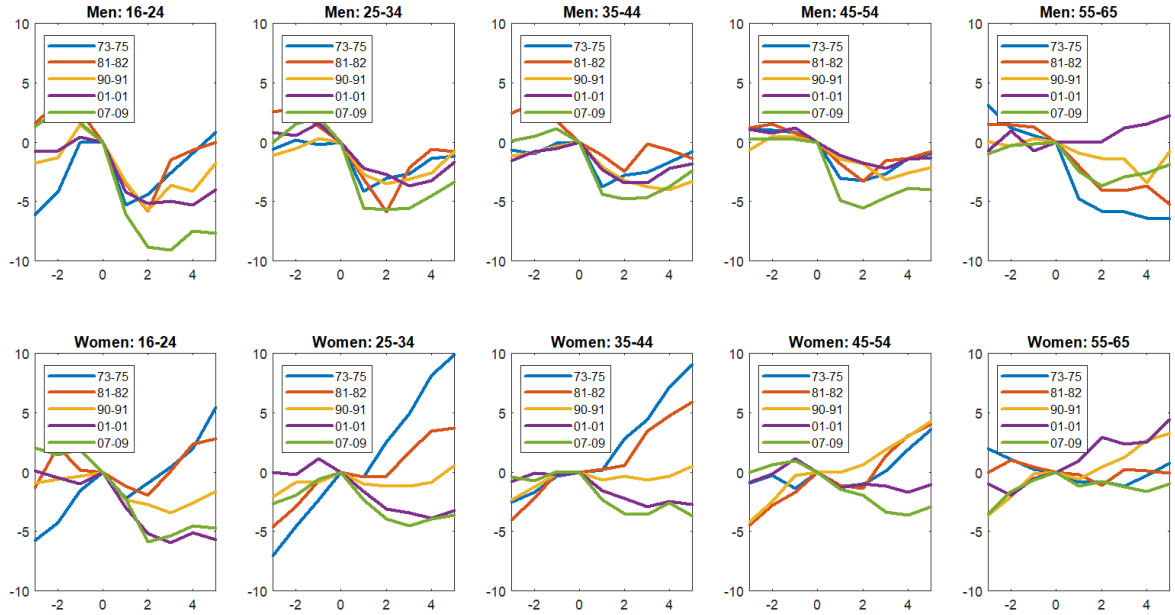


Figure 27: Slowing recoveries for workers of different Ages



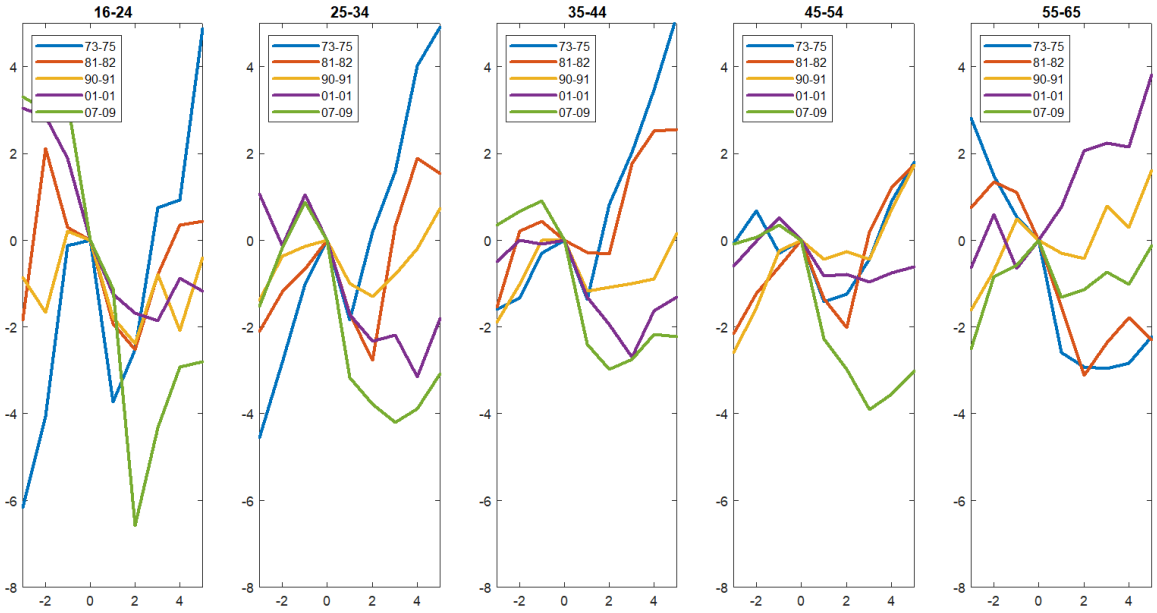
(a) All workers



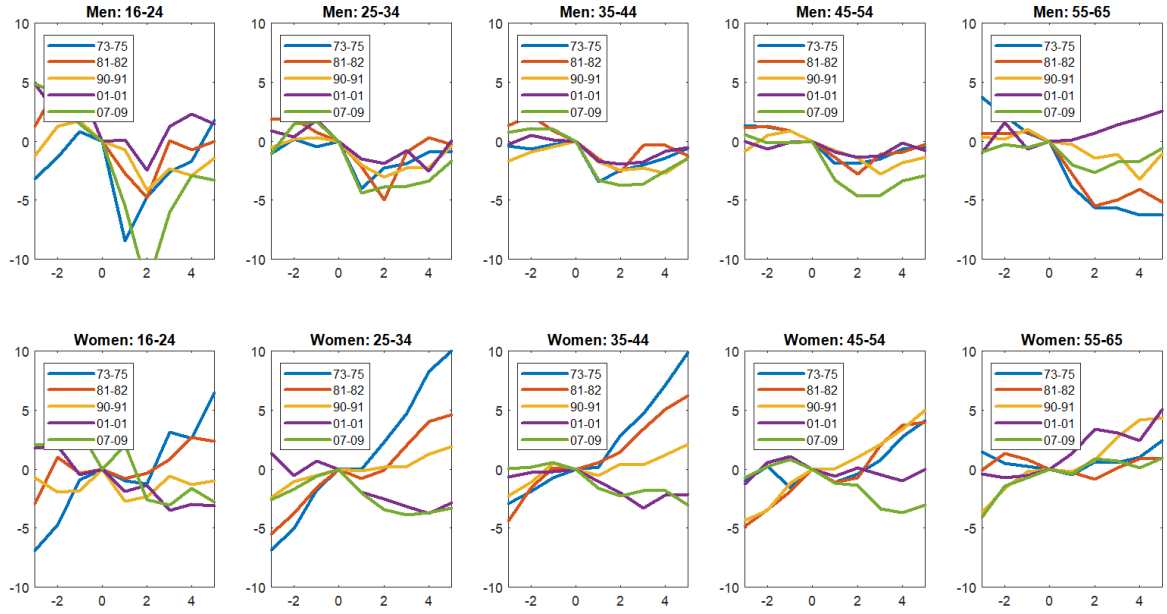
(b) Men and Women workers

Notes: This figure graphs the employment-to-population of workers divided into 5 age categories (16-24, 25-34, 35-44, 45-54, 55-65) during the last 5 recessions and the subsequent recoveries. The x-axis measures time (in years) whereas the y-axis measures the employment to population ratio. I normalize each series to zero at the pre-recession peak. Each series is calculated by aggregating microdata from the March ASEC of the CPS.

Figure 28: Recoveries for *married* workers of different Ages



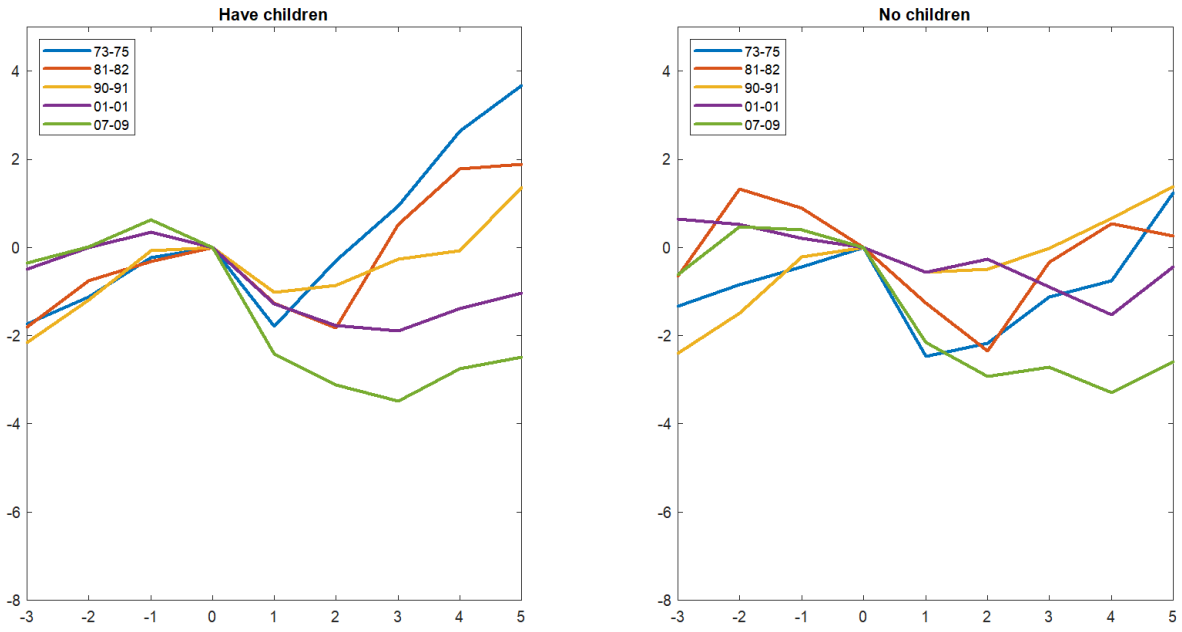
(a) All workers



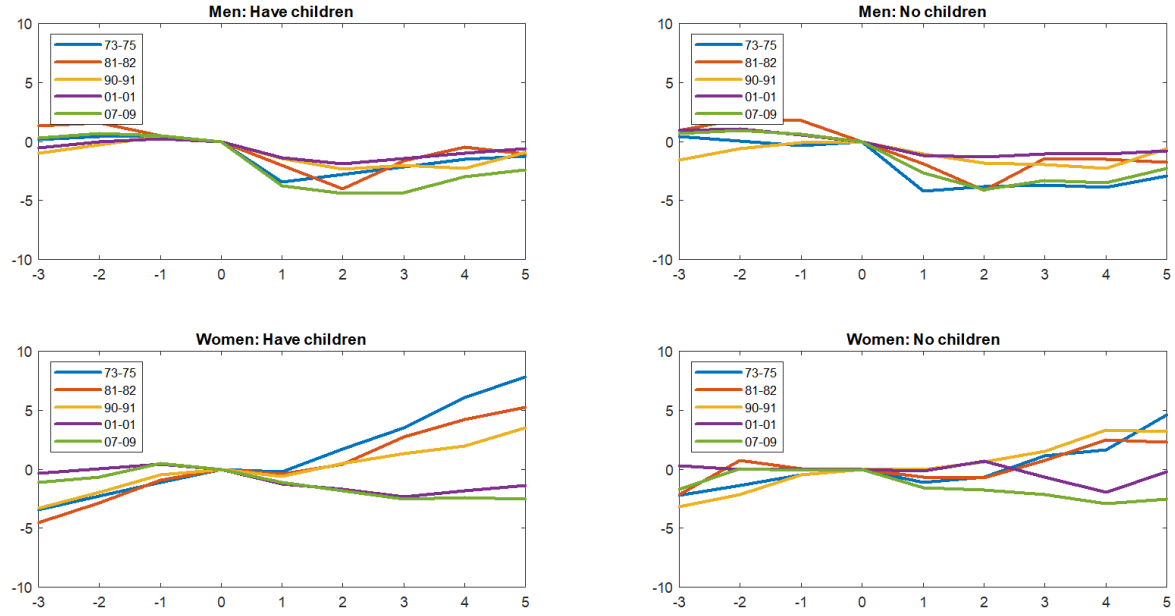
(b) Men and Women workers

Notes: This figure graphs the employment-to-population of workers divided into 5 age categories (16-24, 25-34, 35-44, 45-54, 55-65) during the last 5 recessions and the subsequent recoveries. The x-axis measures time (in years) whereas the y-axis measures the employment to population ratio. I normalize each series to zero at the pre-recession peak. Each series is calculated by aggregating microdata from the March ASEC of the CPS.

Figure 29: Recoveries for *married* workers differing by presence of *children*



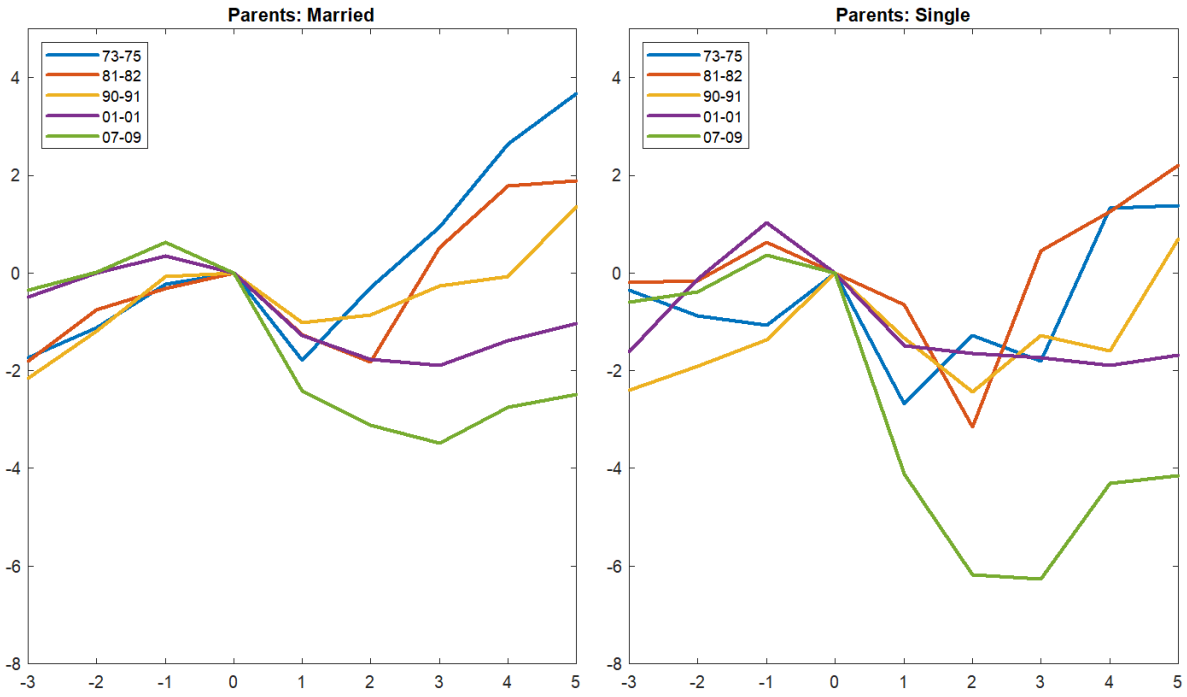
(a) All workers



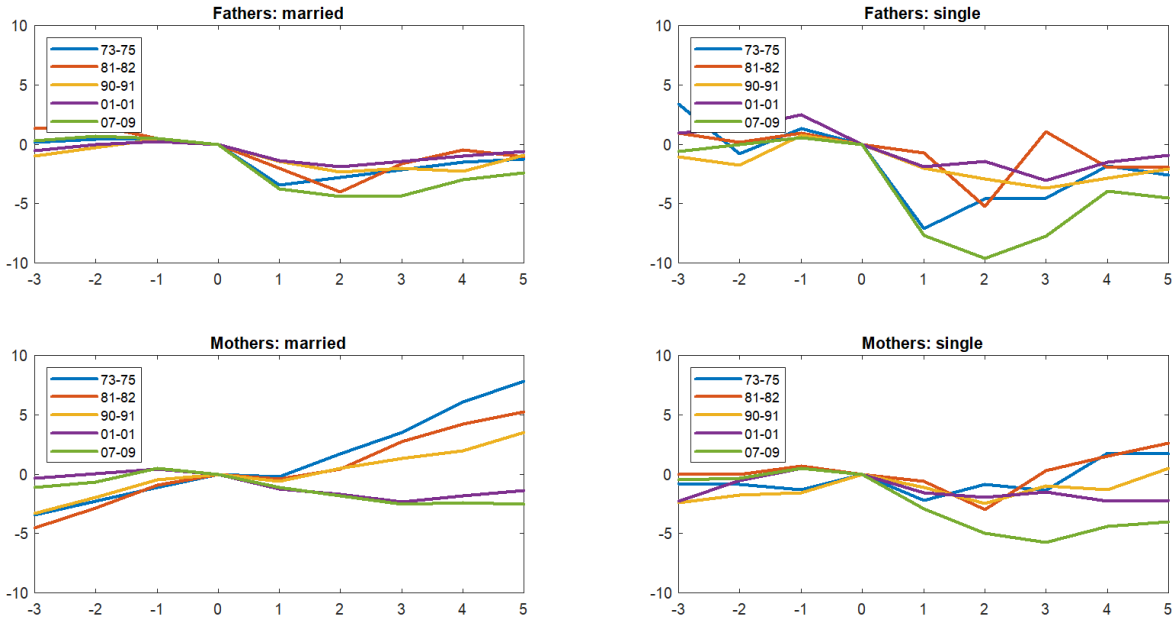
(b) Men and Women workers

Notes: This figure graphs the employment-to-population of married workers divided into 2 groups based on the presence of children during the last 5 recessions and the subsequent recoveries. The x-axis measures time (in years) whereas the y-axis measures the employment to population ratio. I normalize each series to zero at the pre-recession peak. Each series is calculated by aggregating microdata from the March ASEC of the CPS.

Figure 30: Recoveries for workers with children differing by *marital status*



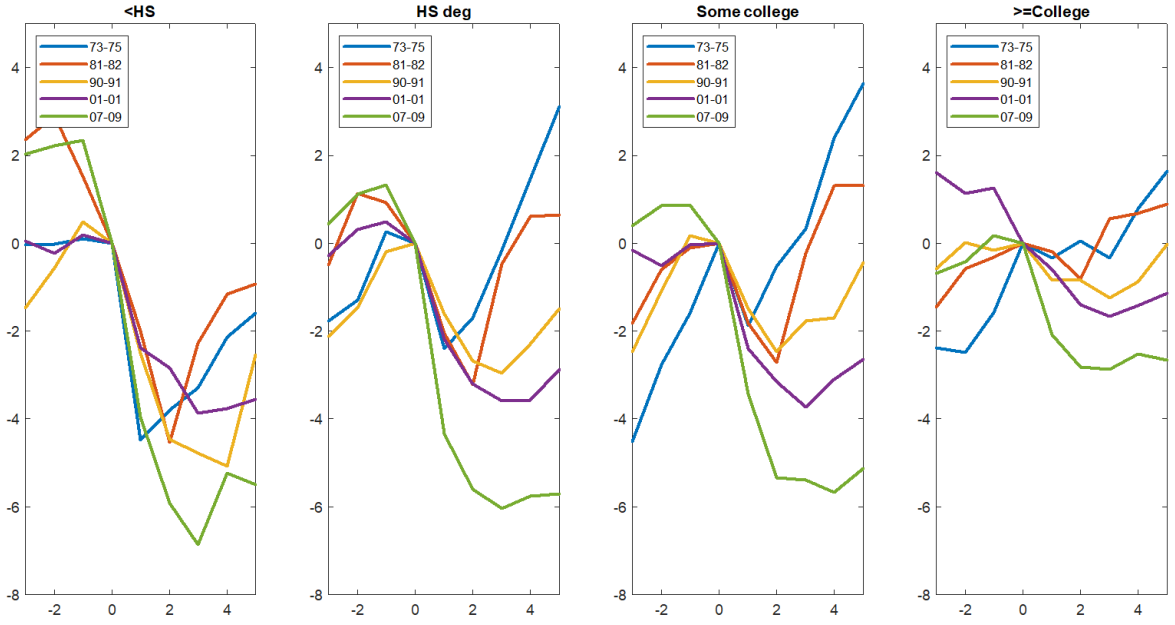
(a) All workers



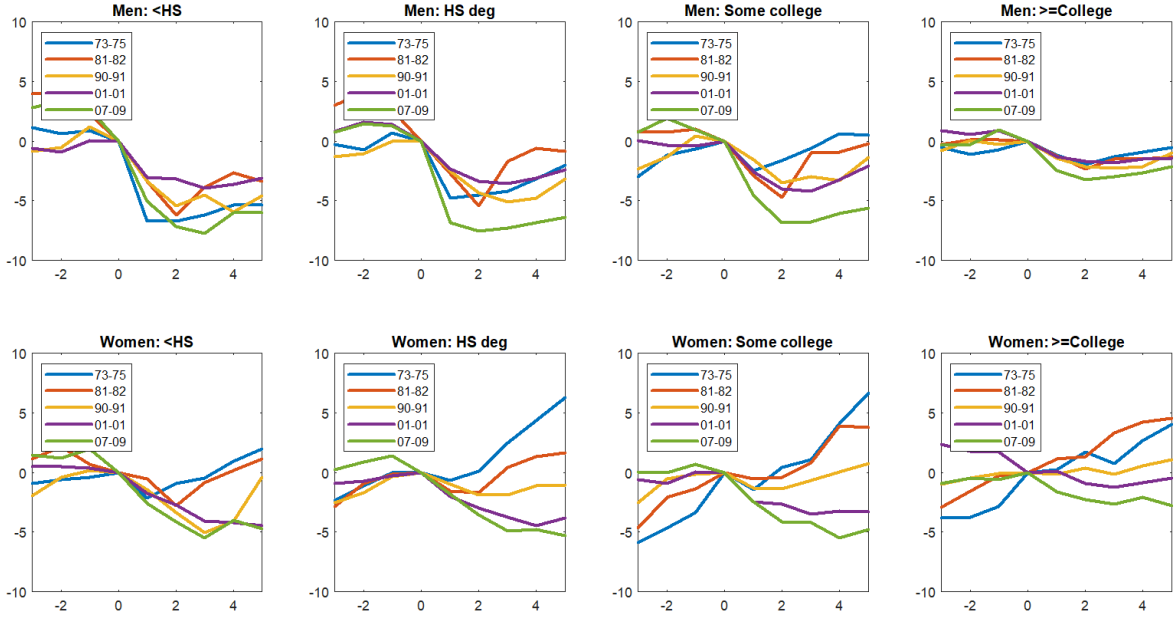
(b) Men and Women workers

Notes: This figure graphs the employment-to-population of workers with children divided into 2 groups based on their marital status during the last 5 recessions and the subsequent recoveries. I assume that singles include all those who are divorced, widowed or never married. The x-axis measures time (in years) whereas the y-axis measures the employment to population ratio. I normalize each series to zero at the pre-recession peak. Each series is calculated by aggregating microdata from the March ASEC of the CPS.

Figure 31: Recoveries for workers differing by *education level*



(a) All workers



(b) Men and Women workers

Notes: This figure graphs the employment-to-population of workers which are divided into 4 categories based on their education levels (<HS, with HS degree, some college, ≥ college degree) during the last 5 recessions and the subsequent recoveries. I assume that singles include all those who are divorced, widowed or never married. The x-axis measures time (in years) whereas the y-axis measures the employment to population ratio. I normalize each series to zero at the pre-recession peak. Each series is calculated by aggregating microdata from the March ASEC of the CPS.

Figure 32: Cyclical response in Labor Supply: Aggregate

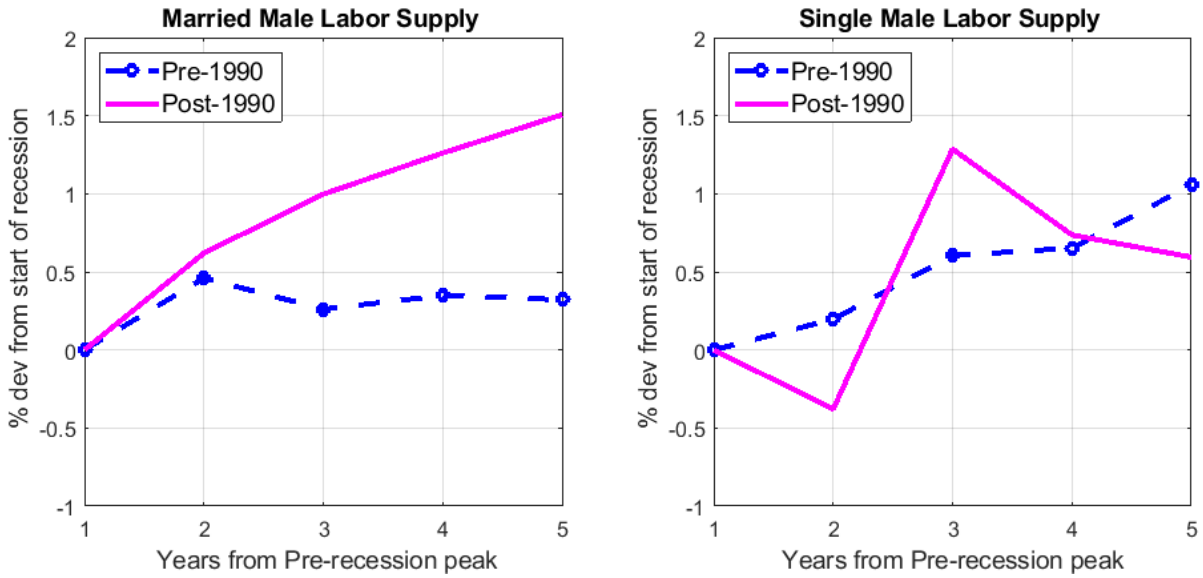


Figure 33: Role of underlying factors in the cyclical response in women's labor supply

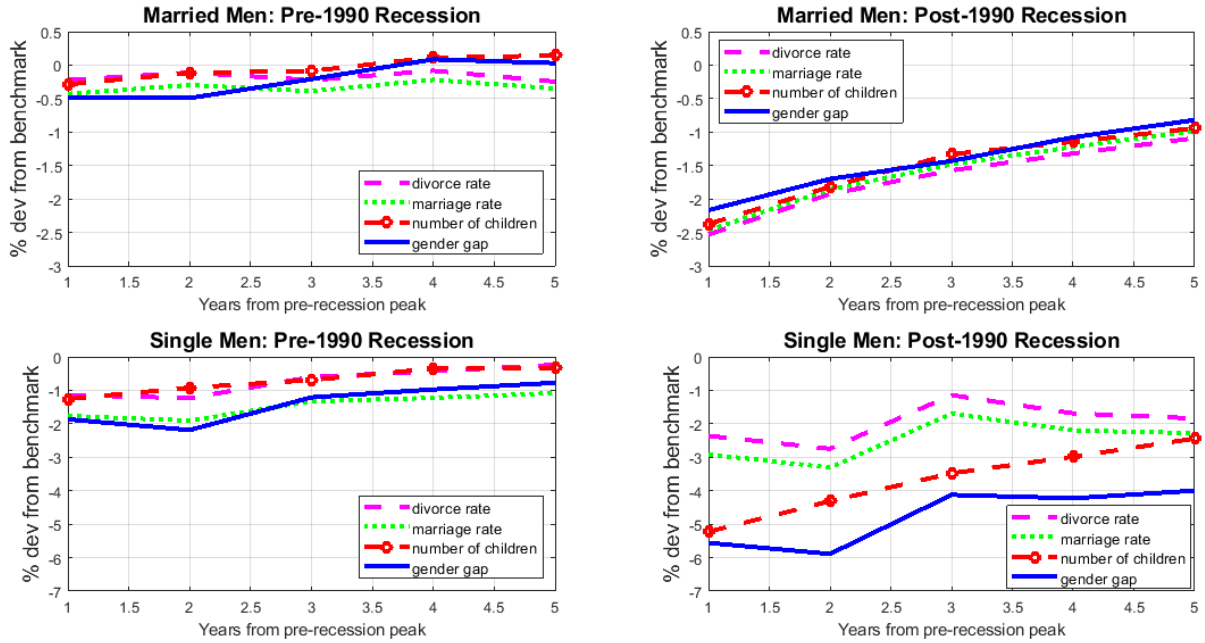


Figure 34: Effectiveness of Child Care Subsidy on Cyclical response in Labor Supply for Men

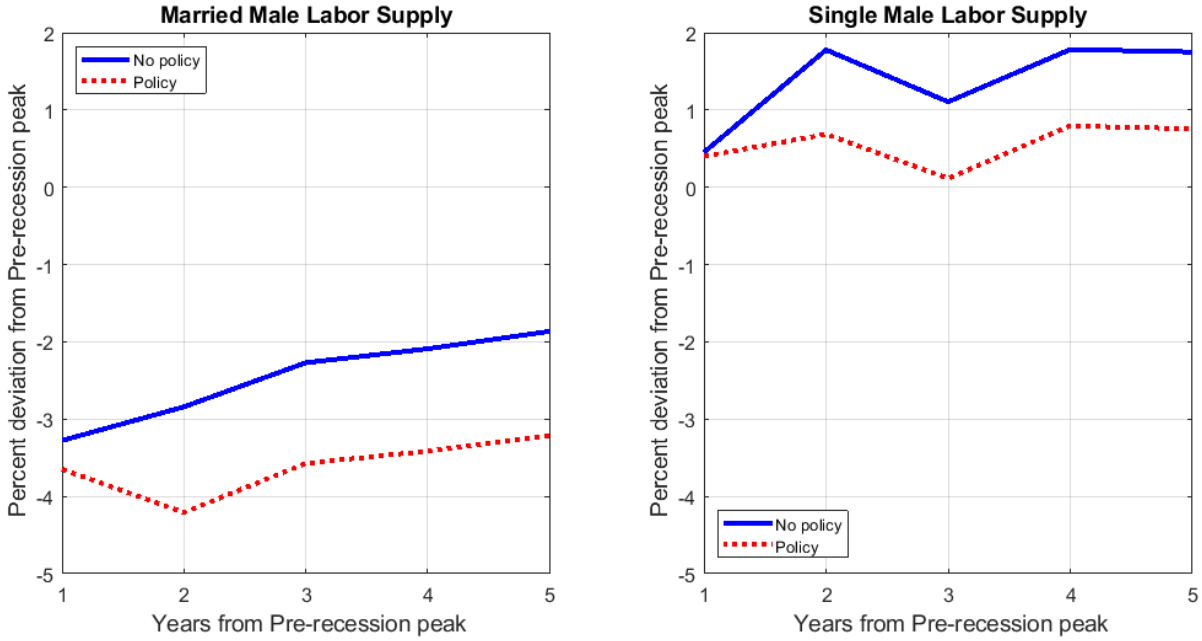


Figure 35: Effectiveness of Tax Break on Cyclical response in Labor Supply for Men