From Trend to Cycle: the Changing Careers of Married Women and Business Cycle Risk.

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Abstract

As married women's labor force participation has increased in the United States, the cyclical volatility of their employment has also increased. We provide a unified theory that can reconcile these facts. Lower volatility of married women's employment over the business cycle is driven by counter-cyclical motives to remain in the labor force to provide insurance against their spouse's income risk. Changes in fundamentals that increase attachment subsequently lower the ability of wives to adjust labor supply to provide insurance in recessions– they are more likely to have permanently high labor supply anyway. The model predicts that some forces driving the growth in female participation– increasing returns to tenure and decreasing fixed cost of work– increase attachment and cyclical volatility. The closing gender wage gap, by contrast, reduces both. A quantitative evaluation predicts that the former two forces have dominated in the United States with some ebbing for recent cohorts. Microeconomic evidence support both this prediction and the specific mechanism of precautionary spousal insurance. Implications for welfare and intra-household insurance are discussed.

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1 Introduction

Married women have become an increasingly important part of the workforce over the second half of the 20th century. In 1976, married women worked 15% of all hours in the United States. In 2015 they worked 21% of total hours. We document that this rise was accompanied by a change in the composition of which married women work and in the nature of their careers. Increases in aggregate married women's hours and employment across cohorts have been largely driven by the rise of career women, defined as those consistently working in full-time jobs over their lives. Career women have largely replaced women with long spells of non-participation over their lives. The share of women in the latter category fell from 70% of the 1930s birth cohort to less than 30% of the 1960s birth cohort.

In other words, rising female employment is not simply a story of daughters working more than their mothers. It is also a story of daughters becoming increasingly attached to the labor market by working more hours, more consistently over their lives. The complex cross-sectional changes underlying the aggregate numbers has important implications for intra-household insurance and the volatility of aggregate hours that would be missed by focusing on the aggregates alone. Ellieroth (2019) develops a theory of "precautionary labor supply" where a married women provides intra-household insurance by choosing to stay attached to labor market participation when her spouse's income risk is high, such as in a recession. This channel of precautionary labor supply is only functional when there is a participation margin to adjust. A woman who plans to work full-time with no interruptions over her life has almost no margin to increase her labor relative to her plan to hedge against the risk her spouse loses a job during a recession. By contrast, a woman who plans on quitting her job while she has children under 5 years old can change her plan and continue work during that time if a recession occurs. Thus the change in careers trending towards higher attachment reduces precautionary labor supply in households with career women.

Through the lens of a structural model Ellieroth (2019) provides evidence that precautionary labor supply is quantitatively important for both households' income risk and the volatility of aggregate employment over the business cycle. Precautionary labor supply is consistently present over the business cycle in both theory and data whereas the added worker effect is not. It contributes to the fact that, on average over the second half of the 20th century, married women's employment had been half as volatile over the business cycle as other demographic groups even after controlling for factors such as industry, education, and more. Their presence in the workforce

implied a 12 percent lower volatility of hours worked over the business cycle. A study ignorant of the change in the composition of married women's careers would extrapolate these trends and conjecture that their higher share of employment would further reduce the aggregate volatility of hours over the cycle. An informed study of the underlying mechanism would link the trend towards careers with increased attachment to a lower precautionary labor supply effect. This leads to a horse race: the cyclical volatility rises if the change in careers is large enough to dominate the overall increase in the share of married women's hours. Through this channel, the rise in married women's participation can be reconciled with signs of growth in the cyclical volatility of hours seen in the Great Recession.

An analysis that takes the volatility of careers as given and does the appropriate back-of-the-envelope calculation changing both the level and career composition of married women's employment is still incomplete. The factors that caused women to change careers can also fundamentally change the choices women make within career types including their ability to provide precautionary labor supply and affect cyclical volatility. Unfortunately (only for the researcher), recessions are infrequent whereas underlying mechanisms are ever evolving. Thus we do not have statistical power to measure changing volatilities at the aggregate or career level over periods of time shorter than several decades. We take a structural approach to deal with this limitation. We embed canonical theories of female labor force participation trends in a rich model where women living in households make labor force participation decisions at both the high and short frequencies. The advantage is that these theories- changes in the gender wage gap, increasing returns to tenure, and decreasing opportunity costs; are all things we can either measure reasonably well at a high frequency either directly in the data or inferred through other directly measurable targets. Thus we can provide predictions for movements to new careers and presence of precautionary labor supply without having to observe a recession and these predictions are consistent with how these theories may change precautionary labor supply within career types. It also allows our framework to be used to understand the paths of various countries, racial demographic groups, income groups, and other slices of the data where groups differ in their main drivers of participation.

Prevalent theories of the secular increase in married women's hours have different implications for career choice and that career choice fundamentally affects hours volatility over the business cycle. The first theory is one of increasing returns to experience over the past half century— that consistent work experience leads to ever higher relative wage growth. Naturally, this induces all women to choose higher labor force attachment even if on the margin. The result is a larger share

of career women and a lower ability to provide precautionary labor supply for women of all careers. Both of these forces work together to produce a definitive increase in the cyclical volatility of women's hours. A reduction in the cost of work increases the participation of women who consistently working part-time but increases volatility in some career types but not in other. On net, the volatility of hours increases for the change in the cost of work consistent with U.S. data. A decline in the gender wage gap decreases the volatility of hours and increases the share of women with large non-employment gaps over their life-cycle. For the U.S., an increasing return to experience is the most important for contributor to the rise in women's hours but all three factors are present. Feeding observed and inferred trends in these factors into the model nets an additional 0.9 percentage point decline in aggregate employment during recessions during the 2000s relative to the 1960s. By contrast, an analysis that fixes the cyclicality of married women's employment and simply increases their share in aggregate employment would predict a decrease in aggregate employment declines after 2000.

Our findings are in line with research on the impact of returns to experience on trends on both female labor force outcomes and the cyclicality of hours.[1] Olivetti (2006) calculates that the observed increase in women's returns to experience accounts for half of the decline in the gender wage gap and almost all of the increase in married women's hours of work from 1970 to the 1990s.[2] Using an overlapping generations model, Hansen and İmrohoroğlu (2009) show exogenous wage returns to tenure ("learning by doing") reduces the volatility of hours for younger individuals and increases the volatility for older. In all of these papers, the elasticity of hours with respect to experience is the crucial quantitative factor.[3] This elasticity is also central to our work. Increasing returns to experience decreases the intertemporal elasticity of labor supply which delivers more career women, lower "precautionary labor supply", and higher cyclicality of employment. Our work differs because the wealth elasticity of hours is also a strong factor because wives are responding to changes in their husband's income.[4]

Our findings provide a different view than the empirical literature connecting the growth in

[1] We will also relate to other theories of female employment trends, particularly Attanasio et al. (2008).

[2] In concurrence, Jeong et al. (2015) find the returns to experience for women increased by over 80% from 1970-90 and only by 40% for men.

[3] Jaimovich et al. (2013) similarly relate wage returns experience to cyclical volatility of hours, but assume experience is a function of age and additional explore complementary of experience with capital. Foundational research focused on the nexus between life-cycle motives and hours volatility include Ríos-Rull (1996) and Gomme et al. (2004), with much subsequent research following.

[4] In this sense, the study of spousal response to disability in Gallipoli and Turner (2009) is much related.

female hours and employment to an increasing cyclicality of aggregate hours and employment. Albanesi and Sahin (2018), Doepke and Tertilt (2016), Albanesi (2018), and Fukui et al. (2018) connect gender differences in labor market outcomes and their cyclicality to the aggregate increase in women's labor force participation. In particular, Albanesi (2018) and Fukui et al. (2018) find that the slowdown of growth in female employment has contributed to recent "jobless" recoveries. We add additional predictions that the cyclical volatility of employment should be permanently higher even after the trend changes in female labor force participation levels off. Furthermore, our framework is useful for predicting how employment volatility should evolve if women's careers (labor force attachments) change even if aggregate participation remains relatively constant.[5] Our work is in similar spirit to Krusell et al. (2017) who document procyclical labor force participation and feature an analysis of similar quantitative mechanisms as we do. We differ from this work in including both empirical documentation of and a theory replicating gender, the household, and changes over time in participation over the business cycle.

Finally, our framework is useful for researching how risk sharing and overall welfare of married couples have changed alongside increasing labor force participation of wives. This relates our work to studies on household risk sharing, particularly over the business cycle such as informal insurance (Valladares-Esteban and Choi (2016)); welfare (Krusell et al. (2009)); and wealth (Mustre-del Rio (2015)).

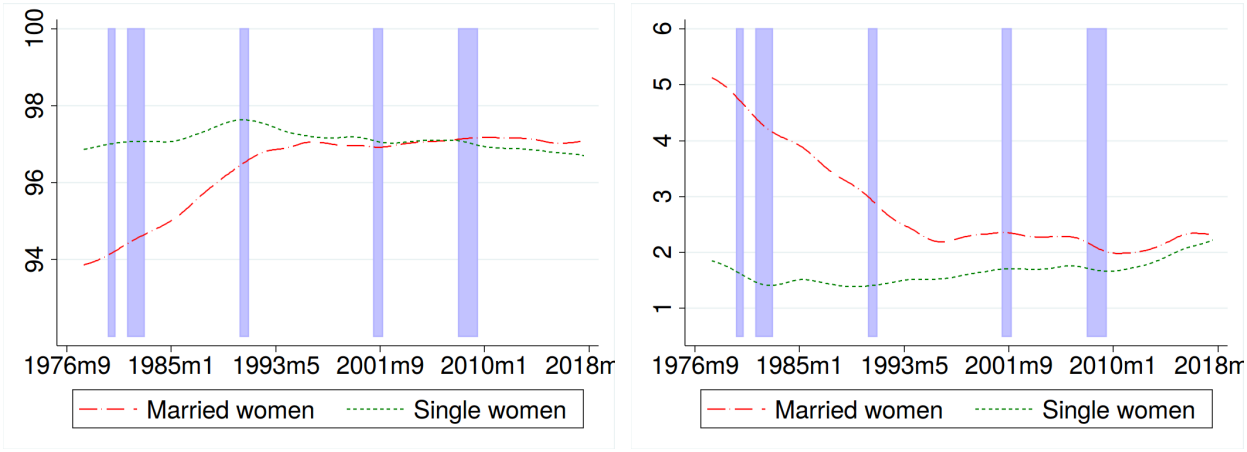
2 Empirical Motivation

Trends in Married Women's Labor Supply and their Careers. Between 1976 and 2018, married women's labor force participation rate increased from 50 percent to 75 percent, and similarly their employment-population ratio increased from 45 percent in 1976 to 70 percent in 2018. While more married women join the labor force and become employed over time, the fraction of married women in the labor force and among the employed remained constant at around 30 percent between the mid-1970s until now. This is because marriage rates have declined. Nevertheless, while the share of married women in the labor force did not change, their contribution to aggregate hours

[5] Our approach relates to Chang et al. (2018) who emphasize both intensive and extensive margins (a feature of our work particularly relevant to life-cycle women); and to Attanasio et al. (2015) who emphasize household structure and history dependence through wealth accumulation.

increased.

We argue that increases in married women's participation has been accompanied by increases in their attachment to participation. In other words, it is not just that additional women are working over time (extensive margin) but that individual women work more over their lives (intensive margin from lower intertemporal elasticity of labor supply). This claim is supported by increasing E-to-E transition rates (maintaining consistent employment over time) stemming from declines in E-to-N rates (mostly quits out of the labor force). Figure 1(a) displays E-to-E transition rates derived by linking consecutive CPS monthly files and considering all married women that are employed in the previous month and employed in the current month[6]. We see that married women experience a strong increase in their E-to-E transition rate between 1976 and the mid-1990s which coincides with the increase in other labor market statistics such as the labor force participation rate or the employment-population ratio. The stronger attachment or increase in the E-to-E transition rate is driven by a decline in the E-to-N (Employment-to-Not in the labor force) transition rate as displayed in figure 1(b). While single women's E-to-N transition rates have been low and constant, employed married women became increasingly less likely to leave the labor force.



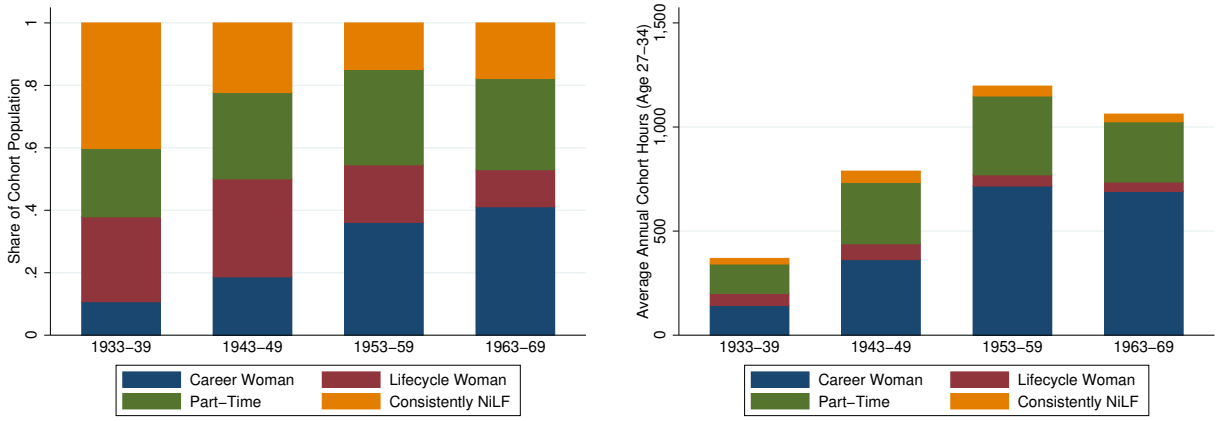
(a) E-to-E transition rate

(b) E-to-N transition rate

Figure 1: **Changes in transition rates for married and single women**

[6]This measure only considers employment-to-employment transitions and does not control for whether the individual remains in the same job, with the same employer or experiences a change in either of them. See the appendix for more details about calculation of transition rates.

Microeconomic data provide further evidence supporting the claim that the attachment of married women to the labor force has increased overtime. The increase in aggregate hours is associated with more women choosing to work consistently high hours throughout their lives. The share of married women whose annual hours worked exceeded 1500 (fulltime) while aged 26-50 steadily quadrupled from 10% for cohorts born in the 1930s to over 40% for those born in the 1960s.[7] These "career" first replaced women whose average hours were less than 800 ("Consistently NiLF") in the early cohorts. For the later cohorts, they primarily replaced "life-cycle women" who work mostly fulltime in their 40's and work half as many hours during ages 26-39 as they do when they are 40-60 years old.[8] A final additional change was an increase in women whose average annual hours worked were between 800-1499 from age 25-50 ("Part-time"). In sum, the composition of married women's hours worked shifted to hours worked by career women.



(a) Married Women by Career Type

(b) Married Women's Hours by Career Type

Figure 2: **Cohort Changes in Married Women's Careers.**

We compute counterfactual hours worked following the methodology by Shimer (1998) to more precisely quantify the contribution of the change in the composition of careers of married women working to the cyclicality of hours. We divide married women in CPS data into

[7] Authors' calculations from PSID data. Details on sample construction in the online appendix.

[8] An analysis quantifying a "Life-cycle" woman by years of full-time work after age 30 equal age-26 and "Consistently NiLF" as those reporting as out of the labor force 4 years in a row yields similar qualitative results, but with a higher share of career women from 18% to 58% over the four cohorts with fewer Part-time women and slightly fewer consistently NiLF women.

three types: Career women (annual hours $>$ 1800), part-time women (1800 $>$ annual hours $>$ 400), NiLF women (annual hours $<$ 400)[9]. Aggregate hours for married women at time t are: $\text{hours}_t = \sum_i \omega_t(i)\text{hours}_t(i)$, where $\omega_t(i)$ is the share of married women in group i at time t, $I = \{\text{career}, \text{part-time}, \text{nilf}\}$, and $\text{hours}_t(i)$ are hours worked by married women in group i at time t. We fix the share of married women in the aggregate to the 1976 value (the beginning of our data) and compute counterfactual hours as: $\text{hours}_t^{\text{cf}} = \sum_i \omega_{1976}(i)\text{hours}_t(i)$. This predicts how hours would have evolved if the composition of married women's careers had not changed. Figure 3(a) shows that the rise in hours until the mid-1990s is almost entirely due to the change in the composition of married women[10]. Counterfactual hours are constant and actually decline in the 2000s. Similarly striking is the effect of the changing composition on the cyclicality of hours as shown in figure 3(b). While the cyclicality of married women's actual hours is significantly lower than for the other groups, the counterfactual analysis shows that hours would be even less cyclical if the composition of married women remained at their 1976 value, a time with a high share of part-time and NiLF married women and only few career women.

(a) Trend

(b) Cycle

Figure 3: **Counterfactual and actual hours for married women**

[9]Since we use CPS data which allows for mainly cross-sectional studies, we cannot include life-cycle women since this would require a long panel-dimension. However, life-cycle women are either one of the three types in different stages of their lives, so they are covered implicitly.

[10]See the appendix for other counterfactuals. Both changes in the age and education composition of married women show only little difference between actual and counterfactual hours.

The Importance of Married Women for Understanding the Volatility of Employment over the Business Cycle. We have provided evidence that the cyclicality of married women's employment and hours have increased overtime and linked this increase to an increase in their labor force attachment. We now provide evidence that married women are quantitatively important for understanding aggregate labor facts over the business cycle. It is not just that married women account for a large and growing fraction of aggregate hours worked in the economy now, it is also that their cyclical volatility differs from other groups.

Figure 4 shows detrended aggregate hours worked in the United States for married women, married men, and single individuals.[11] It shows that married women have a significantly lower cyclicality of hours worked in the aggregate than the other groups across the whole time-span between 1976 until 2018. This volatility can be further decomposed into volatility that is due to business cycle fluctuations and other residual volatility. Similar to Jaimovich and Siu (2009) and Doepke and Tertilt (2016), we measure volatility due to business cycle volatility as the percent standard deviation of the predicted value of regressing each detrended hours worked series on the detrended unemployment rate. The detrended unemployment rate serves as a measure of the business cycle and therefore, this projection allows us to observe the fluctuations in hours due to fluctuations in the business cycle.

Table 1 shows that married women have the lowest volatility in aggregate hours worked that is due to business cycle fluctuations. Their cyclical volatility is only half of married men's volatility and even less when compared to single women. Similarly, the R^2 from the regression of the detrended hours worked series on the detrended unemployment rate is significantly lower for married women and shows that only little of their hours fluctuations are due to business cycle fluctuations in the unemployment rate. We split the sample into pre-1995, the time where there was a pronounced increase in the labor force participation rate and employment rate for married women, and post-1995 when participation flattened out. Table 1 shows that both between 1976-1995 and post-1995 married women have a substantially lower cyclicality in their hours worked and experience only a moderate increase of 25% in their hours volatility while hours volatility for married men and single individuals increased by between 30% and 40%.

[11] Annual hours worked series from the Current Population Survey (CPS) Annual Social and Economic Supplement (ASEC) from 1976 until 2018 detrended using a HP-filter with smoothing parameter 6.25

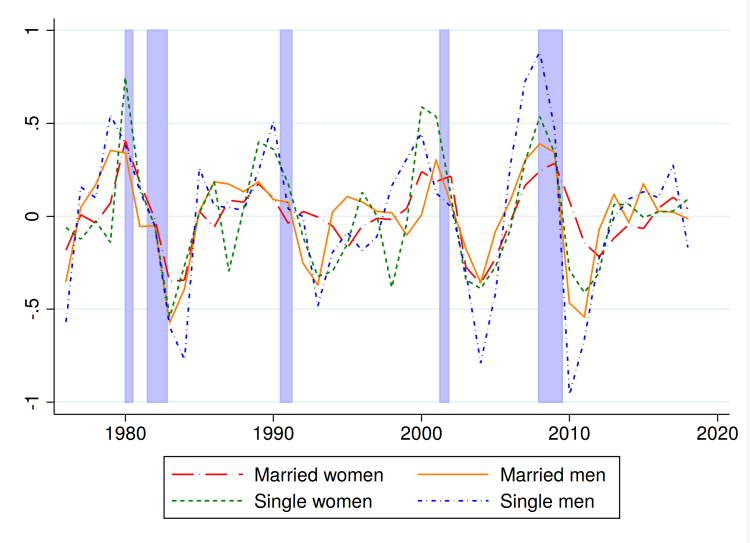


Figure 4: Cyclical component aggregate hours worked

	Married		Single	
	Men	Women	Men	Women
		1976-2018		
Total volatility	0.57	0.66	1.13	0.96
Cyclical volatility	0.27	0.14	0.53	0.30
R^2	22.30	4.49	9.55	21.55
		1976-1995		
Total volatility	0.61	0.72	1.00	0.99
Cyclical volatility	0.22	0.12	0.42	0.25
		1996-2018		
Total volatility	0.55	0.63	1.25	0.95
Cyclical volatility	0.31	0.15	0.61	0.33

Table 1: Married women have the lowest cyclical volatility

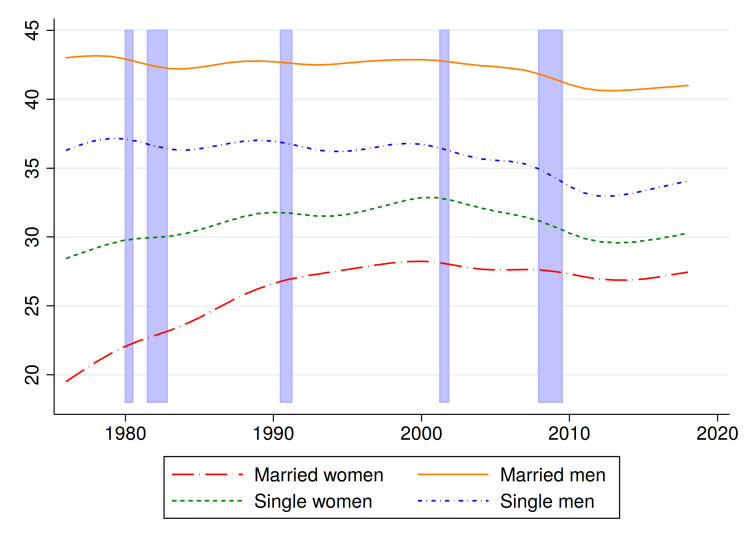


Figure 5: Trend component aggregate hours worked

3 Theory

Our empirical motivation shows increased married women's attachment to participation has coincided with (1) an increasing trend in their overall share of employment; and (2) an increase in the volatility of their employment over the business cycle. We now write a theoretical model that poses this association as causal, driven by changes in married women's inter-temporal elasticity of labor supply. A complete view of married women's attachment includes dynamic considerations related to both her own and her spouse's current and expected labor market prospects. Factors related to her own labor market prospects include: (1) returns to experience (or wage growth declines associate with participation interruptions); and (2) current and future opportunity costs related to home production around child bearing. Factors relating to her spouse's labor market prospects show up as wealth effects accompanying both the risk and realized loss of his job when borrowing is constrained. The gender wage gap weighs the relative importance of each spouse's labor market prospects to married women's labor supply.

We begin with a stripped down version of the model to tie the trend to the cycle: how each of these mechanisms affect the level and intertemporal elasticity of a married woman's labor supply. In the quantitative model, we add heterogeneity across women to provide a cross section of career types. Comparing the model-predicted cross-section to the data is a way to both infer how labor

markets have changed for women over time and also to test the validity of the model.

4 Simplified Model

In this section we exclude ex-ante heterogeneity from the definition of the value function in order to focus on the theoretical mechanisms. In other words the exposition is for a woman of a single ω, κ type whereas there will be a distribution of these types in the quantitative model.

Demographics. The model is populated by households headed by women aged $\tau \in \{0, 1, 2...T\}$ who age and die stochastically. There is a forced retirement at age $T - 1$.

Preferences and Choices. Households have separable utility in consumption and leisure. Utility is increasing and concave in consumption, but is decreasing and convex in hours worked. There is also an additional separable and fixed utility cost κ of being employed at any hours. These preferences are represented as $U(c, h, \kappa) = u(c) - v(h) - \kappa$. All households choose (1) consumption c and savings a each period; and (2) how much time the woman will spend on home production. Households with an unemployed woman choose how much time she spends on searching for a job ($s \in [0, 1]$). Households with an employed woman choose how much time she spends at work ($h \in [0, 1]$) and whether she quits her job. Retired households are not allowed to work in the labor market.

Labor Market Technology. An employed woman's labor income each period is the number of hours she chooses to work times her wage. A woman's wage depends on her productivity. Productivity is a function of her fixed productivity ω, her current experience e, and the state of the business cycle Z. The experience component e weakly grows during each period of work experience and weakly decreases during non-employment according to transition functions $g(e, h)$ and $g^N(e)$, respectively. The magnitude of the growth in experience is increasing in her chosen hours at work. The income paid to market work is a linear combination of wages and hours: $w(\omega, e; Z)h$.

A woman's transitions between employment and non-employment have both endogenous and exogenous components. While employed, she is free to choose to quit to non-participation the

next period. There is also an exogenous job loss hazard that depends on the aggregate state of the economy: $\lambda^u(Z)$.

Transitions from non-employment to employment are limited. An unemployed woman chooses how much time to spend searching for a job s. She then must wait for the arrival of a job opportunity with probability $s^\eta \lambda^f(Z)$ to begin employment. The component $\lambda^f(Z)$ is exogenous and depends on the aggregate state Z.

Home Production Technology and the Non-Pecuniary Cost of Employment Both market and non-market work (home production) contribute to the resources available to consumption. A woman's productivity in non-market work is increasing in the fixed component of her market work productivity, ω. Home production has decreasing returns in hours. Altogether the income gain from home production is $f(\omega)\ell^\eta$ where ℓ is the time spent on home production.

Husbands' Labor Market Income The time varying and exogenous state variable x^m denotes the labor market state of a woman's husband. It may take one of 3 values: $x^m = e$ if he is employed; $x^m = u$ if he is not employed; $x^m = r$ if he is employed but recently unemployed.

A husband's state scales his total labor income to a portion of his potential labor income $\phi^m(x^m)$. A household of a woman whose husband is employed receives his total labor income (ie: $\phi^m(e) = 1$. A household of a woman whose husband is unemployed or recently unemployed receives a share $\phi^m(u) < 1$ and $\phi^m(u) < \phi^m(r) < 1$ of his potential income, respectively. The former captures unemployment benefits and the latter provides a persistent wage scar upon re-employment that has been extensively documented in the empirical literature (Jacobson et al. (1993)).

The status of the husband evolves exogenously according to a Markov process $\pi^m(x'^m|x^m, Z)$. Transition probabilities depend on the current aggregate state Z. The inclusion of the recently unemployed state allows for a higher hazard of job loss for recent job losers as documented by Stevens (1997) and others.

The potential labor income of a husband depends on his permanent idiosyncratic component α^m, his wife's age τ, and the change in wage with the aggregate state $z^m(Z)$. His permanent component is drawn from a distribution jointly with his wife's permanent component $F^m(\alpha^m|\alpha^w)$.

His wage depends on his wife's age simply to economize on state variables since most couples are close in age and we abstract from the labor supply decision of husbands that would otherwise provide variation in experience by age. Altogether, the husband's log labor income is:

$$y^m(x^m, \tau, \alpha^m, z^m) = age(\tau) + \phi^m(x^m) + \alpha^m + z^m(Z)$$

Agents' Decisions We define the problem a not-yet-retired woman faces recursively, by the value function $V_\tau(e, a; s^m, Z)$. To economize on notation, we have collapsed the state of her husband to $s^m = \{x^m, \alpha^m\}$. Additional state variables are age τ, experience e, the household's assets a, and the aggregate state Z.

The states τ, Z, and s^m (with the exception of α^m which is fixed) evolve each period according to processes that are orthogonal to all choices made and will be summarized by an expectation operator. To be explicit, these are defined by

$$\begin{aligned}
&\Pr[\tau' = \tau + 1] = 1 - \phi^{age}(\tau'|\tau) \qquad \Pr[\tau' = dead] = 1 - \phi^{dead}(\tau'|\tau) \\
&\Pr[x'^m = x_j^m] = \pi^{xm}(x_j^m|x^m, \tau, Z) \\
&\Pr[Z' = Z_j] = \pi^Z(Z_j|Z)
\end{aligned}$$

The value associated with a household with an employed wife with experience e, assets a, husband state s^m during aggregate state Z is provided by the following equation.

$$\begin{aligned}
V_\tau^E(e, a; s^m, Z) = &\max_{h,c,a'} u(c) - v(h) - \kappa + \\
&\beta(1 - \lambda^u(Z))E_{\tau', s'^m, Z'} V(e', a'; s'^m, Z') + \beta\lambda^u(Z)E_{\tau', s'^m, Z'} V^N(e', a'; s'^m, Z') \\
\text{subject to} \quad &c + a' \leq w(e, \omega; Z)h + f(\omega)(1 - h)^\nu + y^m(s^m; Z) + Ra \\
&e' = g(e, h) \\
&a' \geq \underline{a} \qquad h \in (0, 1)
\end{aligned}$$

The choice variables are hours spent working h, consumption c, and savings a'. Current income is a combination of market production $w(e,\omega;Z)h$, home production $f(\omega)(1-h)$, and husband's income $y^m(x^m,Z)$. Wages $w(e,\omega;Z)$ are a function of productivity in market work through a fixed factor ω, experience e, and the state of the business cycle Z. Relative productivity in home production is given by $f(\omega)$.[12]

The continuation value includes that a woman may exogenously lose her job with probability $\lambda^u(Z)$. With probability $\lambda^u(Z)$, she does not lose her job but the continuation value $V(e',a';s'^m,Z')$ will provide her an endogenous quit decision defined below.

The value associated with a household whose wife is non-employed is provided by:

$$
\begin{aligned}
V_\tau^N(e,a;s^m,Z) = & \max_{s,c,a'} u(c) \\
& + \beta E_{\tau',s'^m,Z'}[(1-s\lambda^f(Z))V_{\tau'}^N(e',a';x'^m,Z') + s\lambda^f(Z)V_\tau(e',a';x'^m,Z')] \\
\text{subject to} \quad & c + a' \leq f(\omega)(1-s)^\nu + y^m(x^m,Z) + Ra \\
& e' = g^N(e) \\
& a' \geq \underline{a} \qquad s \in [0,\bar{s})
\end{aligned}
$$

The choice variables are hours spent searching for a job s, consumption c, and savings a'. Time not devoted to searching for a job is devoted to home production. The search technology provides the opportunity to take a job with a probability that depends on search time s and the aggregate state Z: $s\lambda^f(Z)$. If a job opportunity does not arise then the woman remains non-employed. If a job opportunity does arise then the woman faces the following value function if $\tau < T$.

$$
V_\tau(e,a;s^m,Z) = \max\{V_\tau^E(e,a;s^m,Z), V_\tau^N(e,a;s^m,Z)\}
$$

[12] Home production is a function of market productivity to keep many women across the income spectrum close to the participation margin in order to enable the quantitative model to replicate two facts. First, the fact that a large share of highly productive women in early cohorts chose non-participation but that this share is less than less productive women. Second, that many women across the income spectrum are close enough to the participation to display the degree of "precautionary labor supply" found in the data.

This value function is also the continuation value for the employed woman. Let $Q(e, a; s^m, Z)$ be the quit policy of the woman; ie: $Q(e, a; s^m, Z) = 1$ if $V_\tau^E(e, a; s^m, Z) < V_\tau^N(e, a; s^m, Z)$ and zero otherwise. Finally, the value function for a retiree ($\tau = T$) is the simple consumption savings problem that follows.

$$V^T(e, a; s^m, Z) \equiv V^T(a) = \max_{c,a'} u(c) + \beta d_T V^T(a')$$
$$\text{subject to} \qquad c + a' \leq Ra$$

Two assumptions simplify the retiree's problem such that there is no uncertainty besides survival probability d_T.[13] First, it is assumed that the husband retires first or at the same time as the wife and so he no longer earns labor market income. Second, it is assumed that the interest rate is fixed and exogenous. This implies that asset returns do not depend on the aggregate state Z. Thus this function can be solved in closed form.

5 Understanding the Cyclicality of Married Women's Employment in Relation to Drivers of the Trend.

It is well understood that each of: increasing returns to experience, decreasing gender wage gap, and decreasing non-pecuniary cost of work; have increased women's labor force participation during the 20th century to some extent. In this section we derive expressions related to the cyclical behavior of married women's hours in the model we have constructed. We then show how these cyclical behaviors change with respect to each theory of the increasing trend in married women's labor force participation.

Hours of wives are less cyclical than hours of identical individuals with no spousal income. This follows from two assumptions. First, leisure is a normal, non-Giffen good. Second, spousal labor falls, at least in expectation, during recessions. The Euler equation describing the leisure

[13] The value of death irrelevant to all choices and so is assumed to be zero.

labor choice is:

$$v'(h) = u'(c)[w(e, Z) - f(e)] + \beta E[V_e(g(e, h), a', s'^m, Z')]g_h(e, h)$$

The budget constraint which provides consumption given a choice of hours h and savings a' is:

$$c + a' \leq w(e, Z)h + \phi f(e)(1 - h) + y^m(s^m; Z) + Ra$$

. We model recessions as reducing both $w(e, Z)$ and $y^m(s^m, Z)$; and as increasing the probability of job loss during the subsequent period in the expectation operator. A recessionary decline in her own wage w implies that the right-hand side of the equation falls and hours must decrease for the left-hand side of the equation to fall as well. A married woman experiences additional recessionary decline in consumption from an income effect of her husband's income y^m falling. This offsets the substitution effect of the decline in her own wage w and lowers the right-hand side of the equation less than if she had no partner or no decline in her partner's income.[14] The result is that her hours fall less during a recession. The opposite logic holds for an expansion. Thus pro-cyclical spousal labor fluctuations result in lower cyclical fluctuations of her own income and this impact is increasing in the share of household income that is earned by her spouse.

Similar logic holds along the participation margin. Consider a woman with an arbitrary individual state $\{e, a, y^M\}$ during an expansion $Z = z_h$. Let $\hat{\kappa}$ be the value of κ for that woman such that she is indifferent between continuing to work at her optimal choices $\{c^E, h^E, a'^E\}$ and quitting to non-employment. Let $\{c^N, a'^N\}$ be her choices in non-employment. Note that, at indifference, she will choose $s = 0$ and not search for a job if she is non-employed. The indifference condition can be written as:

$$u(c^E) - v(h^E) - \hat{\kappa} + \beta EV(g(h^E, e), a', y'^m, Z') = u(c^N) + \beta EV^N(g^N(e), a', y'^m, Z')$$

[14] $V_e(e', a', s'^m, Z)$ also increases when y^m falls. $V()$ is increasing in a' and a' falls when y^m falls. This increases the marginal utility of resources of which one is experience e.

The allocations further satisfy the relevant budget constraints:

$$c^E + a'^E \leq w(e, Z)h^E + f(e)(1 - h^E)^\nu + y^m(x^m, Z) + Ra$$
$$c^N + a'^N \leq f(e)\bar{s}^\nu + y^m(x^m, Z) + Ra$$

Similarly to the extensive margin, first consider a woman without spousal income. It is unclear whether a recession alone leads to lower labor supply on the extensive margin. On the one hand, a recession causes a decline in her wage. This only lowers the value of employment and would push her towards quitting. On the other hand, the continuation value of each employment and unemployment change because of the changes in job loss and job finding probabilities. If job finding probabilities fall enough relative to the increase in job loss probabilities, then a "job hording" effect would push her towards not quitting. Regardless, a decline in spousal income y^m lowers the value of non-employment more than the value of employment. This is because consumption while employed must be greater than consumption while non-employed for the indifferent woman ($c^E > c^N$). Then, because utility is concave, utility over consumption when employed falls less than utility over consumption when non-employed when the husband's income falls. This pushes the value of non-employment down more than the value of employment and induces the women to want to keep working, on the margin. In summary, our assumptions alone do not provide a clear cyclicality of the woman's labor force participation but they do provide that her labor force participation is less cyclical when her husband's income is pro-cyclical.

The next step is to consider how the lower cyclicality of labor supply associated with pro-cyclical spousal income changes when fundamentals associated with the trend increase in female labor force participation change. First, consider an reduction in the wage gap, specifically an increase in the wage of the woman relative to her spouse. This reduces the share of spousal income in total household income and reduces the pro-cyclical income effect that offsets the counter-cyclical substitution effect of a lower wage. In other words, female labor supply becomes more counter-cyclical on both the intensive and extensive margins. Second, consider a fall in the fixed cost of work, κ. This reduces the net marginal advantage to work, what she can earn in the market minus home production: $w(e, Z) - f(e)$. This results in the substitution effect of changes in $w(e, Z)$ becoming stronger and making labor more counter-cyclical. Third, consider an increase in the re-

turns to experience modelled as an increase in the penalty for lowering hours: $f^{\hat{N}}(e)$ such that $f^{\hat{N}}(e) \leq f^{N}(e)$ for all e. This lowers the relative continuation value of non-employment versus employment and increases the job hoarding incentives. As a result, labor supply becomes even less cyclical. All of these claims apply on the margin only. They are only true fixing a woman's state. The total effect of each trend change also changes the distribution of states. This is quantitatively important. How changes in the distribution can over-turn these marginal results will be the focus on the quantitative section of the paper and is just another reason why a structural model adds clarity to this problem.

As a final point, we should explain that our preferences and technologies are specifically chosen to match the facts we are most interested in. The reduced cyclicality of own hours in the cyclicality of spousal labor income is strengthened by preferences where leisure is an elastic normal good. This is one reason we choose separable utility instead of preferences used in literature focused on spousal labor over the life-cycle and in the cross section such as in Attanasio et al. (2008) where the marginal utility of consumption is increasing in time spent at work. The interpretation of those preferences is that there is a pecuniary cost of working long hours. That is absent from our model because eliminating it helps our model better capture the cyclical behavior of married women's labor supply. These strong income effects do work against us in matching the fact that (1) women across the own wage and spousal income spectrum display reduced cyclical volatility of labor; and (2) women across the own wage and spousal income spectrum increased labor supply over the last 70 years. We are able to match these additional facts with our assumption that home production technology is increasing and concave in the permanent component of labor productivity. This gives us somewhat narrow bands of comparative advantage in formal work– ie: it puts women all long the income spectrum closer to the margin of participation by raising the opportunity cost less than proportionally with potential labor income. The asummption that home production is more concave than in productivity than wages provides that comparative advantage in formal work fans out, increasing for higher wage women, which will allow us to match salient cross-sectional patterns that high wage women tend to work more.

6 Quantitative Analysis

We add additional heterogeneity to the quantitative model in order to replicate the variation in labor force attachment for different women over their life-cycles. We then apply the model to learn which the sources of the increase in women's participation over time also increased their attachment. The rich heterogeneity in life-cycle attachment is provided by the addition of two sources of permanent heterogeneity, each drawn at birth and known to each woman. The first is a draw of permanent productivity. The second is an age-specific path of non-pecuniary costs of work.

7 Calibration

We choose functional forms and parameters to replicate features of US business cycles, marriage patterns, and to induce agents' optimal choices to replicate cross-sectional features of female hours and employment as well as changes over time. Baseline parameters are chosen to replicate the experience of the 1940s cohort. From there, we change three parameters: (1) the value of experience, (2) the fixed cost of work, and (3) the gender wage gap; to understand how each affects the participation decisions of women, their careers, and their hours over the business cycle. Functional forms choices are part of the calibration and chosen so that the model can replicate the cross-cohort patterns observed in the data and over time.

A model period is a month. Women progress through four age groups: 25-39, 40-54, 55-64, and a final age group of retirees. Ageing is a simple Markov process. Agents expect to be in each age group for the correct amount of time on average and when we simulate the model they age the correct amount of time exactly. Death is stochastic and the probability of death is set to match life-expectance for each cohort.

Preferences take the following form:

$$u(c, \ell; \kappa) = \frac{c^{1-\gamma}}{1-\gamma} - \mu_h \frac{h^{1+\eta}}{1+\eta} - \kappa$$

We chose utility to be separable in consumption and disutility of hours because the focus of this paper is on the cyclicality of married women's labor supply. Assuming separability makes

labor more responsive to changes in non-labor income than the assumption that marginal utility of consumption is increasing in labor supply as is sometimes used in the literature. Matching the response of labor supply to non-labor income is key to our particular question about how female labor force participation affects business cycle employment volatility since Ellieroth (2019) shows responses to their husband's income risk in line with the precautionary labor supply motive is the key empirical driver of married women's lowered cyclicality of labor. We set $\gamma = 2$ and the discount factor as $\beta = 0.99$. The remaining utility parameters and processes are jointly estimated as discussed at the end of this section.

If home production were absent, our utility specification would provide the counterfactual result that women's labor supply is strongly increasing in her own wage and decreasing in her husband's income. The empirical patterns, by contrast, show that labor supply follows only weakly in these dimensions. Women across the wage and spousal income spectrum work and make voluntary transitions between employment and non-participation for reasons including child-care. We deliver these cross-sectional patterns by assuming narrow comparative advantage in formal work that fans out, or increases, in a woman's own wage. Specifically, market wages are given by a market wage $w(\omega, e)$ that is subject to a business cycle shifter $\phi(z)$ so that total labor income for h hours is $y^w = \phi(z)w(\omega, e)h$. The market wage function is parameterized as $w(\omega, e) = \tau_w \omega(1 + \gamma_e e^{\xi_e})$ where τ_w is the cohort specific gender wage gap, ω is one of three fixed productivity types, and e is the woman's experience in years. Productivity in home production is also increasing in the fixed component of market productivity, ω. The specific functional form is $f(\omega) = \bar{y}_h + z_h(\omega)^{\alpha_h}$. If $\alpha_h < 1$ then comparative advantage in market work is increasing in ω.

The non-pecuniary cost of employment is divided into a fixed component $\bar{\kappa}$ and a life-cycle component $\kappa^m \geq 1$ which scales the cost of work during child raising years. The distribution of the fixed component is set as a truncated normal with a low value set as zero, the standard deviation set as half the range, and the upper value estimated. This component of non-pecuniary costs allows the model to match variation in persistent participation decisions not accounted for by exogenous household pecuniary factors such as own or husband's wage that we see in the data. The extra cost κ^m is drawn from a uniform distribution with the lower bound set to 1 (no increase during child raising years) and the upper bound estimated. This component provides observed life-cycle departures from the labor force in order to provide child care that is also not fully explained by wages and income.

Market wage parameters are estimated directly in the PSID using a Mincer regression with a Heckman two-step correction. The selection equation is an ordered probit with three outcomes: full time employment, part time employment, and non employment. The exclusion restrictions in the selection equation include age, race, education, number of children, age of youngest child, and four lags of husband's residual income. The wage equation regressors include years of full time experience and the square; the two inverse mill ratios from the first step, one for full time and one for part time; and year and time fixed effects. Experience is measured as actual years of experience in the PSID. Fixed productivity ω is assumed to be drawn from a truncated normal distribution with the standard deviation calculated in this regression. The wage penalty during recessions is estimated in PSID data to be $\phi(recession) = 0.85$ relative to a normalized $\phi(expansion) = 1.0$. For the 1940's cohort, we estimate $\phi^w = 0.7$, $\gamma = 0.3$, and $\xi = 0.8$. The fixed productivity is drawn from a truncated normal distribution. The estimation provides a mean of 0.65 to match the gender wage gap in the model simulation that is equal to the 1940's cohort with selection accounted for by labor supply choices in the model.

Experience evolves according to the process $e' = (1-\delta_e)e+\theta_e e\ell^{\psi_e}$. An nonemployed woman's experience depreciates at rate δ but is bounded below by zero. An employed woman's experience increases and increases at a higher rate if she works more hours h. The parameters are also chosen to match our PSID Mincer regression: $\delta_e = 0.005$, $\theta_e = 0.025$, and $\psi_e = 0.66$. Under these parameter values experience grows approximately twice as fast for a women that works full time ($h = 0.5$) during employment than it declines during nonemployment.

The parameters of the home production function are estimated jointly with preference parameters to match targets listed in 4. The career types are: "career women" with annual hours averaging more than 1,500 hours annually over the ages 25-54; "part-time" women who average 400-1,500 hours annually over the ages 25-54; and "NiLF" (not in the labor force) who average less than 400 hours annually from age 25-54. A fourth category, "Life-cycle Women", supersedes the former three and is defined as averaging over 1,500 hours annually between age 40-54 but less than 600 hours between ages 25 and 39. We choose these categories because they both represent variation in the economic incentives we are interested in and capture well the shift in total hours and labor force attachment, a key to cyclical volatility, over time. Under a theory of precautionary labor supply, the career women have the least margin to adjust labor supply over the business cycle because they always supply labor fully, their whole lives. Life-cycle women have the strongest margin because they can delay quitting. NiLF women may join the labor force during a recession but it is difficult

to find a job during a recession. Part-time women have the most flexibility on the intensive margin. This taxonomy provides a clear calibration targets related to the mechanisms of interest and also provides a clear way to decompose our results into how changes in labor market fundamentals change women's career type and change behavior over the cycle within career types. Finally, the technology for home production is non-linear in hours spent on home production, $1-s$, according to $f(\omega)(1-s)^{\nu_h}$. The curvature parameter is estimated jointly with other parameters but the target of mean hours worked of employed women is informative. This figure is 1600 hrs for the 1940s cohort, or 40% of the assumed 16 hours available in a day net of sleeping.

Job loss rates (π) are exogenous and fluctuate over the business cycle. Job loss rates for men can be estimated directly from the CPS rotating panel but job loss rates for women can not be. This is because separation rates for women in the model are a combination of exogenous job loss shocks and endogenous choices to leave the labor force. As a result we estimate the exogenous component to be consistent with the total employment to non-employment rates seen for women in the CPS panel.[15] The results of our estimation provide an exogenous job loss probability for women of three percent during expansions and of five percent during recessions. This is slightly lower than the four and seven percent, respectively during expansions and recessions, for men.

Job finding rates depend on time devoted to search s according to $s^{nu}\lambda^f(z)$ where $\lambda^f(z)$ is lower in recessions than expansions. Since women choose how to allocate their unit of time between search and home production, there is both an exogenous and endogenous component of job finding. This means the exogenous portion is not directly observable and must be estimated for women. We set ν to provide quadratic costs of search, a common specification in business cycle models. Model estimates find the exogenous component of the job finding rate is fifteen percent lower for women during recession than expansion.

The remaining parameters of the model specify the exogenous process related to husband's income. We estimate the process for husband's income directly because there are no choices around husband's labor supply. A husband's income while employed follows a life-cycle pattern according to the wife's age and the mean level is drawn jointly from a distribution dependent on her own productivity ω. This provides the assortative matching that we see in the data where high earners often marry high earners and low earners often marry low earners. A husband's labor market state can be

[15] We fix business cycle job loss and finding rates as constant across cohorts. This is partly because we lack enough data due to the rare occurrence of recessions to estimate time variation in these rates but is also a choice for clarity. We are isolating the choices of women as the only factor in our model driving trends in employment volatility.

Parameter	Value	Parameter	Value
Discount	$\beta = 0.99$	Interest Rate	$R = 0$
Utility Consumption	$\sigma = 2$	Disutility of Work	$\mu = 1.0$
Curvature hours search	$\nu = 0.5$		
Experience Function: $e' = (1-\delta_e)e + \theta_e e \ell^{\psi_e}$			
$\delta_e = 0.005$	$\theta_e = 0.026$	$\psi_e = 0.8$	
Wage Function: $w(\omega, e) = \tau_{1940}\omega(1 + \gamma_{1940}e^{\xi_e})$			
$\tau_{1940} = 1.0$	$\gamma_{1940} = 0.3$	$\xi_e = 0.8$	
Husband's income			
Scale old	0.94	Scale young	0.89
job loss rate	4%	job finding rate	5%
Wage penalty recession	0.88	Wage scar	0.78
Wage scar duration	3.4 yrs	Recent U additional job loss rate	$2.5x$

Table 2: Externally Set Parameters. Parameters either chosen or calculated directly in the data.

Parameter	Value	Parameter	Value
Wage Function: $w(\omega, e) = \tau_{1940}\omega(1 + \gamma_{1940}e^{\xi_e})$			
	$mean(\omega) = 0.65$	$sd(\omega) = 0.71$	
Home Production: $f(\omega) = \bar{y}_h + z_h * \omega^{\alpha_h}$			
$\bar{y} = 0.11$	$z_h = 0.45$	$\alpha_h = 0.21$	
Curvature hours home production	$\nu_h = 0.65$		
Cost of work			
highest fixed type	$\bar{\kappa} = 0.075$	highest lifecycle type: $\kappa^m = 0.17$	
Curvature of util work hours	$\eta = 1.4$		

Table 3: Parameters Jointly Estimated

employed, unemployed, and a third state indicating currently employed but recently unemployed. The recently unemployed state amplifies the wealth effects associated with job loss in two ways: a wage penalty and a higher separation probability. These channels that are consistent with the extensive literature on wage scarring showing the typical displaced worker earns significantly lower income for several years after a job loss. Part of this is due to lower earnings upon re-employment (15% less in our calibration) and part to a greater chance of future job loss (2.2 times as high as those without a scar). The average duration of the scar state is 3.3 years in expansion and 4 years in recession.

Utility parameters are abstract but have a consumption equivalent interpretation in the cali-

Moment	Data	Model
Wage Gap	0.66	0.66
St Dev Fixed Effect in ln(Wages)	0.37	0.37
Shares		
Lifecycle	31%	33%
Part Time	28%	24%
Career	19%	17%
Mostly NILF	22%	25%
av hours of employed	40%	40%
tot E-NonE expansion	5.0%	4.6%
tot E-NonE recession	4.8%	4.4%
quit E-NonE expansion	3.4%	3.5%
quit E-NonE recession	2.8%	2.6%

Table 4: Target moments for jointly estimated parameters

brated model. For a household with average income and a fulltime employed wife, the average utility cost from the intensive margin of her hours is equal to about a 6% tax on consumption. For a part-time household this number is smaller, 1.1%. The average disutility from the fixed component of the extensive cost of work is equal to a 10.2% tax and rises to 16.4% during child bearing years, on average. These numbers do not include the opportunity cost of work from lost hours in home production.

The model's fit to targets of the estimation is shown in Table 4. Some targets are closely identified by single parameters after the other parameters of the model are fixed. These parameters, such as hours worked or the wage gap, are easy to hit exactly. The remaining moments are complex combinations of many parameters. For these there is some distance between the model and the data, but the key counter-cyclical quit rates are generated by the model and the margin to provide them is appropriately constrained by coming close in replicating the key share of Life-cycle women. The model does well in predicting career shares out-of-sample for future cohorts as discussed in later analysis.

8 Quantitative Drivers of Labor Supply Choices

There are three main forces that affect a woman's ex-ante plan for her labor supply plan over her life cycle. They are (1) her productivity in the market relative to at home; (2) her husband's income;

and (3) her nonpecuniary cost of work. As in the data, careers in the model are mostly shaped by a woman's own productivity and nonpecuniary cost of work. Husband's income is of lower quantitative importance. Career women, those who consistently work full-time over the life-cycle, are predominately highly productive women with low cost of work. Women who mostly never participate are the opposite: low productivity and high cost of work. Life-cycle women, those who work little during child raising years and work full time later in life, are mostly highly productive women who draw a high cost of work during child raising years. Part-time women, those who consistently work part-time over the life-cycle, are those who have a low wage and low cost of work.[16] Since these women face a low fixed cost of work, they can justify picking up a few hours of market work after decreasing returns in home production lowers the value of home production below market work.

All groups of women quit less during recessions and this generates the lower reduction in married women's hours through the same mechanism as is apparent in our CPS data. There are two channels that reduce quits during recessions. Quantitatively, the primary channel is one of insurance against spousal job loss. It is true that a woman is less likely to quit if her husband actually loses his job, but even the elevated threat of job loss reduces lower quits through what we call "precautionary labor supply". The woman who would otherwise quit due to a high cost of working decides instead to maintain employment during a recession to hedge against the higher risk that her husband loses his job in which case they would both be out of work.

The second channel that reduces married women's quits during recessions is one of "job hording". As we have documented, married women have higher frequency flows in and out of the labor market than other demographics. These flexible labor supply choices are possible when jobs are easy to find. During a recession, jobs are harder to find and a woman who would otherwise quit then rejoin will have a tougher time rejoining. Therefore she limits her quit behavior and raises the threshold for how high a transitory shock to her cost of work must be for her to quit.

A third channel works in the opposite direction. Wages fall during recessions which raises incentives to quit. This limits the impact of the first two channels that lower quits, but the first two channels dominate quantitatively to generate the pro-cyclical employed to out of the labor force transition rates in the data.

The impact of the business cycle and realized unemployment of a husband on precautionary

[16] Part-time in the model is defined as working less than 40% of time available.

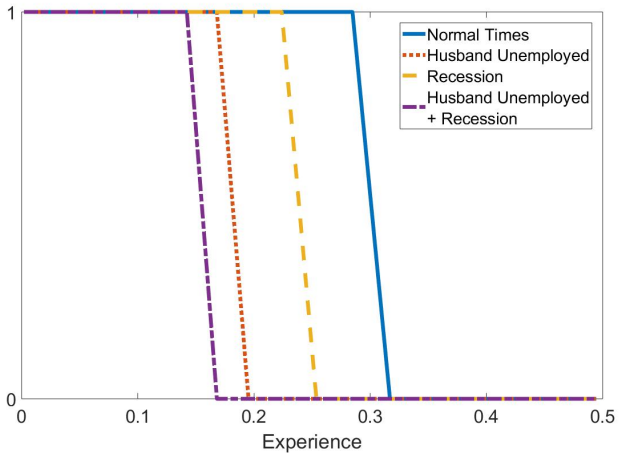


Figure 6: Work policy- the productivity threshold at which a married woman chooses to quit.

labor supply can be seen in Figure 6. The x-axis shows experience, a measure of productivity. The policy functions mark the productivity threshold at which this woman chooses to quit in the simulation for the 1940s cohort.[17] During normal times (expansions), shocks to the pecuniary cost of work cause women with productivity up to 0.33 to quit. This is equal to one-third of the maximum wage in the model. The remaining lines show that the average quit threshold falls during recessions or if a woman's husband is unemployed due to the mechanisms we have discussed. Quantitatively, the incidence of having a husband unemployed lowers the quit rate for women more than the mere occurrence of a recession. This is both because the income effect of a realized husband's job loss is greater than a higher risk of a husband's job loss but also because the opposing effect of job hording that reduces quits is higher during recessions when jobs are harder to find.

The model generates a near negligible increase in the "added worker effect" during recessions, as is consistent with the empirical literature. The added worker effect is the idea that unemployed married women choose to become employed when their spouses become unemployed. Figure 7 provides the average job search intensity for women across experience, a measure of productivity. Job search intensity varies little for an unemployed woman with an employed spouse across normal and recessionary times. Furthermore, search intensity actually decreases for an unemployed woman with an unemployed spouse during recessions compared to normal times. How can this be?

[17] Note that women start with a random draw of experience distributed uniformly from one-tenth to one-half of the maximum experience.

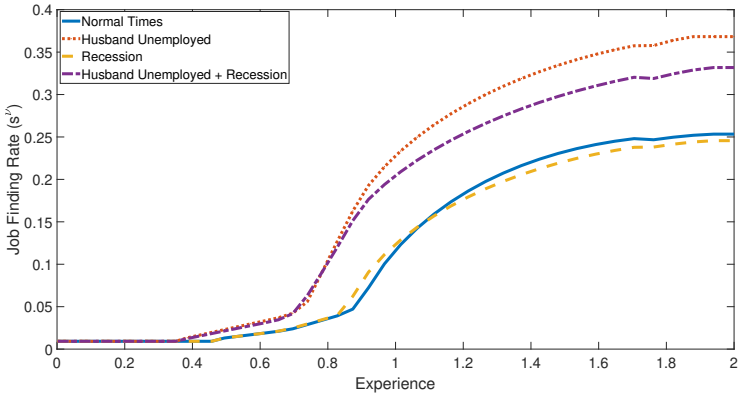


Figure 7: Job search intensity over the experience distribution.

The basic impetus for the added work effect is always at play. A spousal job loss is a large negative income effect. It raises the marginal utility of consumption and most women can produce more consumption with market work than in home production. Yet, although they'd like to be working, it is harder to find work during a recession. The reduction in job search efficiency is large enough to counter the income effect and barely change job search behavior during a recession. During an expansion it is only the income effect at play and so search increases.

Careers interact with the reduction in quit rates in a fundamental way. A married woman must have some potential to quit to begin with in order to reduce her quit rate during recessions. Figure 8 provides an impulse response of quits by career type for the 1940's cohort. Observe that career women do not show up on the graph. This is because career women, by definition, have such low quit rates to begin with that they do not change the total married women's quit rate over the business cycle. Life-cycle women and "Mostly NiLF" women have the highest reaction and lower their quit rates by over five percent during a recession. The life-cycle women are those who typically quit during their child rearing years. During recessions a larger share decide to stay in the labor force. The "Mostly NiLF" women are those mostly not in the labor force. They show up here as women who had joined the labor force in response to a husband's job loss. If this happens proceeding a recession they are more likely to stay employed through the recession.

The reduction in quit rates is persistent. This is because women work during a recession when they otherwise wouldn't have gain experience. Experience is persistent and raises their wages. For some this is enough to persistently increase their labor supply. This phenomenon has been

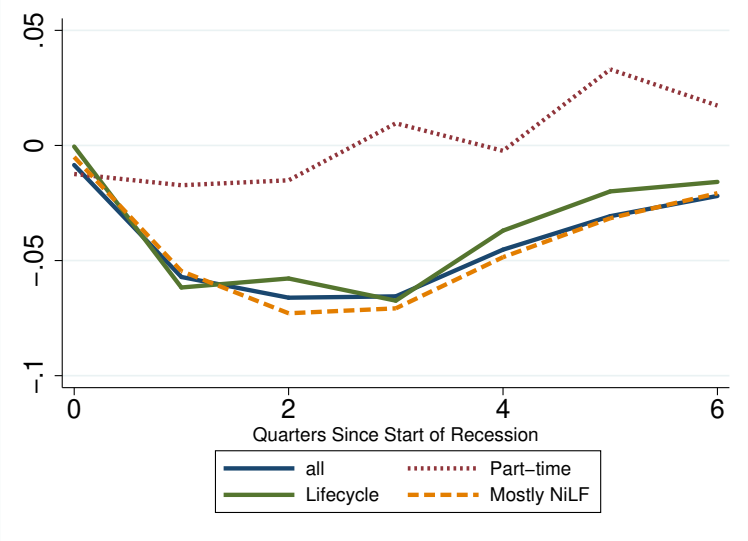


Figure 8: Impulse response- simulated reaction of employment by career type to a recession for the 1940s cohort.

documented as higher life-time participation rates for cohorts of women who experience more recessionary years during their working age.

The total impact of careers on the volatility of hours over the cycle can be seen in Figure 9. The path of career women basically tracks the impact of exogenous displacement rates in the model since they almost never quit by choice. The fall in employment for the other groups of women is lower because, as shown in Figure 8, they reduce their quit rate and this helps maintain a higher level of employment for them.

Table 5 presents the response of the intensive and extensive margin of labor supply for each career type along with their share of the population in the 1940s cohort. Recall that all women face the same changes in job loss over the business cycle. The changes in employment and hours for Career women represent the impact of changing the exogenous job loss rate with virtually no behavioral change. The remaining groups change their quit rates in ways to off-set higher job loss rates during recessions and increase quit rates to off-set lower job loss rates in expansions. Life-cycle women have the largest behavioral response. Mostly Not in the Labor Force (NiLF) women are not far behind but represent a much lower share of hours worked and employment.

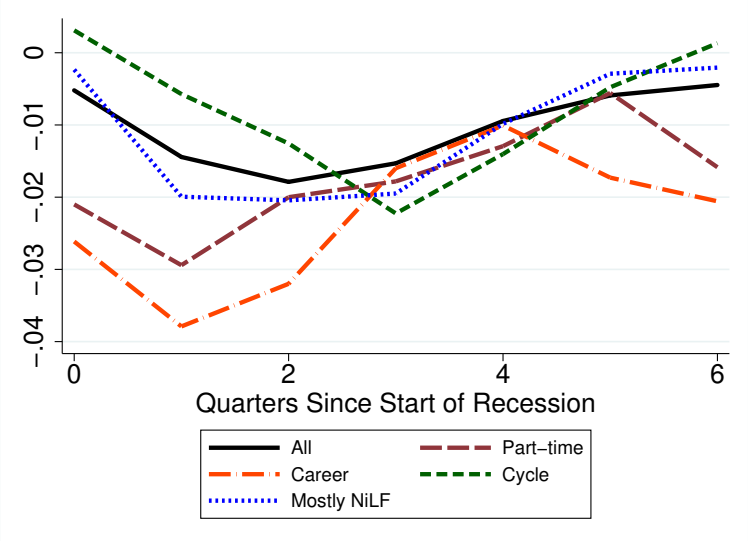


Figure 9: Impulse response- simulated reaction of quits by career type to a recession for the 1940s cohort.

	Change in Recession		
	Hours	Employment	Share of Pop
Part-Time	-3.5%	-2.8%	33%
Career	-4.3%	-3.3%	17%
Life-Cycle	-0.9%	-0.8%	29%
Mostly NiLF	-1.2%	-0.8%	21%
All	-2.0%	-1.8%	100%

Table 5: Simulated results for the 1940s cohort calibration.

9 Connecting Trend to Cycle

We now use the model to predict how different theories of increasing labor supply of married women affect their careers and, in turn, the volatility of their hours over the business cycle. We do so by modifying parameters in the model, one at a time, to produce the observed increase in married women's employment that we see in the data between the 1940s and 1970s cohorts. We then simulate how much hours would drop during a typical recession over 1974-2016.

There are two main ways in which changes in the labor market will affect the volatility of married women's hours over the cycle. First, each change in the labor market will change the composition of careers. As shown in the previous section, life-cycle women were critical for reducing the fall in married women's employment during recessions whereas career women were not able to lower quit rates to offset the higher recessionary lay-off rates. Second, each change in the labor market will change the behavioral response within groups and thus the within group volatility of hours over the cycle in different ways that will be discussed. For this discussion it is useful to reference the Euler equation for hours and the condition for the marginal participant who is indifferent between working or quitting:

$$v'(h) = u'(c)[w(e,Z) - f(e)] + \beta E[V_e(g(e,h), a', s'^m, Z')]g_h(e,h)$$

$$u(c^E) - v(h^E) - \hat{\kappa} + \beta EV(g(h^E,e), a', y'^m, Z') = u(c^N) + \beta EV^N(g^N(e), a', y'^m, Z')$$

Mechanism 1: Increasing Returns to Experience The first theory of the increase in married women's labor supply that we consider is an increase in the value of experience in the labor market. We model this as an increase in the parameter γ in the wage technology function $w(\omega, e) = \phi^w(\omega + \gamma e^{\xi})$, while adjusting ϕ^ω to keep the average wage constant.

Increasing the returns to experience increases both women's hours and their attachment to the labor force. When experience is a larger component of wages, $V()$ is more steeply increasing in e. Therefore, a woman will work higher hours according to the Euler condition 9 because the marginal gain of additional experience $V_e()$ is higher and hours increase future experience: $g_h(e,h) > 0$. A worker indifferent between quitting or not according to 9 will also be pushed towards not quitting when returns to experience increase. While V^N is also more steeply increasing in e, $g^N(e) \leq e$ and

$g(h^E, e) \geq e$, generally. In words, the cost of losing experience during non employment is higher and increases the value of employment relative to non-employment.

Higher returns to experience result in higher life-cycle attachment. More women choose to be career or part-time women who work consistently to avoid the higher penalty of lost experience when pausing from the labor force. This composition change increases the volatility of employment over the cycle by reducing the ability to reduce quits during recessions and increase them during expansions. Change in behavioral responses within career types works in the opposite direction for those who still have a relevant quitting choice. Volatility decreases for life-cycle and mostly non-participants because the channel of building experience is an extra benefit of maintaining employment during recessions. Therefore they quit even less. At the end of the day, the composition effect dominates quantitatively. When choosing an increase in returns to experience to fully generate the increase in married women's labor supply we find that hours drop 0.7 percentage points more during recessions. This is about a 10% increase relative to the 1940s cohort.

Mechanism 2: Decrease in the Cost of Work. A second theory of the increase in married women's labor supply is a decrease in the fixed cost of going to work. This could be due to things like technological advances or cheaper child care. We model this theory as a decline in the mean value of κ, the pecuniary cost of work. We find that a decrease in the pecuniary cost of work primarily increases married women's hours by shifting life-cycle women and mostly not in the labor force to consistent part-time work. This change in composition increases the volatility of hours over the cycle. The volatility of hours also increases for most career types. The fall in κ brings women whose home productivity is closer to their market productivity into the labor force. These women are more likely to choose higher intensity in home production when wages fall during a recession. These forces work together to provide hours that drop 1.8 percentage points more during a recession when the increase in married women's hours is driven entirely by a decrease in the cost of work. This is about a 26% larger decline than for the 1940s cohort who faced a higher fixed cost of work.

Mechanism 3: Decrease in the Gender Wage Gap. A third theory of the increase in married women's labor supply is the decrease in the gender wage gap. We model this by increasing ϕ^w in the wage technology $w(\omega, e) = \phi^w(\omega + \gamma e^\xi)$ which raises all women's wages proportionally.

The decrease in the gender wage gap primarily increases hours by lowering the number of women who are never in the labor force. The women primarily join the labor force as life-cycle women and continue to remain outside of the labor force during child raising years. There is also a smaller shift in women from part-time to full-time work. These changes in composition lower employment volatility over the business cycle as there are more life-cycle women who have the lowest volatility and the change from part-time to full-time doesn't affect volatility much. The behavioral change within careers works in the same direction and hours volatility falls for all career groups. This is due to the wife's income becoming a larger share of household income, amplifying the insurance she can provide.

Comparison of the three theories. All three changes potentially impacting married women's labor supply are evident to have occur over the past century. We estimate that the market returns to experience have increased and the gender wage gap has decreased. There is also a literature that provides evidence that the cost of joining the labor force has declined for married women, although the results here are more mixed. One thing we learn from our model is that an increase in the returns to experience is the only theory capable of increasing the share of career women by the magnitude of which we see in the data, as seen in Figure 10. The decrease in the gender wage gap is the most counter factual because it increases the share of life-cycle women whereas their share declines in the data. This does not mean that the decrease in the gender wage gap did not affect married women's labor supply, it just means that its impact is offset by some of the other theories in shaping married women's labor market attachment.

Table 6 shows the changes in careers and employment during recessions relative to the 1940s cohort when the change in labor supply for the 1970s cohort is provided by each theory individually. The column labelled "Empl" shows how much more or less employment falls in percentage points during a recession for women with a specific career in the 1970s cohort compared to the 1940s cohort. The employment volatility of married women declines when the increase in their participation is driven by a closing of the gender wage gap alone. By contrast, an increase in the returns to experience or a decrease in the cost of work increases employment volatility and, quantitatively, the decrease in cost of work increases volatility by 2.5x that of an increase in returns to experience. The bottom line results are driven both by changes in the share of married women in each career type and by the change in behavior within career types. The column labeled "Pop Share" shows the percentage point change in the distribution of women of each career type in the

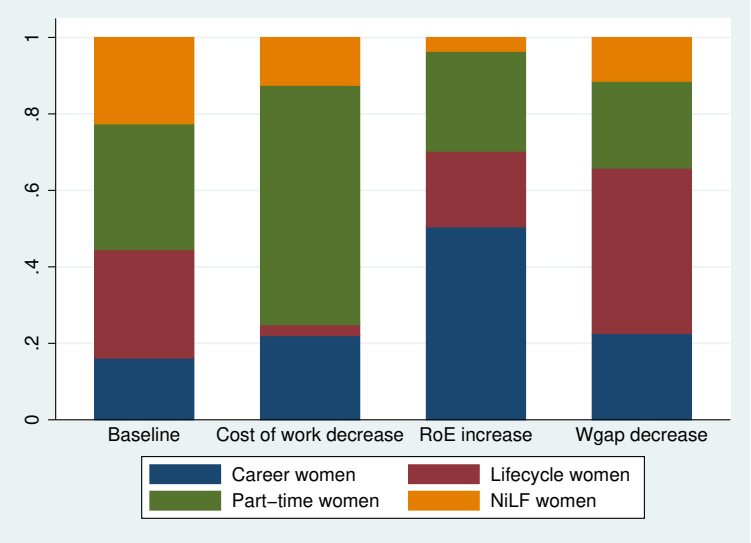


Figure 10: Change in the distribution of careers implied by each theory operating alone to provide the increase in married women's hours between the 1940 and 1970s cohorts.

1970s cohort compared to the 1940s cohort. Both the decrease in the gender wage gap and the increase in returns to experience increase employment declines in recessions within groups. The decrease in the cost of work has mixed results depending on career type.

	Return to Exp ↑		Wage Gap ↓		Cost of Work ↓	
	Empl	Pop Share	Empl	Pop Share	Empl	Pop Share
Part-Time	-0.5	-5	-0.4	-5	-0.1	+40
Career	-0.2	+33	-0.2	+4	+0.3	+4
Life-Cycle	-0.8	-10	-0.1	+12	-0.7	-27
Mostly NiLF	-0.4	-18	0.0	-11	+0.4	-17
All	+0.7		-1.4		+1.8	

Table 6: Percentage point change in the decline in employment during a typical recession for the 1970s cohort relative to the 1940s cohort when cohort differences in labor supply are provided by each theory individually.

	1940	1950	1960	1970	1980
Wage Gap in Married Couples	0.71	0.74	0.77	0.76	0.77
Return to Experience (γ)	0.50	0.55	0.58	0.68	0.69
Employment Rate	0.67	0.70	0.72	0.74	0.74
Fixed Cost of Work relative to 1940s	1.0	1.01	0.88	1.0	1.04

Table 7: Targets exactly matched and the inferred change in the fixed cost of work for each cohort.

10 Cohort Analysis.

We now feed into the model differences in key parameters to understand the determinants of how labor has been supplied by married women across cohorts and understand the implications for business cycle volatilities and intra-household insurance. For each cohort we calculate the average unconditional wage gap between husband and wife pairs and estimate the returns to experience. These calculations are done in the PSID data using the same Heckman selection correction with ordered probity described in the calibration section. We can feed these estimates directly into our model by calibrating our wage and experience transition functions appropriately. The model would not replicate the employment trend of married women with these two changes alone and so we add a change in the mean of the distribution of the fixed cost of work to exactly match the employment trend. This change is an unmeasured residual but can be interpreted in several ways including changes in culture, the value of time spent with children, etc. All targeted moments are exactly matched and detailed in Table 7.

Table 7 shows that changes in the gender wage gap and returns to experience did not occur on parallel trends. The gender wage gap in married couples closed more sharply in earlier cohorts and then leveled off after the 1950s cohort. Returns to experience have also leveled off for later cohorts but showed the largest increase between the 1960s and 1970s cohorts.

Moments not targeted in the cohort analysis include moment related to careers and labor market flows both on average and over the business cycle. Table 8 provides a comparison of the career distributions generated by the model to those in the PSID data. Careers are well measured in the data and provide a good idea of the theory's successes in capturing some dimensions of labor force attachment and the composition of the increase in women's hours in the data.

Table 9 shows the model predictions for employment, voluntary flows to non employment, and wife's share of income. Employment becomes substantially more volatile over the business cycle

	1940		1950		1960		1970		1980	
	Model	Data	Model	Data	Model	Data	Model	Data	Model	Data
Part-Time	0.24	0.28	0.23	0.30	0.26	0.30	0.12	-	0.18	-
Career	0.17	0.19	0.27	0.28	0.40	0.40	0.38	-	0.37	-
Life-Cycle	0.33	0.31	0.33	0.18	0.14	0.12	0.20	-	0.27	-
Mostly NiLF	0.25	0.22	0.17	0.17	0.19	0.19	0.20	-	0.19	-

Table 8: Untargetted moments.

Cohort	Employment/Pop		Voluntary E to Non-E		Wife's Share of Income	
	Exp	Δ Recess	Exp	Δ Recess	Exp	Δ Recess
1940	67%	-1.7%	3.5%	-33.0%	22.5%	+2.5%
1950	70	-5.9	2.5	-30.0	26.2	+2.3
1960	72	-4.6	1.8	-25.5	29.9	+2.3
1970	74	-7.2	2.3	-26.7	27.6	+2.1
1980	74	-6.3	2.4	-29.6	27.2	+2.3

Table 9: Cohort predictions for the business cycle.

after 1940 with a prediction of slight reversal for the 1980s cohort. The increased volatility stems from the voluntary E to Non-E margin decreasing over time. It is of a lower level during good times and adjusts, percentage wise, less during recessions. Despite these changes, wife's share of income remains pro-cyclical, although slightly less so over time. This margin moves less quantitatively than the others in part because the level of wife's share of income increases and so a percentage change is larger, and because of composition changes in lower income women adjusting their quits more over the business cycle in subsequent cohorts.

Table 10 shows the predictions for household income volatility. All cohorts experience larger falls in household income during recessions and smaller falls in household incomes when a husband loses his job than the 1940s cohort. The former result is from wives' employment becoming more counter-cyclical as their participation becomes less counter-cyclical. It is not just that the wives' no longer increase their income during a recession they also no longer decrease their income in an expansion. Both help to increase the decline in income during recession relative to expansion. The later result is the effect of more households having a second earner and the income of the second earner being a larger share of household income. The bottom three rows show the results for the experiments where all changes in employment are driven by only one factor. The lower fixed cost only decreases cyclical volatility because it introduces many low hour partime workers

Cohort	Change in Household Income Relative to Change for 1940's cohort Δ Recession	Δ Husband's Job loss
1940	1	1
1950	+15.2%	-5.1%
1960	+24.2%	-7.5%
1970	+16.2%	-6.1%
1980	+25.6%	-5.4%
Fixed Cost only	-7.9%	-2.4%
Return to Exp. only	+14.8%	-12.9%
Wage gap only	+19.2%	-8.8%

Table 10: Changes in income volatility relative to the 1940s cohort.

who expand on the intensive margin during a recession. These part time earners earn relatively low incomes and so these effects are fairly small. Both of the other factors, returns to experience and the gender wage gap, increase income volatility along with increasing employment.

11 Conclusion.

We have developed a model of married women's labor supply that replicates paths of labor market attachment for women over their careers and have shown historically lower attachment can account for the historically lower volatilities of employment for married women over the business cycle. We then show that the forces that increased married women's labor supply after the 1950s fundamentally changed the nature of their labor force attachment and careers, and in turn the volatility of married women's hours and employment over the business cycle.

Our main result that the forces that increased married women's labor supply also modestly increased business cycle volatility. This is consistent with the observation that business cycle volatilities have increased for recent recessions such as the Great Recession. It is not, however, what one might expect under the following logic that our work has shown to be incorrect: that women have historically had less volatility of employment over the business cycle implies that having a greater share of aggregate hours worked by married women should reduce business cycle volatility. Instead, one must consider why married women are working more and realize that what is driving married women to work more can also fundamentally change how they behave over the business

cycle.

These results are useful for both understanding how the nature of recessions have changed over time and how the ability of households to insure themselves from business cycle risk has changed as well. We find that part of the increase in business cycle volatility of hours and employment is attributable to higher labor force attachment of market participants. What we learned in this paper can be useful for understanding why some countries with similar female labor force participation have different business cycle volatilities– the women in one country could be more attached than the women in another. It can also be used to make predictions about future labor market recoveries. Finally, the specific mechanisms of household insurance over the cycle studied in this paper should inform questions of whether some social transfers, such as the child tax credit or the dependent care tax credit, should be counter-cyclical or should expand with higher female labor force participation.

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