

# Women's Labor Force Participation and the Business Cycle\*

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## Abstract

This paper studies the macroeconomic implications of the rise in participation and attachment to the labor force of women and secondary earners. I develop a business cycle model of couples that features labor market frictions, endogenous labor supply, and human capital accumulation. Households face unemployment risk over the business cycle, and secondary earners adjust their labor supply to respond to this risk, so that they are more likely to participate when primary earners face a high risk of job loss. I validate the model using novel empirical evidence on added worker effect heterogeneity by previous labor market experience and income. A large mass of marginal secondary earners will dampen fluctuations in aggregate employment if the income effect induced by unemployment is greater than the substitution effect due to lower wages. The magnitude of the counter-cyclical effect is proportional to the distance from the participation frontier of secondary earners, which in turn depends on the gap in net wages between partners. For values of the wage gap smaller than 20%, women's aggregate labor supply elasticity converges to men's, and the dampening effect wanes.

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# 1 Introduction

Over the course of the twentieth century, women have been catching up dramatically in terms of pay and labor force participation in the U.S., and today they contribute to a much larger share of total employment. As a consequence, the U.S. has gone from having a majority of households with one breadwinner to a structure in which the most common type of household is a dual-earner household.

In this paper, I show that the extent to which secondary earners participate in the labor markets significantly impacts how households' labor supply and aggregate employment respond to the business cycle. If unemployment risk in downturns is high enough relative to movements in the wage rate, a large mass of flexible secondary earners available to enter the labor market will have the effect of dampening fluctuations in aggregate employment. However, the dampening effect wanes when women and secondary earners have little room to increase their labor supply.

The dampening effect of secondary earners relies on the fact that they may respond to their partners becoming unemployed by entering the labor force and finding a job. This mechanism, sometimes called the “added worker effect” (Lundberg 1985), is a way by which non-working partners can provide insurance to the family against income shocks, and it induces a negative correlation between spouses' employment statuses. Importantly, I offer new empirical evidence showing that this effect is stronger when the secondary earner's previous employment period is more recent and her income is high. This means that not all secondary earners respond in the same way to partners' job loss: Individuals closer to the participation frontier are potentially more effective added workers. Understanding the evolution of women's attachment to the labor force is, therefore, a crucial factor for the business cycle.

Motivated by the micro-evidence at the individual level, I develop a business cycle model with singles and couples and fluctuations in labor market flows. The model features imperfectly uninsurable uncertainty and job-finding and losing frictions, as in Krusell et al. (2011), Krusell et al. (2017), McKay and Reis (2021), Mankart and

Oikonomou (2017). Households jointly decide on consumption, labor supply, and savings. The labor market is subject to search frictions: workers may lose jobs, and unemployed workers must wait for job offers. Not all individuals are always part of the labor force because searching and working are costly in terms of utility. The human capital of employed workers increases over time due to returns to experience, while the human capital of workers who are out of employment, either because they are suffering an unemployment spell or are out of the labor force, depreciates.

Within couples, none, one, or both individuals can choose to work. The model generates gender differences in participation and attachment through various channels. First, women face an exogenous wage gap that manifests as lower efficiency units of labor. The wage gap in the model is chosen to match the unconditional average hourly wage of employed women relative to employed men. It could reflect differences in education, occupation, misallocation, discrimination, or a combination of different factors. Second, couples are subject to joint progressive taxation, which has been shown to significantly hold back female labor supply by subjecting secondary earners to high marginal tax rates<sup>1</sup>. Because of this, women participate less and less often and hence accumulate less human capital than men.

The economy is subject to shocks to aggregate total factor productivity and frictions in the labor market, which raise unemployment risk in downturns. In the absence of time-varying unemployment risk, marginal secondary earners and workers would quit their job or stop searching during recessions when wages are low, and fewer workers would desire to enter the labor markets. This effect is present in many standard models of labor supply. However, if unemployment risk in downturns is high enough relative to movements in the wage rate, secondary earners who are just below the participation frontier will enter the labor market. The theory highlights the importance of cyclical idiosyncratic risk: how single and married men and women respond differently to it heavily influences the properties of aggregate labor supply.

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<sup>1</sup>See, for example, (Borella, De Nardi, and Yang, 2022), among others.

The baseline model is calibrated on data between 1975 and 1985 and can match labor force participation rates and unemployment rates by different groups and the level and cyclicalities of job finding and separation rates by men and women. To quantitatively account for the changing importance of married women's participation from the 1970s to today, I conduct a comparative statics exercise using the calibrated model and compare the business cycle in different economies that differ only by the extent of the gap in wages between partners.

The model predicts that (i) the family insurance motive is larger than the substitution effect from lower wages in downturns, and (ii) hours and consumption volatility respond non-monotonically to changes in the wage gap. As the wage gap grows smaller, women have a higher earnings capacity, both because they face higher wages and because they accumulate more work experience before quitting the labor force. Consequently, they find it easier to enter during recessions, acting as a dampening force on the severity of recessions. I show quantitatively that a reduction in the wage gap from 50% to 30% has translated into a 6% decrease volatility of hours per capita and a 10% decrease in consumption volatility. For levels of the wage gap lower than 20%, women's participation and labor supply elasticity look more similar to men's. Most women are left with little room to increase their labor supply, and the dampening effect on employment disappears. Most households rely on self-insuring through assets.

**Related Literature** This paper relates to several strands of literature. First, the literature that studies the determinants of aggregate labor supply in the presence of an extensive margin. Keane (2011) and Keane and Rogerson (2012) advocate the importance of studying how some of the features studied in this paper (e.g., incomplete markets, preference heterogeneity, human capital, and the extensive margin) affect labor supply responses. When the extensive margin is operative, the slope of the aggregate labor supply schedule is determined by the distribution of reservation wages (see Chang and Kim (2006)). Individuals closer to the reservation

wage will be more sensitive to temporary wage changes, especially at monthly or quarterly frequencies (Erosa, Fuster, and Kambourov (2016)).

A related literature that explores business cycles implications has therefore identified the importance of marginal workers for aggregate employment fluctuations: A large mass of marginal individuals typically implies large fluctuations in employment and hours (Hansen (1985), Rogerson (1988) , Hagedorn and Manovskii (2008), Jaimovich and Siu (2009), Ljungqvist and Sargent (2017)). However, this paper shows that, contrary to what would emerge in a model without couples or without pro-cyclical unemployment risk, a larger proportion of marginal secondary workers has the opposite effect of stabilizing fluctuations. The model highlights that this is especially true if there are many marginal workers just *below* the participation frontier.

This paper also belongs to a literature that incorporates families into macroeconomics, showing that accounting for the family leads to new answers to classic macroeconomic questions (see Doepke and Tertilt (2016) for a review). In particular, I focus on how couples provide each other with insurance from labor market risk and how the large changes in the nature of the family affect the evolution of aggregate labor supply over the business cycle.

This paper is most related and builds on recent works that explore how spousal insurance can affect the aggregate economy. Mankart and Oikonomou (2017) pioneered the introduction of couples in models of labor market flows and participation, which Krusell, Mukoyama, Rogerson, and Sahin developed in the context of “bachelor” households. They analyze the cyclicalities of the labor force in U.S. data for different groups and show that spousal insurance contributes to its average acyclicity. Bardoczy (2022) shows that spouses can provide significant active and passive consumption insurance in a similar framework, where recessions are caused by movements in the discount factor and are accompanied by higher rates of job loss. In particular, he makes the important point that even if secondary earners earn only a smaller fraction of household income, it is those who gain the most from doing so

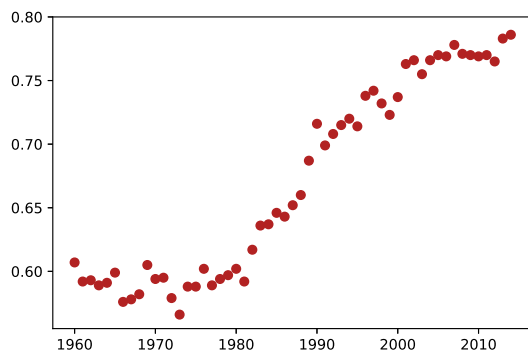
that select into “adding a worker”. Since in his framework recessions do not come with movements in the marginal product of labor, the trade-off with the substitution effect caused by lower wages is not present.

Contributing to this body of work, this paper models secular trends in labor force participation and attachment. The resulting insight is that movements in spousal labor supply have a larger impact on aggregates when there are more marginal secondary earners; i.e., the strength of the counter-cyclical effect is proportional to the distance from the participation frontier of secondary earners. Quantitatively, getting a realistic mass of marginal women (and men) is, therefore, especially important. Relatively to previous papers, two novel features are important in this sense: progressive taxation and human capital accumulation and depreciation. Borella, De Nardi, and Yang (2022), among others, show that progressive taxation significantly holds back female labor supply in dual-earner couples. Moreover, without human capital depreciation – for example, if productivity follows a mean-reverting process – many non-participating women with high productivity would be ready to enter at any point, even if the wage gap is relatively high.

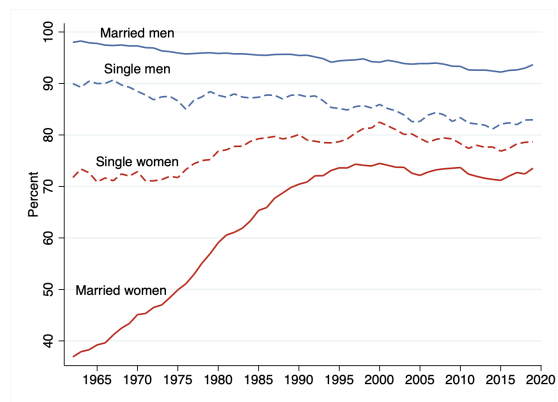
At the hearth of the micro-foundation of the model lies the fact that partners jointly decide their labor supply and are subject to involuntary labor market separations. The so called added worker effect, i.e., a worker joining the labor force in response to their spouse’s job loss, has been extensively studied in the empirical labor literature. Lundberg (1985), Stephens (2002), Parker and Skoufias (2004), and Juhn and Potter (2007) are examples. Bacher, Grubener, and Nord (2022) show that counter-cyclical entry is much more pronounced for young than for old households. Guner, Kulikova, and Valladares-Esteban (2020) use a decomposition method based on joint transition probabilities to show that the share of households in which both members are non-employed would be around 16% higher in the absence of the added worker effect. I confirm the existence of the added worker effect in PSID data and offer new empirical evidence on the importance of the previous experience of married women.

There is also evidence that the added worker effect has strengthened over time among single earner couples. Mankart and Oikonomou (2016) and Guner, Kulikova, and Valladares-Esteban (2020) find so in CPS data. Mankart, Oikonomou, and Pascucci (2021) argue that this is because structural changes – such as declining gender wage gap – increased the insurance value of the added worker effect and not because of declining search frictions. A similar effect is present in my model. Finally, recent work finds that women respond not only to the realization of their husband displacement but also to a higher risk of displacement. For example, Park and Shin (2020) show that wives increase their labor supply significantly in response to increases in the variance of husbands’ permanent wage shocks, reducing the welfare cost of increased earnings risk since the early 1970s. Ellieroth (2022) argues that women respond to increases in unemployment risk by quitting less.

The last strand of literature that this paper contributes to is the literature that considers how changes in demographics, and especially in women’s participation, change the business cycle. Jaimovich and Siu (2009) perform a cross-country analysis and document that a larger mass of young workers contributes to amplifying fluctuations. Fukui, Nakamura, and Steinsson (Forthcoming), and Olsson (2020) show that recoveries for men have always been slow, and only recoveries for women have slowed since the early 1990s as a result of a slower or zero increase in the labor force participation of women. Finally, (Albanesi, 2019) provides evidence in an estimated DSGE model that women’s employment plays a crucial role in phenomena such as jobless recoveries, the productivity slowdown, and the great moderation. Compared to these papers, I focus explicitly on the interplay between insurance motives and labor supply. In my model, the strength of this motive is the main driver of fluctuations in hours.



(a) Female to male earnings ratio, workers working year-round, full-time.



(b) Labor Force Participation by different groups

Figure 1: Source: U.S. Census Bureau Current Population Report, Income and Poverty in the United States: 2020, Table A-7. and Current Population Survey.

## 2 Empirical Evidence

I first discuss some long-run trends in labor supply by men and women, and by single and married individuals. Then I bring some new evidence of the existence and extent of the so called added worker effect using micro data.

### 2.1 Trends in Labor Supply

Data on trends in employment and income come from Current Population Survey March Annual Social and Economic Supplement (ASEC), ranging from 1962 to 2019. I focus on prime-age workers and exclude respondents younger than 25 or older than 55. The choice of schooling and retirement is therefore mostly not considered. All individuals are weighted by the individual weights provided by the survey.

Figure (1b) shows the trends in labor force participation by gender and marital status. The most striking feature is that participation among married women rose from around 40% in the sixties to around 70% in recent years. At the same time, participation among single women slightly increased, while that of married men decreased from 98% to around 93%.



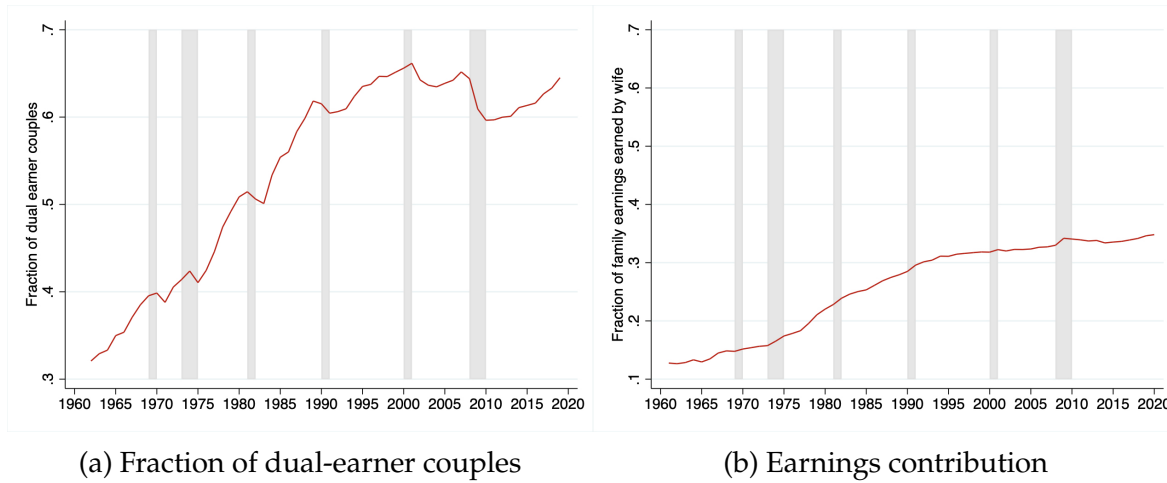


Figure 2: The number of dual-earner couples over all couples increased to 65%, and married women now contribute to around 35% of couple's earnings. Source: CPS ASEC.

As a consequence, the most common type of household in the U.S. today is a dual-earner household. Specifically, the number of dual-earner couples increased to 70% of all couples, and married women now contribute to around 35% of couple's earnings (see Figures (2a) and (2b)).

The increase in participation among married women has coincided with a strong decrease of the wage gap. Figure (1a) plots the ratio of median earnings of women working full-time, year-round and of median earnings of men working full-time, year-round. While until around 1980 women only earned 60% of men working comparable hours, they earned around 78% in the 2010s. It is important to notice that this is a measure of the *unconditional* wage gap, which reflects differences in education, job experience, occupation, child penalties, on top of possible overt and covert discrimination. That is, this is the difference in the wage that a woman and a man will face on average at different points in time.

## 2.2 Micro evidence: Active Spousal Insurance

The study uses data from the Panel Study of Income Dynamics (PSID), covering years from 1968-1997. These are the years for which PSID has annual coverage of

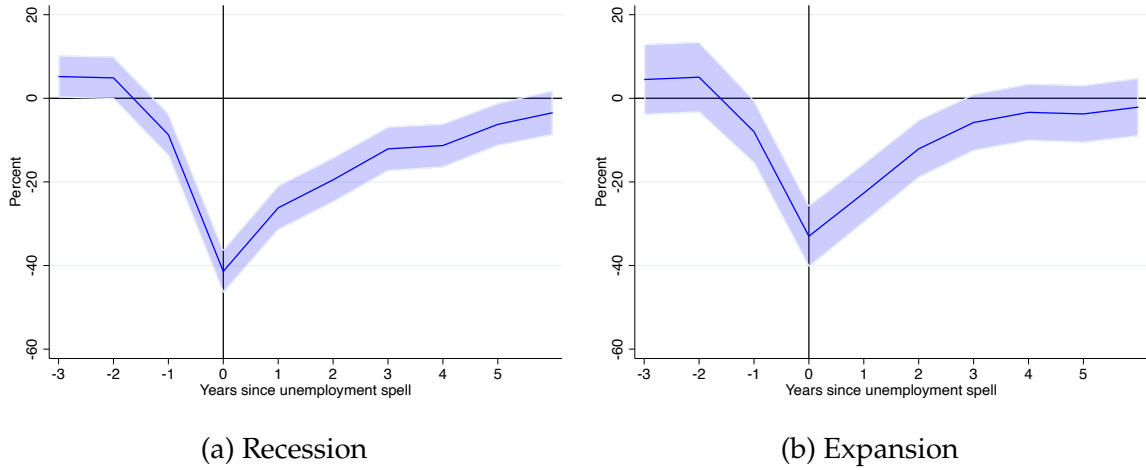


Figure 3: Fall in labor earnings after unemployment spell, married men. Source: PSID.

households<sup>2</sup>. The main advantage of the PSID compared to other publicly available datasets is that it follows families over time. Therefore, it allows me to (i) study longer term effects of unemployment, (ii) document whether spouses who enter the labor force in response to their partner becoming unemployed do eventually find a job, and (iii) explore heterogeneity with respect to previous experience. On the other hand, one of the main disadvantages is the relatively low sample size. For example, the Current Population Survey (CPS), which has been recently used to study the added worker effect for example by Mankart and Oikonomou (2016, 2017) and Guner, Kulikova, and Valladares-Esteban (2020) has a larger sample size, but only follows people for four consecutive months.

For this analysis, the sample is restricted to cohabiting families in which both the husband and the wife are between the ages of 25 and 60. The resulting sample contains 10,454 couples. I create a variable that indicates whether the husband becomes unemployed using the Employment Status variable. Specifically, the variable is equal to one if the husband goes from "Working Now" in the previous year to

<sup>2</sup>Including the years 1999-2019 presents some challenges because households are only interviewed every two years. Since most of the adjustment for spouses happens the year that the husband becomes unemployed, such a lower frequency is likely to miss it. Nonetheless, I conduct a robustness analysis on those years in Appendix A.

"Unemployed, looking for work" in the current year. I exclude individuals who go from employment to out of the labor force (for example, retirement), or who go from employment to "Only temporarily laid off or sick leave". I end up with 1,871 such events. PSID also asks unemployed people the reason why they have lost their previous job. Of those 1,871 workers who became unemployed, 80% were laid-off or their employer went out of business, 15% quit, 5% are unemployed because their seasonal work ended.

I first document the impact of unemployment on husband's earnings in recessions and expansions using a dynamic diff-in-diff centered around husband's unemployment spell as in Jacobson, LaLonde, and Sullivan (1993), Stevens (1997), David and Von Wachter (2011), Birinci (2020):

$$Earnings_{it} = \alpha_i + \gamma_t + \beta X_{it} + \sum_{k \geq -3}^5 \psi_R^k D_{it}^{R,k} + \sum_{k \geq -3}^5 \psi_E^k D_{it}^{E,k} + \epsilon_{it} \quad (1)$$

where  $Earnings_{it}$  are husband's annual labor earnings, and is  $D_{kit}$  an indicator variable that equals one when husband in family  $i$  is  $k$  years from becoming unemployed either in a recession year ( $R$ ) or expansion year ( $E$ ), where recession years are defined by the NBER.

The main variable of interest is then the effect on spousal labor supply.

**Long-term Effects of Unemployment on Husband's Income** Coefficients are reported as a percent of average earnings. Married men who become unemployed lose about 40% of labor earnings on impact, and it takes around 3 to 5 years to recover completely. Becoming unemployed in a recession has more severe consequences than in an expansion. This confirms results in Davis and Von Wachter (2011) and Birinci (2020) on my dataset and years<sup>3</sup>.

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<sup>3</sup>Since this dataset does not include the Great Recession, the differences between recessions and expansions are less pronounced than in Birinci (2020)

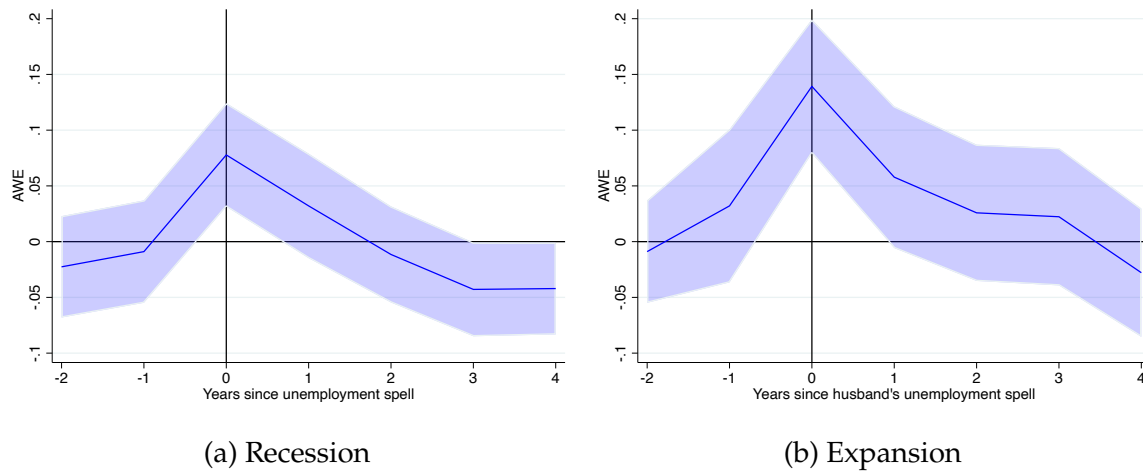
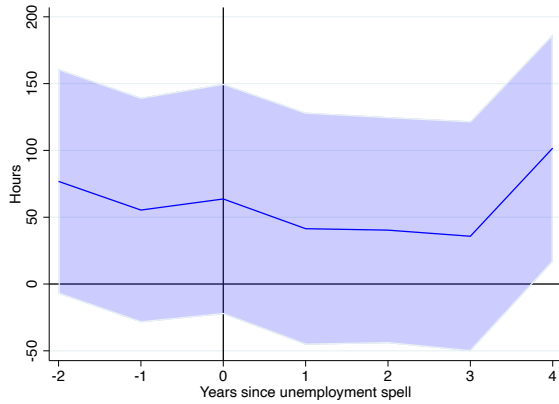


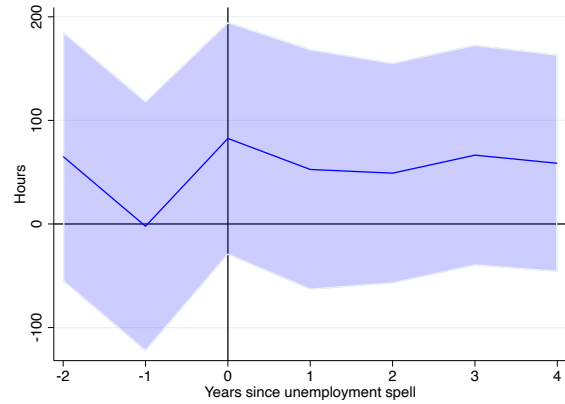
Figure 4: Added worker effect: NE flows. Source: PSID.

**Effect of Unemployment on Spouses** If the wife of a man who becomes unemployed was not working, she is more 8 to 14 percentage points more likely to get a job. She will work more hours and earn more compared to women whose husbands do not become unemployed. This is mostly in line with previous results, with a twist. Previous work is on CPS that only follows people for four months, so most of the action is from out of the labor force to *searching for a job*, but hard to see how many wives actually get a job. PSID follows people for longer so I can see that number and confirm that it is significantly larger than 0.

As can be seen in Figure 6, the Added Worker Effect is stronger for women who have worked more often in the past and earn higher income. On the other hand, If the wife of a man who becomes unemployed was already working, her income and hours do not significantly change compared to other women. This points to the fact that it is harder to increase hours if you are already working.

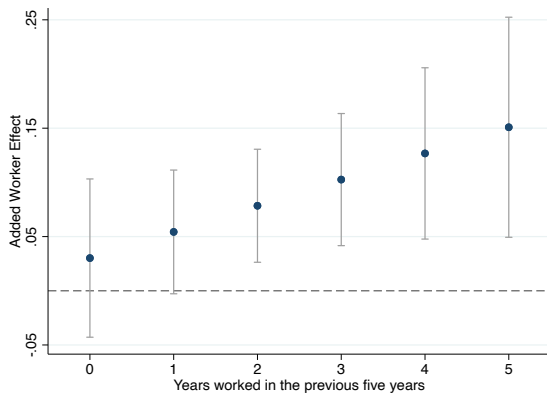


(a) Recession

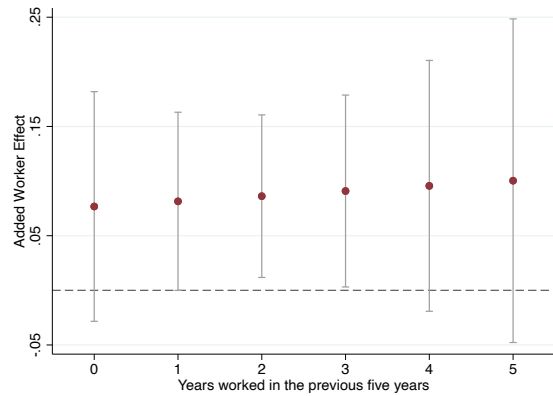


(b) Expansion

Figure 5: No changes in hours for women already working. Source: PSID.

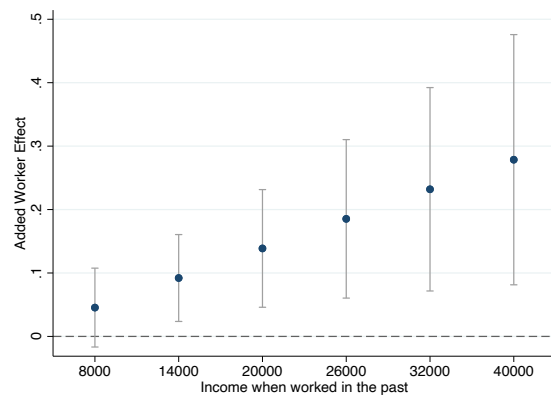


(a) Recession

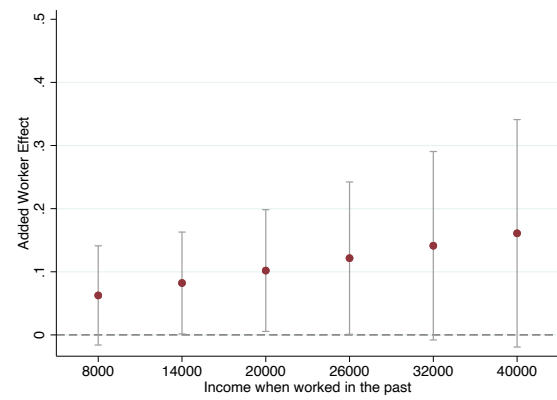


(b) Expansion

Figure 6: Added worker effect becomes stronger if the wife has worked more often in the past, especially in recessions. Source: PSID.



(a) Recession



(b) Expansion

Figure 7: Added worker effect becomes stronger if the wife had higher income when working. Source: PSID.

## 3 The Model

### 3.1 Overview

The core model is one of singles and couples' consumption and labor supply in the presence of imperfectly insurable uncertainty and job-finding and losing frictions.

### 3.2 Environment

**Agents and Preferences** The economy is populated by a measure one of households. They differ in terms of their marital status (married and single of two genders), labor market status and human capital. Marital status and gender are permanent types, and they determine the stochastic processes for labor market shocks and human capital accumulation.

Households derive utility from consumption and derive disutility from working for pay ( $n$ ) and from searching for work ( $q$ ). Labor supply and search decisions are at the extensive margin only. The period utility function for a single of gender  $g$  is given by:

$$u_{single,g}(c, n, q) = \frac{c^{1-\sigma}}{1-\sigma} - \phi_g n - \kappa_g q \quad (2)$$

and the period utility function for couples is:

$$u_{couple}(c, n_f, n_m, q_f, q_m) = \frac{c^{1-\sigma}}{1-\sigma} - \eta_f n_f - \eta_m n_m - \kappa_f q_f - \kappa_m q_m \quad (3)$$

The two members of each couple are assumed to make joint decisions on consumption and labor supply. Discussion on unitary model and perfect commitment HERE. Finally, each household discounts the future at factor  $\beta$ .

**Wages** The effective wage of an individual depends on the aggregate wage in the economy  $w$  and the number of efficiency units the individual is endowed with. The latter depends accumulated human capital, and on the individual's gender. Labor

income  $y$  for employed individuals  $i, j$  of gender  $g \in \{m, f\}$  working  $n$  hours is:

$$y_{i,m} = h_i w(n_i), \quad y_{j,f} = (1 - \delta) h_j w(n_j) \quad (4)$$

Two things are worth noting: first,  $\delta$  acts as a wedge between women's underlying productivity and their market productivity. Therefore, it is the main driver of the wage gap in the model. Second, individuals with a higher human capital have a higher effective wage.

**Labor market frictions** One of the main sources of risk in the model is unemployment. Every period a fraction  $s$  of employed households loses employment and must search to regain employment. Following Krusell, Mukoyama, Rogerson, and Sahin (2017) I abstract from vacancy creation and instead specify a process in which workers find jobs with an exogenous probability  $f$ .

At the beginning of the period, individuals are characterized by their work status and by whether they receive unemployment insurance or not. Individuals can be employed ( $e$ ), out of the labor force ( $o$ ), or unemployed. Unemployed individuals either receive unemployment benefits ( $u_b$ ) or are unemployed without benefits ( $u_{nb}$ ). Couples are composed of two individuals and are therefore characterized by the individual state of each partner, for a total of sixteen possible combinations.

The transitions across states depend endogenously on individuals' labor supply and search effort decisions and exogenously on labor market finding and separation shocks. Specifically, the employment state at the beginning of the period determines the probability that the worker receives a job offer, and that she will be eligible to receive unemployment benefits.

Agents have to receive an offer to be able to work. If a job offer is received, the worker can decide whether to accept the offer and, if so, whether to work full-time or part-time. If she accepts the offer, she will become employed ( $e$ ). If she decides to turn down the offer, she becomes non-employed. Non-employed individuals can



	Offer	No offer, non UI eligible	No offer, UI eligible
Employed	$(1 - s)$	0	$s$
Out of labor force	$f$	$(1 - f)$	0
Unemployed, no UI	$f^*$	$(1 - f^*)$	0
Unemployed, UI	$f^*$	$\lambda(1 - f^*)$	$(1 - \lambda)(1 - f^*)$

(a) Given their current employment and eligibility status, individuals exogenously receive a new offer and/or lose their unemployment benefits. Employed individuals lose their jobs with probability  $s$ . Out of labor force and unemployed individuals find a job with probabilities  $f$  and  $f^*$  respectively, with  $f^* > f$ . UI benefits expire at rate  $\lambda$ . All finding and separation rates are gender and marital status specific, and depend on the aggregate Total Factor Productivity  $Z$ .

	Employed'	Out of labor force'	Unemployed, no UI'	Unemployed, UI'
Offer	$\mathbb{1}(n = 1)$	$\mathbb{1}(n = 0, q = 0)$	$\mathbb{1}(n = 0, q = 1)$	0
No offer, non UI eligible	0	$\mathbb{1}(q = 0)$	$\mathbb{1}(q = 1)$	0
No offer, UI eligible	0	$\mathbb{1}(q = 0)$	0	$\mathbb{1}(q = 1)$

(b) Given their offer status, individuals make labor supply decisions ( $n$ ) and search effort decisions ( $q$ ), which endogenously determine next period's employment status.

Table 1: Transition from current employment status to future employment status

decide whether to engage in costly search activity to increase their future job-finding probability. Non-employed individuals who do not exert search effort are considered out of the labor force ( $o$ ); if they exert search effort they are considered unemployed ( $u$ )<sup>4</sup>. If a job offer is not received, individuals are automatically non-employed.

Employed agents experience involuntary separation with probability  $s$ . Only agents who become unemployed after the arrival of a separation shock can claim benefits. If they turn down an offer or voluntarily quit a job, they do not have access to unemployment benefits. For as long as they receive benefits, they must exert search effort. Notice that all unemployed agents exert the same search effort, whether they receive benefits or not. Finally, unemployment benefits expire at a constant rate in every period. A complete description of the transition probabilities can be found in Table 1.

The exogenous finding rates, separation rates, and unemployment benefit duration all depend on the aggregate state of the economy ( $Z$ ). Specifically, during a recession, finding rates go down and separation rates go up, leading to higher involuntary unemployment. The duration of unemployment benefits is also longer.

Cyclical idiosyncratic risk is at the heart of the theory: how single and married men and women respond differently to it heavily influences the cyclical properties of labor supply. Cyclical idiosyncratic risk is also important because it leads business cycles to have substantial welfare costs.

**Human capital accumulation process** An individual's human capital  $h$  is discrete and defined on a grid  $H$ . The human capital accumulation and decumulation process is stochastic and follows a first-order Markov chain that depends on hours worked  $n$ . If an individual works positive hours, human capital is more likely to go up, especially if she works full-time. If an individual works zero hours, either because she is out of the labor force or unemployed, human capital is more likely to go down

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<sup>4</sup>This classification closely follows the criterion of the CPS whereby individuals are considered unemployed if they are actively searching for a job.

(depreciate). This process captures both random shocks to productivity and returns to experience.

### 3.2.1 The decision problem for singles

Values for individuals can be measured at two points in time: at the beginning of the period, before they receive offers to work, or in the middle of the period, after they have received the offers, when they take labor supply, consumption, and search effort decisions depending on their offer status (see timeline in figure TBD). In what follows, it is convenient to define a *middle of the period* state variable  $s \in \{ \text{Offer, No Offer UI eligible, No Offer non-UI eligible} \}$ , which determines the individual's offer status.

At any given time, a single individual is also characterized by their gender  $g$ , human capital  $h$ , assets  $a$ . After observing the aggregate state of the economy and her individual middle of the period state variables, she chooses how much to consume and how much to save in a one-period bond, whether to work zero hours, part-time, or full-time, and whether to exert search effort  $q$ .

For given pricing functions and aggregate law of motion  $\Phi' = H(Z, \Phi)$ , the recursive problem of a single of gender  $g$  is:

$$V_g(a, h, s; \mathcal{S}) = \max_{c > 0, a' \geq 0, n \in \{0,1\}, q \in \{0,1\}} \left\{ u_g(c, n, q) + \beta \sum_{h', s'} \int_{Z'} \pi(h' | h, e, n) \pi(s' | s, g, n, q, Z') \pi(Z' | Z) [V_g(a', h', s'; \mathcal{S}')] \right\} \quad (5)$$

subject to

$$c + a' = \mathcal{T}(y(g, h, s, n; \mathcal{S}); \mathcal{S}) + (1 + r(\mathcal{S}))a + T$$

where I denote by  $\mathcal{S}$  the collection of all aggregate variables. Earnings are subject to progressive taxation according to a tax schedule  $\mathcal{T}(y, \mathcal{S})$ . Earnings  $y(g, h, s, n; \mathcal{S})$  can take two forms: labor earnings or unemployment insurance.

Specifically, for given  $\tau_0$ ,  $w$ , and  $r$  the constraint for singles with an offer is as

follows:

$$c + a' = \tau_0 (h w_g (n))^{(1-\tau_1)} + (1+r)a + T \quad (6)$$

Where  $w_g$  is the wage paid to either men ( $w$ ) or women  $((1-\delta)w)$ . The constraint for singles who are unemployed and eligible to receive benefits is:

$$c + a' = q\tau_0 (bh w_g)^{(1-\tau_1)} + (1+r)a + T \quad (7)$$

Here  $b$  denotes the unemployment benefit replacement rate relative to potential income  $(1-\delta^g)hw$ . Notice that individuals receive unemployment benefits only when search effort is exerted ( $q = 1$ ). Finally, the constraint for non-employed singles who are not eligible to receive benefits is simply:

$$c + a' = (1+r)a + T \quad (8)$$

When the individual is out of the labor force or unemployed without benefits, labor earnings are zero and the only two sources of income are asset income and government transfers  $T$ . Notice that when  $n = 0$ , the constraint in (6) coincides with constraint (8). That is, an individual who decides not to work faces the same constraint as a non-employed individual who does not currently have an offer, and hence is forced not to work.

This definition allows us to define the *beginning of the period* value function as simply the expectation over the possible values in the middle of the period, where probabilities to receive an offer or not are defined in Table 1a.

### 3.2.2 The decision problem for couples

For given pricing functions and aggregate law of motion  $\Phi' = H(Z, \Phi)$ , the value function in the middle of the period for two spouses is given by:

$$\begin{aligned}
 W(a, h^f, h^m, s_f, s_m; \mathcal{S}) = & \max_{c > 0, a' \geq 0, n_f, n_m \in \{0, 1\}, q_f, q_m \in \{0, 1\}} \left\{ u(c, n_f, n_m, q_f, q_m) + \right. \\
 & + \beta \sum_{h^{f'}, h^{m'}, s^{f'}, s^{m'}} \int_{Z'} \pi(h^{f'} | h_f, n_f) \cdot \pi(h^{m'} | h_m, n_m) \cdot \pi(Z' | Z) \cdot \\
 & \left. \pi(s^{f'}, s^{m'} | s_f, s_m, n_f, n_m, q_f, q_m, Z') \cdot \left[ W(a', (h^f)', (h^m)', (s_f)', (s_m)'; \mathcal{S}') \right] \right\}
 \end{aligned} \tag{9}$$

with budget constraint

$$c + a' = \mathcal{T}(y(h_f, h_m, s_f, s_m, n_f, n_m; \mathcal{S}); \mathcal{S}) + (1 + r(\mathcal{S}))a + T$$

When both spouses have an offer, for given  $\tau_0$  and  $w$ , the couple's labor income net of taxes is given by:

$$\mathcal{T}(y) = \tau_0 \left( (1 - \delta) h^f w(n^f) + h^m w(n^m) \right)^{1 - \tau_1} \tag{10}$$

If the wife decides not to work, then  $n_f$  is zero and the only source of labor income for the couple comes from the husband's salary. Two things are worth noting: discussion of productivity wedge  $(1 - \delta)$  here. Discussion of joint taxation.

If only the wife has an offer, while the husband is eligible for unemployment insurance, net labor income is given by:

$$\mathcal{T}(y) = \tau_0 \left( (1 - \delta) h^f w(n^f) + q_m b h^m w(n^m) \right)^{1 - \tau_1} \tag{11}$$

and so on.

### 3.2.3 Firms

There is a representative firm hiring labor and producing output according to the following constant returns to scale production technology:

$$Y = Z K^\alpha L^{1-\alpha}$$

For the firm, hours worked by men and women are perfect substitutes. Therefore, in every period the aggregate wage per efficiency unit of labor is  $w = Z(1 - \alpha) \left(\frac{K}{L}\right)^\alpha$ . Differences in the effective wage of an individual are driven by the number of efficiency units they are endowed with.

### 3.2.4 Business cycle fluctuations

The main driver of business cycle fluctuations is total factor productivity  $Z$ .  $Z$  is assumed to follow an AR(1) process in logs:

$$\log(Z_t) = \rho_z \log(Z_{t-1}) + \sigma_z \epsilon_t, \quad \epsilon_t \sim \mathcal{N}(0, 1) \quad (12)$$

The exogenous finding rates and separation rates also depend on the aggregate state of the economy  $Z$ , and are therefore stochastic. Specifically, during a recession, finding rates go down and separation rates go up, leading to higher involuntary unemployment, as will be described in section 4.3.

### 3.2.5 The Government

The government provides two social insurance programs. The first is a progressive labor income tax. The tax function  $\mathcal{T}(y)$  depends on two parameters that separately govern scale and progressivity, such that if  $y$  is pre-tax income,  $\tau_0 y^{1-\tau_1}$  is after-tax income, as in Benabou (2002), Heathcote, Storesletten, and Violante (2017) and Holter, Krueger, Stepanchuk (2019). Couples' income is taxed jointly, which has been shown to be important for the decision to participate of secondary earners (References).

The second program is unemployment insurance. An individual classifies for unemployment benefits when she is unemployed and eligible for the program ( $u_b$ ) and receives benefits proportionally to what her earnings would be if she was employed full-time. If  $y$  are potential earnings of an unemployed worker, then after-tax unemployment benefit is  $b\tau_0 y^{1-\tau_1}$ . The parameter  $b$  controls the generosity of unemployment insurance. Finally, unemployment benefits expire stochastically at rate  $\lambda(Z)$ .

The income obtained from tax revenues is used to pay for exogenous government expenditure  $G$ , which does not provide utility to individuals and does not vary over the business cycle. Here discussion on don't want to focus on effects of time-varying govt expenditure.

In every period, the government adjusts the level of public expenditure  $G$  in order to keep a balanced budget:

$$\begin{aligned}
& \underbrace{\tau_0 w^{(1-\tau_1)} \int_{E_i} \left( \sum_g ((1-\delta_g) h_{i,g,s} n_{i,g})^{(1-\tau_1)} + ((1-\delta) h_{i,f} n_{i,f} + h_{i,m} n_{i,m})^{(1-\tau_1)} \right)}_{\text{Total taxes paid by employed workers}} + \quad (13) \\
& \underbrace{-(1-\tau_0) (bw)^{(1-\tau_1)} \int_{U_i} \left( \sum_g ((1-\delta_g) h_{i,g,s})^{(1-\tau_1)} + ((1-\delta) h_{i,f} + h_{i,m})^{(1-\tau_1)} \right)}_{\text{Total UI claims net of taxes}} + \\
& + \underbrace{T}_{\text{Direct transfers}} - \underbrace{G}_{\text{Government expenditure}} = 0
\end{aligned}$$

where wages, the measure of employed and unemployed workers, and hours worked all depend on the aggregate state of the economy  $\mathcal{S}$ .

### 3.3 Competitive Equilibrium

A recursive competitive equilibrium consists of  $K, L, w, r, \tau_0, \pi_c^{g,single}, \pi_c^{couple}, \pi_n^{g,single}, \pi_{n_f}^{couple}, \pi_{n_m}^{couple}, \pi_a^{g,single}, \pi_a^{couple}, V_g, W, \Phi, H$ , satisfying:

1. Given pricing functions  $r(Z, \Phi)$ ,  $w(Z, \Phi)$ , tax policy, and aggregate law of motion  $H(Z, \Phi)$ ,  $V^g(a, h, s; Z, \Phi)$  solves the optimization problem of the single household (5), and  $\pi_c^{g,single}, \pi_n^{g,single}, \pi_q^{g,single}, \pi_a^{g,single}$  are associated decision rules.
2. Given pricing functions  $r(Z, \Phi)$ ,  $w(Z, \Phi)$ , tax policy, and aggregate law of motion  $H(Z, \Phi)$ ,  $W(a, h^f, h^m, s_f, s_m; Z, \Phi)$  solves the optimization problem of the married household (9), and  $\pi_c^{couple}, \pi_{n_f}^{couple}, \pi_{n_m}^{couple}, \pi_{q_f}^{couple}, \pi_{q_m}^{couple}, \pi_a^{couple}$  are associated decision rules.
3. Labor market clears:

$$L = \sum_g \int (1 - \delta_g) h \pi_n^{g,single}(a, h, s; \Phi, Z) d\Phi + \int (1 - \delta) h_f \pi_{n_f}^{couple}(a, h^f, h^m, s_f, s_m; Z, \Phi) d\Phi + \int h_m \pi_{n_m}^{couple}(a, h^f, h^m, s_f, s_m; Z, \Phi) d\Phi \quad (14)$$

4. Asset market clears:

$$K = \sum_g \int \pi_a^{g,single}(a, h, s; \Phi, Z) d\Phi + \int \pi_a^{couple}(a, h_f, h_m, s_f, s_m; Z, \Phi) d\Phi \quad (15)$$



5. Wage and interest rate are consistent with optimal decision of firms:

$$w = Z(1 - \alpha) \left( \frac{K}{L} \right)^\alpha \quad (16)$$

$$r = Z\alpha \left( \frac{L}{K} \right)^{(1-\alpha)} \quad (17)$$

6. Balanced budget: for given level of transfers  $T$ , tax rates  $\tau_0$  and  $\tau_1$  and UI replacement rate  $b$ , government expenditure  $G$  adjusts to keep a balanced budget.

7. The aggregate law of motion  $H$  is induced by the optimal decision rules  $\pi_a^{g,single}$  and  $\pi_a^{couple} \in A$ , transition probabilities of individual productivity  $h \in H$ , transition probability of labor market status  $s \in \{ \text{Offer, No Offer UI Eligible, No Offer non UI eligible} \}$  and the distribution of gender, singles and couples.

### 3.4 Discussion

Unpacking the model

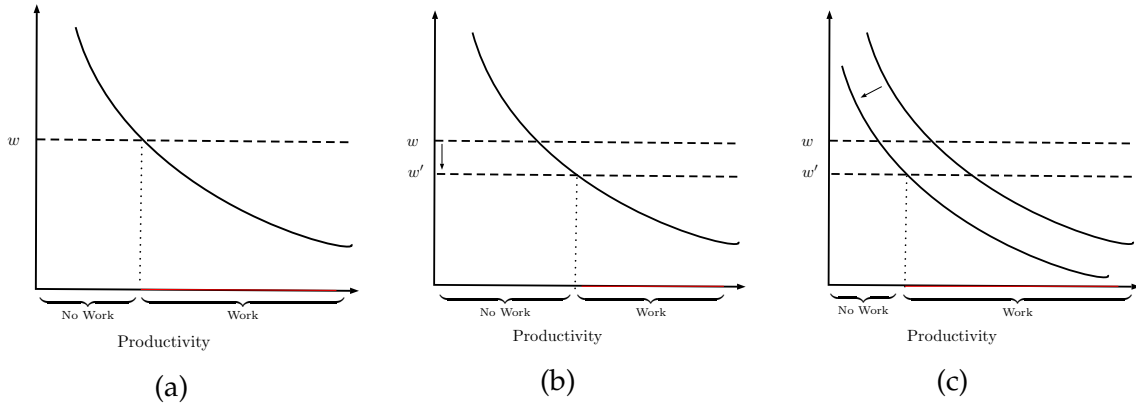


Figure 8: Intuition

## 4 Calibration

The baseline model is calibrated on data between 1975 and 1985. The set of parameters is divided into two groups. The first one is calibrated following direct empirical observations or existing literature. The second group of parameters is estimated inside the model by the method of simulated moments. The estimation aims at matching (i) labor force participation rates and unemployment rates by different groups (ii) earning losses upon displacement and (iii) the level and cyclicalities of job finding and separation rates by men and women.

### 4.1 Data

Data for the calibration comes from Current Population Survey (CPS) and Panel Study of Income Dynamics (PSID). The unit of time is assumed to be a month, in line with the CPS data on worker flows.

### 4.2 Preferences and technology

The period utility function for couples is:

$$u_{couple}(c, n_f, n_m, q_f, q_m) = \frac{c^{1-\sigma}}{1-\sigma} - \eta_f n_f - \eta_m n_m - \kappa_f q_f - \kappa_m q_m \quad (18)$$

I set  $\sigma$  to be 1 (log utility). The disutility of working for married women and men,  $\eta_f$  and  $\eta_m$ , directly influences labor force participation, and is calibrated to match the labor force participation ratios of the respective groups (55% and 97%). The disutility of search  $\kappa_f$  and  $\kappa_m$  are calibrated to match unemployment rates (4.5% and 6%). I pick the discount factor  $\beta$  to be 0.97.

The capital share is  $\alpha = 0.3$ , and the depreciation rate is chosen to be  $\delta_k = 0.0083$ , which corresponds to 2.5% quarterly. I set the persistence of aggregate TFP shocks to be 0.7 and the variance of innovations to be 0.004.

### 4.3 Search technology

**Search frictions and separations** I calibrate search frictions and separation shocks separately for men and women in the model to match average gross flows between employment states, similarly to Krusell, Mukoyama, Rogerson, Sahin (2017), Albanesi and Sahin (2017), Mankart and Oikonomou (2017). E-U rate and U-E rate close between model and data. N-E rate harder to match. E-N rate given by extreme value shocks.

**Changes in frictions over the cycle** Functional form:  $s(Z) = s^* \cdot Z^{\epsilon_s}$  (constant elasticity  $\epsilon_s$ ). This can equivalently be written in percentage deviations from steady states:  $\log(s(Z)/s^*) = \epsilon_s \cdot \log(Z/Z_{ss})$ , with  $Z_{ss} = 1$ . The level  $s^*$  is chosen to match average E-U rates for men and women separately. The elasticity is chosen to match the standard deviation of E-U rates over the business cycle. The same procedure is used for finding rates out of unemployment, which are chosen to match U-E rates. Finally, finding rates out of the labor force could also potentially vary over the business cycle. As Mankart and Oikonomou (2017), I assume that they vary at the same rate as finding rates out of unemployment. This is because the model must be free to get movements in and out of the labor force endogenously.

### 4.4 Human capital accumulation process

Human capital is stochastic, but its underlying process depends on whether the individual is working or not, making it therefore partly endogenous. The process for human capital accumulation and depreciation is described in Table 2. Human capital is defined on a grid, and in a given month individuals can stay at their current human capital level, or move one point to the left or to the right. If an individual works positive hours, human capital is more likely to go up ( $p_{up}^w > p_{up}^{nw}$ ). If an individual works zero hours, either because she is out of the labor force or unemployed, human capital is more likely to go down ( $p_{down}^w < p_{down}^{nw}$ ). This process

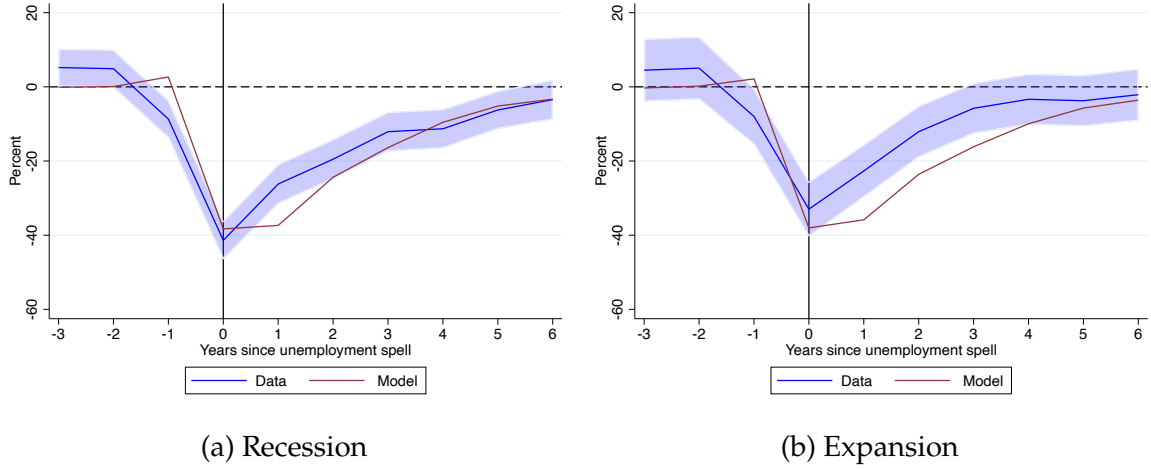


Figure 9: This figure plots the fall in labor earnings after unemployment spell for married men in PSID and in model simulated data. I estimate the fall in earnings using a dynamic diff-in-diff on PSID data and on model simulated data. The blue line shows the point estimates on impact in PSID, and the shaded area is the 95% confidence interval. The red lines correspond to the model generated estimates.

captures both random shocks to productivity and returns to experience.

I choose five points for human capital grid for each individual, so households have a total of twenty-five possible combinations. Points are spaced so that the difference between each point is a constant 1.4 log points. The probabilities are partly endogenous and partly exogenously chosen to match (i) expected earning losses during unemployment, (ii) expected wage growth when employed, and (iii) the labor earnings distribution across employed individuals. I set  $p_{up}^w$  to match a 1.1 percent average quarterly return to labor market experience (ADOT 2020) and  $p_{down}^{nw}$  to match wage losses upon unemployment (around 2.5% quarterly).

Figure 9 compares married men's earnings losses upon job displacement in recessions and in expansions between the data and the model. Since the empirical analysis is conducted at an annual frequency, I aggregate the model simulated data at a yearly period, and run the same regression in section 2.2 in PSID data and in the model simulated data. The model is able to match the large loss in labor earnings, although it overestimates persistence in both recessions and expansions. This is likely because the returns to experience are taken from the data on all workers rather

	$h_1$	$h_2$	$h_3$	$h_4$	$h_5$
$h_1$	$(1 - p_{up}^w)$	$p_{up}^w$	0	0	0
$h_2$	$p_{down}^w$	$p_{stay}^w$	$p_{up}^w$	0	0
$h_3$	0	$p_{down}^w$	$p_{stay}^w$	$p_{up}^w$	0
$h_4$	0	0	$p_{down}^w$	$p_{stay}^w$	$p_{up}^w$
$h_5$	0	0	0	$p_{down}^w$	$(1 - p_{down}^w)$

(a) Transition probabilities when  $n = 1$ , with  $p_{stay}^w = (1 - p_{down}^w - p_{up}^w)$ .

	$h_1$	$h_2$	$h_3$	$h_4$	$h_5$
$h_1$	$(1 - p_{up}^{nw})$	$p_{up}^{nw}$	0	0	0
$h_2$	$p_{down}^{nw}$	$p_{stay}^{nw}$	$p_{up}^{nw}$	0	0
$h_3$	0	$p_{down}^{nw}$	$p_{stay}^{nw}$	$p_{up}^{nw}$	0
$h_4$	0	0	$p_{down}^{nw}$	$p_{stay}^{nw}$	$p_{up}^{nw}$
$h_5$	0	0	0	$p_{down}^{nw}$	$(1 - p_{down}^{nw})$

(b) Transition probabilities when  $n = 0$ , with  $p_{stay}^{nw} = (1 - p_{down}^{nw} - p_{up}^{nw})$ .

Table 2: Human capital accumulation and depreciation process. If an individual works positive hours, human capital is more likely to go up ( $p_{up}^w > p_{up}^{nw}$ ). If an individual works zero hours, either because she is out of the labor force or unemployed, human capital is more likely to go down ( $p_{down}^w < p_{down}^{nw}$ ). This process captures both random shocks to productivity and returns to experience.

than on recently unemployed workers, who might climb the job ladder faster. Notice that the only difference between recessions and expansions are changes in job market frictions. Expansions therefore have a lower scarring effect because unemployed workers can find a job faster.

## 4.5 Taxes and social insurance programs

As discussed in the model section, the tax function depends on two parameters that separately govern scale and progressivity: If  $y$  is pre-tax income,  $\tau_0 y^{1-\tau_1}$  is after-tax income. The government also gives a lump sum transfer to all citizens. Daruich and Fernandez (2020) and Boar and Midrigan (2020) also allow for progressive taxation and a lump-sum transfer to better match the extent of redistribution in

Parameter	Description	Value	Source/Target
Preferences and Demographics			
$\beta$	Discount factor	0.97	Standard
$\sigma$	EIS	1	
$\mu_f, \mu_m$	Proportion single women and men	15%, 15%	U.S. data
Human capital			
$\Delta h$	Distance between grid points	1.4 log points	Wage growth Wage losses
$p_{up}^w$	Prob. h goes up when working	0.02	
$p_{down}^{nw}$	Prob. h goes down when not working	0.06	
Productivity wedge			
$\delta$	Wedge women’s productivity	0.4	U.S. data
Technology			
$\alpha$	Share of capital	0.3	U.S. data
$\delta$	Depreciation rate	0.0083	
$\rho_z$	TFP autocorrelation	0.7	
$\sigma_z$	TFP shock variance	0.004	
Government Policy			
$\tau_0$	Level income tax	0.8	HSV (2019)
$\tau_1$	Progressivity of income tax	0.18	HSV (2019)
$b$	UI replacement rate	0.5	KMP (2016)
$T$	Unconditional transfers	0.02	DF (2022)
$\lambda$	Benefits expiration rate	1/6	U.S. Data

Table 3: Externally calibrated parameters

Parameter	Description	Target
<b>Preferences</b>		
$\eta_{f,c}$	Disutility of working for married women	Participation rates
$\eta_{f,s}$	Disutility of working for single women	
$\eta_{m,c}$	Disutility of working for married men	
$\eta_{m,s}$	Disutility of working for single men	
$\kappa_{f,c}$	Disutility of search for married women	Unemployment rates
$\kappa_{f,s}$	Disutility of search for single women	
$\kappa_{m,c}$	Disutility of search for married men	
$\kappa_{m,s}$	Disutility of search for single men	
$\sigma_\epsilon$	Variance of EV shocks	N-E rate
<b>Human capital</b>		
$p_{down}^w$	Prob. h goes down when working	
$p_{up}^{nw}$	Prob. h goes up when not working	
<b>Search frictions</b>		
$s_m$	Separation rate women	E-U rates
$s_f$	Separation rate men	
$f_f$	Finding rate unemployed women	U-E rates
$f_m$	Finding rate unemployed men	
$f_f^*$	Finding rate out of labor force women	N-E rates
$f_m^*$	Finding rate out of labor force men	
$\epsilon^m(s)$	Elasticity separation to TFP men	s.d.(E-U rates)
$\epsilon^f(s)$	Elasticity separation to TFP women	
$\epsilon^m(f)$	Elasticity finding rate unemployed men	s.d.(U-E rates)
$\epsilon^f(f)$	Elasticity finding rate unemployed women	
$\epsilon^m(f^*)$	Elasticity finding rate olf women	See text
$\epsilon^f(f^*)$	Elasticity finding rate olf men	

Table 4: Internally calibrated parameters

	Data	Model
Employment rates		
Married Women	0.51	0.51
Married Men	0.9	0.9
Single Women	0.7	0.7
Single Men	0.78	0.78
Fraction of Couples		
Both members working	0.51	0.0527
Only female working	0.04	0.037
Only male working	0.41	0.4
Neither working	0.04	0.036

Table 5: Labor Market Steady State. Data comes from CPS, averages 1970-1985.

the United States. Daruich and Fernandez estimate the level of lump-sum transfer that is consistent with the difference between after-tax-and-transfers annual income and pre-tax annual income for low-income households to be around \$1600 per year in 2000 dollars. I follow them and set  $\tau_0 = 0.8$  and  $\tau_1 = 0.18$  as in Heathcote, Storesletten, Violante (2017), and  $T = 0.02$ . Finally, I set unemployment benefits replacement rate  $b = 0.5$  (see, e.g. Krueger, Mitman, Perri (2016)) and their expiration rate  $\lambda = 1/6$  per month so that the average duration of benefits is equal to six months.

## 5 Quantitative Results

### 5.1 Steady-state in the Baseline Economy

In this section I characterize the steady-state of the baseline economy. Table 5 reports statistics on the labor supply by different groups in the data and in the model. The data come from CPS and are averages of the period 1970 to 1985. Notice that the disutility of leisure and search are chosen to match labor force participation rates and unemployment rates, and hence employment rates as a residual. On the other hand, the division of labor for couples is not explicitly targeted. In the data, most of



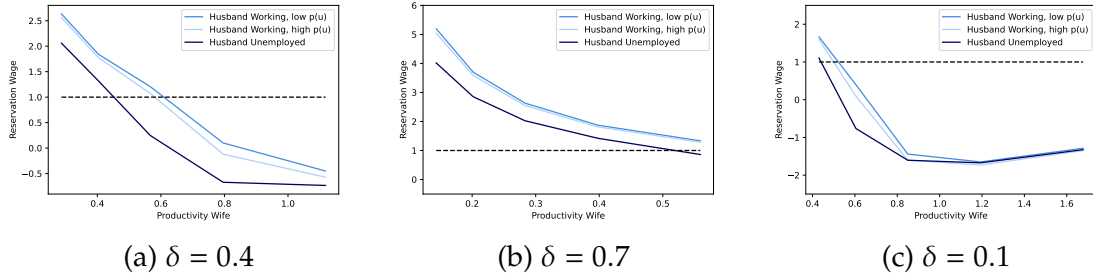


Figure 10: Reservation wages in different economies for a mean level of assets. The dark blue and purple lines correspond to the baseline economy, when the husband is employed and when the husband is unemployed respectively. The light blue line is obtained by shocking the same baseline economy with a higher and persistent probability that married men separate from their jobs.

the couples are either dual earner couples or couples in which only the husband is working. There are 4% of all couples in which only the wife is working, and in 4% of all couples neither partner is working. The model presents similar patterns.

## 5.2 Labor Supply Elasticities

The reservation wage broadly refers to the wage that makes an individual indifferent between working and not working. Since the model is dynamic, there is a meaningful distinction between a temporary and permanent change in wages. Similarly to Preston and Mui (2021), I define the reservation wage as the one-period wage that would make an individual indifferent between working and not working. For any individual at a given point in time, I calculate the change in the current wage required to make them indifferent and assume that the wage returns to its steady-state level forever after one period.

Assuming that ties are broken in favor of working, for each individual the extensive-margin labor supply can be formulated as a standard reservation wage rule:

$$n = \mathbb{1}(w \geq \bar{w})$$

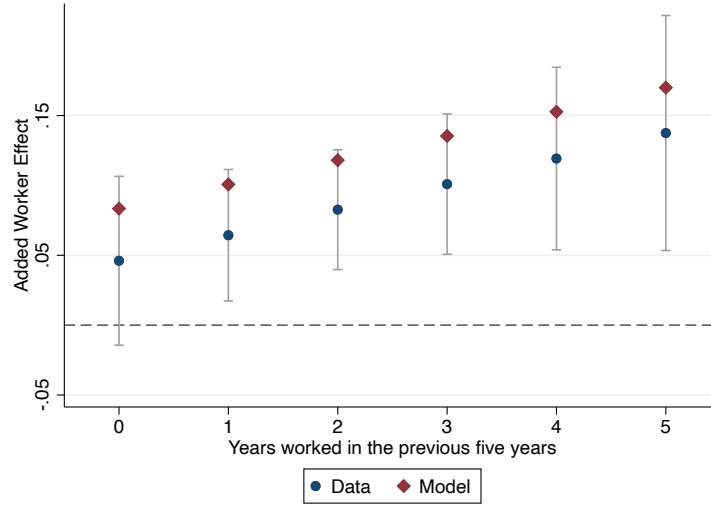


Figure 11: This figure plots the change in the probability of going from out of the labor force to employed when husband becomes unemployed depending on previous labor market experience, both in the model and in the data. I estimate the probability using a dynamic diff-in-diff on PSID data and on model simulated data. The unemployment dummy is interacted with a variable that encodes how often the wife worked in the previous five years. The blue circles show the point estimates on impact, and the whiskers are the 95% confidence interval. The red diamonds correspond to the model generated estimates.

### 5.3 Model Validation

The added worker effect is not targeted by the calibration, which only uses information on average aggregate individual gross flows. In this section, I test the model's ability to replicate the probability that a married woman becomes employed upon her husband becoming unemployed. Since the empirical analysis is conducted at an annual frequency, I aggregate the model simulated data at a yearly period and run the same regression in section 2.2 in PSID data and in the model simulated data.

In Figure 11, I plot the coefficients generated from the PSID sample (blue circles) and those obtained using model-generated data (red diamonds). The model is able to match the empirical evidence on the level and gradient of the added worker effect by previous experience quite well. Although it somewhat overestimates the magnitude compared to the point estimates, especially for low experience levels, it

always falls within the 95% confidence bands.

Two channels allow the model to match the positive gradient with respect to experience found in the data. The first is human capital accumulation: Women who have worked very little in their past mostly sit at the bottom of the human capital grid. Lower human capital and hence effective wage means their incentive to act as an active secondary earner is dampened. The second is that asset-rich households tend at the same time to have low wife's participation and to rely more on their assets to insure against unemployment risk.

It is important to notice that in the model differences in previous participation act exclusively through incentives and not through frictions. In the model, once a woman has decided to join the labor force, she has the same probability of finding a job as anyone else searching. In practice, women who have been out of the labor force for a longer time might face higher frictions, for example, due to lower connections or knowledge of the labor market. This might lower the probability of finding a job on impact.

## 6 Changes in Women's Employment and Business Cycles

How do changes in the level of female employment affect the business cycle? In order to answer this question, I conduct a comparative statics exercise using the calibrated model. Specifically, I will compare the business cycle (stochastic steady state<sup>5</sup>) in different economies, where all parameters remain the same but women's productivity wedge  $\delta$  is lowered, thereby exogenously raising female productivity. As a results, the ratio of the effective wage that women face and the effective wage for men ( $w_f/w_m$ ) raises over time. This exercise exclusively teases out the effect of the wage gap as a driver of female employment.

Fukui, Nakamura, Steinsson (2021), and Olsson (2020) share the focus on women's

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<sup>5</sup>for details on how the stochastic steady state is computed, see Appendix D.

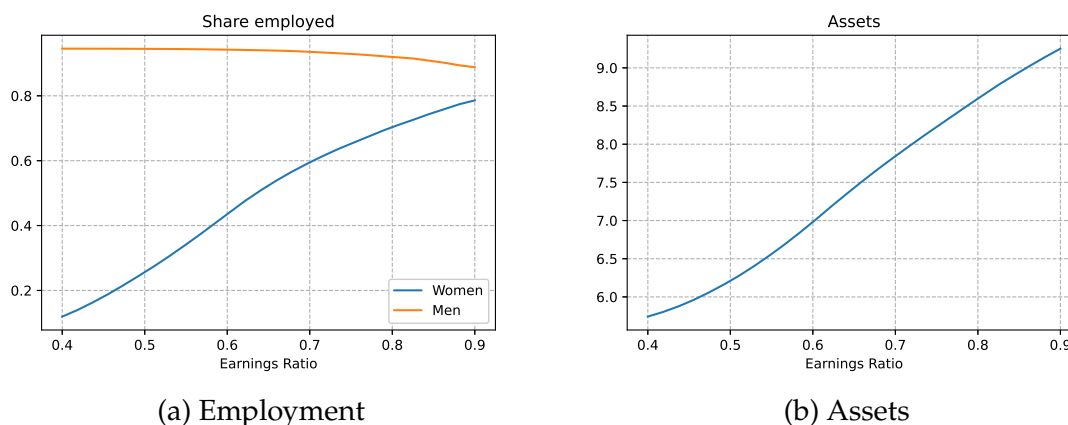


Figure 12: Share employed married men, employed married women, and assets as the earnings ratio goes up. Each point refers to a steady state in which the earning ratio stays at that specific level.

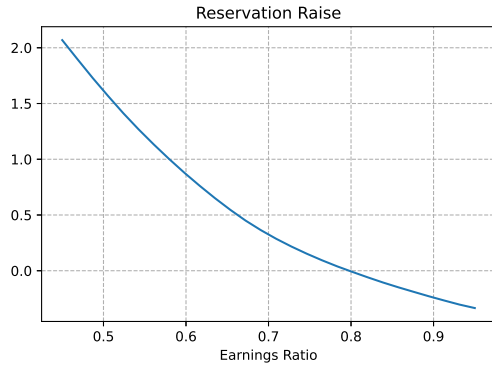
productivity as a structural driver of higher female employment. The increase in female productivity can have different interpretations: For example, an increase in women's educational attainment, an increase in female-biased technical change such as the rise of the service sector (see Ngai and Petrongolo (2017)), or a decrease in discrimination and misallocation of talent (Hsie Klenow ).

First, I will evaluate whether a change in women's productivity can generate an increase in female employment. As shown in Figure 12, a higher earning ratio leads to a large increase in female employment and a slight decrease in male employment. These results are similar to Olsson (2020), who shows that decreasing the wage gap leads to an increase in married women's participation, a slight decrease in married men's participation, and only minor changes in the labor supply of singles. This is because, with balanced growth type preferences, income and substitution effects roughly cancel for single women, and the labor supply is approximately the same. In my model, the presence of human capital accumulation makes the wage gap a more significant driver of participation than it would be otherwise: Small differences in the wage gap are amplified by the presence of learning on the job.

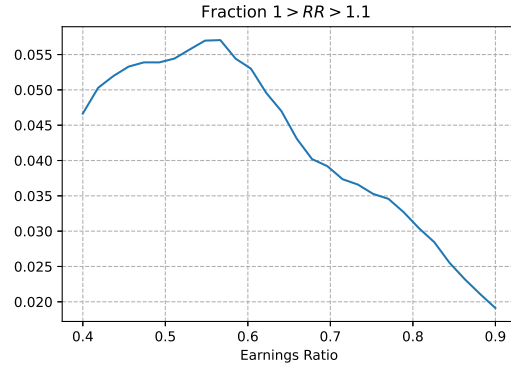
This exercise is equivalent to asking: what would the business cycle look like in a

world where the only difference is that women are more productive? Naturally, one drawback of this approach is that it does not allow me to study what the business cycle would look like *along* a transition in the wage gap. This has been the focus of other mentioned recent papers that find that a faster increase in women's labor force participation results in shorter recoveries from recessions. I abstract from this point which has been extensively studied to focus on the relationship between the mass of marginal workers and the amplification of business cycle shocks.

Figures 13, 14 and 15 show the comparative statics with respect to the earnings ratio ( $w_f/w_m$ ). Women's participation is counter-cyclical (panel a), and the largest movements in participation occur when the earnings ratio is between 0.6 and 0.7 (panel b). As a consequence, the volatility of total effective hours per capita decreases as more women start participating, until it arrives to its minimum at around 0.68 (panel c). For reference, this is the value that the gender gap reached in the 1990s. After that, the effect on the volatility of hours per capita keeps waning. On the other hand, the volatility of consumption does not go back to the previous levels (panel d). This indicates that the economy is now relying on other forms of insurance: wealth accumulation, and income pooling. Figure 15 shows an important distinction: the U-shaped effect exists when looking at the standard deviation of total hours per capita. However, as women become a larger part of the labor force, a mechanic effect is also at play. Since women's hours are less volatile (partly by construction, because the probability of getting fired in downturns is lower, and partly endogenously), the standard deviation of *percentage deviations* from the steady state keeps decreasing.

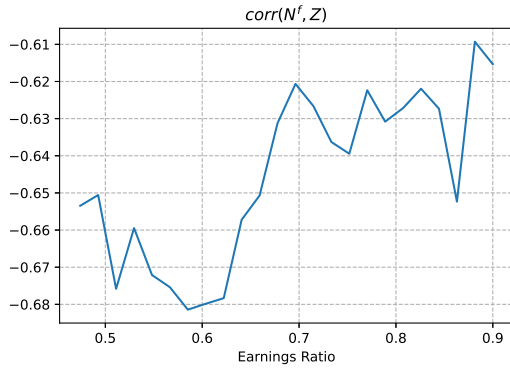


(a) Average reservation wage

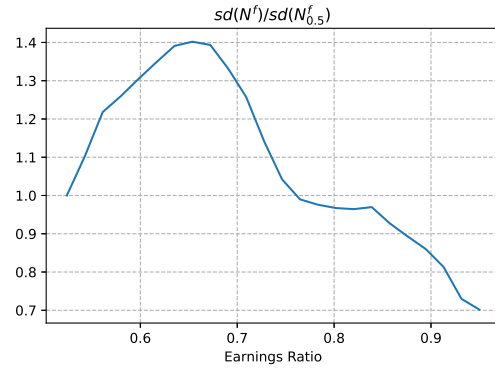


(b) Proportion marginal wage

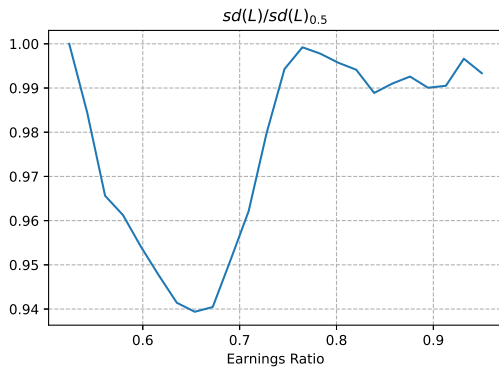
Figure 13: Reservation wage in the economy as the earnings ratio ( $w_f/w_m$ ) grows. The current wage in the economy is always normalized to 1.



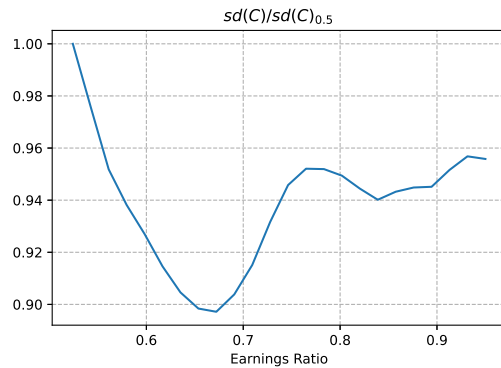
(a) Correlation Participation Women and TFP



(b) Standard Deviation Participation Women

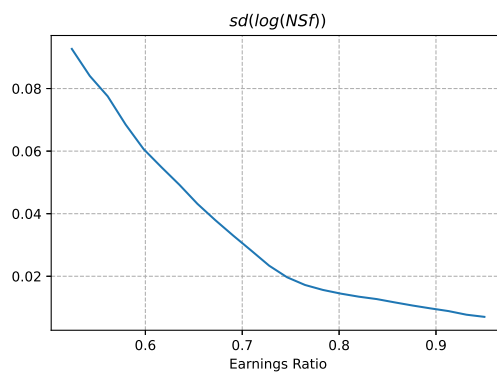
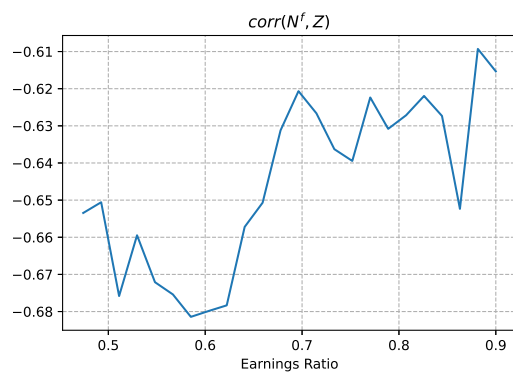


(c) Standard Deviation Total Hours

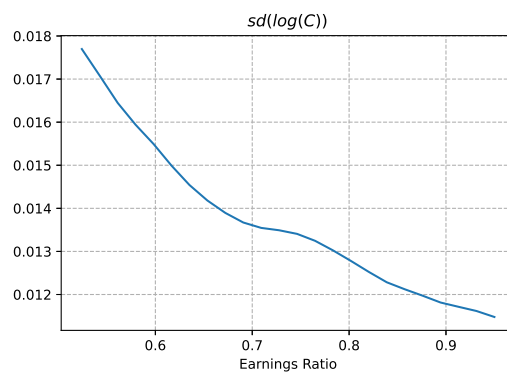
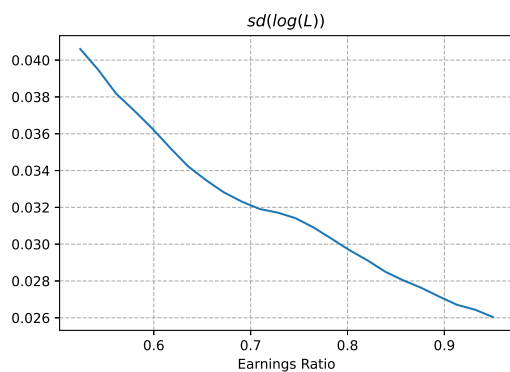


(d) Standard Deviation Consumption

Figure 14: Business cycle volatility in different steady states



(a) Correlation Participation Women and TFP (b) SD Log Deviations Participation Women



(c) SD Log Deviations Total Hours (d) SD Log Deviations Consumption

Figure 15: Business cycle volatility in different steady states, compositional effect

## 7 Conclusion

In this paper, I show that the extent to which secondary earners participate in the labor markets significantly impacts how households' labor supply and aggregate employment respond to the business cycle. If unemployment risk in downturns is high enough relative to movements in the wage rate, a large mass of flexible secondary earners available to enter the labor market will have the effect of dampening fluctuations in aggregate employment.

The model predicts that (i) the family insurance motive is larger than the substitution effect from lower wages in downturns, and (ii) hours and consumption volatility respond non-monotonically to changes in the wage gap. As the wage gap grows smaller, women have a higher earnings capacity, both because they face higher wages and because they accumulate more work experience before quitting the labor force. Consequently, they find it easier to enter during recessions, acting as a dampening force on the severity of recessions. I show quantitatively that a reduction in the wage gap from 50% to 30% has translated into a 6% decrease volatility of hours per capita and a 10% decrease in consumption volatility. For levels of the wage gap lower than 20%, women's participation and labor supply elasticity look more similar to men's. Most women are left with little room to increase their labor supply, and the dampening effect on employment disappears. Most households rely on self-insuring through assets.



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# Appendices

## A Additional Empirical Results

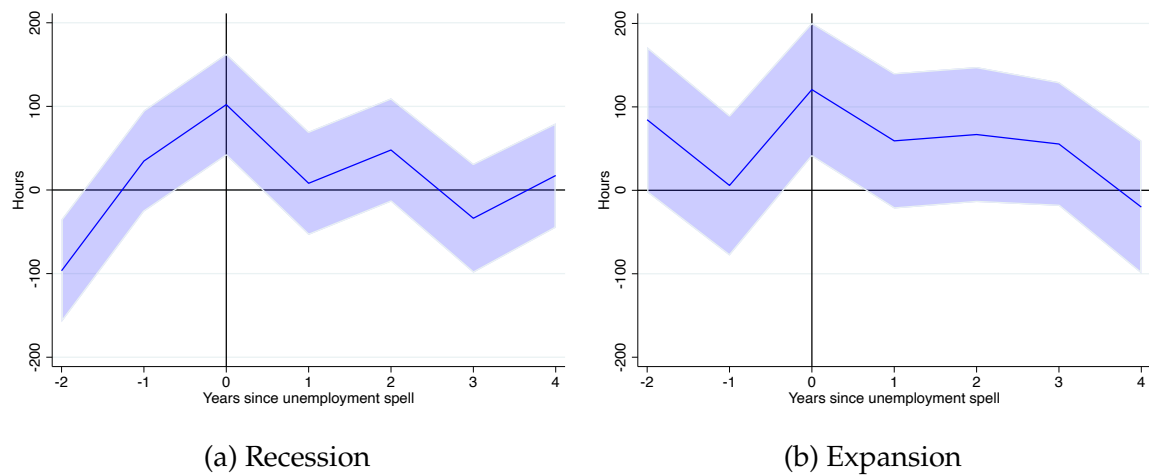


Figure 16: Added worker effect: Hours. Source: PSID.

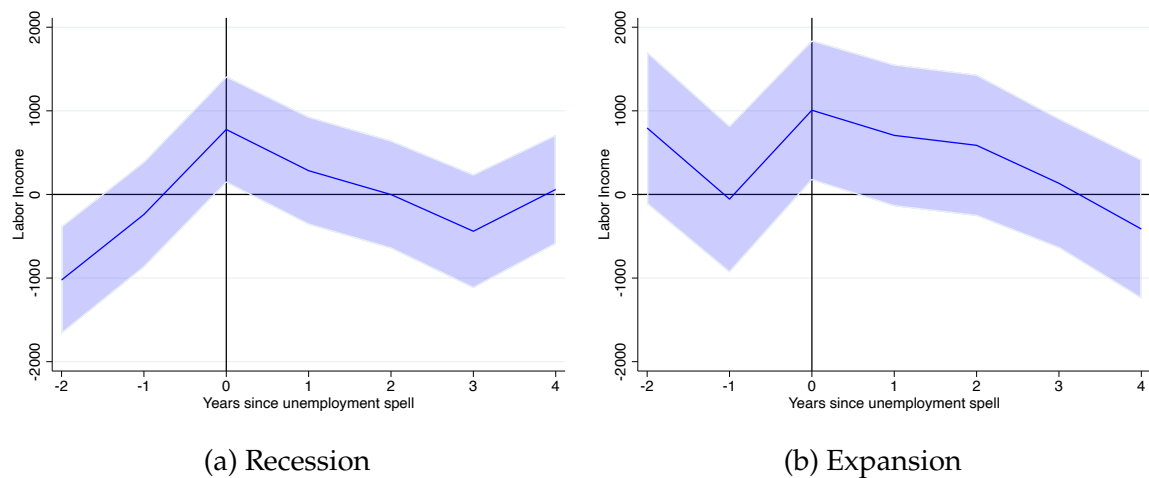


Figure 17: Added worker effect: Income. Source: PSID.

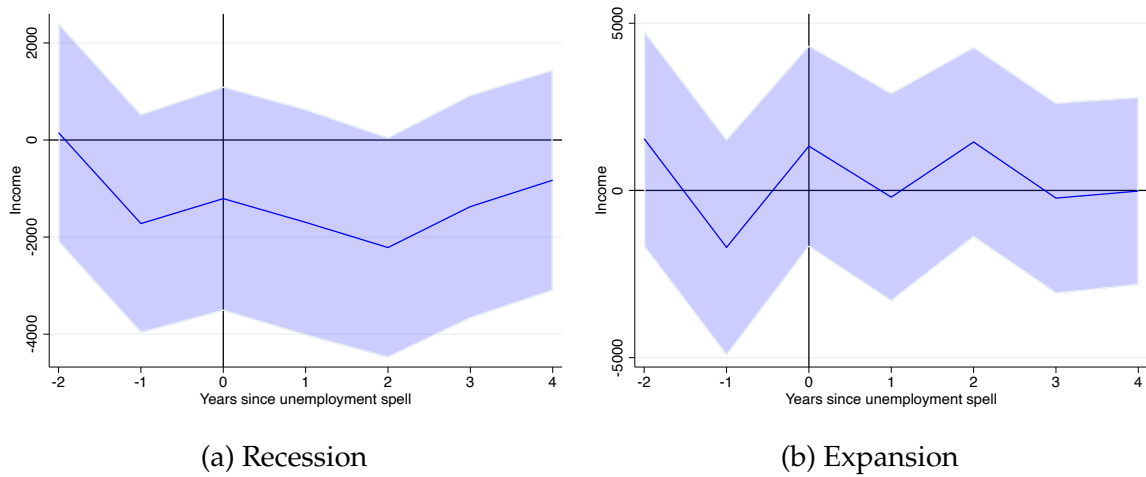


Figure 18: No changes in income for women already working. Source: PSID.

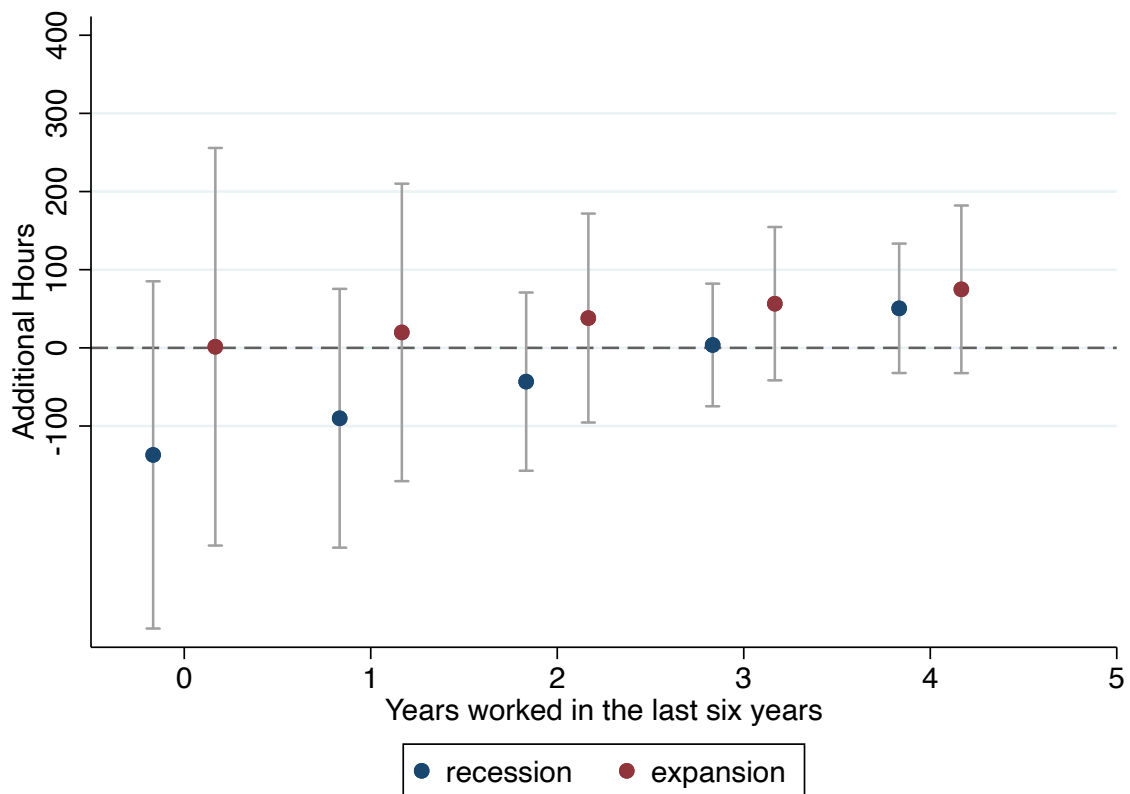
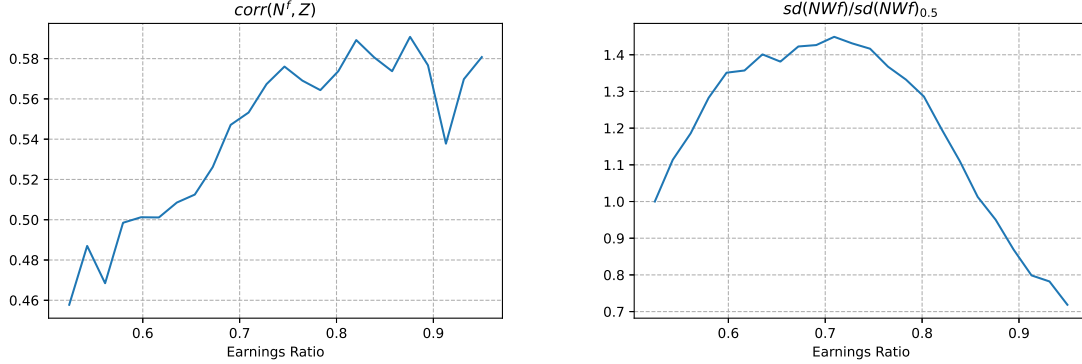
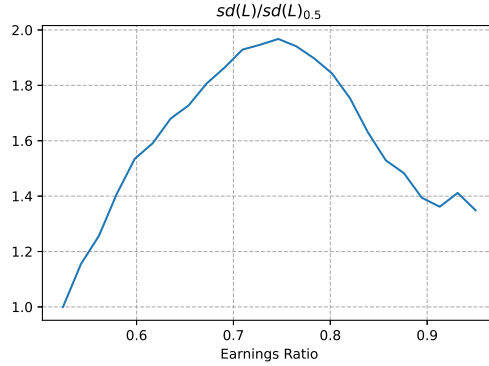


Figure 19: No changes in hours for women already working, conditioning on work experience.

## B Business Cycle, No Movement in Unemployment Risk



(a) Correlation Participation Women and TFP (b) Standard Deviation Participation Women



(c) Standard Deviation Total Hours

Figure 20: Business cycle volatility in different steady states, NO movements in unemployment risk, only wage

## C A Simple Static Model

**Environment** The economy is populated with a measure one of married/cohabiting couples and a measure one of singles. The utility function for a single of gender  $g$  is given by:

$$U_g(c, l) = \log(c) - \eta_g l$$

where  $c$  is consumption,  $l \in \{0, 1\}$  is labor supply, and  $\eta_g \geq 0$  is the relative weight of leisure in utility. The utility function for a couple is:

$$U(c, l_m, l_f) = \log(c) - \eta_m l_m - \eta_f l_f$$

where  $c$  is consumption<sup>6</sup>,  $l_m, l_f \in \{0, 1\}$  is labor supply of husband and wife respectively, and  $\eta_m, \eta_f \geq 0$  are the relative weights of leisure in utility.

Assume that with probability  $u_m$ , a given men in the economy suffers an unemployment shock and is unable to work ( $l_m = 0$ ), and with probability  $u_f$  women suffer an unemployment shock ( $l_f = 0$ ). The realization of the shock is independent across spouses.

Single individuals solve the problem:

$$\max \sum_s \pi(s) [\log(c(s)) - \eta_g l(s)]$$

subject to the budget constraint:

$$c(s) + \psi l(s) = w_g l(s) + y$$

where  $\psi > 0$  represents the fixed cost of running a household when working and  $y$  is unearned income. The assumption is that a person who does not work can replace the cost  $\psi$  through costless home production.

For a married couple, individuals jointly solve the problem:

$$\max \sum_s \pi(s) [\log(c(s)) - \eta_f l_f(s) - \eta_m l_m(s)]$$

subject to the budget constraint:

$$c(s) + \psi \min(l_f(s), l_m(s)) = w_f l_f(s) + w_m l_m(s) + y$$

---

<sup>6</sup>Here I assume that all consumption in the family is a public good. In reality there are some private and some public elements in household consumption; see Salcedo, Schoellmann, and Tertilt (2012) for a detailed analysis.

here  $\psi > 0$  represents the fixed cost of running a household when both partners are working and  $y$  is unearned income. Male and female wages, denoted by  $w_m$  and  $w_f$ , as well as unearned income can potentially vary in the population, reflecting potential difference in human capital, wealth and transfers.

**Reservation wages and aggregate hours** Assume for simplicity that parameters are such that single and married men are always working conditional on being employable. Let's define the *reservation wage*  $\bar{w}$  as the wage that makes a women indifferent between working and not working.

Assuming that ties are broken in favor of working, for each woman who is not unemployed the extensive-margin labor supply can be formulated as a standard reservation wage rule:

$$n_f = \mathbb{1}(w_f \geq \bar{w})$$

For single women,  $\bar{w}^S$  is simply given by:

$$\log(\bar{w}^S + y - \psi) - \eta_f = \log(y)$$

Simplifying:

$$\bar{w}^S = \tilde{\eta}_f y + \psi$$

where I defined  $\tilde{\eta}_f \equiv \exp(\eta_f) - 1$ . Notice that if  $\eta_f = 0$ , then the reservation wage  $\bar{w}^S$  is simply equal to the participation cost  $\psi$ . When  $\eta_f > 0$ , it increases linearly with unearned income  $y$ .

Married women have two different reservation wages: one when the husband is employed, and one when he is unemployed. When the husband is employed,  $\bar{w}^{M,E}$  is implicitly given by:

$$\log(\bar{w}^{M,E} + w_m + y - \psi) - \eta_f = \log(w_m + y)$$



Simplifying:

$$\bar{w}^{M,E} = \tilde{\eta}_f (w_m + y) + \psi$$

Again, notice that if  $\eta_f = 0$ , then the reservation wage  $\bar{w}_e$  is simply equal to the participation cost  $\psi$ . When  $\eta_f > 0$ , it increases linearly with total disposable income, given by the sum of male wages  $w_m$  and unearned income  $y$ .

When the husband is unemployed,  $\bar{w}^{M,U}$  is given by:

$$\log(\bar{w}^{M,U} + y) - \eta_f = \log(y)$$

or

$$\bar{w}^{M,U} = \tilde{\eta}_f y$$

It is easy to see that the reservation wage when the husband is employed is always higher than the reservation wage when the husband is unemployed. That is because overall disposable income is lower and the cost  $\psi$  does not have to be paid. Intuitively, there is a fraction of women who do not work if their husband is working, but choose to enter the labor force if the husband is unemployed.

Women are therefore more likely to work when female wage  $w_f$  is high, and when the utility cost  $\eta_f$ , the monetary cost  $\psi$ , the male wage  $w_m$ , or unearned income  $y$  are low, and when husband's unemployment risk is high. Aggregate hours worked by single women equals the fraction of single women who are not unemployed and have a higher wage than the reservation wage:

$$N_f^S = \int_i n_{f,i}^S di = (1 - u_f) \int_i \mathbb{1}(w_{f,i} \geq \bar{w}_i^S) di$$

Aggregate hours worked by married women equals the fraction of women who are not unemployed and have a higher wage than the reservation wage, considering the two husband's employment cases:

$$N_f = \int_i n_{f,i} di = (1 - u_f) \left( (1 - u_m) \int_i \mathbb{1}(w_{f,i} \geq \bar{w}_i^{M,E}) di + u_m \int_i \mathbb{1}(w_{f,i} \geq \bar{w}_i^{M,U}) di \right)$$

**Elasticities** Consider one possible case where the only dimension of heterogeneity in the population is unearned income  $y$ , the distribution of which is described by a distribution function  $F(y)$  with continuous marginal density  $f(y) = F'(y)$ . I assume that the density satisfies the assumptions  $F(0) = 0$ ,  $F'(y) > 0$ ,  $\lim_{y \rightarrow 0} f(y) = 0$ , and  $\lim_{y \rightarrow \infty} f(y) = 0$ . That is, all individuals have at least some positive unearned income and the distribution thins out at each tail (one example is a log-normal distribution for  $y$ ). This corresponds to the case where wages are homogenous for everyone and there is wealth inequality.

Aggregate hours worked by single women are then given by:

$$N_f^S = (1 - u_f) F\left(\frac{w_f - \psi}{\tilde{\eta}_f}\right)$$

while aggregate hours worked by married women are given by:

$$N_f^M = (1 - u_f) \left( (1 - u_m) F\left(\frac{w_f - \tilde{\eta}_f w_m - \psi}{\tilde{\eta}_f}\right) + u_m F\left(\frac{w_f}{\tilde{\eta}_f}\right) \right)$$

Let's compare elasticities with respect to own wage, cross wage and unemployment.

The elasticity of labor supply with respect to own wage for single women is:

$$\frac{\partial N_f^S}{\partial w_f} \frac{w_f}{N_f^S} = \frac{w_f}{\tilde{\eta}_f} \frac{F'\left(\frac{w_f - \psi}{\tilde{\eta}_f}\right)}{F\left(\frac{w_f - \psi}{\tilde{\eta}_f}\right)}$$

which is unambiguously positive. The elasticity of single women labor supply with respect to male wages and unemployment is simply zero.

The elasticity of married women labor supply with respect to own wage is:

$$\frac{\partial N_f^M}{\partial w_f} \frac{w_f}{N_f^M} = \frac{w_f}{\tilde{\eta}_f} \frac{(1 - u_m) F'\left(\frac{w_f - \tilde{\eta}_f w_m - \psi}{\tilde{\eta}_f}\right) + u_m F'\left(\frac{w_f}{\tilde{\eta}_f}\right)}{(1 - u_m) F\left(\frac{w_f - \tilde{\eta}_f w_m - \psi}{\tilde{\eta}_f}\right) + u_m F\left(\frac{w_f}{\tilde{\eta}_f}\right)}$$

which is also unambiguously positive.

**Proposition:** for low enough levels of male unemployment, provided that at least some married women are working, married women's own wage elasticity is always higher than single women's own wage elasticity.

This results may seem to suggest that a higher proportion of married households should make aggregate labor supply more variable. However, let's consider the possibility of insurance within the family, and hence the elasticities with respect to husband's wage and unemployment risk.

The elasticity of labor supply with respect to husband's wage is:

$$\frac{\partial N_f}{\partial w_m} \frac{w_m}{N_f} = -w_m \frac{(1 - u_m)F' \left( \frac{w_f - \tilde{\eta}_f w_m - \psi}{\tilde{\eta}_f} \right) + u_m F' \left( \frac{w_f}{\tilde{\eta}_f} \right)}{(1 - u_m)F \left( \frac{w_f - \tilde{\eta}_f w_m - \psi}{\tilde{\eta}_f} \right) + u_m F \left( \frac{w_f}{\tilde{\eta}_f} \right)}$$

which is unambiguously negative. Finally, the elasticity of labor supply with respect to husband's unemployment is:

$$\frac{\partial N_f}{\partial u_m} \frac{u_m}{N_f} = u_m \frac{F \left( \frac{w_f}{\tilde{\eta}_f} \right) - F \left( \frac{w_f - \tilde{\eta}_f w_m - \psi}{\tilde{\eta}_f} \right)}{(1 - u_m)F \left( \frac{w_f - \tilde{\eta}_f w_m - \psi}{\tilde{\eta}_f} \right) + u_m F \left( \frac{w_f}{\tilde{\eta}_f} \right)}$$

which is positive since  $F \left( \frac{w_f}{\tilde{\eta}_f} \right) > F \left( \frac{w_f - \tilde{\eta}_f w_m - \psi}{\tilde{\eta}_f} \right)$ .

Effects of a recession, depending on average distance from the participation frontier

**Recessions** Define a recession as:

- a decrease in  $w_f$
- a decrease in  $w_m$
- an increase in unemployment probability  $u$

For single women, the effect on hours worked is unambiguously negative. For married women, it depends on the relative strength of the three channels.

Note that since this is a static model,  $\bar{w}$  today depends only on the realization of unemployment and not on increase in uncertainty tomorrow.

**Effects of distance from the participation frontier** First, let's define a notion of *distance from the participation frontier*  $x$  as the increase of reduction in the wage needed to make a woman indifferent between participating or not:

$$(1 + x)w_f = \bar{w}_f$$

What happens to aggregate labor supply in a recession as a function of  $x$ ?

Main point: if married women act as a dampening force, that is more true if there are more marginal women.

## D Hours Volatility and Responses to Aggregate Shocks

Summarize previous work I had on hours volatility

- Women's Hours Are Less Volatile Over the Cycle
- Labor market flows over time: summarize flows for different time periods.
- Why do Women have Lower Cyclical Volatility?
- How Much Due to Job vs Status?

Doepke and Tertilt (2016), Olsson (2020), among others, document that women's hours are less volatile than men's at a business cycle frequency. I provide a summary here.

Sector accounting exercise: How much of this lower volatility can be explained by the fact that women work disproportionately in less volatile occupations and sectors,

such as the service sector? Answer: about two thirds. But not all like Olsson hand would argue.

Extend the analysis in Ellieroth (2019) to include all years in the CPS. Since there are big changes in trends, especially for E-N flows, I detrend the data (using Hamilton filter). The main findings from Ellieroth are confirmed. Description. Table.

## E Computational Details

The individual problem of the household is solved through the endogenous grid method. Since the model features discrete choices, the value function may not be globally concave, and the first order conditions are necessary but not sufficient. The consumption choices implied by the endogenous grid method must therefore be adjusted to get rid of suboptimal points. For a review of endogenous grid method with continuous and discrete choices, see Iskhakov, Jorgensen, Rust and Schjerning (2017) and Druedahl (2020). I follow the upper envelope algorithm proposed by Druedahl (2020) to solve efficiently for the policy functions.

For calculating stochastic steady states, I use the method proposed by Boppart Krusell Mitman (2017), modified as proposed by Reiter (2018). With this method, individual agents' decisions are preserved as a fully non-linear function of their own individual states. Then, a impulse response function in response to a small unforeseen (MIT) shock is calculated. The model solution  $X_t$  and its stochastic properties are then calculated as a linear superposition of the impulse response functions:

$$X_t = \sum_{k=0}^K \hat{x}_k z_{t-k}$$

where  $\hat{x}_k$  are the elements of the impulse response function appropriately scaled and  $z_t$  is a long sequence of shocks. If the dependency on the vector of aggregate states is linear, under certainty equivalence, the model solution is exact. Otherwise, it is only an approximation.

Reiter (2018) proposes a generalization of the method that takes advantage of the fact that impulse response captures some of the non-linearities of the model. Specifically, instead of calculating just one impulse response function to a small shock, we can calculate many impulse response functions for shocks of different sizes and magnitudes. The model solution  $X_t$  can then be written as a moving average of past shocks:

$$X_t = \sum_{k=0}^K \widehat{x}_k^{\mathcal{J}(z_{t-k})} z_{t-k}$$

where  $\mathcal{J}(z)$  is defined as the indicator of the interval into which the shock  $z$  falls. The method allows for improvements in accuracy provided the model is not strongly non-linear.