Spousal Insurance, Precautionary Labor Supply, and the Business Cycle

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Abstract

I document that married women are less likely to leave the labor force and are more attached to employment in recessions. Using a two-person household incomplete assets markets model with labor market frictions, I show that married women exhibit precautionary labor supply in response to the higher threat of job loss experienced by their husband in recessions. Quantitative analysis shows that married women's precautionary labor supply behavior is an important mechanism of intra-household risk sharing and accounts for 30% of married women's low cyclicality of employment. Furthermore, I show that spousal insurance reduces consumption volatility in married households by 30% over the business cycle.

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1 Introduction

The cyclicality of aggregate hours in the United States differs substantially by gender and marital status. Married women have a significantly lower cyclicality of hours worked in the aggregate than married men, single men, and single women. This paper evaluates the hypothesis that spousal

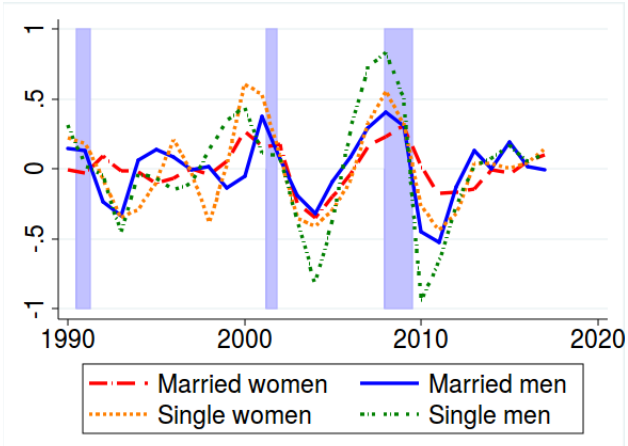


Figure 1: Married women have lowest cyclicality of aggregate hours worked

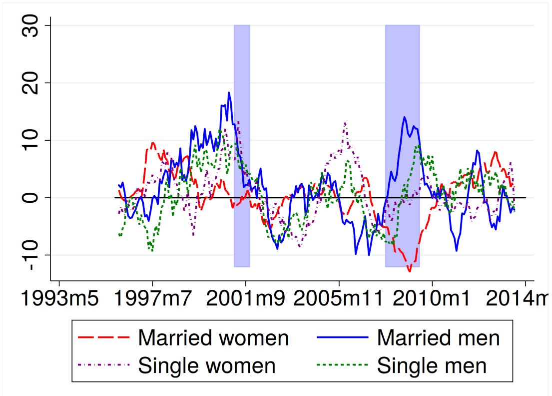
insurance and intra-household risk sharing contribute to the low cyclicality of married women's employment. In particular, I argue that married women adjust their labor supply in response to an increase in job loss risk faced by their husbands, which in the aggregate will dampen the hours cyclicality for married women. In light of this finding, I ask the following question: Do married women provide spousal insurance over the business cycle? And related, how do they insure the household and how much insurance do they provide?

I document that much of married women's low cyclicality of hours is a result of procyclical employment (E) to not in the labor force (N) transition rates.[1] Using Current Population Survey (CPS) data, I find that married women are less likely to leave the labor force and are more attached to employment in recessions relative to normal times. (See figure 2a). The higher attachment to employment in recessions then leads to acyclical employment to employment (E-to-E) transition rates for married women (See figure 2b).[2]

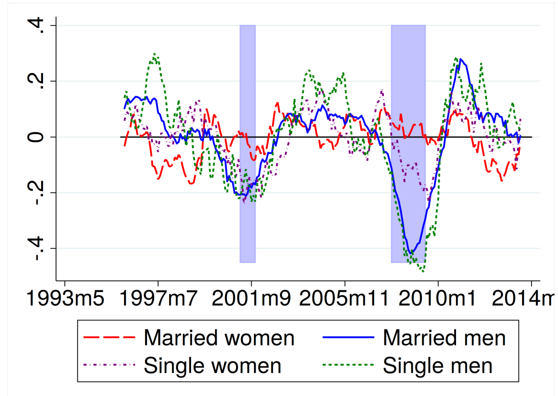
This empirical finding motivates the analysis of an additional and novel mechanism of spousal insurance over the business cycle in this paper: precautionary labor supply. Precautionary labor

[1]Recent work by Doepke and Tertilt (2016), Albanesi (2017), and Fukui, Nakamura, and Steinsson (2018) also documents the low hours cyclicality for married women. I complement their work by showing that the employment to not in the labor force margin is the crucial margin contributing to the low cyclicality.

[2] See the empirics section for a detailed analysis of transition rates and their cyclicality.



(a) Employment-to-Not in the labor force (E-to-N)



(b) Employment-to-Employment (E-to-E)

Figure 2: Change from a year ago transition rates

supply refers to an increase in labor supply in the presence of increased risk. Labor supply adjustments by one spouse as a form of intra-household risk sharing in the presence of aggregate risk have been studied in the past but the focus has been on the added-worker effect. The added-worker effect occurs when a wife joins the labor force in response to her husband's job loss. The recent literature only finds a small added-worker effect in recessions and therefore, concludes that household insurance from the added-worker effect is limited.[3] The distinction between the two mechanisms is that the added-worker effect focuses on the non-employed wife's transition into the labor force in response to actual spousal job loss, whereas precautionary labor supply is a response of an already employed wife to the increased risk of spousal job loss.

The motive for precautionary labor supply stems from two sources. First, assets markets are incomplete and households can only partially self-insure through savings. Second, recessions are periods of increased income risk since job separation rates are high and job finding probabilities are low, and men and women are affected differently.[4] In the typical household in the United States, the husband is the primary earner and highly attached to the labor force, whereas the wife is more loosely attached and the secondary earner.[5] Independent of the state of the economy, a married woman's labor supply decision and choice to cross the participation margin depends on her value of employment, the primary earner's employment and income, and household savings. In normal

[3]See e.g. Gorbachev (2016) or Birinci (2018)

[4]For example see the report by Wall (2009) on "man-cessions" and his summary of research on the different impact of recessions on men and women, and the higher incidence of job loss and unemployment rates for men.

[5]Married women's labor supply decisions are shown to be jointly determined with her husband's labor supply decision and the household's fertility decision. Reasons for married women's participation choice and loose attachment are for example children as shown by Hotz and Miller (1988), wives relatively lower wages compared to her husband (Blau and Kahn (2007)) as well as the interaction of children with wage gaps (Eckstein and Wolpin (1989), Waldfogel (1998))

times, a married woman might quit employment and leave the labor force as a result of a positive shock to her value of non-employment, a positive shock to her husband's employment or income, or an increase in household savings.[6] However, in recessions, she might choose to remain employed and not quit in response to the increase in her non-labor income risk due to the primary earner's higher job loss probability, and her own lower job finding probability.[7] This married woman who chooses to remain employed in response to the increase in risk in recessions provides spousal insurance from precautionary labor supply.[8] This spousal insurance mechanism is consistent with the empirical fact that married women's transition rates from employment to not in the labor force are lower in recessions.

In order to derive implications of married women's labor supply choices for intra-household risk sharing and the cyclicality of employment, I develop a quantitative model of married women's labor supply over the business cycle. The model features incomplete assets markets, labor market frictions, aggregate risk, and endogenous movements between employment, unemployment, and not in the labor force for married women. Married women's labor supply decisions are determined by the interaction of aggregate risk and idiosyncratic shocks. Aggregate risk results from rising job loss and falling job finding probabilities in recessions. Changes in aggregate risk along with incomplete assets markets directly impact married women's precautionary labor supply. Furthermore, married women face idiosyncratic earnings risk and stochastic disutility of working and searching which affect their labor supply independent of the aggregate state of the economy.

The quantitative results and the degree of precautionary labor supply depend on the number of married women who are on the margin between employment and non-participation and which cyclical changes affect their decision to stay employed. Idiosyncratic earnings risks is gender-specific and shocks to married women's disutility of working and searching are estimated in the model to match employment, unemployment, and labor force participation of married women as well as transition rates between labor market states. Matching these moments is important to make sure that the share of married women on the margin in the model is close to the share in the data. Both job loss and job finding probabilities as well as their cyclicality are gender-

[6]We can think of a shock to non-employment, e.g. as the arrival of children

[7]Married women's decision to remain employed due to an increase in her own job finding probability is referred to as job hoarding. If she quits, she cannot directly re-enter the labor force but faces a job offer arrival probability, and therefore hoards on the job. Job hoarding commonly occurs in the presence of frictions and was first formalized in a paper by Garibaldi and Wasmer (2005)

[8]Studies by Buckles, Hungerman, and Lugauer (2018) and Schaller (2013) show that households delay fertility in recessions, one of the crucial determinants of married women's labor force participation, in response to worsening labor market conditions for men.

specific in order to analyze how differences in the cyclicality of the probabilities between men and women affect precautionary labor supply. This is important since the higher job loss risk for the husband increases the wife's non-labor income risk and increases her labor supply. Lastly, I include correlated job loss probabilities since married women's ability to smooth income shocks depends on the correlation of job loss among spouses within households.

In the quantitative model, I find that the channel of precautionary labor supply accounts for about 30 percent of the procyclical E-to-N transition rate for married women in the data. In a counterfactual analysis, I compute the contribution of gender-specific job loss and job finding probabilities. I find that about half of the precautionary labor supply response by married women is due to differences in the cyclicality of risk between married men and women but the other half is due to insurance motives.

Spousal insurance is potentially important for households to smooth consumption in response to the large income shocks resulting from increased separation rates in recessions. In order to answer how much spousal insurance married women provide over the business cycle, I compute consumption volatility in the model and compare it to consumption volatility in a single-earner married household model. I find that spousal insurance reduces consumption volatility in married households by about 30 percent.

The structure of the paper is as follows. Section 2 reviews the existing empirical and quantitative literature on the added-worker effect and female labor supply. Section 3 presents empirical evidence on the cyclicality of different labor market outcomes for married women, married men, and single individuals. The quantitative model is presented in section 4. Section 5 presents the calibration of model parameters. Section 6 illustrates how the model generates the precautionary labor supply mechanism and section 7 presents the main results of the quantitative analysis. Sections 8 and 9 analyze the contribution of the mechanism to aggregates and quantify the reduction in risk. Section 10 concludes.

2 Related Literature

This paper relates to a relatively large empirical literature on the added-worker effect and determinants of female labor supply as well as a more recent strand of literature which focuses on female labor supply and its impact on the macroeconomy in structural quantitative models. Furthermore, this paper relates to papers focusing on the labor supply of individuals on the extensive and intensive margin. Lastly, studies on the cyclicality of marriage, divorce, and fertility are related to this paper by highlighting non-market work factors and their cyclical impact on married women's decisions.

Starting with the seminal work by Lundberg (1985), there has been a significant empirical literature focusing on the added-worker effect, i.e. studying how the secondary earner reacts to job loss experienced by the primary earner. While these studies show that wives respond to job loss of their husbands and adjust their labor supply by joining the labor force to make up partially for the income loss, more recent studies find only little or no evidence of the importance of the added-worker effect during recessions. Mankart and Oikonomou (2016b) and Starr (2014) find an added worker effect during recessions as well as normal times, but it is relatively small in magnitude. Juhn and Potter (2007) and Gorbachev (2016), however, find no added worker effect and conclude that households rely on different mechanisms of insurance in particular since the number of non-participating wives has declined. This paper relates to this empirical literature and shows both empirically and theoretically that there is an added-worker effect, which, however, is small in magnitude and is not particularly more pronounced during recessions. Furthermore, the paper proposes a different mechanism of spousal insurance which is more apparent now and focuses on the response of wives to an increased threat of job loss rather than actual job loss.

This paper is probably closest related to Mankart and Oikonomou (2016a) who analyze the cyclicality of the labor force participation rate in the United States focusing on the differential response of singles, married men and married women to aggregate risk. This work complements their paper by focusing in more detail on spousal insurance and labor supply and disentangles the channels through which households respond to increased labor market risk. Furthermore, this paper allows to quantify spousal insurance over the business cycle and its impact on Macro outcomes, such as employment and hours.

Recent work by Wang (2019) analyzes the search behavior of household members over the business cycle and studies how the added-worker effect and comparative advantage among spouses leads to a countercyclical search intensity of married women. While the paper by Wang (2019) focuses explicitly on the added-worker effect and the increased search intensity of married women during recessions, which is one margin of spousal insurance, this paper complements her findings and analyzes the transitions between employment and non-employment as a form of precautionary labor supply. Birinci (2018) studies the spousal response to a displacement of the household head and the interplay with government transfers. Similarly, to other papers in the line of research, the author finds a positive, but small response of the secondary earner to job loss by the primary earner. In this paper, I document the added-worker effect and similarly find a positive but small response by the secondary earner, but furthermore, highlight precautionary labor supply by the wife as an inmportant source of spousal insurance. Olsson (2018) studies how the increase in women's labor force participation has affected the cyclicality of aggregate employment in the United States. The author finds that the slowdown of the growth in female labor force participation contributed to the sluggish recoveries of the labor market starting in the 1990s. My paper abstracts from the trend and solely focuses on the business cycle and thus complements Olsson (2018). The attachment to employment in recessions by married women, if followed by higher employment to non-employment transitions during recovery phases, would yield a similar finding as the work by Olsson (2018). Lastly, Choi and Valladares-Esteban (2019) study spousal insurance and unemployment insurance in a model similar to mine by combining a Aiyagari framework with labor market frictions as standard in search models, but abstract from aggregate risk and business cycle implications and mainly focus on the interplay of the added-worker effect and unemployment insurance.

A relatively recent strand of literature analyzes female labor supply over time in order to explain the trend in female labor supply as well as to identify crucial determinants explaining female labor supply and differences in labor market outcomes between men and women such as Albanesi (2017), Albanesi and Sahin (2018), Attanasio, Low, and Sanchez-Marcos (2005), Attanasio, Low, and Sanchez-Marcos (2008), Fukui, Nakamura, and Steinsson (2018), Jones, Manuelli, and McGrattan (2015), Blundell, Pistaferri, and Saporta-Eksten (2016). This paper greatly builds on their advances, but specifically focuses on business cycle fluctuations and cyclicality of labor supply while abstracting from the trend.

Furthermore, this paper relates to recent papers featuring models of individual and household labor supply which incorporate labor market frictions in an incomplete markets model. In particular, this paper uses the methodology and builds on to the model developed in a paper by Krusell, Mukoyama, Rogerson, and Sahin (2017) and incorporates a richer household structure similar to Mankart and Oikonomou (2016a). Compared to Krusell, Mukoyama, Rogerson, and Sahin (2017), I add a second spouse to the household rather than focusing on a single-agent household, and model the wife's choices, risks, and constraints to focus on married women's decisions and response to risks and shocks to the household.

While this paper analyzes intra-household insurance provided by the wife and its impact on labor market outcomes, such as aggregate hours and transition rates, it relates to the mainly empirical literature on the cyclicality of marriage, divorce, and fertility. In particular, marriage, divorce, and fertility decisions as well labor supply decisions are likely to be determined jointly. Furthermore, aggregate economic conditions are likely to impact not only market related decisions of households but also whether to marry/divorce and when to have children. The literature on the cyclicality of fertility is broadly in consensus that fertility is procyclical, i.e. households delay having children during recessions until economic times improve. Schaller (2016) finds that fertility is procyclical, which holds among different demographic groups, however, the effect of an increase in the unemployment rate is small. Sommer (2016) finds that households are more likely to delay childbirth when earnings risk increases, as is the case during recessions. A recent paper by Buckles, Hungerman, and Lugauer (2018) finds that not only is aggregate fertility procyclical, but the decline already starts prior to the recession, which implies that the decision to have children is fairly sensitive to households' expectations about the condition of the economy. This complements my paper, which argues that households form expecations about aggregate risk and wives respond prior to the actual occurrence of job loss by adjusting their labor supply. While it seems fairly established that child birth in the aggregate is procyclical, there is no strong consensus on the cyclicality of marriage and divorce. In general, recent papers by Schaller (2013), Amato and Beattie (2011), and Hellerstein and Morrill (2011) find that divorce rates are lower during recessions implying procyclical divorce rates. However, whether marriage is procyclical or countercyclical also depends on the cyclicality of marriage rates. Schaller (2013) finds that both marriage and divorce rates are lower in recessions. Therefore, depending on whether marriage or divorce rates (inflow or outflow of marriage) decline by more impact cyclicality of marriage in the United States.

3 Empirics

This section presents empirical evidence regarding the differences in volatility of labor market outcomes for the different gender-marital status groups and differences in labor market risk. I use data from the Current Population Survey (CPS), both the Basic Monthly Files as well as the Annual Social and Economic (ASEC) supplement.[9]

[9]See the appendix for a description of my different data sources.

3.1 Macro Evidence

3.1.1 Cyclicality of hours worked

Figure 1 showed that married women have a significantly lower cyclicality in the aggregate hours worked than the other three groups using data on individual hours worked per week from the CPS ASEC file. This aggregate volatility in hours worked can further be decomposed into volatility that is due to business cycle fluctuations (Cyclical volatility) and volatility due to other factors, such as personal reasons, household formation, etc. Following Jaimovich, Siu, and Pruitt (2013) and Doepke and Tertilt (2016), I estimate the aggregate hours worked cyclicality due to business cycle fluctuations for each group by regressing the detrended hours worked series for each group on a (detrended) business cycle indicator. I choose the detrended unemployment rate as an indicator for business cycles. Therefore, I estimate the following linear regression for married women, married men, single women, and single men separately, where $g = m, f$ indicates whether the observation is male of female, and $r = m, s$ indicates married or single, and both hours and the unemployment rate are of annual frequency and detrended using a HP filter with smoothing parameter 1600.

$$\text{hours}_t^{g,r} = \beta_0 + \beta_1 \text{unemployment rate}_t + \varepsilon_t \tag{1}$$

Since this paper argues that wives adjust their labor supply in response to the cyclicality of labor market risk faced by their husbands, and therefore, respond directly to the changing conditions of the labor market, I use the unemployment rate as the business cycle indicator rather than GDP per capita as used by Jaimovich, Siu, and Pruitt (2013) and Doepke and Tertilt (2016). The labor market has been lagging significantly in the recent recessions in the United States and, thus, the unemployment rate is a better measure of business cycles with regards to the cyclicality of job loss and job finding probabilities.

Cyclical volatility then is computed as the percentage deviation of the predicted hours, $\widehat{\text{hours}}_t^{g,r}$, from trend. Thus, the measure captures only the fraction of volatility in hours that is due to (or correlated with) business cycle fluctuations in the unemployment rate.

Table 1 starts by showing the estimation results from the regression equation in (1) for married women and men as well as single women and men. The results are in line with figure 1. Aggregate hours for married women respond significantly less to fluctuations in the unemployment rate than aggregate hours for the other groups. Married women's aggregate hours' response to an increase in

	Aggregate detrended hous			
	Married women	Married men	Single women	Single men
Unemployment rate	-0.0197	-0.1616*	-0.1586	-0.3535**
	(0.0591)	(0.0873)	(0.0964)	(0.1652)

Table 1: Regression results

the unemployment rate is not statistically significant whereas the response for men, both married and single, is substantially bigger and statistically signficant, Single women's response is larger as well, however, not statistically significant.

Table 2 shows the decomposition into total volatility and cyclical volatility. The top panel

	Married		Single	
	Men	Women	Men	Women
	Intensive and extensive margin			
Total Volatility	0.5607	0.5513	1.1630	0.9599
Cyclical Volatility	0.2563	0.0478	0.6627	0.3381
R^2	21.62	0.73	32.47	12.41
Share	0.45	0.09	0.57	0.35
	Intensive margin			
Total Volatility	0.2854	0.3413	0.3796	0.3696
Cyclical Volatility	0.2209	0.1059	0.2020	0.2074
R^2	50.12	10.85	40.25	37.71
Share	0.77	0.31	0.53	0.56

Table 2: Married women have the lowest cyclical volatility

shows total and cyclical volatility for both the intensive and extensive margin, thus, it includes all individuals, in and out of the labor force, whereas the bottom panel only considers working individuals. Total volatility is simply the percent standard deviation of each aggregate hours worked series from trend for the data in figure 1. Cyclical volatility is computed as described above.

First, total volatility is greater for all individuals when considering both the intensive and extensive margin. This is not surprising since changes in hours are usually smaller than changes in hours from switching between non-employment and employment.

I start by considering volatility of aggregate hours for both the intensive and extensive margin, i.e. the top panel. With regards to total volatility, there are significant differences by marital status. Single men and women have a total hours volatility that is almost twice as large as the volatility of married men and women. Married men's and women's total volatility is similar and married men's is slightly larger. Married men and women, however, differ greatly with respect to their cyclical volatility. Married women's cyclical volatility is only about one fifth of that for married men. Single women's cyclical volatility is similar in magnitude to married men's whereas single men experience an almost twice as large cyclical volatility. This indicates that married women's aggregate hours worked are significantly less cyclical with regard to the business cycle than aggregate hours worked by singles and married men. Not surprisingly, the R^2 from the regression of the detrended aggregate hours worked series on the unemployment rate is also lowest for married women since fluctuations in the unemployment rate explain only little of the variation in their aggregate hours worked. Lastly, the share of total volatility which is due to cylical fluctuations is lowest for married women as well.

A similar result arises when only considering working individuals in the bottom panel. Again, married women have the lowest cyclical volatility, R^2, and share of total volatility due to cyclical volatility. The share of cyclicality volatility of total volatility for married women, however, is greater for working married women than all married women, which gives some indication that much of the low cyclicality is due to the extensive margin rather than the intensive margin. The next section supports this point more formally.

3.1.2 Extensive vs. intensive margin

Aggregate hours worked for individuals can vary due to two reasons: individuals moving between employment and non-employment and changes in hours by employed individuals. Following Jaimovich, Siu, and Pruitt (2013), I decompose the hours cyclical volatility for married women into two components: volatility due to movements between employment and non-employment and volatility due to pure hours adjustments of working married women.

This simple variance decomposition shows that for married women variation on the extensive margin, i.e. transitions between employment and non-employment, accounts for the majority of the cyclical volatility. Table 3 shows that about 78% of the hours volatility stems from the extensive

	Extensive margin	Intensive margin
Cyclical volatility	78%	22%

Table 3: Decomposition of cyclical volatility into the extensive and intensive margin

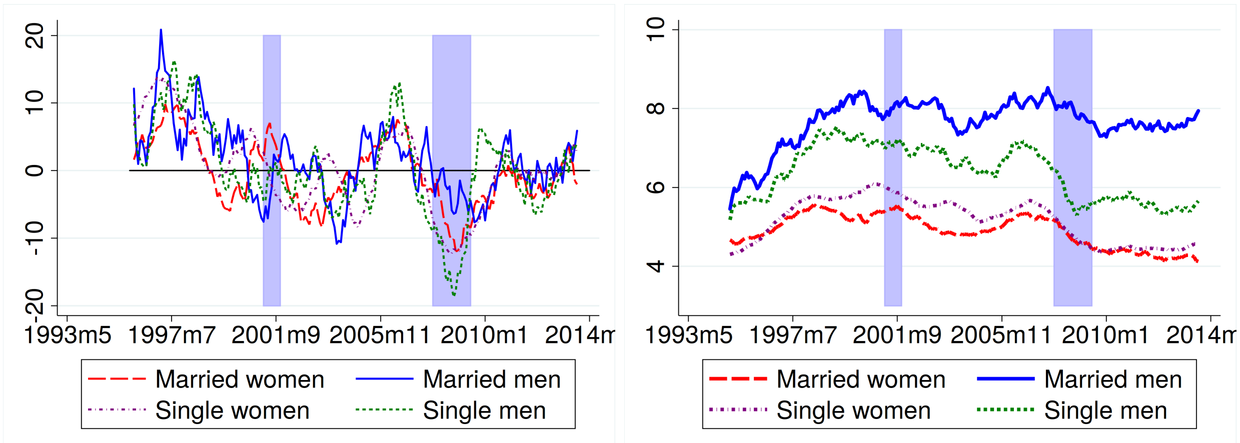
margin only 22% are due to pure hour fluctuations. Since movements between labor market states account for the majority of the aggregate hours worked cyclicality for married women the rest of my empirical section as well as the model will only consider the extensive margin.

3.1.3 Transition rates

Since the majority of the cyclicality in hours worked for married women stems from movements between employment and non-employment rather than pure adjustments of hours by working married women, this section analyzes the cyclicality of transitions between employment and non-employment. As highlighted in the introduction, contrary to past analyses of married women and spousal insurance, the important margin to consider is the transition from employment to not-in-the-labor force (N-to-E) and employment to employment (E-to-E). Furthermore, I show that married women do not differ significantly in their E-to-U transition rates, i.e. in their cyclicality of job loss.

I use the short panel structure of the CPS and link individuals across subsequent months following the methodology by the Bureau of Labor Statistics to calculate gross worker flows for married women, married men, as well as single women and single men. Next, I compute transition rates or transition probabilities similar to Shimer (2012) and Elsby, Hobijn, and Şahin (2015). I address the problems which commonly arise using the CPS to compute transition rates and discuss possible solutions. See the appendix for a detailed explanation of my computation of transition rates.

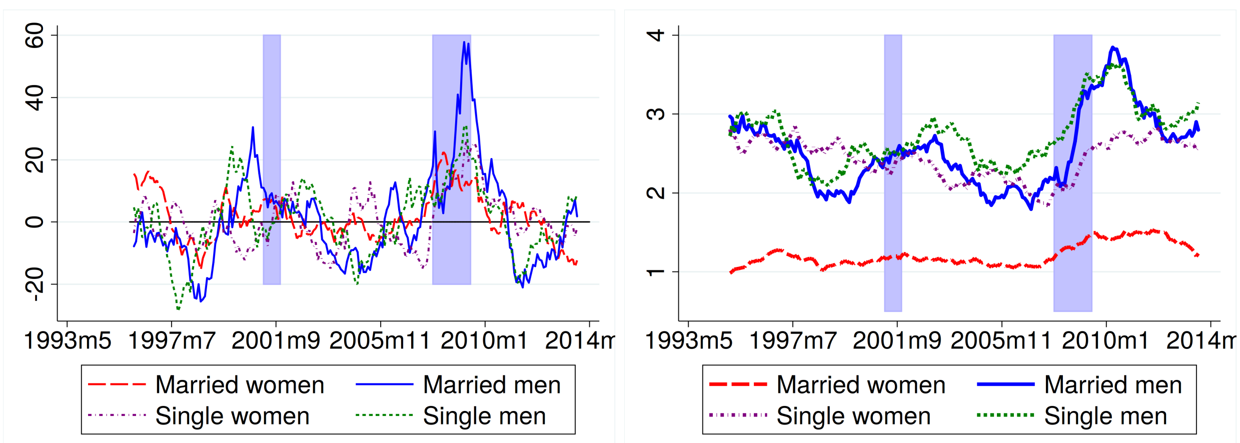
Figures 3 and 4 display the transition rates relating to the classic added-worker effect, i.e. transitions from not-in-the-labor force (N) into the labor force into either employment (E) or unemployment (U). All figures show both the change from a year ago and the level. Starting with the change in the N-to-E transition rate from a year ago, we see that for married women it is barely distinguishable from single women and the drop during recessions is larger than for married men. The change from a year ago in the N-to-U transition rate is actually lowest for married women compared to married men and singles during recessions. If the added-worker effect was the main reason for the low cyclicality of married women in the aggregate, we would expect their N-to-E and N-to-U transition rates to be higher during recessions relative to normal times and in particular higher than for the other groups, but this is not the case. While the N-to-E transition rate for married women is actually lower in recessions instead of higher, the N-to-U transition rate is indeed higher in recessions but the change is lowest for married women.[10]. These observations do not necessarily contradict the existence of an added-worker effect for individual households and individual married women, but they present evidence that the added-worker effect is not able to explain the low volatility of hours in the aggregate for married women.



(a) Change from a year ago

(b) Level

Figure 3: N-to-E transition rate



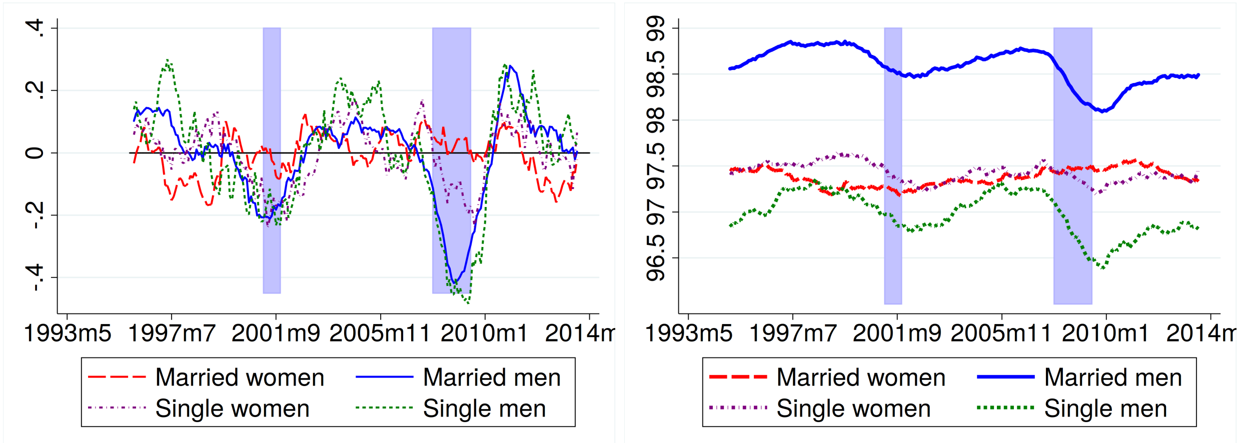
(a) Change from a year ago

(b) Level

Figure 4: N-to-U transition rate

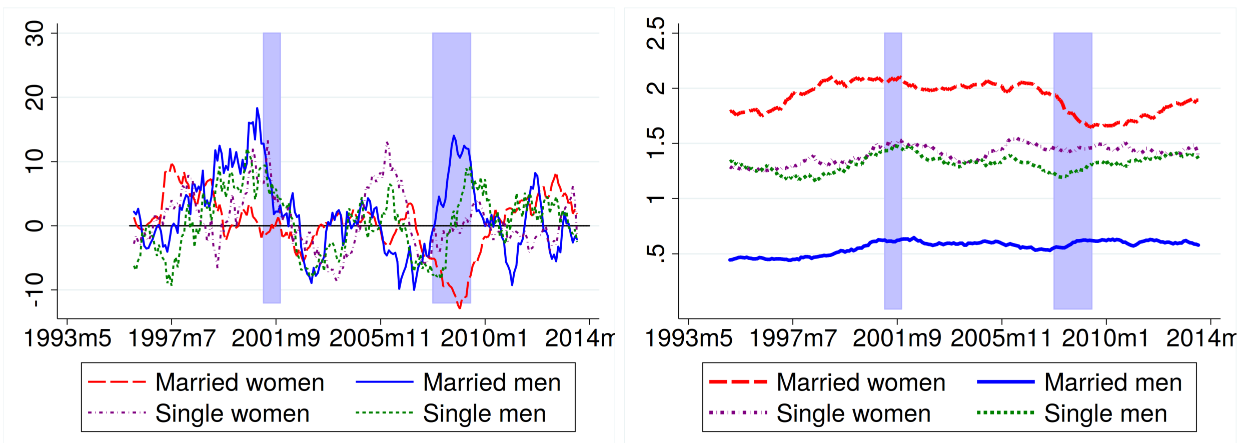
However, married women differ substantially from married men and single individuals in the cyclicality of their transitions out of employment as pointed out already in the introduction. Figures 5 and 6 reiterate the findings from the introduction. Figure 5 shows that while married men

[10] Elsby, Hobijn, and Şahin (2015) also look at the existence of an added-worker effect in the aggregate by comparing the cyclicality N-to-U and N-to-E transition rates for men and women, however, regardless of their marital status, and similarly do not find any evidence in the aggregate



(a) Change from a year ago (b) Level

Figure 5: E-to-E transition rate



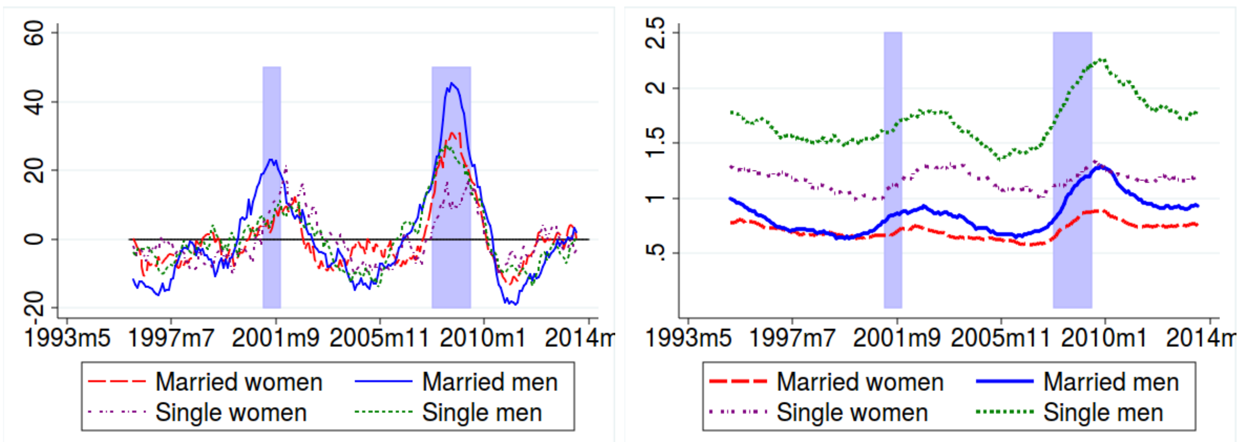
(a) Change from a year ago (b) Level

Figure 6: E-to-N transition rate

and singles experience a decline in their E-to-E transition rates married women's rates are positive for the whole period of the 2007-2009 recession and significantly less negative for the early 2000 recession. The important margin to consider to understand this countercyclicality in married women's E-to-E transition rates are the transitions from employment to not in the labor force (E-to-N).

Figure 6 highlights that married women are less likely to leave the labor force during recessions compared to normal times as well as married men and single individuals. While the E-to-N transition rate for married men, single men, and single women is highly countercyclical, it is highly procyclical for married women. In times of recessions, when the unemployment rate is high and productivity growth low, married women are less likely to make a transition from employment to not in the labor force and their E-to-N transition rates decline. For all other groups, their E-to-N transition rates rise during recessions indicating that they are more likely to leave from employment into not in the labor force during recessions.

Lastly, figure 7 shows the involuntary E-to-U transition rates for married men and women as well as single men and women. In the CPS, unemployed indiviuals get asked their reason for unemployment in order to distinguish between workers who lost their job involuntarily, such as due to temporary layoff, involuntary job loss, or ending of a temporary hob, compared to workers who quit their jobs, re-enter or newly enter the unemployment. Figure 7 shows the cyclicality only for worker who specify that their unemployment is due to the former reason, involuntary job loss. We



(a) Change from a year ago

(b) Level

Figure 7: E-to-U transition rate

can see that married women's involuntary E-to-U transition rate is similar to the other groups. In particular, there is no indication that married women experience significantly lower job loss shocks during recessions, which could therefore explain their low E-to-N transition rate. While married men have the highest increase in their E-to-U transition rate during recessions, married women are similar to single men and single women.

Table 4 summarizes the above findings and presents a measure of cyclicality of the transition rates. It shows the estimation results from regressing each log transition rate on the log unemployment rate. The estimated coefficient, therefore, can be interpreted as the elasticity of each transition rate with regards to business cycle fluctuations in the unemployment rate. While the magnitudes of the estimated coefficients may appear small, it is worth noting that in the recent recession the unemployment rate more than doubled and therefore, increased by more than 100 percent. This implies that for married women an increase in the unemployment rate by 100 percent is associated with an increase in the E-to-E transition rate by 0.3 percent, for the other groups the increase in the unemployment rate is associated with a decline ranging between 0.3 and 0.8 percent. In order to put these numbers into perspectives, the drop in the E-to-E transition rate for married men in absolute numbers during the 2007 recession equals about the total number of unemployed married men in 2018.

	Married Women	Married Men	Single Women	Single Men
E-to-E	0.0023***	-0.0072***	-0.0031***	-0.0086***
	(0.0009)	(0.0007)	(0.0010)	(0.0013)
E-to-U	0.4950***	0.7946***	0.4633***	0.5802***
	(0.0716)	(0.0633)	(0.0854)	(0.0669)
E-to-N	-0.2514***	0.1863***	0.0691	0.0628
	(0.0367)	(0.0636)	(0.1911)	(0.0610)

Table 4: Elasticities of transition rates with respect to fluctuations in the unemployment rate

The reduction of leaving the labor force for married women during recessions is reflected by the negative estimated coefficient of the E-to-N transition rate. A 100 percent increase in the unemployment rate is associated with a 25 percent decline in their E-to-N transition rate. The other groups experience an increase ranging between 6 and 18 percent.

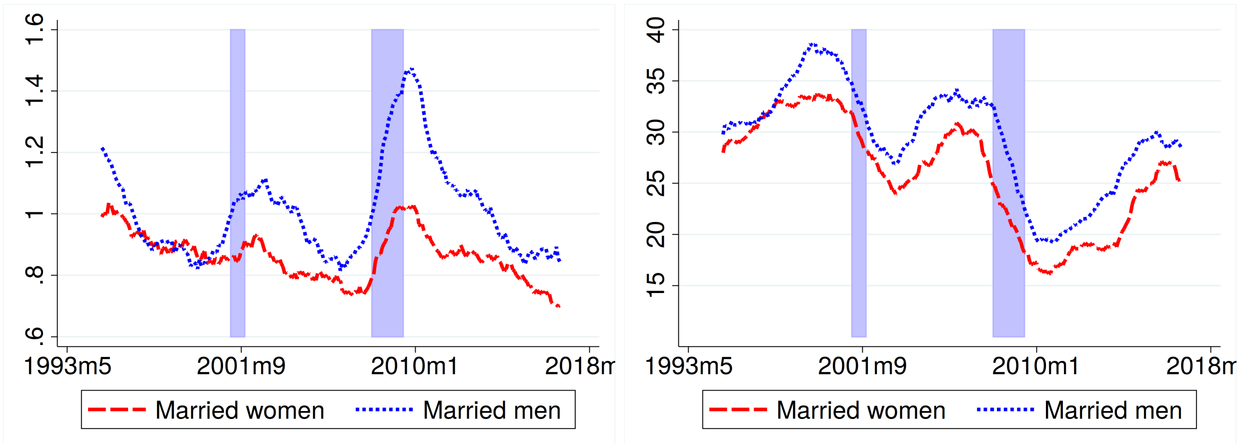
For completion, table 4 also shows the cyclicality of the E-to-U transition rates. Married women's E-to-U transition rate increases less compared to men's, both married and single, and more compared to single women during recessions. Thus, there is no indication that the drop in the E-to-N transition rate for married women is due to a substantially lower risk of getting laid off in recessions than for the other groups.

Thus, both the figures as well as the estimation show that married women in the aggregate are more attached to employment and less likely to leave the labor force in recessions relative to both normal times and married men and single men and women.

3.1.4 Labor Market Frictions

In my quantitative model I will show that part of the employment and hours cyclicality of married women can be explained by cyclical risk faced by their spouses. This section explores job finding and job loss probabilities for married men and married women in the United States between 1995 and 2015 using monthly CPS data and similar to the consensus in the literature shows that married men experience a significantly higher countercyclical job loss probabilty than married women.

I follow the methodology by Shimer (2012) and estimate job finding and job loss probabilities for men and women controlling for time aggregation in transition rates.[11]



(a) Job loss probabilities

(b) Job finding probabilities

Figure 8: Job loss and finding probabilities for men and women in the United States 1995 until 2015

Figure 8a shows that married men and married women in the United States face very different job loss probabilities over the business cycle. While job loss probabilities are only mildly countercyclical for married women, married men have strongly countercyclical job loss probabilities. In particular in the recent recession, married men experience job loss probabilities which were about 50 percent higher than what married women experienced. On the other hand, figure 8b shows that there is a small difference in the level of the job finding probability between married men and married women. However, the job finding probability shows a similar cyclicality for both groups.

Table 5 highlights the findings from the figures. In order to compute the cyclicality measure each time series is logged and then cyclicality is measured as the regression coefficient when regressing the log job finding and log job loss series on the log unemployment rate. Similar to the cyclicality measure of the transition rates in the previous section, the regression coefficient can be interpreted as the elasticity of each probability with respect to changes in the unemployment rate. With regards to the average job loss and job finding probabilities, married men have a slightly higher job loss and job finding probability than married women on average. Also, they do not differ much in the cyclicality of their job finding probability. Both experience highly procyclical job finding probabilities. However, married women's job loss probability is less than half as cyclical as married men's job loss probability. Married men are characterized by a highly countercyclical

[11]See Shimer (2012) for a more detailed explanation of using a continuous model with discrete data.

		Married men	Married women
Average	Job loss probability	0.0101	0.0086
	Job finding probability	0.2954	0.2601
Cyclicality	Job loss probability	0.5286***	0.2078***
		(0.0579)	(0.0591)
	Job finding probability	-0.7641***	-0.8533***
		(0.0390)	(0.0523)

Table 5: Correlation of job loss and finding probabilities for men and women with the unemployment rate

job loss probability, i.e. in times of high unemployment rates they also experience a high job loss probability.

3.2 Other Hypotheses

While this paper argues that spousal insurance and expectations about aggregate economic conditions and therefore labor market risk contributes to the observed low cyclicality of aggregate hours for married women, there are certainly other reasons one might suspect can (at least partially) explain the low hours cyclicality. Furthermore, there is substantial heterogeneity among married women and different demographic groups might have a different impact on aggregate labor market outcomes. In the following, I will discuss other potential hypotheses explaining the observed low aggregate hours cyclicality of married women and show that it holds for different subgroups.

3.2.1 Industry and Occupation

The most common reason cited in the literature to explain differences in labor market outcomes between men and women, for example differences in the cyclicality of the unemployment rate, is the different occupation and industry composition for men and women. In particular, men in the United States are more likely to work in industries or choose occupations which are more affected by economic downturns and therefore, are characterized by signficantly higher job loss rates. In the recent recession, unemployment rates for men were significantly higher than for women. However, I will argue in the following that the difference in industry/occupation composition cannot explain why *married* women's aggregate hours are significantly less cyclical than for the other groups.

First, in the appendix I show that *married* and *single* women have a similar distribution across the different industry and occupation categories, which implies if this was the main driver we would expect single women to be characterized by a similar low hours cyclicality.

Second, and more importantly I show that married women still have the lowest aggregate hours cyclicality even if controlling for different types of industries. I repeat the decomposition into total volatility and volatility directly related to business cycle fluctuations in the previous section for married men, married women, single men, and single women for two types of industries: manufacturing and services (See appendix for my classification). Since I aggregate the annual data by gender, marital status, and industry classification, I do not have enough data to show the hours volatility for finer industry groups. Some categories will have very few observations and there is too much noise leading to very imprecise results. Nevertheless, the broader classifications shows that while there may be differences between particular industries, employment in the service sector vs employment in the manufacturing sector alone cannot explain the observed differences in hours volatility for married women and the other groups.

Tables 6 display the estimation results from regressing the detrended aggregate hours series for each gender-marital status-industry group on the unemployment rate. These results show how much each hours series fluctuates in respond to fluctuations in the unemployment rate and thus, replicates the methodology on cyclical volatility in section 3.1.1. First, for both the service and manufacturing industry groups, the estimated coefficient for married women is the lowest indicating that their hours decline the least (or do not decline since the estimated coefficient is not statistically significant) when the unemployment rate increases, i.e. in recessions. Thus, their hours seem to fluctuate less over the business cycle within both industry groups compared to married men and single individuals.

Second, these results show that indeed aggregate hours fluctuations associated with business cycle fluctuations in the unemployment rate are lower for the services industry, but for all groups and in particular for men, both single and married. While the estimated coefficient did not change in magnitude between the manufacturing and service group for married women, it slightly declined for single women, and it is 25 percent lower for married men and 50 percent lower for single men. However, the "ordering" of the groups with regards to their cyclical volatility among each industry category is unaffected.

Table 7 displays the cyclical volatility for each gender-marital status-industry group, i.e. the volatility in aggregate hours related to (business cycle) fluctuations in the unemployment rate, and emphasizes the findings. Married women's aggregate hours are significantly less cyclical in both the manufacturing as well as the service industries and similar in magnitude between the two industry

	Manufacturing			
	Married women	Married men	Single women	Single men
Unemployment rate	-0.0481	-0.1618**	-0.1056	-0.2617***
	(0.0535)	(0.0610)	(0.0793)	(0.0842)
	Services			
	Married women	Married men	Single women	Single men
Unemployment rate	-0.0396	-0.1231***	-0.0921**	-0.1354*
	(0.0291)	(0.0354)	(0.0357)	(0.0709)

Table 6: Regression Results: Manufacturing and Service Industries

categories. Therefore, differences in the industry of employment explain part of the cyclicality

	Married women	Married men	Single women	Single men
	Manufacturing			
Cyclical volatility	0.0829	0.2482	0.1732	0.4180
	Services			
Cyclical volatility	0.0734	0.1851	0.1577	0.2195

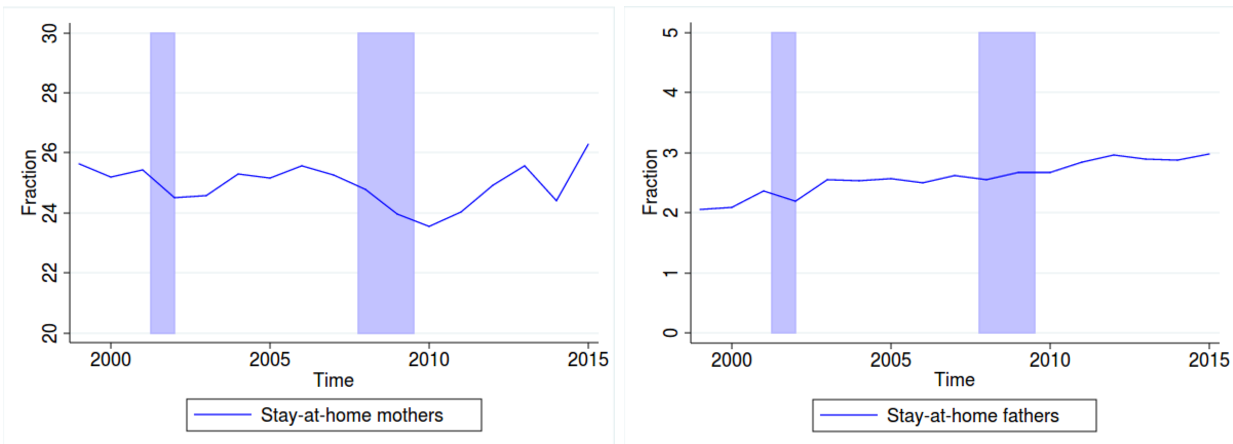
Table 7: Cyclical volatility: Manufacturing and Service Industries

in aggregate hours, however, married women's cyclical hours volatility is lowest regardless of the industry.

3.2.2 Children

When (married) women choose whether to work or not to work one of the more important factors to consider is the presence of children as well as the number of children and age of children. Mothers with young children or many children are less likely work than childless married women or mothers with few or older children. I will show in the following that the presence of children certainly matters in the aggregate to which married women work, with regards to cyclicality in the aggregate children do not seem to cause big differences between mothers and childless married women.

Figures 9a and 9b show the fraction of stay-at-home married mothers and fathers in the United States between 1998 and 2015, covering two recessions. From figure 9a it is clear that the choice to participate in the labor market and work or stay at home for married mothers is not acyclical, but very much procyclical. The fraction of married mothers who stay at home drops with the beginning of both recessions and recovers a couple years after the recession to its pre-recession value. For comparison, in the same time period the fraction of stay-at-home fathers is completely acyclical and we might detect a slight upward trend. But it does not appear that there is a switch between parents in who is raising children, but rather married mothers respond to business cycle fluctuations. Therefore, we even see a response to business cycle fluctuations and aggregate risk



(a) Married mothers

(b) Married fathers

Figure 9: Stay-at-home married mothers and fathers in the United States 1998 until 2015

among mothers. In the recent recession the fraction of stay-at-home married mothers is about 2 to 3 percentage points lower than during normal times which implies some mothers choose to work despite having children. While this figure does not yield any evidence whether these are married mothers who join the labor force during recessions or married mothers choose to remain employed during recessions when they would not during normal times, it indicates that on average in the aggregate having children does not prevent mothers from insuring their family.

These findings are in line with the literature studying the cyclicality of fertility and the response of fertility to changes in the aggregate economic conditions. The consensus among these studies is that fertility is procyclical, meaning households delay fertility in recessions until the economy is back in normal times.[12]

3.3 Summary

Before moving to the model and the quantitative analysis, this section briefly summarizes the most important empirical results.

[12] See the related literature section on a more detailed summary of findings regarding the cyclicality of fertility.

I find that 1) Married women have a lower hours and employment cyclicality than married men and single individuals; 2) Married women are more attached to employment and less likely to leave the labor force in recessions; and 3) Men have a significantly higher cyclicality of job loss than women. In the next section I will use a quantitative model to analyze whether 2) and 3) can explain 1).

4 Model

4.1 Environment

4.1.1 Setting

As documented in the previous section, much of the oberved low cyclicality for married women stems from movements between employment and not in the labor force which appears to be related to the cyclicality of labor market risk faced by their husband. Therefore, I model an economy with two-person households, incomplete asset markets, and labor market frictions which generate endogenous movements between employment, unemployment, and not in the labor force. Recessionary and normal times in the model directly affect labor market frictions to study the cyclicality of transitions for married women.

This model is similar to Mankart and Oikonomou (2016a) and Krusell, Mukoyama, Rogerson, and Sahin (2017) by combining labor market frictions similar to a standard search model with an incomplete markets heterogeneous agents model similar to a Bewley-Huggett model. In particular, while Krusell, Mukoyama, Rogerson, and Sahin (2017) model an individual making labor supply and consumption choices facing job loss and job finding frictions, I extend their framework by adding a second potential worker to the household and address the resulting household interactions and choices. Thus, my model is similar to Mankart and Oikonomou (2016a), who model two-person households, but model the two household members identically and do not distinguish between primary and secondary earners. I show that it is crucial to model the differences in frictions faced by men and women to understand the behavior of married women in respond to aggregate and individual shocks.

Similar to the two papers, my model distinguishes explicitly between the labor market states employment, unemployment, and not in the labor force for married women (and employment and unemployment for married men, more details provided below).

The model features only married households and I abstract from marriage/divorce, therefore, I use the terms men and women in the context of the model synonymously to married men and married women or husband and wife.

4.1.2 Agents

The economy is populated by a continuum of infinitely lived unit measure of ex-ante identical households, and each household i is comprised of husband ($j = 1$) and wife ($j = 2$).[13] Time t is discrete and runs forever.

4.1.3 Preferences

The household is unitary, which means the spouses pool their income and choose joint consumption. Therefore, I abstract from any bargaining within the household, and thus, allow for an easier comparison to standard one-person household problems.[14]

The unitary household has a joint consumption choice c_t, saving choice a_{t+1}, as well as a discrete labor supply $e_{2,t}$ and discrete search choice $s_{2,t}$ for the wife. Since the majority of employment cyclicality is due to movements between the different labor market states rather than due to changes in the hours worked, women in the model only make extensive labor supply decisions, i.e. to work or not to work, and extensive search decisions, i.e. to search or not to search. Husbands, on the other hand, are fully exogenous. They are either employed or unemployed and households take as given the movement between employment and unemployment. This means married men in the model work until they get laid off due to an exogenous job destruction shock and then become unemployed. Once without a job, they are unemployed and remain unemployed until they receive a job offer. If they receive a job offer, they have to accept it and become employed.

Preferences are as follows

$$\log(c_t) - \alpha(\varepsilon_2)e_{2,t} - \kappa_t s_{2,t} \tag{2}$$

The household can choose $e_{2,t} \in \{0, 1\}$ for the wife if she has a job or job offer. If the wife chooses to not work $e_{2,t} = 0$ or does not have a job offer, she can choose between active search $s_{2,t} = 1$ or passive search $s_{2,t} = 0$. In order to map the model to the data and explicitly distinguish between unemployment and not in the labor force, the wife is considered unemployed when she actively

[13] For the remaining part I will suppress the subscript i for households for ease of notation if it is clear that the variable refers to a household.

[14] See the appendix for a discussion when relaxing the unitary household assumption

searches, and not in the labor force otherwise. This is similar to the official classification of the BLS which classifies an individual as unemployed if he/she reports to have actively looked for a job in the past four weeks.

The parameters α and κ_t are the disutilities resulting from working and searching for the wife, respectively. The disutility α depends on the woman's (shadow) wage and the search disutility κ_t is stochastic to match the flows between unemployment and not in the labor force.

Although I deNUNify the data, there remains a substantial number of transitions between unemployment and not in the labor force (U-to-N), and a smaller but still important number of transitions from not in the labor force to unemployment (N-to-U), which cannot be explained by shocks to labor supply, productivity or frictions. Thus, I follow Krusell, Mukoyama, Rogerson, and Sahin (2017), who point out the same problem, and model the search disutility κ_t as distributed according to a three point distribution with mean $\bar{\kappa}$ and support $\{\bar{\kappa} - \varepsilon_\kappa, \bar{\kappa}, \bar{\kappa} + \varepsilon_\kappa\}$. Thus, it is iid across households and time.

Flows between employment and not in the labor force (E-to-N) in the model are a result of shocks to employment, the value of (non) employment, or spouses' productivity. In order to have enough married women close to the non-participation margin in the model, I model their disutility from working $\alpha(\varepsilon_2)$ as a function of their wage or if without job in terms of their shadow wage, where

$$\alpha(\varepsilon) = \delta\varepsilon \qquad 0 > \delta > 1 \tag{3}$$

Assumption (3) entails that highly productive women in the market face a higher utility cost to not working, which implies they are also highly productive at home and it is more costly for them to work. This is a reasonable assumption given that in the data we see the reduction of E-to-N transitions during recessions across all income groups for married women.

4.2 Income

Both, men and women, have stochastic productivity which follows a gender-specific AR(1) process

$$\log \varepsilon_{i,t} = \rho_j \varepsilon_{i,t-1} + \sigma_{\varepsilon,j} \nu_{i,t}$$

Productivity shocks between spouses are uncorrelated and household productivity is denoted by $\mathcal{E}$ which is simply the vector of productivity states for both spouses. Therefore, both spouses have exogenous labor income $w_{j,t}\varepsilon_{i,t}$ for $i \in \{1, 2\}$.

Furthermore, households have access to a risk-free asset a, which pays an exogenous real interest rate r. Households can save, but they cannot borrow, i.e. $a_{t+1} \geq 0$. Therefore, both wages for husband and wife and the real interest rate are exogenous.

4.2.1 Labor Market Frictions

Both members of the household face labor market frictions, a job finding probability $\lambda_j(s, y)$ and a job loss probability $\chi_j(y)$. The job finding probability and the job loss probability depend on i, i.e. men and women face different labor market frictions. The business cycle in the model is indicated by y and determines the level of frictions in recessionary and normal times. Recessions in this economy are periods of low job finding and high job loss probabilities and normal times are characterized by high job finding and low job loss probabilities. The aggregate state y only only impacts the labor market frictions.

Job loss shocks are correlated within households, i.e. spouses are more likely to lose their jobs in the same period. For an Employed-Employed household, this leads to the following joint household job loss probabilities:

$$\pi_{L^m}\left[(1-\varphi)\pi_{L^f} + \varphi 1\{L^m = L^f\}\right] \tag{4}$$

where $L^i \ \forall i = m, f$ is the job loss outcome for both spouses and equals 1 in case of job loss and zero otherwise. The parameter φ measures the degree of correlation of job loss between the spouses. If $\varphi = 1$, then the job loss shocks are perfectly correlated and both spouses job loss probability will only depend on the husband. If the husband loses his job, then the wife will experience an exogenous job destruction as well. The other extreme would be $\varphi = 0$, in this case, the job destruction shocks are completely unrelated and each spouse loses their job independently from each other. For both spouses the probability of losing and keeping the job has to add up to one, such that

$$\pi_{L^m=1}(y) = \chi_1(y) \tag{5}$$

$$\pi_{L^m=0}(y) = 1 - \chi_1(y) \tag{6}$$

and

$$\pi_{L^f=1}(y) = \chi_2(y) \tag{7}$$

$$\pi_{L^f=0}(y) = 1 - \chi_2(y) \tag{8}$$

Furthermore, the level of the exogenous job destruction shock for each spouse $\chi_j(y)$ depends on whether the economy is in a recession ($y = 1$) or normal times ($y = 0$) and differs between men and women. The probability of losing a job is higher in recessions than in normal times for both spouses, $\chi_j(1) > \chi_j(0)$ for $j \in \{1, 2\}$. The wife's job destruction shock is correlated with her husband's displacement shock but independent of her husband's current labor market state. Therefore, for a household in which the husband is unemployed and the wife is employed, the job loss probability for the wife is $\tilde{\chi}_2$, where $\tilde{\chi}_2 = (1-\varphi)\chi_2 + \varphi\chi_1$. This enforces that married women have the same job loss probability regardless of whether her husband is currently employed or unemployed.[15]

The job finding probability $\lambda_j(s, y)$ additionally depends on whether the individual actively searches or not. Active search increases the probability of finding a job relative to passive search, and therefore, $\lambda_2(1, y) > \lambda_2(0, y)$ for $y = 0, 1$. Since the husband is unemployed whenever he is without a job, this only affects the wife and his job finding probality $\lambda_1(y)$ only depends on the indicator for the business cycle. Furthermore, the probability of finding a job is lower in recessions for both spouses, i.e. $\lambda_j(s, 1) < \lambda_j(s, 0)$.

If the husband is unemployed, he will find a job in the current period with probability $\lambda_1(y)$ or remain unemployed with probability $(1 - \lambda_1(y))$. If the wife is unemployed, she will find a job with probability $\lambda_2(1, y)$ or stay unemployed without a job offer with probability $(1 - \lambda_2(1, y)))$. If she is not in the labor force she will receive a job offer with probability $\lambda_2(0, y)$ or remain out of the labor force with probability $(1 - \lambda_2(0, y))$.

4.2.2 Timing

Events in each period t of the model will unfold as follows: At the beginning of the period each member of the household will know whether they are employed, unemployed, or not in the labor force depending on the choices and shocks from the previous period. They will observe their realized idiosyncratic shocks (productivity shocks for both spouses, search disutility for the wife) and aggregate shocks as well as their savings they brought into this period from the previous period.

[15]See the appendix for the derivation.

Given these states, they will decide for the wife whether to work or not or whether to actively or passively search depending on which labor market state she started the period with.

4.3 Household Problem

The states for each household are their assets a, the productivity shock for each spouse ε_i, wife's search disutility κ, the current labor market state for the wife $S_2 \in \{E, U, N\}$, and the current labor market state for the husband $S_1 \in \{E, U\}$. The aggregate state is $y \in \{0, 1\}$ indicating the state of the economy. Thus, there a six mutually exclusive types of households distinguished by their joint labor market states since the husband's labor market state can take two different outcomes and the wife's three. This means there are six different value functions for the households. In order to simplify notation, the following shows the recursive formulation of the household problem once both the idiosyncratic and aggregate shocks are realized.

Households are distinguished by the job status of their spouses: Each spouse starts a period either as jobless (L) or with a job offer (J). Thus, at the beginning of the period, the households face either of the four value functions (the first superscript identifies the husband and the second superscript identifies the wife): $W^{EJ}(a, \mathcal{E}, \kappa, y)$ if both spouses have a job offer, $W^{UL}(a, \mathcal{E}, \kappa, y)$ if both spouses are jobless, and $W^{EL}(a, \mathcal{E}, \kappa, y)$ or $W^{UJ}(a, \mathcal{E}, \kappa, y)$ if one of the spouses has a job offer and the other is jobless.

If the husband has a job offer, he will always be employed (E). If the wife has a job offer, the household can choose for her between employment (E), unemployment (U), and not in the labor force (N). If the husband is jobless, he will always be unemployed (U), whereas the household can choose between unemployment (U) and not in the labor force (N) if the wife is jobless.

Thus, if both spouses are jobless, the household decides whether the wife engages in active or passive search (unemployment or not in the labor force) as well as how much to consume and how much to save. The value for a household with two jobless (UL) members is the maximum of the two options based on their savings, joint productivity and state of the economy:

$$W^{UL}(a, \mathcal{E}, \kappa, y) = \max\{V^{UU}(a, \mathcal{E}, \kappa, y), V^{UN}(a, \mathcal{E}, \kappa, y)\}$$

Similarly, if the husband has a job offer and the wife if jobless, the husband is employed (E) and the household can choose between unemployment (U) and not in the labor force (N) for the wife and consumption and savings. The value for a household with a jobless wife and a husband with a job offer is the maximum of the value when the wife is unemployed V^{EU} or the wife is not in the labor force V^{EN}

$$W^{EL}(a, \varepsilon, \kappa, y) = \max\{V^{EU}(a, \varepsilon, \kappa, y), V^{EN}(a, \varepsilon, \kappa, y)\}$$

If the husband is jobless and the wife has a job offer, an additional choice for the household arises. The husband will be unemployed (U), but now it can decide between employment (E), unemployment (U), and not in the labor force (N) for the wife. So the value for a W^{LJ} becomes the maximum of these three options:

$$W^{UJ}(a, \varepsilon, \kappa, y) = \max\{V^{UE}(a, \varepsilon, \kappa, y), V^{UU}(a, \varepsilon, \kappa, y), V^{UN}(a, \varepsilon, \kappa, y)\}$$

Lastly, if both spouses have a job offer, the value for a W^{JJ} household is the maximum of the values depending on whether the wife chooses employment, unemployment or not in the labor force.

$$W^{EJ}(a, \varepsilon, \kappa, y) = \max\{V^{EE}(a, \varepsilon, \kappa, y), V^{EU}(a, \varepsilon, \kappa, y), V^{EN}(a, \varepsilon, \kappa, y)\}$$

Next, I am going to define the values for the household depending on the different employment states for the spouses.

4.3.1 Employed-Employed (EE) household

A household which has both spouses employed chooses joint consumption and savings and has to pay the disutility cost α since the wife is working. The household receives labor income from both spouses as well as savings from the previous period. β is the household's discount factor. The value function for a household which has both spouses employed is

$$\begin{aligned}
V^{EE}(a, \mathcal{E}, \kappa, y) = \max_{c,a'} \log(c) - \alpha(\varepsilon_2) + \beta\mathbb{E}[(1-\chi_1(y))\left[(1-\varphi)(1-\chi_2(y)) + \varphi\right] W^{EJ}(a', \mathcal{E}', \kappa', y') + \\
\chi_1(y)(1-\varphi)(1-\chi_2(y))W^{UJ}(a', \mathcal{E}', \kappa', y') + \\
(1-\chi_1(y))(1-\varphi)\chi_2(y)W^{EL}(a', \mathcal{E}', \kappa', y') + \\
\chi_1(y)\left[(1-\varphi)\chi_2(y) + \varphi\right] W^{UL}(a', \mathcal{E}', \kappa,' y')]
\end{aligned}$$

$$\text{s.to} \quad c + a' = (1+r)a + w_1\varepsilon_1 + w_2\varepsilon_2$$

The household faces four mutually exclusive situations tomorrow: (1) With probability $(1 - \chi_1(y))(1 - \chi_2(y))$ both spouses keep their job and start tomorrow with a job offer $W^{EJ}(a, \mathcal{E}, \kappa, y)$; or (2) with probability $(1 - \chi_1(y))\chi_2$ the husband remains employed and the wife receives an exogenous job destruction shock so that tomorrow the husband will have a job offer but the wife will start as jobless $W^{EL}(a, \mathcal{E}, \kappa, y)$; (3) the household will start tomorrow with the wife having a job offer and the husband jobless $W^{UJ}(a, \mathcal{E}, \kappa, y)$ if he loses his job with probability $\chi_1(y)$ and the wife keeps hers with probability $(1 - \chi_2(y))$; (4) lastly, with probability $\chi_1(y)\chi_2(y)$ they will start as a household in which both spouses do not have a job offer $W^{UL}(a, \mathcal{E}, \kappa, y)$.

This value function illustrates nicely how expectations matter for the employment decision of the wife. The aggregate state of the economy y enters into the households expectations for the continuation value. If the economy is currently in normal times and the household expects to stay in normal times in the next period, depending on the asset accumulation, they might find it optimal to choose non-employment for the wife. If the economy continues in normal times, the job loss probability for the husband is low and the job finding probability for the wife is high. Therefore, if they have accumulated enough assets the wife might decide to leave the labor force since the probability that her husband loses his job is relatively low and even if he does, it is relatively easy for her to rejoin the labor force. However, if the economy is entering into a recession, a period of high job loss and low job finding probabilities, the wife might be less likely to leave, even if the household has the same level of assets. Now it is relatively more likely that the husband will lose his job and if that happens it is relatively harder for the wife to rejoin the labor force. So she will stay employed to insure against the possible job loss of the primary earner and the income loss associated with the job loss. This attachment to employment of the wife in response to a possible job loss by the husband due to a recession is a form of precautionary labor supply.

4.3.2 Unemployed-Employed (UE) household

An UE household consists of an unemployed husband, who remains unemployed until a job offer arrives, and an employed wife who can choose between employment, active search, and passive search. Furthermore, the household decides how much to consume and how much to save. The household has to pay $\alpha_2(w_2\varepsilon)$ in participation cost for the wife. The household receives income from savings and labor income from the employed wife. The value function for this type of household is

$$
\begin{aligned}
V^{UE}(a, \mathcal{E}, \kappa, y) = \max_{c,a'} \log(c) - \alpha(\varepsilon_2) + \beta\mathbb{E}[&\lambda_1(y)(1-\tilde{\chi}_2(y))W^{EJ}(a', \mathcal{E}', \kappa', y')+ \\
&(1-\lambda_1(y))(1-\tilde{\chi}_2(y))W^{UJ}(a', \mathcal{E}', \kappa', y')+ \\
&\lambda_1(y)\tilde{\chi}_2(y)W^{EL}(a', \mathcal{E}', \kappa', y')+ \\
&(1-\lambda_1(y))\tilde{\chi}_2(y)W^{UL}(a', \mathcal{E}', \kappa', y') \\
\text{s.to } \; c + a' = (1+r)a + w_2\varepsilon &
\end{aligned}
$$

Both husband and wife will have an offer tomorrow and start as a W^{EJ} household if the husband receives a job offer with probability $\lambda_1(y)$ and the wife keeps her job with probability $(1-\tilde{\chi}_2(y))$. The husband will be unemployed and the wife employed W^{UJ} with probability $(1-\lambda_1(y))\tilde{\chi}_2(y)$. The husband will be employed next period with probability $\lambda_1(y)$ and the wife will lose her job with probability $\tilde{\chi}_2(y)$ and they will be continuation value W^{EL}. Lastly, with probability $(1-\lambda_1(y))\tilde{\chi}_2(y)$ both husband and wife are jobless next period W^{UL}.

Again, this value function highlights the role of expectations in the wife's decision between employment and non-employment. Similarly to the previous case, the wife's decision is affected by her expectation of the state of the economy in the next period. Since her husband is jobless, she is less likely to leave the labor force than in the case where her husband has a job. However, if the household has a large amount of assets accumulated and the wife expects the economy to remain in good times, she might consider leaving the labor force, since the probability of her husband finding a job is high and if he does not her probability of rejoning employment is high. However, if she expects a recessions, she is very unlikely to leave since it became less likely that her husband gets a job offer.

4.3.3 Employed-Jobless (EL) household

A household in which the husband is employed and the wife is jobless chooses joint consumption, savings, and whether the wife searches or not. If they choose $s_2 = 1$, then the wife is unemployed and the household has to pay the stochastic disutility cost of searching κ. If they choose $s_2 = 0$, the wife does not actively search and the household does not face any disutility from searching. In this case the wife is considered not in the labor force. The household only receives labor income from the husband and from savings from the previous period. The value function for this type of household is

$$V^{EL}(a,\mathcal{E},\kappa,y) = \max_{c,a',s_2} \log(c) - \kappa + \beta\mathbb{E}[(1-\chi_1(y))\lambda_2(s,y)W^{EJ}(a',\mathcal{E}',\kappa',y')+$$
$$\chi_1(y)(1-\lambda_2(s,y))W^{UJ}(a',\mathcal{E}',\kappa',y')+$$
$$(1-\chi_1(y))(1-\lambda_2(s,y))W^{EL}(a',\mathcal{E}',\kappa',y')+$$
$$\chi_1(y)(1-\lambda_2(s,y))W^{UL}(a',\mathcal{E}',\kappa',y')$$
$$\text{s.to} \;\; c + a' = (1+r)a + w_1\varepsilon$$

Both spouses will have a job offer tomorrow $W^{EJ}(a',\mathcal{E}',\kappa',y')$ if the husband keeps his job with probability $(1-\chi_1(y))$ and the wife receives a job offer with probability $\lambda_2(s,y)$. They will be a LJ household $W^{UJ}(a',\mathcal{E}',\kappa',y')$ if the husband becomes unemployed with probability $\chi_1(y)$ and the wife finds a job with probability $\lambda_2(s,y)$. Similarly, the husband has a job offer next period and the wife does not $W^{EL}(a',\mathcal{E}',\kappa',y')$ if the husband remains employed with probability $(1-\chi_1(y))$ and the wife remains jobless with probability $(1-\lambda_2(s,y))$. They will be a jobless household $W^{UL}(a',\mathcal{E}',\kappa',y')$ if the husband loses his job with probability $\chi_1(y)$ and the wife does not receive a job offer with probability $(1-\lambda_2(s,y))$.

4.3.4 Unemployed-Jobless (UL) household

If the husband is jobless, he has to be unemployed and the household has to pay the search cost κ. The wife, however, can choose between unemployment and not in the labor force. In the case in which both husband and wife are jobless the household has a consumption, savings, and search choice for the wife. If the wife decides to search the household has to pay the stochastic search cost κ for her. Otherwise, she is not in the labor force and no search cost needs to be paid. Then the value function for a jobless household is

$$V^{UL}(a,\mathcal{E},\kappa,y) = \max_{c,a',s_2} \log(c) - \kappa + \beta\mathbb{E}[\lambda_1(y)\lambda_2(s,y)W^{EJ}(a',\mathcal{E}',\kappa',y')+$$
$$(1-\lambda_1(y))\lambda_2(s,y)W^{UJ}(a',\mathcal{E}',\kappa',y')+$$
$$\lambda_1(y)(1-\lambda_2(s,y))W^{EL}(a',\mathcal{E}',\kappa',y')+$$
$$(1-\lambda_1(y))(1-\lambda_2(s,y))W^{UL}(a',\mathcal{E}',\kappa',y')$$
$$\text{s.to} \;\; c + a' = (1+r)a$$

With probability $\lambda_1(y)\lambda_2(s,y)$ both spouses will have a job offer tomorrow and the continuation value is $W^{JJ}(a', \mathcal{E}', \kappa', y')$, whereas both spouses are jobless next period $W^{LL}(a', \mathcal{E}', \kappa', y')$ with probability $(1-\lambda_1(y))(1-\lambda_2(s,y))$. The household will have a spouse with a job offer and one without if either the husband finds a job with probability $\lambda_1(y)$ or the wife receives a job offer with probability $\lambda_2(s,y)$.

5 Calibration

This section describes my calibration and estimation of the parameters in the model. A time period in the model is one month. I start by describing externally set parameters before moving on to the internally estimated parameters.

5.1 Definition of a recession

A crucial decision in this context is how to define a recession relative to normal times. In the data, both recessionary and expansionary phases are stretching over multiple months with varying labor market outcomes which I need to map into two states in my model. In particular, I need to decide what the exogenous job destruction and job offer probability is in recessions and in normal times. Different papers in this line of research have used different criteria to model recessions and to define one value for each labor market friction parameter in a recession and one value in normal times.

I will use other model moments to evaluate the definition of a recession in the context of the model. In the following I will follow the classification by Krusell, Mukoyama, Rogerson, and Sahin (2017) for two reasons. First, since my model augments theirs by adding a second earner to the household and model the shocks and risks a household faces, this allows for a comparison between their findings and my findings. Second, compared to other definitions of recessions and normal times in the literature, this one is most conservative and therefore, offers a lower bound in the degree of spousal insurance over the business cycle.

Values for the labor market friction parameters in recessions (R) and normal times (N) are defined as follows:

$$\chi_j^N = \chi_j - \varepsilon_{\chi_j} \quad \text{and} \quad \chi_j^R = \chi_j + \varepsilon_{\chi_j} \tag{9}$$

$$\lambda_j^N(s) = \lambda_j(s) + \varepsilon_{\lambda_j(s)} \quad \text{and} \quad \lambda_j^R(s) = \lambda_j - \varepsilon_{\lambda_j(s)} \tag{10}$$

where χ_j and $\lambda_j(s)$ are the job destruction shock and job finding probabilities estimated from the stationary model without any aggregate fluctuations. This implies that in normal non-recessionary times, the exogenous job loss probability χ_j^N for both spouses, $j = 1, 2$, is ε_{χ_j} lower than the average exogenous job loss probability in the stationary case, and the job offer probability from unemployment $\lambda_j^N(1)$ for both spouses and from not in the labor force for the wife $\lambda_2^N(0)$ is $\varepsilon_{\lambda_j(s)}$ higher than compared to the stationary case. Similarly, during recessions, the exogenous job destruction probability χ_j^R is ε_{χ_j} higher than in the stationary case, and the job offer probability from non-employment $\lambda_j^R(s)$ is $\varepsilon_{\lambda_j(s)}$ lower than in the stationary environment.

Therefore, first, in recessions, the probability of losing a job is higher than in normal times and the probability of finding a job is lower than in normal times. Second, I estimate the two shocks to market frictions governing normal and recessionary periods ε_{χ_j} and $\varepsilon_{\lambda_j(s)}$ such that the standard deviation of the E-to-U, U-to-E, and N-to-E transition rates in the model match the standard deviations of their data counterparts. I will show in the analysis of the quantitative results section that this choice of defining recessions and normal times will yield reasonable moments of other in the model untargeted labor market outcomes, such as the standard deviation of the unemployment rate.

5.2 Externally set parameters

Table 8 summarizes the externally set 13 parameters and their values, targets, and sources.[16] The parameters for the exogenous productivity process, the persistence of productivity ρ and the standard deviation of productivity are gender-specific and taken from Chang and Kim (2006). The authors in that paper estimate the AR(1) productivity process separately for men and women using PSID data and controlling for self-selection. Since the estimates are gender-specific but do not distinguish by marital status, I assume that single and married women and single and married men are characterized by similar productivity processes. Since the estimates by Chang and Kim (2006) are obtained for annual data, I use the methodology by Mankart and Oikonomou (2016a) and Chang and Kim (2006) to convert the estimates into monthly values. We can see from table 8 that women have a lower persistence than men and a slightly higher variance. I set the probability of a recession occurring ρ to be equal to 0.986, which implies that a business cycle lasts on average six years in this model with a period being defined as a month. The wages for both spouses are relative to each other and taken from the CPS outgoing rotation group basic monthly files between

[16] MM in the table indicates Married Men, and MW indicates married women.

Targeted Parameters			
Parameter		Value	Source
Persistence of productivity MM	ρ_1	0.98	Chang and Kim (2006)
Std. deviation of productivity MM	σ_1	0.13	Chang and Kim (2006)
Persistence of productivity MW	ρ_2	0.973	Chang and Kim (2006)
Std. deviation of productivity MW	σ_2	0.15	Chang and Kim (2006)
Prob. of recession	ρ	0.986	cycle lasts 6 years
Wage husband	w_1	1	normalized
Wage wife	w_2	0.8	wage gap CPS 1995-2017
Separation shock MM	χ_1	0.008	E-to-U transition rate MM
Job offer (U) MM	λ_1	0.287	U-to-E transition rate MM
Job offer (U) MW	$\lambda_2(1)$	0.2408	U-to-E transition rate MW
Shock to separation MM	ε_{χ_1}	0.0025	Std. deviation E-to-U MM
Shock to job offer MM	$\varepsilon_{\lambda_1(1)}$	0.0765	Std. deviation U-to-E MM
Shock to job offer MW	$\varepsilon_{\lambda_2(1)}$	0.0686	Std. deviation U-to-E MW

Table 8: Externally set parameters

1995 and 2017. I normalize the husband's wage to 1 and the wife's wage is set to 0.8 to match the wage gap among married households in the United States. The parameters governing the labor market frictions for the husband are also taken from the CPS basic monthly files. Since husbands are modelled as exogenous, their separation probability χ_1 and job offer probability from unemployment[17] λ_1 are equal to the average E-to-U transition rate and average U-to-E transition rate for married men, respectively, in the data. The parameters governing the shocks to both labor market frictions for married are as explained in the previous section and set equal to the standard deviation of the E-to-U and U-to-E transition rates in the data. Similarly, I also take married women's job offer probability from unemployment $\lambda_2(1)$ from the data and set it equal to the average U-to-E transition rate for married women in the data. While married women in the model have can choose whether to accept a job offer when they actively search, there is no reason for them to not accept the job offer and therefore, I take it directly from the data. The shock to married women's job finding probability determining good and bad economic times again is set equal to the standard deviation of the U-to-E transition rate in the data as explained in the previous section.

[17] Reminder: Married men can only be unemployed if they are without a job but not leave the labor force.

5.3 Jointly estimated parameters

After externally setting the above parameters, there are 9 parameters left to estimate; the disutility of searching and working parameters $\bar{\kappa}$, ε_{κ}, δ, the labor market friction parameters for the wife χ_2, $\lambda_2(0)$, ε_{χ_2}, $\varepsilon_{\lambda_2(0)}$, the discount factor β, and the correlation of job loss shocks among spouses within a household φ. Table 9 displays the estimated parameters, their values, targets, and source. While I specify one target for each parameter, I estimate the parameters jointly using a Simulated Method of Moments approach in which I minimize the sum of squared differences between the model and data moments.

Internally calibrated parameters						
Description	Parameter	Value	Moment	Target	Model	Source
Cost of search	$\bar{\kappa}$	0.1460	Unemployment rate MW	0.0366	0.0366	CPS
Search shock	ε_{κ}	0.0756	U-to-N transition rate MW	0.1233	0.1237	CPS
Disutility of work	δ	0.4019	Employment-Population ratio MW	0.7164	0.7180	CPS
Discount factor	β	0.994	Avg. Asset to Income Ratio Married	5.90	5.88	Kuhn et al. 2013
Separation shock MW	χ_2	0.0125	E-to-U transition rate MW	0.0070	0.0063	CPS
Job offer (N) MW	$\lambda_2(0)$	0.1204	N-to-E transition rate MW 0.0490	0.0507	CPS	
Correlation separation shock	φ	0.0465	Correlation job loss	0.0289	0.0282	CPS
Shock to separation MW	ε_{χ_2}	0.0018	Std. deviation E-to-U MW	0.0018	0.0017	CPS
Shock to job offer (N) MW	$\varepsilon_{\lambda_2(0)}$	0.0125	Std. deviation N-to-E MW	0.0080	0.0086	CPS

Table 9: Estimated parameters from CPS

5.3.1 Disutility of working and searching

The disutility parameters of searching $\bar{\kappa}$ and working δ directly affect the stocks of married women in different labor market states in the economy. In particular, the average utility cost of searching $\bar{\kappa}$ determines the average unemployment rate for married women in the economy. The higher the utility cost of searching to the household is, the less likely the wife will be to actively search and be unemployed, which lowers the unemployment rate for married women. Similarly, if there was no cost to actively searching for a job, all non-employed married women would choose to search, which in turn would increase the unemployment rate for married women. Thus, the disutility derived from searching and the unemployment rate for married women in the model economy are inversely related. A similar relationship is true for the disutility of working parameter δ. As a reminder, I model the disutility of working as a function of the woman's (shadow) wage, i.e. $\alpha(\varepsilon) = \delta\varepsilon$. The parameter governs the disutility of working for married women, the higher δ, the higher the disutility from working. Since it multiplies the (shadow) wage for married women, it furthermore implies that the disutility of working is even higher for married women who are highly productive in the market. The disutility to the household of the wife working directly impacts the employment-population ratio in the economy. The higher the disutility from working, the less married women choose to work and the lower the employment-population ratio of married women in the model economy. On the reverse, a lower disutility of working implies more married women choose to work and therefore, a higher employment-population ratio. The disutility of working parameter δ can be interpreted as a reduced form way of modelling the different factors that impact a married woman's decision to work or stay out of the labor force.

The shock to the disutility cost of searching parameter ε_κ is estimated so that the average U-to-N transition rate in the model matches the average U-to-N transition rate in the data. As explained previously in the model section, the data features a large number of transitions between unemployment (U) and not in the labor force (N) every month, even after deNUNifying the data, which cannot be explained by the model. Some of these might be spurious or misclassifications in the data. Therefore, I follow Krusell, Mukoyama, Rogerson, and Sahin (2017) and add the search shock so that the model U-to-N transition rate is closer to its data counterpart.

5.3.2 Discount factor

Households in this model can use precautionary savings in addition to labor supply responses to insure themselves against income shocks over the business cycle. Savings in the model depend on the discount factor β. In order to ensure that households in the model do not accumulate too few or too much savings, I estimate the parameter β to match the average assets-to-income ratio for married households in the United States. The data is taken from a project by Kuhn and Rios-Rull (2015) who compile data on U.S. earnings, income, and wealth for different groups using the Survey of Consumer Finances from 1989 to 2013. I use their collected data on average income and average assets for married households for the years 1995 until 2013 and compute the average assets-to-income ratio.

5.3.3 Correlation of job loss shock

The parameter φ governs the correlation of job loss among spouses within a household, i.e. it affects the probability of a household that both spouses lose their jobs within the same period. The higher φ, the higher is the correlation among spouses, and the higher is the probability that both spouses lose their job in the same period. The correlation of job loss shocks among spouses crucially affects a household's ability to self-insure and share risks. In the extreme case of perfect correlation of the spouses' job loss shocks, households would be basically not able to share risks and smooth any income shocks. I estimate the correlation of joint loss in the CPS data as the correlation among spouses to make an employment to unemployment (E-to-U) transition in the same month. In the monthly CPS data, the correlation or probability of joint job loss is about 3 percent. Shore and Sinai (2010) as well estimate the correlation of couples' unemployment events and find that couples have a 5% probability of losing their job in the same year if the spouses are employed in different occupations, and a 16.3% probability of joint loss if spouses are employed in the same occupation.Both Shore (2015) and Gorbachev (2016) support this claim and show that spousal income shocks are becoming increasingly more correlated and it is the large absolute income shocks that are strongly correlated and tend to coincide for men and women in the data.

5.3.4 Labor market frictions

The key parameters in the model and in the quantitative analysis are the job separation and job destruction rate and in particular the differences between normal times and recessions. I estimate these four parameters in two steps as described in section 5.1. First, I estimate the exogenous job destruction shock and job offer probability from not in the labor force for married women along with the other parameters from the stationary model. For married men, I could just use the average of their E-to-U and U-to-E transition rates from the data as their separation and offer probability, respectively, since I assume that their labor market transitions are exogenous. However, for married women I need to estimate them within the model. In the data, individuals might leave employment for two reasons, they quit or they are fired. If individuals lose their job due to either of the two reasons, they can choose to be unemployed or leave the labor force. While I can observe in the data the reason for unemployment[18], i.e. quit or laid off, I cannot observe why someone leaves from employment to not in the labor force. If not all transitions from employment to not in the labor force are voluntary but some occur due to an exogenous destruction shock, the observed E-to-U transition rate in the data potentially understates the true job loss probability. Therefore, I estimate the separation shock within the model and match the model E-to-U transition rate with the data E-to-U transition rate. As can be seen in table 9, the estimated job destruction shock for married women is 0.0125 and overstates the observed average E-to-U transition rate computed from CPS data. Thus, some married women who experience an exogenous job destruction shock

[18]In the Current Population Survey, respondents who report being unemployed in the current month get asked for the reason for unemployment. Possible answer choices are job loser/layoff or temporary job ended, job leaver, re-entrant or new-entrant

choose to leave the labor force and to not actively search for a job.

Similarly, I also estimate married women's job finding probability from not in the labor force, $\lambda_2(0)$, within the model. In the data I only observe when an non-employed individual accepts a job offer and becomes employed but I cannot observe the non-employed individuals who receive a job offer but choose to not accept it and therefore, remain non-employed. Thus, the observed average N-to-E transition rate understates the true job finding probability for a non-employed individuals, if some of the offers are rejected. I estimate the job offer probability from not in the labor force for married women in the model such that the average N-to-E transition rates in the model matches the average N-to-E transition rates in the data. Table 9 shows that while the average N-to-E transition rate for married women in the data is 4.9%, the estimated job arrival probability in the model is 12.04%.

Second, once I obtain the stationary values for the frictions, I estimate the parameters which govern the job offer probability and job loss probability in recessionary and normal times as described in the previous section. In particular, the job destruction shock in recessions is ε_{χ_i} higher and the job offer probability is $\varepsilon_{\lambda_i(s)}$ lower compared to the stationary model and vice versa for non-recessionary times. These shocks are estimated such that the std. deviation of the E-to-U and N-to-E transition rates in the model matches the respective counterparts in the data.

6 Precautionary labor supply in the model

Before analyzing the quantitative results from the model and its cyclical implications, this section illustrates the spousal insurance mechanism, precautionary labor supply, as generated in the model. Furthermore, in the appendix I illustrate how this model also features an added-worker effect. In order to highlight precautionary labor supply in response to a change in aggregate conditions, I fix the productivity level for both spouses and the search shock for the wife, i.e. the following figures show precautionary labor supply for a household where only aggregate risk varies.

Figure 10 illustrates the joint labor market states policy functions for three types of households in non-recessionary times as a function of household's assets. Normal times are characterized by high job finding and low job loss probabilities for both spouses. The top line shows the policy function for a household in which both spouses have a job offer (JJ), for the middle line only the husband has a job offer and the wife is jobless (JL), and lastly in the bottom case both spouses are jobless (LL). The thresholds between different labor market states are a result of the wealth effect. For example, considering the JJ household, if the household is asset-poor, they will choose employment for the wife, whereas if they are asset-rich, the household finds it optimal to not incur the utility cost of working for the wife and chooses not in the labor force for her. If the wife is without a job offer, as it is the case for the JL and LL household, she will actively search (unemployment) if the household is asset-poor and passively search (not in the labor force) if the household has more assets. By construction of the model, the husband will be always employed if he has a job offer as illustrated for the JJ and JL household where he is employed across the whole assets range. Similarly, if the husband is without a job offer, he is unemployed across the whole assets range.

Figure 10 shows that it is never optimal for the household to choose unemployment for the wife if she has a job offer. In the top panel, a wife with a job offer is either employed if the household is asset-poor or not in the labor force if the household becomes richer in terms of their assets, but never chooses unemployment. This is due to the job hoarding behavior by married women in this model. Job hoarding occurs in models of labor supply decisions which feature labor market frictions, such as exogenous job loss and/or job finding probabilities. Similar to Mankart and Oikonomou (2016a) this model features job hoarding for the wife. In general, job hoarding implies that agents in a dynamic model choose to be employed for higher asset levels than it would be statically optimal[19]. If employed agents are deciding whether to remain employed or quit in the current period, they also take into consideration that once they quit, they cannot re-enter into employment right away since there is a probability that they do not receive a job offer. Thus, they remain employed either until they lose their job exogenously or until they accumulated enough assets and then leave the labor force altogether. But they would not choose to quit into unemployment, since then they are incurring the utility cost of searching. Unemployment in this model can be interpreted as workers who are available and want to work but cannot because of frictions, i.e. it is an indicator of desired labor supply limited by frictions. Therefore, individuals who actively search indicate their willingness to work and their desire to be employed which is only limited by the frictions in the model. Thus, an individual who receives a job offer, will always take the job offer and never reject it.

Figure 11 illustrates how a change in aggregate, higher job loss probabilities and lower job finding probabilities, translates into a precautionary labor supply response for the wife. As a result of a change in the aggregate state of the economy, the thresholds shift to the right. Now married

[19]This behavior occurs in both single and dual earner households

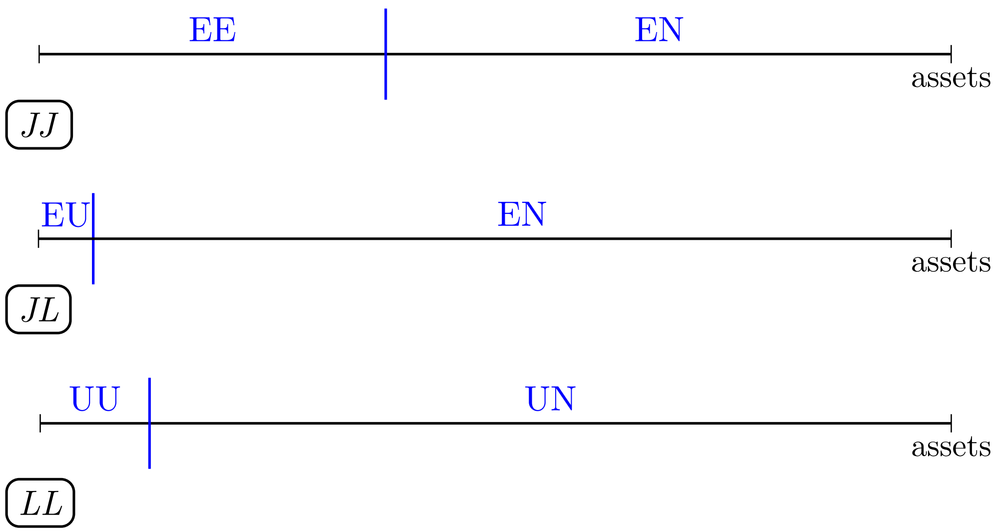


Figure 10: Precautionary labor supply

women will quit from employment or unemployment into not in the labor force for higher asset levels than in non-recessionary times, since the risk of job loss for the husband increases and her probability of finding a job when non-employed decreases. This means for JJ households that hold assets between the old and new threshold, it will now be optimal for the wife to be employed rather than leave the labor force. Thus, the wife chooses to remain employed due to higher uncertainty. Similarly, if the wife does not have a job offer (JL or LL households), she chooses to remain unemployed and keep actively searching as a precaution in the event of job loss of her husband.

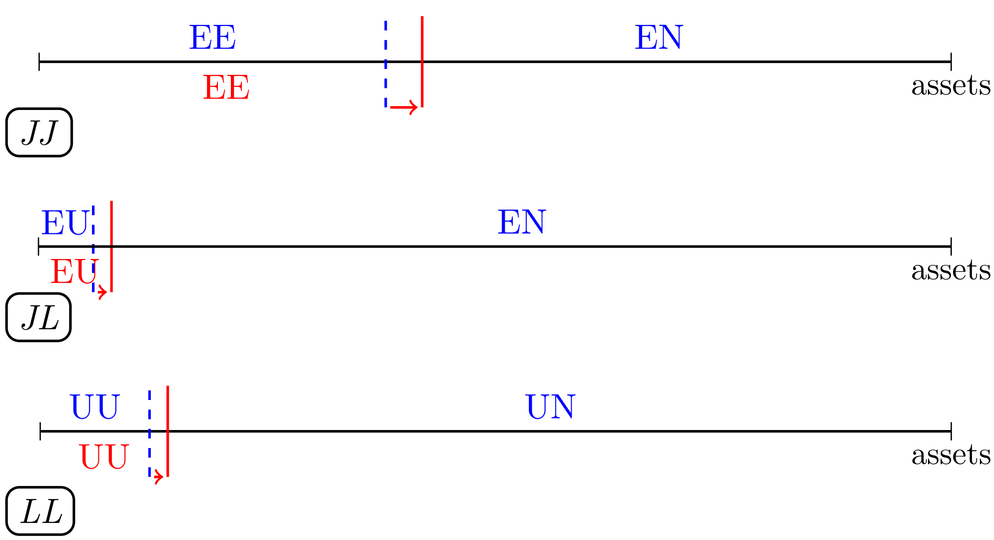


Figure 11: Precautionary labor supply

The size of the aggregate precautionary labor suppy response depends crucially on the number of households that have married women at the margin of employment and non-participation. In the next section, I will show that this is a non-negligible fraction of households.

However, there is a trade-off in the model between lower E-to-N transitions due to precautionary labor supply and more E-to-N transitions due to the increase in exogenous job separations during recessions. Consider figure 12 as an illustration of the latter part of the trade-off. Figure 12 shows the joint labor market states policy functions for a different household. Its productivity level and search cost is fixed, but the wife's productivity is lower and her search cost is higher compared to the previous household. When the economy switches from good to bad times, this household's

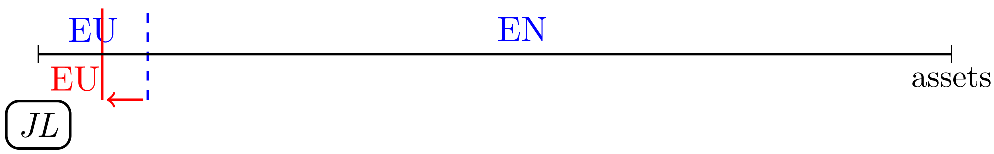


Figure 12: More E-to-N transitions due to higher separation rates

threshold shifts to the left and the wife chooses not in the labor force for assets levels she would have chosen unemployment in normal times. Since she has a relatively low productivity and incurs a high utility cost from searching she leaves the labor force in recessions since searching is costly, her job finding probability decreased, and she has low productivity. Thus, if this married woman was formerly employed and loses her job, she leaves the labor force directly rather than remain unemployed. In recessions, separation rates are higher, so more married women lose their job, but some of them are also more likely to leave the labor force.

Therefore, we have this trade-off in the model between lower E-to-N transition rates because of married women providing precautionary labor supply and higher E-to-N transition rates due to higher job loss rates.

7 Results from Quantitative Analysis

This section shows my main quantitative results and relates it to the empirical findings and stylized facts from previous the sections.

7.1 Stationary Results

Table 10 shows the transition rates generated in the stationary model and for the U.S. economy between 1995 and 2017. I targeted four rates in my model estimation, the E-to-U transition rates, the U-to-E transition rate, the N-to-E transition rate, and the U-to-N transition rate. I explained in

	Data			Model		
	E (t)	U (t)	N (t)	E (t)	U (t)	N (t)
E ($t-1$)	0.9738	0.0070	0.0192	0.9728	0.0063	0.0208
U ($t-1$)	0.2408	0.6329	0.1241	0.2404	0.6362	0.1237
N ($t-1$)	0.0483	0.0120	0.9397	0.0507	0.0213	0.9280

Table 10: Model and data levels of transition rates for married women

the previous section that despite deNUNifying the data, about 12 percent of unemployed individuals every month flow from unemployment into not in the labor force. The stochastic disutility of searching for married women helps matching the number and table 10 shows that the model does a good job in matching the average U-to-N transition rate. Furthermore, I estimated the outflow of employment due to an exogenous separation shock (E-to-U transition rate) and inflow into employment from unemployment and not in the labor force (U-to-E and N-to-E transition rate) and the model matches them both well. All remaining transition rates are not targeted, but the model does a good job in matching their data counterparts. In particular, the stationary model generates average E-to-N transition rates that are close to the average E-to-N transition rate of married women in the data. This implies that the model does a good job in matching the number of married women crossing the participation margin from employment each month and it captures married women's idiosyncratic shocks well. Table 11 shows the targeted employment-population

Stock	Data	Model
Employment-Population Ratio	71.64%	71.80%
Unemployment rate	3.66%	3.66%
Labor force participation rate	74.17%	74.53%

Table 11: Model and data labor market stocks for married women

ratio, unemployment rate, and labor force participation rate for married women in the model and data and shows that the model matches them well as well. The stochastic disutility of working and searching does a good job in matching the number of women crossing the participation margin as well as the number of employed and unemployed married women.

7.2 Cyclicality of Stocks

The next step is to evaluate the cyclicality of the labor market stocks in my model compared to the data. Much of the implications of my model depend on the definition of labor market risk in recessions compared to normal times. Table 12 shows the standard deviations of the unemployment rate, employment-population ratio, and not in the labor force participation rate in the model and data. These three moments are untargeted but provide a good benchmark for evaluating the cyclical properties of my model and the definition of risk in recessions and normal times. We can see that the

Stock	Data	Model
Standard deviations		
Unemployment rate MW	0.0091	0.0101
Employment-Population ratio MW	0.0091	0.0139
Labor force participation rate MW	0.0082	0.0102

Table 12: Cyclicality of labor market stocks

model matches the standard deviations of the three stocks fairly well. The model slightly overstates the standard deviation of the unemployment rate. This is because the model also slightly overstates the cyclicality of the N-to-U transition rate and therefore, more married women are flowing into unemployment in recessions than in the model. Furthermore, the model also slightly overstates the employment-population ratio and the labor force participation rate. Again this is a result of the model slightly overstating the cyclicality of the N-to-U and also the N-to-E transition rate.

7.3 Main Result: Cyclicality of transition rates

This section presents my first main result and analyzes how much of the procyclical E-to-N transition for married women in the data can be explained by aggregate risk in the form of cyclical labor market frictions and precautionary labor supply. I compute cyclicality of transition rats both in the data and in the model by regressing the log transition rate on the log unemployment rate and the reported cyclicality measure is the regression coefficient from this regression.

Married women		
Transition rate	Data	Model
E-to-N	-0.2514	-0.0889

Table 13: E-to-N transition rate

Table 13 shows that the estimated regression coefficient is negative both in the data and in my model, and furthermore, cyclicality of the E-to-N transition rate in the model is about 35% of the cyclicality of the E-to-N transition rate. This result shows that, first, cyclicality of risk in the form of higher job loss and lower job finding probabilities in regressions leads to procyclical E-to-N transition rates in the model. And therefore, married women exhibit precautionary labor supply behavior in the model in the presence of this higher risk in recessions. Second, while the coefficient is smaller than in the data, my proposed mechanism of cyclical labor market frictions and precautionary labor supply is able to explain 35% of the observed cyclicality in the data.

This finding suggests that a portion of the cyclicality of employment and hours displayed by married women stems from the precautionary labor supply behavior in response to an increase in her non-labor income risk due to her husband's higher job loss probabilities. In particular, married women are relatively less likely to leave the labor force in recessions and are more likely to be attached to employment as a result of higher income risk during recessions faced by their spouse. Thus, this relatively simple mechanism of precautionary labor supply seems to explain a significant part of married women's hours and employment volatility.

Married women		
Transition rate	Data	Model
E-to-E	0.0024	-0.0014
E-to-U	0.3648	0.4899

Table 14: E-to-E and E-to-U transition rate

Table 14 shows the cyclicality of the E-to-E and E-to-U transition rates for married women. While in the data, the E-to-E transition rate acyclical to mildly countercyclical, my model produces an acyclical to mildly procyclical E-to-E transition rate. The reason for that becomes clear when we analyze both flow rates from employment to non-employment. While my model generates a countercyclical E-to-U transition rate that is slightly more cyclical than its data counterpart, the E-to-N transition rate is only about 28% of its data counterpart. Thus, my model features a similar outflow from employment to unemployment in recessions, but it does not generate the same reduction in flows from employment to not in the labor force. Therefore, the E-to-E transition rate in the model is slightly procyclical, since the reduction in E-to-N does not make up for the increase in E-to-U flows in recessions.

Table 15 explores the insurance mechanism precautionary labor supply in more detail by computing counterfactuals to analyze how much of married women's procyclical E-to-N transition rate is due to the cyclicality of their husbands' labor market risk and how much is due to their own labor market risk.

	Baseline	No cyclical risk women	No cyclical risk men
Cyclicality	-0.0889	-0.0770	-0.0107
Change	-	-13%	-88%

Table 15: Counterfactual analysis

In compare the baseline results to two counterfactuals. In the first one, I shut down married women's cyclicality of risk and set her job loss and job finding probabilities equal to the values derived in the stationary model. In the second counterfactual, I shut down married men's risk and set his job loss and job finding probability equal to the average E-to-U and U-to-E transition rate for married men in the data.

Table 15 shows that shutting down married women's cyclicality of risk barely affects the procyclicality of the E-to-N transition rate and the estimated cyclicality coefficient is -0.0770 compared to -0.0889 in the baseline model, which implies a decrease by 13 percent. This means that a significant portion of the procyclicality of married women's E-to-N transition rate is due to the cyclicality of risk faced by her husband.

In column 3 of table 15, I analyze the cyclicality of the E-to-N transition rate if married men's job loss and finding probability do not vary with the business cycle. In this case the estimated coefficient is -0.0107 and 88 percent lower compared to the baseline case. The E-to-N transition rate is still procyclical since the married woman faces countercyclical job loss and procyclical job finding probability and her husband is still likely to lose his job in recessions, just not more likely than in normal times. However, the procyclicality of the E-to-N transition rate is substantially lower than in the baseline model. This implies that a substantial part of the procyclical E-to-N transition rate is due to the cyclical risk of the husband rather than due to job hoarding behavior of married women due to her own cyclical risk.

8 Consumption volatility

In this section I am going to quantify how much spousal insurance married women provide over the business cycle by computing the reduction in consumption volatility. In particular, I compute consumption volatility in the baseline model and compare it to consumption volatility in a single-earner married household. This is a married household, in which only the husband works and the wife never works. Thus, married men are modelled as in the main model, but married women never work.

I follow Blundell, Pistaferri, and Preston (2008) and compute consumption volatility as the cross-sectional variance of consumption growth (Var(Δc)) and income volatility as the cross-sectional variance of income growth (Var(Δy)). Then consumption volatility is defined as the ratio of consumption volatility over income volatility $\frac{\Delta c}{\Delta y}$.

I find that in the baseline model consumption volatility is 30.89% lower than in the single-earner married household model. This implies that spousal insurance provided by married women lowers consumption volatility by 30.89% over the business cycle.

In the next step, I am going to quantify the importance of different idiosyncratic risks and shocks to the degree of spousal insurance provided by married women.

9 Shapley-Owen Decomposition

In this section I evaluate the contribution of different sources of risk for married women to the degree of precautionary labor supply and consumption volatility. In particular, this section analyzes how much of precautionary labor supply and consumption insurance is a result of differences in cyclical risk between men and women, i.e. how much is due to differences in risk vs how much is due to insurance motives.

In order to calculate the contribution of the different sources of risk I decompose the contribution of each form of risk and compute the differential impact of each source of risk on precautionary labor supply and consumption insurance. I decompose my findings from the baseline model into the contribution of the following three shocks: (i) gender-specific differences in level and cyclicality of job loss/finding probabilities, (ii) gender-specific differences in the productivity process, and (iii) correlation of job loss probabilities for spouses within the same household. For the first set of shocks, gender-specific differences in level and cyclicality of job loss/finding probabilities, I assign married women the level and cyclicality of married men's job loss and job finding probabilities. For the second set, gender-specific differences in the productivity process, I assign married men's productivity process parameters to married men. Lastly, for the correlation of job loss probabilities for spouses within the same household, I set the correlation equal to zero.

I compute a Shapley-Owen decomposition, which is commonly used in the applied micro literature and derives from a game-theoretic concept.[20] The idea is that the order of shutting down risks matters since the risks interact with each other. Therefore, I compute counterfactual simulations for all possible permutations of shutting down risks and then compute the marginal contribution for each risk including the risk or shutting it down. The contribution of each risk then is the average of all marginal contributions.

Table 16 shows the contribution of each risk to the procyclical E-to-N transition computed in the baseline model and the implied impact on spousal insurance. The first column shows the

Counterfactual	Contribution	Impact spousal insurance
Married men's labor market frictions	50% ↑	Less
Men's productivity process	8% ↑	Less
Uncorrelated shocks	37% ↓	More

Table 16: Decomposition of procyclical E-to-N transition rate

contribution of each set of risks to the procyclicality of the E-to-N transition rate. In the baseline model, the degree of cylicality was measured by regressing the log E-to-N transition rate on the log unemployment rate and the resulting coefficient of -0.0889 is a measure of cyclicality. In the first row, if married women had married men's labor market frictions the coefficient from the baseline model would be 50% higher. Since the coefficient is negative, this implies that the coefficient is smaller in absolute magnitude and therefore, the E-to-N transition rate would be "less" procyclical. This implies that if married women faced the same risks as married men, spousal insurance would be reduced by about half. This result shows that spousal insurance in the form of precautionary labor supply is not simply a result of differences in risks, but about half of the response comes from insurance motives.

Differences in the productivity process between men and women only has a small impact on spousal insurance provided by married women and only contributes for about 8 percent. If shocks were uncorrelated, then not surprisingly, households are able to insure themselves better, and therefore, married women could provide more spousal insurance.

Table 17 shows that same decomposition but for the consumption volatility measure. The first column again shows the contribution of each counterfactual to consumption volatility. If married women had the same cyclicality of risk as married men, then consumption volatility would be 16.39% higher than in the baseline model where married men and married women face different job loss and job finding probabilities over the business cycle. Differences in the cyclicality of risk

[20] This type of decomposition as part of a structural macro model was first used by Michaud and Wiczer (2018).

between men and women is the most important contributor to consumption volatility for married households. If married men and women in the model had the same productivity process only has a small impact on consumption volatility. Similarly, if job loss shocks for spouses were uncorrelated,

Counterfactual	Contribution	Consumption volatility
Married men's labor market frictions	16.39% ↑	More
Men's productivity process	5.87% ↑	More
Uncorrelated shocks	-3.57% ↓	Less

Table 17: Decomposition of consumption volatility

this would lower consumption volatility by 3.57%.

10 Conclusion

In this paper I document that married women have a lower cyclicality in hours and employment than married men and single individuals. I find empirically that married women are more attached to employment and less likely to leave the labor force in recessions relative to both normal times and married men and single individuals, which leads to procyclical employment to not in the labor force (E-to-N) transition rates for married women. In light of the procyclical E-to-N transition rates for married women, I propose a novel mechanism of spousal insurance: precautionary labor supply. While a married woman might quit from employment to not in the labor force in normal times due to a positive shock to her value of non-employment or a positive shock to her husband's employment, she might choose to remain employed and not quit in recessions. In recessions, her non-labor income risk increases due to her husband's higher job loss probability and therefore, she increases her labor supply and remains employed.

I build a quantitative model to analyze married women's labor supply decisions over the business cycle and to derive implications for spousal insurance and the cyclicality of employment. The model features incomplete assets markets, aggregate risk in the form of high job loss and low job finding probabilities in recessions, and endogenous movements between employment, unemployment, and not in the labor force for married women.

I find that the cyclicality of risk and the channel of precautionary labor supply account for about 30 percent of the procyclical E-to-N transition rate in the data. Furthermore, I show that differences between men and women account for about half of the precautionary labor supply response, whereas the other half is due to insurance motives.

Since spousal insurance is potentially an important mechanism to smooth consumption for married households over the business cycle, I compute the reduction in consumption volatility due to spousal insurance provided by married women. In find that consumption volatility is about 30 percent lower in the model with married households compared a single earner married household.

These findings are potentially important to evaluate the risk households face over the business cycle and to derive implications for the interaction of formal and informal insurance. Optimal unemployment insurance, e.g. depends on the importance of spousal insurance to the household and to what degree spousal insurance might be crowded out by formal insurance. This paper offers new insights into how households insure themselves over the business cycle and how much of the risks they are able to insure themselves.

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11 Appendix

11.1 Data

11.1.1 Description Current Population Survey (CPS)

I use data from the Current Population Survey for the years 1995 until 2017 and I use both the basic monthly files as well as the Annual Social and Economic (ASEC)[21] supplement.

The CPS is the largest household survey in the United States and the primary source of monthly labor force statistics. It contains information about employment, earnings as well as individual and household socio-economic characteristics of about 50,000 to 60,000 households each month representing the non-institutional population of the United States. The ASEC additionally provides annual data of about 75,000 household covering in detail social and economic characteristic, such as work experience, income, and hours per week for worked. The reference time period for the ASEC is the previous calendar year and the information is released every March. The basic CPS files, on the other hand, survey households every month and the reference period is the calendar week which includes the 12th day of the month[22].

A great advantage of the CPS is that it provides information not only about the household head but all household members, in my case it is important that I have detailed information about both the husband, who is the household head in most cases but also about the wife. Since the CPS allows to link spouses residing in the same dwellings unit, I can get intensive information about married couples' characteristics, and spouses' behavior and choices. Furthermore, the monthly availability of data and the possibility of linking households and individuals across months[23] makes the CPS well-suited to study questions at business cycle frequency.

In the following I will only use data covering the years 1995 and 2017. Labor force participation and employment for women grew strongly until the mid-1990s, by choosing 1995 as my start date, I pick a time period, where the growth slowed down and there is no strong trend present for married women in many labor force statistics. I face the trade-off that I abstract from the trend but this time period also only covers two recessions.[24]

Futhermore, I only consider individuals that are between 25 and 55 years old and are not members of the Armed Forces. I choose the age bounds in order to abstract from any effects due to

[21]Before 2003 known as the Annual Demographic File (ADF), also known as the "March" supplement

[22]Except for months with major holidays

[23]See later section on transition rates about more details .

[24]For robustness, I consider an extended time period in the appendix, 1990-2017, such that my time period includes an additional recessions but also a short period of an upward trend in women's participation.

education or retirement. Married couples are defined as legally married couples where both spouses are present live at the same physical address. Since the CPS requires spouses to live at the same physical address and be married to link them, I do not consider couples where the spouse is not present and furthermore, I also cannot consider cohabitating couples. Signle men and women are defined by being "not married", i.e. it includes never married, divorced, and widowed men and women.

11.1.2 Linking Households in the CPS and Computing Transition Rates

I will start by briefly reviewing the feature of the CPS that allows for the short panel of individuals and household. The CPS surveys households in a rotation pattern[25], which means households are interviewed for 4 consecutive months, rotated out for 8 months, and then interviewed again for 4 consecutive months. Therefore, not accounting for attrition, about 75 percent of households in a given month can be linked across two consecutive months, and about 50 percent can me linked across three consecutive months.

(i) I start by linking households and individual household members across subsequent months. Since the unique household and personal identifiers in the CPS correspond to the physical location of the household, we can only identify and link individuals who have not moved between the two observation periods. Furthermore, following Madrian and Lefgren (1999), I use type of household, as well as sex and age of household members as indicators to check match quality.[26] Additionally, I use marital status as a measure to rejecting a match, since I am particularly interested in features by sex and marital status. The second issue that arises when linking individuals across months is that it is not possible to link the months May 1995 until September 1995. I will address this again once I describe how I compute transition probabilities, but I will linearly interpolate the values for the missing months.

(ii) I use the linked data to compute gross worker flows for each month, i.e. the number of individuals transitioning between different labor market states each month, as illustrated in table 18. The table iilustrates the flows between employment (E), unemployment (U), and not in the labor force (N). Each worker flow IJ, for $I = E, U, N$ and $J = E, U, N$ is computed by counting the number of individuals that were in labor state I in the previous month and in labor state J in the current month. The problem that arises with this practice and which has been

[25]Commonly referred to as the 4-8-4 pattern

[26]Type of household, sex, and age are characteristics that should not change between months if we are still observing the same household/individual.

	Current month		
Previous month	Employed	Unemployed	Not in Labor Force
Employed	E-to-E	E-to-U	E-to-N
Unemployed	U-to-E	U-to-U	U-to-N
Not in Labor Force	N-to-E	N-to-U	N-to-N

Table 18: Gross worker flows

addressed by Shimer (2012) and Elsby, Hobijn, and Şahin (2015) among others, is that in general it is difficult to distinguish between an unemployed and not-in-the-labor force individual which leads to classification errors and as result we get spurious transitions between unemployment (U) and not-in-the-labor force (N).[27] In general, there are two different approaches of addressing this issue, the first one is the Abowd and Zellner (1985) correction and the second one is a method known as deNUNification. I will follow the deNUNification method as described in Elsby, Hobijn, and Şahin (2015). The Abowd and Zellner (1985) correction method relies on re-interviews of CPS survey participants which have last been conducted in the mid-1990s. Thus, this method relies implicitly on the assumption that the classification error is both time invariant and has not changed over time. Due to these shortcomings I will use deNUNification instead. Elsby, Hobijn, and Şahin (2015) check for comparison and robustness of the two different methods and show that there are slight differences in levels but the cyclical properties of the different worker flows remain unaffected.

The main idea of the deNUNification method is to identify misclassification by frequent reversals between unemployment (U) and not in the labor force (N). Therefore, if an individual's transitions between three consecutive months is NUN or UNU, these are classified as frequent reversals and recoded to NNN and UUU, respectively. Therefore, I apply this method and deNUNify my data to compute gross worker flows and transition rates based on the deNUNified data.

(iii) I use the deNUNified data and gross worker flows to compute transition probabilities between employment, unemployment as the number of individuals with labor force status I in the previous month and labor force status J in the current month relative to all individuals with labor force status I in the previous month.

(iv) Lastly, since my matched data displays high seasonality, I use the X-13ARIMA-SEATS seasonal adjustment program from the Census Bureau to seasonally-adjust the transition rates for married women, married men, single men, and single women.

(v) Due to the monthly frequency of the data, the transition rates display a high level of noise,

[27] See for example Abowd and Zellner (1985), Poterba and Summers (1986), and Elsby, Hobijn, and Şahin (2015) for a more detailed discussion.

in order to reduce some of the noise, I apply a 12-month moving average to the transition rates in the following (See the appendix for the raw transition rates).

11.1.3 Implications of Short-term unemployment for job-to-job transitions

This section shows robustness checks regarding the transition rates. In particular, it is well known that some short spells of unemployment are due to job-to-job transitions and individuals looking for better jobs. Therefore, in the following I exclude individuals with short spells of unemployment from the analysis and show that the cyclical results regarding the transitions of individuals between different labor market states still hold. I identify individuals who are unemployed for one month and were employed before and become employed afterwards, thus, individual with the following transition: E-U-E. I exclude them from the analysis which leaves me with the following transition rates: As can be seen in the table, the responsiveness of the E-to-E and E-to-N

Transition rate	Estimated coefficient			
	Married women	Married men	Single women	Single men
E-to-E	0.0025***	-0.0055***	-0.0035***	-0.0081***
	(0.0008)	(0.0005)	(0.0010)	(0.0012)
E-to-U	0.5577***	0.9228***	0.4088***	0.7630***
	(0.0665)	(0.0730)	(0.0802)	(0.0850)
E-to-N	-0.2517***	0.1884***	0.0699	0.0636
	(0.0366)	(0.0637)	(0.0606)	(0.0575)

transition rates to fluctuations in the (log) unemployment rate is almost unchanged, only the estimated coefficient on the E-to-U transition rates increased, which implies more procyclical E-to-U transition rates.

11.1.4 Implications of Short-term non-employment for job-to-job transitions

Similarly, I can control for whether short spells of non-employment are driving my results. Therefore, I exclude individuals from my analysis who experience one month spells of non-employment after and followed by employment. This implies individuals with an E-N-E transition rate. The following table shows that these individuals are few and excluding them does not change my initial findings. Hence, the procyclicality of married women's E-to-N transition rate and acyclicality of the E-to-E transition rate is not affected by short-term spells of non-employment (both unemployment and not in the labor force) as a result of, for example, frequent job-to-job transitions.

Transition rate	Estimated coefficient			
	Married women	Married men	Single women	Single men
E-to-E	0.0006	-0.0069***	-0.0029***	-0.0093***
	(0.0008)	(0.0006)	(0.0009)	(0.0012)
E-to-U	0.3478***	0.6803***	0.2315***	0.4456***
	(0.0572)	(0.0587)	(0.0661)	(0.0567)
E-to-N	-0.2491***	0.2841***	0.0883***	0.2033**
	(0.0482)	(0.0828)	(0.0267)	(0.0847)

11.1.5 Occupation and Industry distribution for married and single women

First, if the composition was the main driver of the low hours cyclicality for married women, we would expect to see a similar cyclicality for single women, since their shares among different industries and occupations is very similar to the ones of married women as shown in tables 19 and **??**[28].

Industry	Married	Single	Statistically different
Agriculture, Forestry, and Fisheries	1.57%	1.02%	***
Mining	0.21%	0.20%	*
Construction	1.60%	1.32%	***
Manufacturing	9.30%	10.30%	***
Transportation, Communications, and other Public Utilities	4.01%	4.96%	***
Wholesale Trade	2.20%	2.11%	***
Retail Trade	14.30%	17.21%	***
Finance, Insurance, and Real Estate	8.56%	7.69%	***
Business and Repair Services	5.17%	6.19%	***
Personal Services	4.49%	5.70%	***
Entertainment and Recreation Services	1.45%	1.79%	***
Professional and Related Services	42.59%	36.06%	***
Public Administration	4.54%	5.47%	***

Table 19: Share of married and single women among different industries

11.2 Model

11.2.1 Correlated job loss shocks

The correlation of shocks implies that the wife's displacement shock depends on her husband's displacement shock but is independent of her husband's current labor market state. This means

[28] The classification is following the IPUMS classification by Flood, King, Rodgers, Ruggles, and Warren (2018) and provides consistent industrial and occupational codes by following the 1990 Census Bureau classification system. The recoding by IPUMS allows for comparing industries and occupations over time since the raw data experiences a break in 1994 due to a change in the classification

that on average the probability of job loss for the wife is the same regardless of whether her husband is employed or unemployed in the current period.

If the household is currently EE, i.e. both spouses are employed, then the wife's probability of job loss is the sum of her losing the job and the husband loses his job and her losing the job and the husband keeps his job:

$$(1-\chi_1)(1-\varphi)\chi_2 + \chi_1\left[(1-\varphi)\chi_2 + \varphi\right] \tag{11}$$

$$=(1-\varphi)\chi_2 + \varphi\chi_1 \tag{12}$$

$$=\tilde{\chi}_2 \tag{13}$$

11.2.2 Added-worker effect in the model

First, the added-worker effect describes the situation in which the secondary spouse, in the model the wife, joins the labor force into either employment or unemployment following job loss by the primary earner, in the model the husband. Thus, it captures the change in labor market state by the wife in response to the husband's movement from employment to unemployment. The added-worker effect is present regardless whether the economy is in a recession or not. There are just more households affected during recessions since more husbands are going to lose their jobs.

Figure 13 illustrates a situation in which the added-worker effect occurs, in particular a case in which the wife joins the labor force into employment. Figure 13 shows the household's policy functions for the joint labor market states for both spouses as functions of the household's assets. The top line shows the joint labor market states policy function in which both spouses have a job offer (JJ). The bottom line illustrates a household, in which the husband has a job offer and the wife is jobless (JL). We start by considering the top line. The husband is employed at all asset levels because he has a job offer and due to the definition of his optimization problem. The wife also has a job offer, but the household can choose the optimal labor market state for her given their asset level, the spouses' productivity levels, and the husband's labor market state. Figure 13 shows that the household finds it optimal to have the wife employed if they are asset-poor and choose her to be not in the labor force if they have more assets. This is the result of a standard wealth effect.

Now suppose the husband loses his job due to an exogenous job destruction shock and unexpectedly moves from employment to unemployment. This constitutes a change in the type of household from JJ to LJ. Now for a certain range of assets levels (identified here as the red bracket), the household will find it optimal to have the wife employed rather than not in the labor force since the job loss of the husband means lower household wealth. So for households close enough to the wife's threshold between non-employment and employment, job loss for the household results into the wife joining the labor force, i.e. into the added-worker effect.

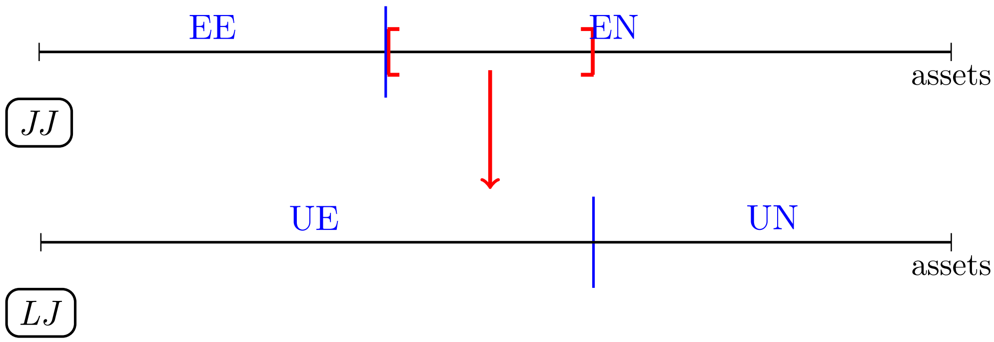

Figure 13: Added-worker effect into unemployment

Figure 14 similarly illustrates the added-worker effect, however, now the wife does not have a job offer and therefore, she joins the labor force into unemployment.

The top line illustrates the joint labor market states policy function for a household in which the husband has a job offer and the wife is jobless (JL). The bottom line shows a household in which both spouses are jobless (LL). Start by considering the top line. The husband is employed for all asset levels if he has a job offer by definition of his optimization problem. The wife does not have a job offer and therefore is non-employed. She will be unemployed if the household is asset-poor and not in the labor force once the household has enough wealth.

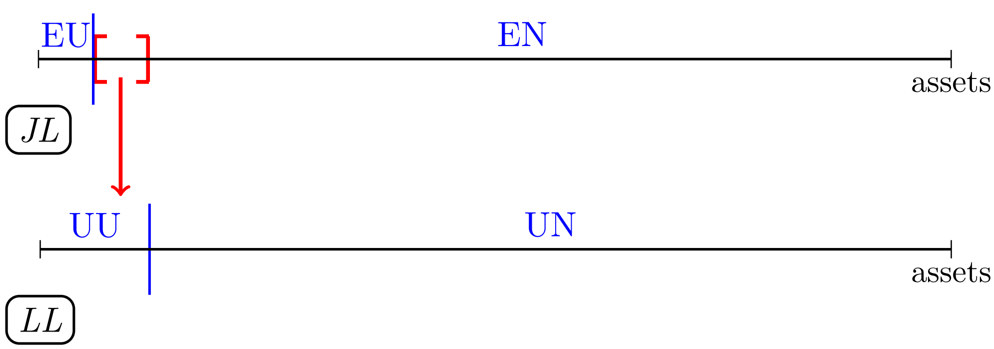

Figure 14: Added-worker effect into unemployment

Now consider the husband loses his job through an exogenous job destruction shock, which constitutes an unexpected movement from employment to unemployment. In figure 14, this can be seen from moving to the top line to the bottom line, i.e. the household went from being a JL household to being a LL household. Now for household in the asset range indicated by red brackets it will be optimal to choose active search for the wife and therefore, she will be considered unemployed. Similar to the added-worker effect into employment, for households close enough to the wife's threshold between unemployment and not in the labor force, job loss for the husband is associated with the wife joining the labor force into unemployment, and therefore, an added-worker effect.

Both added-worker effects shown are for a fixed productivity level for both spouses and a fixed aggregate state of the economy. The size of the added-worker effect in the model will crucially depend on the number of households which are close to the wife's thresholds between employment and not in the labor force and between unemployment and not in the labor force as well as on the size of the husband's job loss probability. One would expect that during recessions, times in which husbands experience a higher job loss probability, would feature more wives making the aforementioned transitions conditional on being close to the threshold since more husbands are being laid off.

11.2.3 Joint distribution over labor market states

Table 21 shows that the model, moreover, does a good job in also matching households' joint distribution over the different labor market states.[29]

Joint household labor market state	Data	Model
EE	71.01%	68.37%
EU	2.13%	2.27%
EN	23.71%	25.36%
UE	2.12%	2.62%
UU	0.28%	0.30%
UN	0.75%	0.61%

Table 20: Joint distribution of husband and wife over labor market states

Table 21 shows that the model also matches the cyclicality of the joint labor market states of both spouses well. It only understates the cyclicality of EN households which is because the model also understates the cyclicality of the E-to-N transition rate for married women and less women remain employed and not leave out of the labor force than in the data. Therefore, the model also overstates the cyclicality of EE and EU households.

[29]The first letter indicates the husband's labor market state, and the second the wife's, so for example, EU indicates that the husband is employed and the wife is unemployed.

Joint household labor market state	Data	Model
EE	-0.8549	-0.9094
EU	0.9159	0.9939
EN	-0.3153	-0.1931
UE	0.9240	0.9448
UU	0.9365	0.9029
UN	0.8713	0.8917

Table 21: Cyclicality of joint labor market states

11.2.4 Cyclicality of all transition rates for married women

Table 22 shows the cyclicality of all transition rates for married women. In each case, cyclicality is computed as the regression of the log transition rate on the log unemployment rate. While the model does overall well in capturing the cyclicality of each transition rate, it fails to capture the procyclicality of the U-to-N transition rate. While in the data, married women are less likely to leave the labor force from unemployment when the unemployment rate is high, in the model they are more likely to leave the labor force from unemployment. Otherwise, the model does a good job in matching the direction of cyclicality.

Married women		
Transition rate	Data	Model
E-to-E	0.0024	-0.0014
E-to-U	0.3648	0.4899
E-to-N	-0.2616	-0.0889
U-to-E	-0.8193	-0.6021
U-to-U	0.3431	0.2167
U-to-N	-0.2418	0.1907
N-to-E	-0.2863	-0.3602
N-to-U	0.4309	0.9048
N-to-N	0.0090	-0.0009

Table 22: Cyclicality of married women's transition rates