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# A spouse and a house are all we need? Housing demand, labor supply and divorce over the lifecycle

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# A spouse and a house are all we need? Housing demand, labor supply and divorce over the lifecycle*

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**Abstract**

To analyze the impact of changes in the value of marriage on household decisions, we present a limited commitment framework of household behavior in which decisions are made regarding labor supply, divorce and housing demand over the lifecycle. We identify and estimate our structural model using exogenous variation in female labor supply and divorce rates due to the *White v. White* case in England. We conclude that limited commitment dampens the added worker effect, while the changes in the value of marriage due to a housing price shock have an asymmetric impact on individual welfare both across gender and marital state. We also show that tightening the credit market in

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different ways can lead to opposite behavior in terms of household savings and female labor supply.

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**JEL codes**: D14, D15, J12, J22, K36, R21

# 1 Introduction

Marriage, beyond companionship, offers individuals several sources of material benefits. Most notably are economies of scale in consumption and risk insurance (Browning et al., 2014). A less-studied aspect of the economic benefits from marriage is the increased possibility for couples to accumulate housing wealth that often require collateralization and insurance from unexpected falls in income or price shocks. At the same time, the presence of housing wealth impacts many household decisions. First, the fact that a majority of households' wealth is illiquid means that the savings channel will be less efficient to insure against income shocks. In addition, the presence of borrowing constraints (often directly tied to income) implies that the secondary earner's labor supply becomes a much more central source of intra-household insurance against income and other shocks (Blundell et al., 2016; Wu and Krueger, 2021).[1] Second, there is a direct relationship between (housing) wealth and marital stability (Chang, 2020; Lafortune and Low, 2020). In a direct way since divorce typically leads to liquidating (and sharing) housing wealth, but also indirectly as a commitment device to keep both partners in the marriage.

Mostly, these interactions have been studied using exogenous marital transitions, which provides good insights at the aggregate level, but might be less appropriate to study the interesting joint dynamics between housing demand, labor supply and stability of marriage. In particular, the decision to stay together with one's spouse depends crucially on the surplus of marriage over the outside option of living alone. Also the ability to accumulate more (housing) wealth together adds to the value

[1] This channel is usually referred to as the *added worker effect* and has been shown to be a key factor in determining the amount of self-insurance household members can provide to each other.

of marriage and therefore makes it less likely that spouses would want to separate. The goal of this paper is to endogenize divorce and to structurally analyze household behavior in the context of changes in the value of marriage caused by shocks in income and housing prices, or, alternatively, changes in divorce legislation and credit market policies.

**Structural model.** To answer our research questions, we use a limited commitment framework, in the spirit of Mazzocco (2007), in which individuals endogenously decide to stay together with their spouse and where (opposite-sex) married couples make consumption, labor supply and housing demand choices over the lifecycle. Limited commitment implies that each individual needs to be as well off inside marriage as outside, implying a sort of participation constraint where at each point in time the value of marriage needs to exceed the value of divorce for each spouse. If this is no longer the case, e.g., due to an unexpected and sufficiently large shock to the household's wealth and/or income, the couple renegotiates the relative share of household resources to make each spouse again better off staying together, or otherwise they will decide to divorce.

An important feature of our model is the inclusion of post-divorce asset division rules and leverage-based borrowing constraints, both affecting the value of marriage and intra-household decisions. For the divorce legislation, we use quasi-natural variation in policy pertaining to post-divorce asset division in England versus Scotland, the so-called *White v. White* case, to identify the process of intra-household resource sharing, akin to the strategy pursued in Voena (2015). More specifically, we first analyze empirical patterns using both panel data on labor supply and time series on marital transitions. Using a difference-in-difference (DiD) framework, we establish a link between labor supply responses to this policy change and homeownership. In particular, married women living in property-owning couples reduce their working hours by about 2 hours per week, whilst we do not find any significant changes amongst married women who rent their property. In addition, we also use time series on marital transitions to establish responses of the (crude) divorce rate to the *White v. White* case. We show how our structural model can replicate these empirical findings.

With regard to the leverage-based borrowing constraints, we include typical loan-to-income (LTI) and loan-to-value (LTV) constraints, which put a limit to the amount of debt the household can accumulate. The restriction pertaining to the LTI ratio postulates that debt is constrained by a multiple of the household's income, with the possibility for the primary and the secondary earner's income to be weighted asymmetrically. The LTV-constraint imposes a limit in terms of a fraction of debt with regards to the value of the house. In our model, though we assume that the male spouse always works full time, the wife's labor supply is assumed to be variable, which affects the household's ability to borrow through the LTI constraint.[2] As such, shocks in income and housing prices, or public policies related to tightening the LTI or LTV constraint will have a direct impact on the value of marriage (in terms of insurance and accumulating wealth) and household behavior.

**Counterfactual exercises.** We use our dynamic model to conduct several counterfactual exercises. First, we evaluate the relative impact the lack of commitment has on the insurance value of marriage. To do this, we simulate the effects of a large, permanent shock to the husband's income and focus on the wife's labor supply response. We find a substantial dampening of the added worker effect (on the extensive margin, i.e., participation in the labor force) by revisions in intra-household bargaining power. As such we illustrate how ignoring such revisions can cause a serious upward bias in the amount of insurance households can provide to themselves. This observation is relevant for the debate on how the optimal level of public insurance (e.g., unemployment benefits) depends on the self-insurance value. (Choi and Valladares-Esteban, 2020)

Next we study the individual welfare effects of a significant but transitory drop in housing prices. We find that particularly single women, regardless of whether they own or rent a property, are most likely to incur welfare costs of such sudden changes in housing value. This is mostly driven by the fact that single women are in majority

[2] This is in line with the vast majority of the literature, in which the wife's market hours is considered to be the variable component of household labor supply.

either owning a flat or renting, and in both cases the increase in house prices implies a higher barrier to accessing larger properties. In addition, in contrast to married women who are also renting, they lack the additional material benefits of sharing resources within marriage.

Finally, our last two exercises are related to public policies with respect to access to credit. In particular, we consider reducing the weight of the secondary earner's labor income in the LTI-limit and, secondly, an increase in the downpayment requirement (the LTV-limit). Both these policies are calibrated with the same preset goal of achieving a certain (macroeconomic) stabilization target. We document that these policies have different effects on household savings and married women's labor supply, with an LTI tightening decreasing the savings and the employment rate, whereas an LTV tightening leads to an opposite conclusion. This is in line with reduced form empirical evidence showing such asymmetric responses of female labor supply (Boca and Lusardi, 2003; Bui and Ume, 2020; Bartscher, 2023).

Interestingly, we also find that the two scenarios have a different impact on the relative value of marriage. Indeed, whereas both policies increase the barrier to homeownership (and/or upscaling housing demand), the tightening of the LTI-limit effectively implies that secondary earners with higher (potential) wages see a relatively larger decrease in the value of marriage over divorce. Consequently, in order to preserve the stability of marriage, they receive compensation in the form of higher private consumption and/or leisure. In contrast, the higher downpayment requirement seems to mostly affect those households that substitute the secondary earner's labor supply with more debt. Given the restricted efficacy of using the variable component of labor supply, such households see a substantial decrease in their marital surplus, which translates in a higher incidence of commitment issues within the household.

**Related literature.** We contribute to several strands of literature. First, we add to the vast literature that studies lifecycle labor supply and consumption, and in particular how households can insure themselves against shocks. Much early attention has been devoted to the variability of consumption to (un-)anticipated (income) shocks (see, e.g., Attanasio et al. (2008) and Heathcote et al. (2014)). Another (large) literature, starting with Lundberg (1985) has focused on the added worker effect.

In an important, and very related, contribution, Blundell et al. (2016) study self-insurance of households, combining channels such as (liquid) savings together with a variable secondary earner's labor supply and allowing for (exogenous) divorce risks. Their framework is very rich, however, an important restriction is that households are *unitary*, which implies that dual-earner households behave as if they are a single decision maker. More formally, they impose full commitment on household decision making, which implies that large unexpected shocks cannot affect the intra-household division of resources beyond (direct) effects on total household's resources. As explained above, this is also how me model endogenous divorce and all this is an important aspect in determining the value of marriage.

Next, while Attanasio et al. (2011) and Attanasio et al. (2012) have thoroughly analyzed housing demand and the interaction between housing wealth and consumption over the lifecycle, they did not include household labor supply. In that respect, there have been only a few papers trying to study both housing demand and the household's labor supply over the lifecycle. Noteworthy exceptions are Bottazzi et al. (2007), Pizzinelli (2018) and Bartscher (2023). In a similar vein, another related contribution is Lafortune and Low (2020), who have argued for the importance of joint held assets (in particular housing) as commitment devices for intra-household specialization, in particular for secondary earners to invest in children and other public goods.

Our paper contributes to this part of the literature by only assuming limited commitment among spouses, which means that the value of marriage is allowed to evolve in response to large, unexpected shocks in the economic environment. As a consequence of this, spouses cannot commit to ex ante Pareto efficient plans. This feature directly affects the incentives to invest in joint assets, similar to Lafortune and Low (2020). However, in contrast to the latter, we also highlight the heterogeneity in female labor supply by leverage ratios, which might counteract some of the benefits to intra-household specialization.

Finally, the theoretical foundations for our model rely on the seminal contributions on the *collective household* model in Chiappori (1988, 1992) and its dynamic extension in Mazzocco (2007). Our model incorporates the basic elements of the risk-sharing, limited commitment environments as found in Ligon et al. (2000), Ligon et al. (2002), Mazzocco et al. (2014), Voena (2015) and Low et al. (2018). We contribute on a formal level to this literature by incorporating housing demand into a dynamic collective household model.

**Outline.** Section 2 discusses the *White v. White* case, which we exploit for identification and estimation of our structural model. Section 3 presents the structural model. Section 4 discusses identification and estimation of the model, and presents the estimation results. Section 5 presents two quantitative exercises on income and housing wealth shocks. Section 6 presents the policy simulations. Finally, Section 7 concludes the paper. The Online Appendix contains more details about our data and our approach.

# 2 Labor supply, divorce and housing: the *White v. White* case

In this section, we will empirically motivate that divorce legislation, the secondary earner's labor supply and housing interact with each other, by exploiting the *White v. White* case in England.

## 2.1 Background

England and Wales have, with some generalization, an equitable division system, in the sense that courts have a large amount of discretion in deciding splits of property and wealth among spouses upon divorce. This is an important difference with other countries, e.g. France or Italy, where people can choose between a particular default property regime and an alternative one. Furthermore, as noted by Smith (2003) and Piazzalunga (2017), pre-marital contracts regarding division of property are also quite uncommon in the United Kingdom, given that such contracts are not legally binding. Both of these aspects in divorce law are quite useful for our own analysis in this paper, since we do not have to be specifically concerned about selection effects of individuals into particular property division regimes.

Instead, ex-post agreements between spouses are encouraged. When spouses agree on such a division, the proceedings for divorce are simplified in the sense that the court just needs to issue a cheaper 'consent order'. In contrast, when the spouses can't agree on such a settlement, the court needs to issue a financial order, which takes more time and is more expensive.[3] From a practical perspective, the division rule as applied before the *White v. White* case was such that, when wealth (matrimonial assets) exceeded the financial needs of the household members, the remaining proceedings were distributed on a 'needs-based' system, that is, taking into account the specific financial needs of the former spouses and their standard of living they were used to.[4]

As noted in Piazzalunga (2017), who cites the *Ferguson v. Ferguson* case from 1994, the court in that case described such an equitable regime as "more fair" than a titular-based system. However, in most cases the courts didn't grant much larger shares to the wife, except for special cases (e.g. in the case where both partners were also business partners), and the wife didn't receive a share larger than 50 % in combination with much smaller shares of previously joint assets (Smith, 2003; Piazzalunga, 2017). A particular example of the latter is the so-called *Dart v. Dart* case in 1996.[5]

[3]Though the option of agreeing ex post on a division rule is important, from an economic perspective the relevant factor is still the (credible) outside option of what each spouse could obtain through a financial settlement enforced by the courts. If the latter employ a more egalitarian division of property, then this would benefit the economically weaker spouse at the point of bargaining.

[4]In practice, courts made (and in some cases still make) use of the so-called 'Duxbury Tables' to calculate the 'reasonable needs' of each spouse. In particular, it is a lump sum amount that is calculated based on the assumption that the economically weaker spouse spends a share of capital and interest received in such a way that when (s)he dies, there is no capital left.

[5]Mr. and Mrs. Dart moved to England from the US (Kentucky), but were living in England when the wife filed for divorce. Mrs. Dart tried to get the case settled in the US, but eventually the case was decided in English courts. The stakes were quite large, given that Mr. Dart had a large fortune estimated to 400 million GBP. Mrs. Dart sought to get a settlement at around 100 million GBP. However, she lost both at the High Court and the Court of Appeal and eventually only got awarded 8.5 million GBP and had to pay the legal costs of her husband.

The *White v. White* case is considered as a decisive change in this pattern of property and asset division upon divorce. Mr. and Mrs. White were business partners of a farming business in Somerset. At the time when the court case regarding their divorce came up, their combined net wealth was estimated at approximately 4.5 million GBP. Initially, Mrs. White was awarded a sum of 980,000 GBP, to which she appealed. The Court of Appeal then granted her 1.5 million GBP, using a 'yardstick of equality'. This decision was then confirmed by a ruling from the House of Lords in October 2000, where Lord Justice Nicholls in particular specified that, when a couple starts with a small amount of assets, which then grow considerably over the course of the marriage, both spouses, including the wife, should expect to receive half of that accumulated wealth, even if she has "never or rarely worked outside the home" (Stowe, 2009). Another argument was made by Lord Justice Thorpe, who argued that typically the wife "sacrifices her potential to generate assets by taking on the domestic commitment to her husband and her children." All this implied that, ever since this case, "the 50/50 split is, more often than not, a given" (Stowe, 2009).

Though most of the practical applications of this case would involve 'big money' cases, it is widely acknowledged that the *White v.White* case had a much broader impact on the post-divorce division of assets (Smith, 2003). In addition, the case was widely promoted with broad media coverage, thereby informing potential married couples about their likely more egalitarian shares of joint assets upon divorce (Piazzalunga, 2017).

## 2.2 Data sources

We use two main sources of data to study the impact of the *White v. White* case. The first source is the British Household Panel Survey (BHPS). The initial wave of the BHPS contained approximately 5,500 households, which sums to about 10,000 respondents. In addition to this basic sample, representative for the national population of the UK, there were booster samples between 1997-2001 consisting of lower-income individuals and from 1999 there was a boost of respondents from both Scotland and Wales. To study the effects of the *White v. White* case on households' labor supply (and other outcomes), we apply some sample restrictions. To be more precise, we consider married women between 25-60 years old living in England or Scotland.[6] The sample range is restricted to 1992-2005, given that some controls at the country-level are not available in 1991 and in 2006 there was the introduction of the Scottish Family Law, which could act as a confounder to the analysis.[7]

As a second source, we use data on divorces from the Office for National Statistics (ONS), 'Vital statistics: Population and Health Reference tables' (years 1990-2005). This allows us to improve the statistical power to study the impact of *White v. White* on divorce. Table 8 in Online Appendix A presents some descriptive statistics of our BHPS sample, while Figure 9 in the same appendix presents the trends in divorce rates for our two countries.

## 2.3 Empirical evidence

To study the effect of the *White v. White* case on household decisions, we employ a very traditional Difference-in-Difference (DiD) regression, with the treatment group defined as married women living in England and the control group married women living in Scotland. In Online Appendix A, we included the results of several extra exercises to confirm the validity of our DiD approach.

We run a regression of the following form:

$$Hours_{i,c,t} = \phi_1 Post \times \mathit{Treated}_{c,t} + \gamma \mathbf{X'}_{i,c,t} + \sum_t f_t + \sum_r f_r + \epsilon_{i,c,t}, \qquad (1)$$

where *Hours* denotes the number of working hours for married women $i$, living in country $c$, in year $t$.[8] The variable $\mathit{Treated}_{c,t}$ is an indicator for being in the treatment

[6] Similar to Piazzalunga (2017), we do not consider Wales in the empirical analysis.

[7] We follow the convention to refer to England, Wales and Scotland as 'countries', whereas the metropolitan and government regions will simply be referred to as 'regions'.

[8] There are several measures for working hours available in the BHPS. The three most common definitions of hours worked involve (i) contractual hours worked, (ii) contractual hours + hours of paid overtime and (iii) contractual hours + total overtime hours. We also experimented with several definitions of being employed in the BHPS, e.g., based on whether or not the respondent has done paid work in the week leading up to the interview, an alternative measure based on self-reported employment status and finally one based on reported hours worked. All these different measures did

group, that is, $Treated_{c,t} = 1$ if the respondent is living in $c =$ England in year $t$. The dummy variable *Post* equals one if the year $\geq 2000$. We always include a full set of region and time dummies, $f_r$ and $f_t$, as well as demographic controls $\mathbf{X'}_{i,c,t}$ at the household and individual level.[9] Furthermore, we always control for the country-level female unemployment rate. Cross-sectional weights are used in all regressions. Finally, we cluster standard errors at the individual level.

We use a similar set-up for the (crude) divorce rate, except of course for the control variables and the inclusion of a linear time trend $\tau$:

$$Divorce_{c,t} = \tilde{\phi} Post \times Treated_{c,t} + \sum_c f_c + \sum_t f_t + \sum_c f_c \times \tau + \epsilon_{c,t}. \tag{2}$$

The results in Table 1 show that there is evidence for an average reduction of married women's working hours by about 2.4 hours per week. We also ran a similar specification as in (1) with employment status as outcome variable, which did not yield any significant results. This is completely in line with earlier findings by studies on the *White v. White* case (Kapan, 2008; Piazzalunga, 2017). In terms of the crude divorce rates, there is an uptick of about 0.2 divorces per 1,000 persons.[10]

not change the conclusions presented in the main text.

[9] Specifically, we include the age and age squared of husband and wife, the education level of husband and wife both defined as their highest qualification received, number of young children ($\leq$ 15 age old) and the household's non-labor income.

[10] We also experimented with the addition of a country-specific quadratic time trend, following Friedberg (1998) and Piazzalunga (2017). This did not affect the point estimate much, only lowering the precision.

Table 1: *White v. White*: labor supply of married women and crude divorce rates.

| | $Hours_{i,c,t}$ | $Divorce_{c,t}$ |
|---|---|---|
| $Post \times Treated_{c,t}$ | -2.418*** | 0.240** |
| | (0.942) | (0.0857) |
| Data source | *BHPS* | *Vit. Stats* |
| Observations | 26,813 | 32 |
| R-squared | 0.191 | 0.986 |
| Demographic (incl. spouse) controls | ✓ | |
| Year | ✓ | ✓ |
| Region | ✓ | |
| Local female unemployment rate | ✓ | |
| Country | | ✓ |
| Country $\times$ $\tau$ | | ✓ |

Notes: estimation on the BHPS sample, married women in the age range of 25-60 years old during the period 1992-2005. Standard errors clustered at the individual level, *** p<0.01, ** p<0.05, * p<0.1. Demographic controls include age and age squared of the respondent, the age and age squared of the husband, the education level of the respondent and the education level of the husband both defined as their highest qualification received, number of young children ($\leq$ 15 age old) and the household's non-labor income. Non-labor income is deflated by the CPI with 2014 as reference year. Cross-sectional weights have been used. Second regression is based on the Vital Statistics data for the period 1990-2005.

Next, we run the same regressions of the form (1), but now separately for homeowners and renters. The results in Table 2 show that most of the labor supply response is concentrated among those married women who are homeowners. This is of course plausible given that homeowners have, on average, more (net) wealth to be split upon divorce, which means that the decision is more affecting them compared to renters. This reduced form evidence is thus indicative that homeownership and post-divorce division rules interact to generate interesting labor supply responses.

Table 2: *White v. White*: labor supply of married women by housing tenure.

| | $Hours_{i,c,t}$ (*homeowners*) | $Hours_{i,c,t}$ (*renters*) |
|---|---|---|
| $Post \times Treated_{c,t}$ | -2.553** | -1.359 |
| | (1.063) | (1.922) |
| Observations | 22,833 | 4,020 |
| R-squared | 0.177 | 0.277 |
| Demographic (incl. spouse) controls | ✓ | ✓ |
| Year | ✓ | ✓ |
| Region | ✓ | ✓ |
| Local female unemployment rate | ✓ | ✓ |

Notes: estimation on BHPS sample, married women in age range of 25-60 years old during the period 1992-2005. Standard errors clustered at the individual level, *** p<0.01, ** p<0.05, * p<0.1. Demographic (incl. spouse) control includes age and age squared of the respondent, the age and age squared of the husband, the education level of the respondent and the education level of the husband both defined as their highest qualification received, number of young children ($\leq$ 15 age old) and the household's non-labor income. Non-labor income is deflated by the CPI with 2014 as reference year. Cross-sectional weights have been used.

# 3 Structural model

In this section, we describe our lifecycle model of household behavior. Married individuals make *Pareto optimal* decisions about consumption, housing demand and labor supply under *limited commitment* (Chiappori, 1988; Mazzocco, 2007; Voena, 2015). This implies that the household maximizes a weighted sum of utility functions of both spouses, where the weights reflect each spouse's relative bargaining power. In addition, spouses cannot commit to future allocations. Hence, the bargaining weights can be revised whenever one of the spouses becomes better off outside of marriage.

## 3.1 General set-up

Time in the model is discrete and will be indicated by a subscript $t$. The lifecycle is divided in two phases, a working phase ($t \leq T_r$) and a retirement phase ($T_r < t \leq T_d$). During the working phase, while married, individuals make joint decisions on private consumption, labor supply and housing demand. Furthermore, individuals within marriage can (unilaterally) choose to divorce their spouse, after which they will remain single for the remainder of the lifecycle.

At the end of the working phase, individuals retire and only make consumption, housing and saving decisions until their death ($t = T_d$). We take a very simple approach for the retirement phase since this is not the focus of our paper. However, we need to include it for the empirical performance of our model. Without a retirement phase it would be very difficult to explain both labor supply profiles and homeownership rates, given that both are useful in the retirement phase as a source of savings to allow for sufficiently high consumption after the labor active part of the lifecycle. We leave a better treatment of the retirement phase, and its impact on the value of marriage, as an important avenue for future research.

We will now discuss the different parts of the model, and set up the optimization problem for the household. In the main text we discuss all the details of the optimization problem of married individuals during the working phase. For more details on the retirement phase and the analogue set-up for singles we refer to Online Appendix B. The main difference for the retirement phase is that income becomes certain and exogenous (i.e., pensions), while the optimization problem for the singles is readily similar to those of married individuals except for the presence of a spouse (i.e., economies of scale and two sources of income).

## 3.2 Preferences

We study opposite-sex couples where variables referring to the husband are indicated by $M$ and those from the wife with $F$. In each period $t$, couples make decisions over private consumption $c_t^M, c_t^F$, female labor supply (leisure), $n_t^F$ ($l_t^F = 1 - n_t^F$), and housing, $H_t \in \{0, 1, 2\}$. We follow Yang (2009) and interpret $H_t$ as a service flow of housing. Here, $H = 0$ indicates the decision to rent, and for ease of notation we think of $H = 1$ as services obtained from flat ownership and $H = 2$ as service flows obtained from owning a house.[11]

[11] In the remainder of the paper we will for simplicity refer to $H = 1$ as 'flat ownership' and $H = 2$ as 'house ownership'.

With respect to private consumption, we follow Voena (2015) and assume that households are characterized by economies of scale. In particular:

$$x_t = F\left(c_t^M, c_t^F\right) = \left[\left(c_t^M\right)^\rho + \left(c_t^F\right)^\rho\right]^{\frac{1}{\rho}},$$

where $x$ denotes total private expenditures of the household. If $\rho \geq 1$, then this functional form implies that the spouses can consume more jointly, compared to what they would if they lived separately.

The intra-period utility of a married ($m$) individual ($i \in \{M, F\}$) takes on the following form:

$$u^i\left(c_t^i, l_t^i, H_t; \theta_t\right) = \frac{(c_t^i)^{1-\sigma^i}}{1-\sigma^i} + \omega_l^{i,m}\frac{(l_t^i)^{1-\psi^i}}{1-\psi^i} + \mathbf{1}\left[H_t > 0\right]\omega_H^i\left(t\right) + \theta_t^i.$$

Some remarks are in order. First, in line with the data, we assume that male labor supply is more stable. We therefore consider the case where men work full time until retirement, meaning that we can ignore the utility from leisure for them.[12] Women's leisure is an explicit choice variable in the model, where $\omega_l^{F,m}$ is a weight attached to her utility of leisure, while $\psi^F$ determines her Frisch elasticity of labor supply. We chose not to include household work as a choice variable, not only for computational reasons, but also given that for identification purposes, there is no empirical evidence that parents have substituted market work for domestic work after the *White v. White* reform (see Online Appendix A for more details).

Second, housing is a public good and yields a (gender specific) time varying marginal utility, which is equal to $\omega_H^i(t)$. In particular, if $H > 0$ we assume:

$$\begin{aligned}
\omega_H^i\left(t\right) &= \bar{\omega}_H^i \times \left(1.7 + 0.5 \times \mathit{children}_t\right), \text{ and} \\
\bar{\omega}_H^i &= \omega_{H,1}^i + \omega_{H,2}^i \times (H-1),
\end{aligned}$$

where $\omega_{H,1}^i$ captures individual $i$'s preference for a flat, whereas $\omega_{H,2}^i$ is the marginal utility (s)he derives from owning a larger-sized house. Note that the preferences

[12] We do allow for some variation in hours worked for married men over the lifecycle through (exogenous) job displacement shocks, see infra.

for housing are allowed to evolve over the lifecycle, in function of household size. The latter is captured by the term $children_t$, which denotes the average number of children in a household of age $t$.[13] Also note that we allow for gender-based differences in preferences over housing, reflected in gender-specific coefficients for the utility of property ownership and housing size.

Finally, spouses receive an individual-specific match quality shock, $\theta_t^i$, which captures the non-material benefits ('love') derived from marriage. These individual match qualities are assumed to follow a unit root process, i.e., using $\epsilon_t^i \sim N\left(0, (\sigma_\theta^i)^2\right)$,

$$\theta_t^i = \theta_{t-1}^i + \epsilon_t^i.$$

## 3.3 Sources of uncertainty

Besides match quality ('love'), individuals face the following sources of uncertainty.

**House prices.** House prices are given by $p_t$, and following Attanasio et al. (2012), we assume they follow an AR(1) process, with a deterministic trend that reflects an upward drift. Specifically,

$$\ln p_t = a_0 + a_1 t + \rho_H \ln p_{t-1} + \varepsilon_t^H,\ \varepsilon_t^H \sim N\left(-\frac{\sigma_H^2}{2}, \sigma_H^2\right). \tag{3}$$

The prices of a flat are given by a constant fraction, $\kappa^H$, of house prices. In that sense, one can interpret (3) as specifying a relative house over flat price process.

**Unemployment shock for men.** As indicated above, men work full time over the entire working phase of the lifecycle ($t \leq T_r$). However, we assume that in each period they face the risk of becoming (involuntarily) unemployed with an associated probability $\pi_u$. Their employment status can therefore be indicated by a variable $e_t^M \in \{0, 1\}$, with $e_t^M = 1$ indicating employment and $e_t^M = 0$ indicating unemployment.

[13] We follow Pizzinelli (2018) and use an equivalization coefficient, based on the following OECD scale: the first adult in the household gets a weight of 1, the second a weight of 0.7 and every child gets a weight of 0.5.

When unemployed they receive an unemployment benefit given by $b_u$. To simplify the analysis, we assume that the probability of becoming unemployed in each period is independent of the employment status in the previous period. We leave a full analysis allowing for unemployment persistence and the impact of subsequent human capital depreciation and household income for future research.

**Earning and wage process.** The earning process of men is given by

$$\ln y_t^M = \alpha^M(t) + \nu_t^M,$$

and the wage process of women by

$$\ln w_t^F = \alpha^F(t) + \nu_t^F.$$

Both men and women face a concave lifecycle profile in earnings (or wages) :

$$\alpha^i(t) = \alpha_1^i t + \alpha_2^i t^2, i = M, F.$$

The permanent shocks, $\nu_t^i$ reflect shock in productivity, health, etc. Following Blundell et al. (2008), we assume that these follow a random walk:

$$\nu_t^i = \nu_{t-1}^i + \varepsilon_t^i,\ i = M, F.$$

Finally, we allow for correlation in spouses' permanent shocks. In particular, $\varepsilon_t = \left(\varepsilon_t^M, \varepsilon_t^F\right) \sim N(\mu_\varepsilon, \Sigma_\varepsilon)$, with

$$\mu_\varepsilon = \left(-\frac{\sigma^2_{\varepsilon^M}}{2}, -\frac{\sigma^2_{\varepsilon^F}}{2}\right) \qquad \text{and} \qquad \Sigma_\varepsilon = \begin{pmatrix} \sigma^2_{\varepsilon^M} & \sigma_{\varepsilon^M,\varepsilon^F} \\ \sigma_{\varepsilon^M,\varepsilon^F} & \sigma^2_{\varepsilon^F} \end{pmatrix}.$$

The correlation in spouses' productivity shocks captures the fact that in reality, through assortative matching patterns in the marriage market, intra-household income shocks are correlated, which can have serious implications for intra-household inequality and the evolution of income inequality (Fernández and Rogerson, 2001;

Lise and Seitz, 2011; Eika et al., 2019; Chiappori et al., 2020).

### 3.4 Budget and borrowing constraints

**Budget constraint.** Married spouses choose savings, $A_t$, expenditures on private consumption, $x_t$, and they also make housing decisions, $H_t$. For the latter, they choose whether or not to buy a house and about the size of the house in case they buy. Income resources for the household are equal to the incomes of husband and wife (if she works, $n_t^F > 0$) and returns on savings from the past period. Income for the husband is given by his labor income, $y_t^M$, in case he works ($e_t^M = 1$), whereas he receives an unemployment benefit, $b_u$ in case he is (involuntarily) unemployed ($e_t^M = 0$). Women earn an hourly wage in period $t$ given by $w_t^F$ and consequently her earnings is given by $w_t^F n_t^F$.

Summarizing, the household faces in each period $t$ the following budget constraint:

$$A_t + x_t + p_t H_t + \Omega\left(H_t, H_{t-1}\right) + q_t \mathbf{1}\left[H_t = 0\right] = \left(1+R\right) A_{t-1} + y_t^M e_t^M$$

$$+ b_u \left(1 - e_t^M\right) + w_t^F n_t^F - \delta^m\left(t\right) \mathbf{1}\left[n_t^F > 0\right] + p_t H_{t-1}, \tag{4}$$

with $q_t$ the rent in period $t$. Some additional explanation for this budget constraint is in order. First, we incorporate a cost of working for women, which we, as in for instance Borella et al. (2018), express in monetary terms by $\delta^m(t) = \delta_1^m t + \delta_2^m t^2$. Second, note that wealth effects from housing stock are captured by the change in housing values and housing status. We assume households face a transaction cost $\Omega\left(H_t, H_{t-1}\right)$ in case $H_t \neq H_{t-1}$, proportional to the housing value and asymmetric for selling and buying. Finally, and following Bajari et al. (2013), we should highlight that the interest rate, $R$, for assets is realistically allowed to vary depending on the sign of household savings. In particular, we assume that $R = R^-$ in case $A < 0$, which implies that the household is a net debtor, while $R = R^+$ in case the household is a net creditor, i.e., when $A \geq 0$. In addition, $R^- > R^+$. This captures the idea that interest rates are generally higher for mortgages than for saving accounts.

**Borrowing constraint.** An important aspect of our model is that households face leverage-based borrowing constraints, i.e., the amount of debt they can accumulate is determined by the housing status. Following Attanasio et al. (2012) and Pizzinelli (2018), we assume:

$$\begin{aligned} Debt_t &\leq \max\{Debt_{t-1}, \min\{LTV_t, LTI_t\}\} \\ LTV_t &= \lambda_H p_t, \\ LTI_t &= \lambda_Y \left( y_t^M e_t^M + (1 - e_t^M) b_u \right) + \lambda_Y^F n_t^F w_t^F. \end{aligned} \tag{5}$$

The policy parameter $\lambda_H$ captures how much the household can borrow as a fraction of the (fluctuating) housing values (i.e., the loan-to-value), which essentially translates to a downpayment restriction. The LTI-limit reflects that the household can only borrow up to a certain multiple of household income, where we allow a different weighting for the primary and the secondary earner in this debt-to-income limit. In particular, the parameters $\lambda_Y$ and $\lambda_Y^F$ reflect the relative weight on the primary earner and secondary earner respectively. The debt in period $t$ can only be bigger than in the previous period, if the outstanding debt is still meeting both the LTV and LTI constraint.

We follow Bottazzi et al. (2007) and Pizzinelli (2018) in assuming that net liquid savings constitutes a single continuous variable and hence we do not allow for a separate choice of mortgage contract and deposits. Obviously, in reality households hold both positive liquid assets and mortgage debt, but decoupling these would significantly add to the computational complexity of our model. Interestingly, our focus on illiquid assets such as housing and neglecting the diversity in the household balance sheet, can be justified by a renewed recent focus on so-called "wealthy hand-to-mouth"-type consumers. These are consumers with large illiquid assets (such as housing), but relatively low amounts of liquid assets. This has direct consequences for example in the context of macroeconomic stabilization policies, see Kaplan et al.

(2014), Kaplan and Violante (2014), Kaplan et al. (2018).[14]

### 3.5 Optimization problems

Given Pareto optimality under limited commitment, the household maximizes a weighted sum of utilities of the spouses, under the added restriction that each spouse must, in each period, be better off inside marriage than divorcing and becoming single. In practice, this means that the bargaining (Pareto) weights evolve as a function of changes in the outside options available for both spouses.

**Optimization problem.** Let $\mathbf{S}_t = \left(A_{t-1}, H_{t-1}, w_t^F, y_t^M, \theta_t^M, \theta_t^F, \tilde{\mu}_t^M, \tilde{\mu}_t^F\right)$ denote all the relevant state variables relevant for the household's decision problem in period $t \leq T_r$. This comprises the asset (debt) carried over from the last period, the housing status with which the household enters period $t$, the wife's wage, the husband's income and the current split of resources within the household (i.e., the Pareto weights). We will denote by $\mathbf{a}_t = \left(c_t^M, c_t^F, l_t^F, A_t, H_t, D_t\right)$ all the choices made by the household in any period $t$ during the working phase.[15]

The couple then solves the following problem:

$$
\begin{aligned}
V_t\left(\mathbf{S}_t\right) &= \max\nolimits_{\mathbf{a}_t} \left(1-D_t\right)\left\{\tilde{\mu}_t^M u^M\left(c_t^M, H_t; \theta_t^M\right) + \tilde{\mu}_t^F u^F\left(c_t^F, l_t^F, H_t; \theta_t^F\right)\right. \\
&\qquad \left. + \beta \mathbb{E}\left[V_{t+1}\left(\mathbf{S}_{t+1} | \mathbf{S}_t\right)\right]\right\} \\
&\quad + D_t\left\{\tilde{\mu}_t^M\left[u^M\left(c_t^M, H_t\right) + \beta \mathbb{E}\left[V_{t+1}^{M,d}\left(\mathbf{S}_{t+1} | \mathbf{S}_t\right)\right]\right]\right. \\
&\quad \left. + \tilde{\mu}_t^F\left[u^F\left(c_t^F, l_t^F, H_t\right) + \beta \mathbb{E}\left[V_{t+1}^{F,d}\left(\mathbf{S}_{t+1} | \mathbf{S}_t\right)\right]\right]\right\},
\end{aligned}
$$

[14] We do also refer the reader to Druedahl (2015), who studies portfolio allocation on different types of assets, but in the context of a unitary model and excluding divorce.

[15] In the retirement phase, the state and choice space can be reduced since income becomes fully deterministic. See Online Appendix B.

subject to the dynamics of the Pareto weights

$$\tilde{\mu}_{t+1}^{i} = \tilde{\mu}_{t}^{i} + \xi_{t}^{i}, \quad \tilde{\mu}_{t}^{M} + \tilde{\mu}_{t}^{F} = 1,$$

and the respective budget and borrowing constraints. That is, (4) and (5) for $D_t = 0$ (i.e. staying married) and the respective individual budget and borrowing constraints (9) - (12) for $D_t = 1$ (i.e., divorcing, see Online Appendix B). In words, the couple needs to consider the utility for both partners in the scenario of both staying married and becoming a divorcee. This dynamic problem depends on the continuation value (discounted at rate $\beta$) and the utility in the given period. The Pareto weights determine the importance of both spouses in the decision process. A solution involves a mapping, say $\mathbf{a}^{*}(\mathbf{S}_t)$ from the state variables to decisions and determines the value of marriage for both spouses. Similar to Voena (2015), we can compute the continuation value through backwards recursion (see Online Appendix D for more details).

**Remarks.** First, to simplify the model, we assume, in contrast to Voena (2015), that divorce is an absorbing state and therefore, we do not allow for remarriage. Though this might underestimate the outside value of marriage, it equally implies that we remain closer to the baseline unitary setup, which might make our results more comparable with the latter. To be more precise, the participation constraints are

$$u^{M}\left(c_t^{M}, H_t; \theta_t^{M}\right) + \beta \mathbb{E}\left[V_{t+1}^{M,d}\left(\mathbf{S}_{t+1}|\mathbf{S}_t\right)\right] \geq V_t^{M,d}\left(\mathbf{S}_t^{M,d}\right), \tag{6}$$

$$u^{F}\left(c_t^{F}, l_t^{F}, H_t; \theta_t^{F}\right) + \beta \mathbb{E}\left[V_{t+1}^{F,d}\left(\mathbf{S}_{t+1}|\mathbf{S}_t\right)\right] \geq V_t^{F,d}\left(\mathbf{S}_t^{F,d}\right). \tag{7}$$

Where $\mathbf{S}_t^{M,d} = \left(A_{t-1}, H_{t-1}, y_t^{M}\right)$ and $\mathbf{S}_t^{F,d} = \left(A_{t-1}, H_{t-1}, w_t^{F}\right)$ are the relevant state variables for a divorced male and female at the start of period $t$.

Next, to compute the continuation value as a divorcee, we need to specify the asset allocation. To reflect the findings of Section 2, we do this as follows

$$A_t^{M} = \frac{y_0^{M}}{y_0^{M} + w_0^{F} \times \bar{n}^{F}} A_t \qquad \text{and} \qquad A_t^{F} = \left(1 - \frac{y_0^{M}}{y_0^{M} + w_0^{F} \times \bar{n}^{F}}\right) A_t. \tag{8}$$

before the *White v. White* case and an equal split afterwards. Where $y_0^M$( resp. $w_0^F$) denote the initial earnings of the husband (resp. wife) and $\bar{n}^F$ denotes an average level of women's labor supply. Although more elaborated than standard in the literature, this is of course a simplification, mostly due to a lack of information and good data on either individualized wealth or any voluntary ex-post settlements between (former) spouses. We treat (potential) earnings for spouses at the start of individuals their lifecycle as a proxy for their potential wealth accumulation.

Finally, the dynamics of the Pareto weights are governed by the participation constraints (6) and (7). More precisely, as in Marcet and Marimon (2019), the $\xi_t^i$, $i = M, F$, correspond to the Lagrange multipliers associated with each spouse's sequential participation constraint. As such they make sure that the participation constraints are satisfied for both partners. Only when this is no longer possible (i.e., one of the bargaining weights is too large) the couple will actually divorce.

# 4 Identification and estimation

We start by listing the parameters that are preset. Subsequently we discuss the identification and estimation of the parameters outside and inside the model. We end by discussing the fit of our model.

## 4.1 Preset parameters

We follow the literature to preset the following parameters.

**Discount factor, preference parameters and economies of scale.** For the CRRA parameters we set $\sigma^M = \sigma^F = 2$ and for the discount factor we choose $\beta = 0.95$, which are typical values in the literature. Similar to Pizzinelli (2018), we set $\psi^F = 6.19$, implying a Frisch elasticity of labor supply of 0.3. The economies of scale parameter $\rho$ is set to match the McClements scale, following Voena (2015), which leads to a value of 1.4023.

**Initial assets.** Given the general lack of good wealth information, we start the model for individuals aged 20 years old with no assets and starting out as renters. However, given that most of the (targeted) empirical moments apply to the age range of 30 and above, we allow individuals to accumulate some wealth before the effective start of the working phase.

**Prices of flats and renting cost.** The parameter $\kappa_H$, reflecting the fraction of flat prices to house prices, is set to 0.6, which is the same value as in Attanasio et al. (2012). The rationale for this value stems from the average ratio of prices for homes with less than 5 rooms (incl. kitchen and bathrooms) to homes with more than 5 rooms. The rental price is set at 3 % of flat prices.

**Credit market parameters.** The rate of return on debt, $R^-$ is set at 7 %, while the return on savings, $R^+$ is equal to 3 %. The parameters determining the borrowing constraint (pertaining to the downpayment and debt-to-income limit) are chosen to reflect some specific UK institutional aspects. In particular, for $\lambda_H$ we pick 0.9, which implies a downpayment of 10 %, which is reflecting the typical maximum value for the UK in the early 2000's (Pizzinelli, 2018). For the LTI-limit there is much more institutional variation, so we follow information in the *Guide to Mortgages* published by the Financial Services Authority in 2004.[16] This report states that typically $\lambda_Y = 3$, while $\lambda_Y^F = 1$. We assume a (proportional) transaction cost of 7 % for selling and 2.5 % for buying, following Gruber and Martin (2004) and Yang (2009).[17]

**Labor market parameters.** The correlation between the productivity shocks among spouses, $\sigma_{\varepsilon^M, \varepsilon^F}$ is set to 0.25, which is the same as in Hyslop (2001) and Attanasio

[16]The FSA was a quasi-judicial body which accounted for regulating the financial industry in the UK between 2001 and 2013.

[17]The paper by Gruber and Martin uses data from the Consumer Expenditure Survey (CEX) on reallocation costs of tax and agency costs and find for median households costs of about 7 % for selling and 2.5 % for buying housing stock. Though these values represent the US context, they are on average close to the calibrated value of (symmetric) transaction costs equal to 5 % in Attanasio et al. (2018), who also use the BHPS to calibrate their model.

et al. (2018). To initialize the process, we picked a value of 0.2, which is the estimate of intra-household correlation of incomes in the year 2000 obtained by Lise and Seitz (2011). The unemployment probability $\pi_u$ is set to 5.5 % and approximates the average unemployment rate in the UK in the early 2000s. The unemployment benefit is set to $b_u = 0.3$, the retirement income is given by a replacement rate of 50 % times the last income the individual earned during the working phase of the lifecycle. Age of retirement $T_r$ is allowed to be asymmetric, where women retire from the age of 60, while men retire at 65.

## 4.2 Parameters estimated outside of the model

In Online Appendix C we present more details on how we estimated the following parameters outside of the model.

**House prices.** The variance of the house price shocks, $\sigma_H^2$ can be estimated using the second moment of growth rates in (net of trend) house prices. For this, we use data from the UK House Price Index (UKHPI) in the range 1968-2008. We deflated nominal house prices by the Retail Price Index (RPI, all items). The persistence coefficient, $\rho_H$ is estimated to be equal to 0.87, while the standard deviation of house price shocks is given by 0.09.[18]

**Wages and earnings.** We used panel data on male earnings and female wages contained in the BHPS to estimate the deterministic lifecycle profiles for female wages $\alpha^F(t)$ and male earnings $\alpha^M(t)$, together with the variances for the permanent productivity shocks, $\sigma^2_{\varepsilon^M}$ and $\sigma^2_{\varepsilon^F}$ . To be more specific, we ran a regression of (log) earnings for men and (log) wages for women on age, age squared and other controls. We also control for selection into the labor market of women, using a Heckman two-step correction regression. The identification of the variances of the permanent shocks is based on the second moments of the growth rates of income and wages and is standard in the literature (Meghir and Pistaferri, 2004; Blundell et al., 2008).

[18] These values are quite similar to the estimates in Attanasio et al. (2012), who estimate the same house price process as we, but on a slightly different range (1968-2000).

## 4.3 Parameters estimated within the model

We start by briefly arguing that our parameters are identified by our data. Subsequently we present our estimated parameters which are estimated via indirect inference.

### 4.3.1 Identification

**Initial Pareto weight.** The initial Pareto weights, $\tilde{\mu}_0^M$ and $\tilde{\mu}_0^F$, are estimated using exogenous variation in the post-divorce asset division in England due to the *White v. White* case. More specifically, the labor supply response of married women in Table 1 help to identify the (initial) bargaining power, similar to the identification strategy pursued in Voena (2015). Intuitively, for Pareto weights that are more favorable for men, the possibility for the household to reallocate resources is larger and therefore, we should expect a larger response in married women's reduction of working hours.[19]

**Cost of working and preference for leisure.** The cost of working for married women $(\delta_1^m, \delta_2^m)$, and for single women $(\delta_1^s, \delta_2^s)$ capture the hump-shaped lifecycle pattern of female employment rates, as illustrated in Figure 1. Intuitively, more concave profiles for the cost of working will force a hump shape pattern in the labor supply of married (resp. single) women. Average hours worked by married and single women across different age ranges and by marital status equally helps us with non-linear patterns in female labor supply on the intensive margin, but in addition add to the identification of the relative weight attached to leisure in married women's utility $(\omega_l^{F,m})$ and for single women $(\omega_l^{F,s})$.

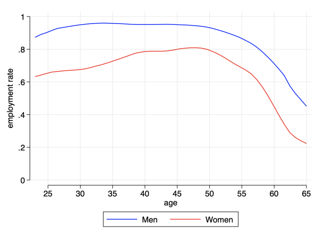
**Housing preference parameters.** The parameters $\omega_{H,0}^F$ and $\omega_{H,0}^M$ reflect the preferences for homeownership for women and men respectively, which directly influences the likelihood of households to buy a flat/house. Consequently, these parameters can be identified using homeownership rates for couples and single men and women (see

[19] This argument is also very similar to the analysis in Newman and Olivetti (2015), where they show that two-earner households can be more durable due to greater flexibility in terms of resources to reallocate such that both spouses are better off inside the marriage.

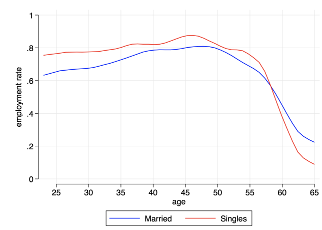
Figure 1 for empirical evidence). On the other hand, the parameters $\omega_{H,1}^{F}$ and $\omega_{H,1}^{M}$ capture the preferences over housing size (that is, flat versus houses). These can be identified by the (median) housing values for both couples and singles.

**Variance of match quality.** The variances of match quality shocks $\left(\sigma_{\theta}^{M}\right)^{2}$ and $\left(\sigma_{\theta}^{F}\right)^{2}$ influences the likelihood of divorce. Higher volatility in match quality shocks imply a larger probability that at some point these shocks will trigger a divorce. Hence there is a theoretical link between these variance parameters and the average (crude) divorce rate.

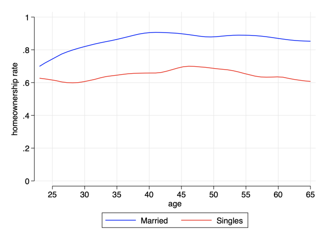
Figure 1: Homeownership and employment rates.




(a) Employment rates by gender




(b) Employment rate women by marital status




(c) Homeownership by marital status

Notes: BHPS, respondents both married and single between 23 and 65 years old, sample range 1992-2005. Cross-sectional weights have been used.

### 4.3.2 Estimation of the auxiliary model using indirect inference

We use indirect inference (Gourieroux et al., 1993) to estimate the parameters that are not preset or estimated outside of the model. The main aspect of this method is the use of an auxiliary model, capturing important aspects of the data. This auxiliary model can be estimated both on observed data, as well as on simulated data from the dynamic structural model. Indirect inference then chooses the parameters in such a way to minimize the distance between these two alternative estimates of the auxiliary model. The auxiliary model to be matched contains the responses in labor supply and (crude) divorce rates to the *White v. White* case, female labor supply moments at different ages (on extensive and intensive margin) and by marital status and homeownership rates. These can be summarized in the vector $\boldsymbol{\phi}^{data}$. The estimates for the structural parameters, $\hat{\boldsymbol{\theta}}$, then solve the following:

$$\min_{\boldsymbol{\theta}} \left(\boldsymbol{\phi}^{sim}\left(\boldsymbol{\theta}\right) - \boldsymbol{\phi}^{data}\right)' \mathbf{W} \left(\boldsymbol{\phi}^{sim}\left(\boldsymbol{\theta}\right) - \boldsymbol{\phi}^{data}\right),$$

where $\boldsymbol{\phi}^{sim}\left(\boldsymbol{\theta}\right)$ denotes the simulated auxiliary model, and $\mathbf{W}$ is a symmetric, positive (semi-)definite weighting matrix.[20] Standard errors for $\hat{\boldsymbol{\theta}}$ are obtained from the asymptotic distribution presented in Gourieroux et al. (1993).

#### 4.3.3 Parameter estimates

The parameter estimates are presented in Table 3. We obtain an initial Pareto weight of 0.78, which is a bit larger than the 0.7 found in Voena (2015). Turning to our estimates of the monetary costs of female labor force participation, $\delta^m(t)$ and $\delta^s(t)$, it is useful to contrast our estimates to those found in Pizzinelli (2018). In particular, we find larger (monetary) penalties for labor force participation of married women, whereas Pizzinelli's estimates are close to our estimates for monetary costs of labor force participation for single women. Interestingly, we also find that the estimated utility parameters for homeownership and housing size (that is, house versus flat) are larger for women than men. Finally, the estimated utility parameters pertaining to leisure are similar for both married and single women.

[20] We opted for the optimal weighting matrix, which coincides with the inverse of the variance-covariance matrix for the parameters of the auxiliary model, i.e., $W = \Sigma^{-1}_{\boldsymbol{\phi}^{data}}$.

Table 3: Parameter estimates.

| Parameter Description | | Estimate | Standard error |
|---|---|---|---|
| Initial bargaining power (men) | $\tilde{\mu}_0^M$ | 0.78 | (0.050) |
| Cost of work married women (linear term) | $\delta_1^m$ | 0.042 | $(0.57\times10^{-4})$ |
| Cost of work married women (quadratic term) | $\delta_2^m$ | 0.00075 | $(0.11\times10^{-4})$ |
| Cost of work single women (linear term) | $\delta_1^s$ | 0.019 | (0.001) |
| Cost of work single women (quadratic term) | $\delta_2^s$ | 0.00041 | $(0.19\times10^{-4})$ |
| Preference for leisure married women | $\omega_n^{F,m}$ | 0.49 | (0.022) |
| Preference for leisure single women | $\omega_n^{F,s}$ | 0.47 | (0.021) |
| Preference for homeownership men | $\omega_{H,0}^M$ | 0.83 | (0.151) |
| Preference for homeownership women | $\omega_{H,0}^F$ | 0.95 | (0.327) |
| Preference for housing size men | $\omega_{H,1}^M$ | 1.28 | (0.231) |
| Preference for housing size women | $\omega_{H,1}^F$ | 1.56 | (0.440) |
| Variance match quality men | $\left(\sigma_\theta^M\right)^2$ | 0.031 | (0.004) |
| Variance match quality women | $\left(\sigma_\theta^F\right)^2$ | 0.027 | (0.002) |

Notes: own calculations based on the same set of 10,000 simulations.

## 4.4 Model fit and summary statistics

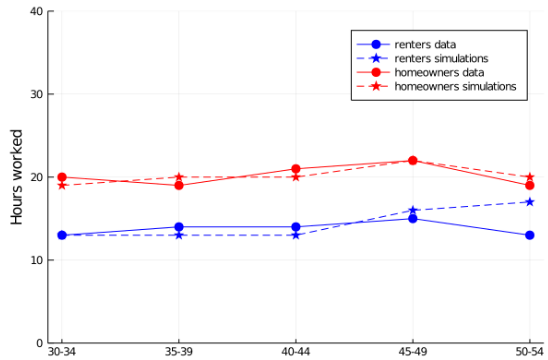
Our structural approach is capable of matching the targeted moments in the data reassuringly well (see Table 12 in Online Appendix E for more details). To further confirm this, we present some patterns in our simulations that are in line with the data and that are essential for the use of our model in the next sections.

Figure 2 presents average hours worked of married women by housing tenure. From this, it is clear that (married) women who are homeowners work more market hours compared to women who are renting. This is driven by the secondary earner's labor supply acting as an insurance device against income and wealth shocks and is in line with earlier findings by Bottazzi et al. (2007) and Pizzinelli (2018).[21]

Another key relationship is the one between the household's leverage ratios and the secondary earner's labor supply. In particular, Figure 3 considers the secondary earner's hours worked broken down by the primary loan-to-income ratio. More specifically, we compare the secondary earner's labor supply in households with high to those with lower p-LTI ratios. Overall we find that in households that have higher p-LTI ratios the secondary earner works more hours on average, compared to those house-

[21] To further confirm this, we show in Table 13 in Online Appendix E that there is a negative gradient between (net) wealth and married women's labor supply that the model is able to replicate.

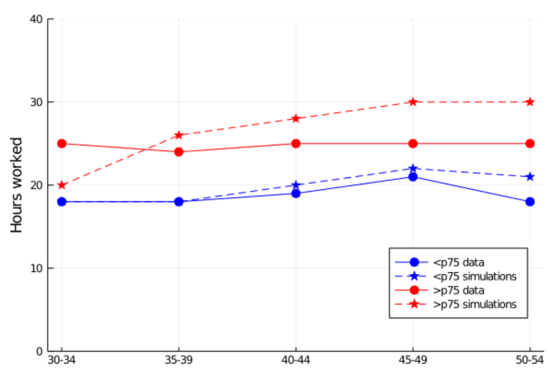
Figure 2: Hours worked married women by housing tenure.




Notes: own calculations based on the same set of 10,000 simulations.

holds in the bottom 75th percentile, and this across all age groups.[22] The positive correlation between the secondary earner's labor supply and the household's p-LTI ratio can be explained by the fact that higher p-LTI ratios imply more exposure to shocks to the primary earner's income, which necessitates more insurance in the form of higher labor supply from the secondary earner. Our model is able to match quite closely the secondary earners' average hours worked in high and lower p-LTI households.

Figure 3: Hours worked married women by p-LTI.



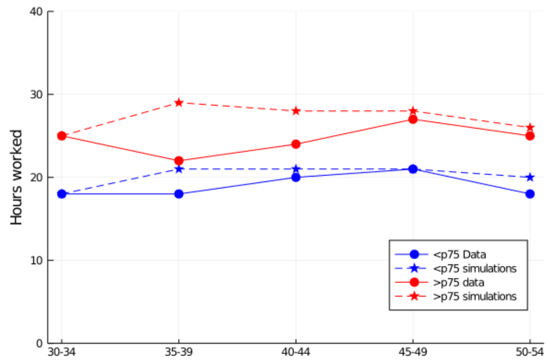

Notes: own calculations based on the same set of 10,000 simulations.

Our model is also able to capture the differences in average hours worked between households with higher and lower loan-to-value ratios. Figure 4 shows that secondary

[22]The composition of those households below or above the 75th percentile is varying over the lifecycle. To take this into account, we computed the average hours worked in each age category broken down by the 75th percentile of the relevant leverage ratio within that same age group.

earners in higher LTV households work more hours on average (across all the age groups). Similar to before, this is in line with the hypothesis that higher indebtedness (and lower equity to cushion against shocks) requires sufficient insurance via the secondary earner's labor supply channel. Finally, we study the response to the *White*

Figure 4: Hours worked married women by LTV.




Notes: own calculations based on the same set of 10,000 simulations.

*v. White* case in terms of female labor supply by housing tenure in Table 4. The simulated responses are in line with the DiD results presented in Table 2. Indeed, among couples who are homeowners we obtain a reduction in female labor supply of about 1.9 hours worked, which is quite close to what we found in the reduced form estimate of the effect on female labor supply for homeowners of the *White v. White* case. We also observe almost no effect of the *White v. White* case on female labor supply among renters.

Table 4: *White v. White*: labor supply of married women by housing tenure.

| $\Delta n_t^F$ (*homeowners*) | $\Delta n_t^F$ (*renters*) |
|---|---|
| -1.914 | 0.0857 |

Notes: own calculations based on the same set of 10,000 simulations.

# 5 Income and housing price shocks

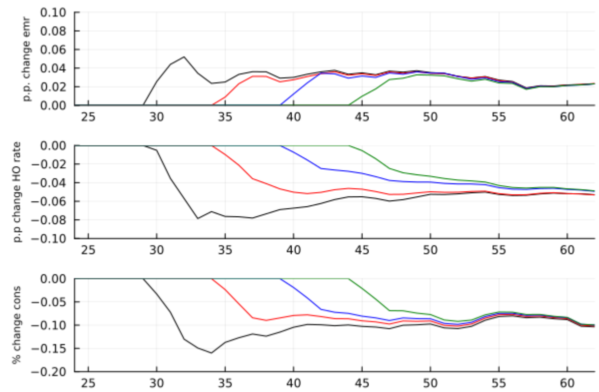
A unique feature of our framework, compared to the literature, is that our model includes both housing demand and labor supply, as well as the feature of limited commitment within the household. In this section, we will therefore use the estimated model to study how households insure themselves against, and respond to, shocks in income and housing prices. The former improves our understanding of the added worker effect, while the latter focuses on the link between homeownership and labor supply and consumption decisions. These exercises will also illustrate the importance of having a good understanding of changes in the value of marriage and its relation to household decisions. To limit the presented results, but still demonstrating the versatility of our approach, we will each time focus on only one type of shock and each time present different empirical measures.

## 5.1 Income shocks

In our first quantitative exercise, we study the impact on households of permanent income shocks to the primary earner. This shock changes the permanent component of household earnings, and therefore naturally has longer run effects on household choices. In practical terms, we solve for counterfactual models in which the primary earner's income permanently drops at a particular age by one standard deviation.

Figure 5 shows the effects on households' consumption, housing demand and the secondary earner's labor supply. A permanent drop in the primary earner's income effectively implies a tightening of the income-related borrowing constraint, making it harder for (particularly younger) couples to access credit, which implies a drop in housing demand. In addition, the (permanent) reduction in household income further implies a decrease in consumption. This is evident from Figure 5, which shows the persistent drops in homeownership rates and household consumption. The drop is more pronounced for younger couples who are often more likely to be restricted by income-related debt limits. Furthermore, given the lower baseline homeownership rate, this responsiveness is driven by a postponement of buying a flat or house. In terms of the secondary earner's labor supply, we find an added worker effect of about 3-5 percentage points in employment rate, with the larger responses concentrated among younger households.

Figure 5: Responses to an unexpected permanent fall in the primary earner's income.



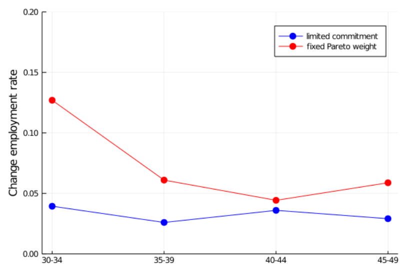

Notes: each plot presents the change (expressed in % or percentage points) in the respective variable to an unexpected permanent one-standard deviation drop in the primary earner's income, occurring at ages 30, 35, 40, and 45. All plots are produced with the same set of 10,000 simulations.

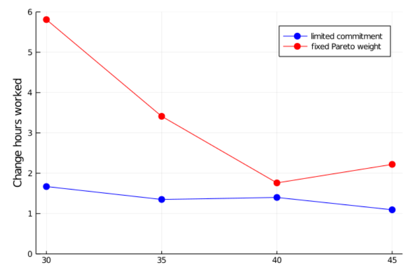
We can also use our model to study the impact of the intra-household bargaining channel on the household responses. That is, the increased barrier to homeownership, thereby reducing the scope for housing wealth accumulation within marriage, reduces the value of marriage. As such, divorce might become more attractive for some secondary earners, notably those with higher potential wages. If this leads to a binding individual participation constraint for the secondary earner then due to limited commitment there will either be a renegotiation of resources in favor of the secondary earner or, if that is not feasible, a dissolution of the marriage.

To investigate this, we first solve the counterfactual scenario assuming a one-standard deviation permanent drop in the husband's income, and allowing for adjustments in the Pareto weights. This is similar to how we calculated the aggregate responses. Next, we solve the same counterfactual scenario with the additional restriction that the Pareto weights of both spouses are restricted to remain fixed at their pre-shock levels. We then compare the responses in terms of the added worker effect across these two scenarios.

The results in Figure 6 show that he added worker effect is dampened, both at the extensive and intensive margin. This is due to the increase in the bargaining power of the secondary earner which, given the disutility of work, leads to a decrease in labor supply. This dampening effect through the intra-household bargaining channel also seems to be the strongest at younger ages. Overall, our results suggest that, at the aggregate level, the extent of intra-household insurance stemming from the adjustments in the secondary earner's labor supply might be overestimated by neglecting limited commitment within the household.

Figure 6: Responses to an unexpected permanent fall in the primary earner's income.




Notes: each plot presents the change (expressed in hours or percentage points) in the respective variable to an unexpected permanent one-standard deviation drop in the primary earner's income, occurring at ages 30, 35, 40, and 45. All plots are produced with the same set of 10,000 simulations.

## 5.2 Welfare effects of house price shocks

In our second quantitative exercise we study the welfare effects of an unexpected increase of house prices. This is motivated by the recurring policy concern surrounding the affordability of buying flats or houses by younger individuals. A large unexpected shock in house prices has several effects on households, most notably those who are thinking of up-or downscaling their housing demand. More specifically, it increases the barrier to buy a flat/house for renters, while homeowners can potentially profit from an outward shift of the budget constraint in case of a sale of their property (the wealth effect). Additionally, property-owners can also borrow more through an easing of the LTV-limit. Flat-owners are affected by opposing forces. Indeed, on the one hand their property increases in value and they also face a relaxed borrowing constraint, though not proportionally as strong as to compensate for the increase in house prices. This then suggests that some flat-owners who contemplate upscaling through buying a house might have to increase their savings.

In this section we focus our attention on the the heterogeneity of welfare gains by marital status. More specifically, we simulate the effects of an unexpected 10 %

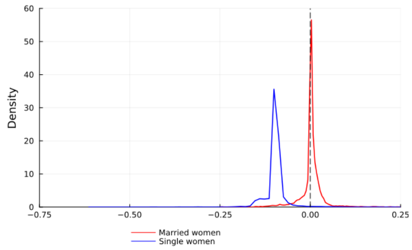
increase in house prices at the age of 25, after which we allow house prices to revert back to the trend. We then compute the consumption/leisure-based equivalent welfare benefit/cost for each individual to evaluate the effects of a large sudden increase in house prices.[23] Figure 7 shows the welfare benefits/costs for women, while Figure 8 presents the welfare effects for men. From these, we find that individuals who, in the counterfactual scenario of sudden higher house (and flat) prices can no longer afford buying a property (i.e. new renters) incur the largest welfare costs on average. This is true both across gender and marital status.

Amongst renters we notice that especially single women tend to incur welfare losses. Indeed, married women who are renting are relatively insulated with a strong concentration of welfare effects around zero. The latter is clearly reflective of the material benefits of sharing resources within marriage, which increases (expected) income and neutralizes the sudden increase in the barrier to property ownership. In contrast, single women who rent now see a further decrease in expected housing wealth, which cannot be compensated through intra-household sharing of resources and therefore implies a larger cost in welfare terms. This stark difference in welfare outcomes is relatively absent for men, where the largest fraction of both married and single renters incur very small welfare costs/benefits. This is also consistent with the fact that our estimates indicate a larger preference for ownership and housing size for women compared to men, which implies that a larger barrier to ownership leads to higher welfare costs.

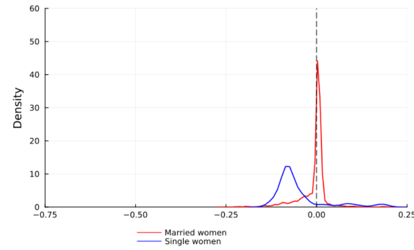
A similar pattern can be found among those individuals who own a property in both the baseline and counterfactual scenario. In particular, single women incur welfare losses from a sudden increase in house prices. Though perhaps counter intuitive given the beneficial effects of house price increases on homeowners, we should note that flat owners who would like to upscale to buying a house might also have to save more due to the relatively slower increase in their housing wealth, and in addition they cannot benefit from income pooling within marriage.

[23] The measure of welfare benefits/costs is the Hicksian equivalent compensation. We refer to the Online Appendix F for more details on its implementation.

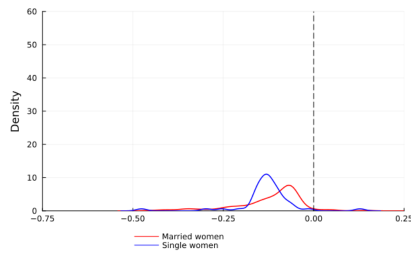
Figure 7: Welfare effects of sudden transitory house price increase: women.




(a) Always homeowners



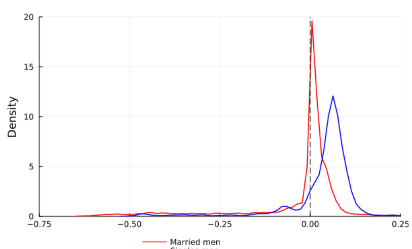

(b) Always renters



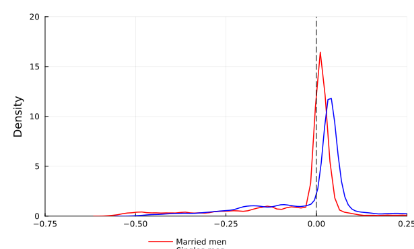

(c) New renters

Notes: distribution of Hicksian equivalent compensation (in percent) in response to a transitory 10 % increase in house prices at age 30. Own calculations based on the same set of 10,000 simulations.

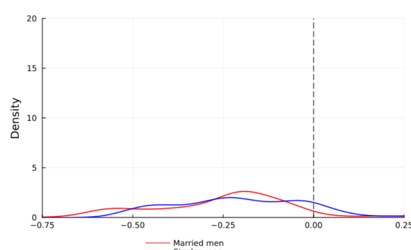
Figure 8: Welfare effects of sudden transitory house price increase: men.




(a) Always homeowners




(b) Always renters




(c) New renters

Notes: distribution of Hicksian equivalent compensation (in percent) in response to a transitory 10 % increase in house prices at age 30. Own calculations based on the same set of 10,000 simulations.

# 6 Tightening credit market access

Our second set of quantitative exercises focuses on policy simulations. Besides divorce legislation, rules affecting tightness of credit markets equally affect the value of marriage through their impact on households' ability to accumulate housing wealth. To uncover the importance of this effect, we consider two scenarios. A first one where the debt-to-income limit is tightened and another where we tighten the downpayment requirement. Both of these will be calibrated so as to achieve the same stabilization goal.

## 6.1 LTI tightening

In the first exercise, we target the debt-to-income ratio by decreasing the importance of the secondary earner in the LTI-limit. More precisely, we lower the value $\lambda_Y^F$ in such a way so as to decrease the homeownership rate of married couples by 10 percentage points, by the age of 25.[24] Such policies have been shown to be relevant for married couples' labor supply decisions, see for example Bartscher (2023) in the US context.

The direct effect of this reduction is of course a decrease in the secondary earner's labor supply. Beyond such a direct effect there is also the increased barrier to homeownership for couples at the margin between renting or buying on the one hand, as well as for those couples who would like to upscale their housing demand from owning a flat to buying a house. This further reduces the need to rely on the secondary earner's labor supply to satisfy the debt-to-income constraint.

In addition to these channels, the reduction in homeownership rates further reduces the value of marriage for those households who are affected at the margin. Indeed, the possibility to pool resources together in order to satisfy the LTI constraint and thereby ease access to credit is one of the main advantages of being married in the model. As a consequence, the implemented policy changes erodes these material benefits of marriage. Secondary earners with relatively high potential wages are those who are most affected by such a policy, since the financial returns of their labor

[24] This corresponds to a decrease of $\lambda_Y^F = 1$ to $\lambda_Y^F = 0.8$.

supply within marriage are now depressed, which implies it is more likely that for them the participation constraint becomes binding. As a result, in such households secondary earners will require a compensation in the form of increased bargaining power, or these households face a larger risk of divorce. Direct consequences of this additional channel is to further depress the secondary earner's labor supply (given higher bargaining power compared to the baseline economy, as well as the disutility of work.)

The results are presented in Table 5. We have broken down the responses along the housing demand and the employment channel. The strongest decrease in the secondary earner's labor supply can be observed for those households who had to downscale from owning a flat or house to renting, with a decrease of the average employment rate in this group of about 4.7 %. These are households with very similar potential wages for the secondary earner compared to those couples who are still homeowners under the tightened LTI-limit, with the main difference that the latter are characterized by on average higher income for the primary earner. The aggregate response of the policy change is a decrease of about 1 p.p. in the employment rate of women in married couples. Note that we also observe that household consumption increases strongly for new renters, which reflects a substitution from saving (to buy a house) towards private consumption.

Table 5: Responses to LTI tightening.

| | % of HH's | $\triangle$ Emp. rate | $\triangle$ HH cons | Avg. $w^F$ | Avg. $y^M$ |
|---|---|---|---|---|---|
| *Homeownwers in both cases* | 28 | 0.10 | 0.46 | 0.87 | 0.82 |
| *Renters in both cases* | 62 | - 1.2 | 4.9 | 0.59 | 0.53 |
| *New renters* | 10 | - 4.7 | 15.9 | 0.87 | 0.61 |
| *Aggregate* | 100 | -1.12 | 5.29 | 0.70 | 0.63 |

Notes: the table contains immediate responses to a tightening in the LTI-limit in terms of the secondary earners' employment rates (in p.p.) and percentage change in household consumption. We also report the average wages and earnings across housing tenure. Own calculations based on the same set of 10,000 simulations.

## 6.2 LTV tightening

Our final exercise is a tightening of the LTV-related limit, with the same aim to decrease the married couples' homeownership rate by 10 percentage points.[25] In this scenario, the households mostly affected are those with higher LTV ratios. Within this group, couples in which the secondary earner's labor supply is substituted for higher debt are the most likely to be affected by the tightening. This group is characterized by relatively lower (potential) wages for the secondary earners, while the primary earner's income is large enough to satisfy the income-related debt limit, suggesting they can still take on higher mortgage debt. These households are now forced to deleverage, which mostly implies a downsizing in housing demand towards renting. The results are presented in Table 6.

Table 6: Responses to LTV tightening.

| | % of HH's | $\triangle$ Emp. rate | $\triangle$ HH cons | Avg. $w^F$ | Avg. $y^M$ |
|---|---|---|---|---|---|
| *Homeowners in both cases* | 27.8 | 1.15 | -3.8 | 0.91 | 0.79 |
| *Renters in both cases* | 61.8 | 0.84 | - 1.5 | 0.59 | 0.53 |
| *New renters* | 10.4 | -1.62 | - 12.6 | 0.77 | 0.70 |
| *Aggregate* | 100 | 0.64 | -3.24 | 0.70 | 0.63 |

Notes: the table contains immediate responses to a tightening in the LTV-limit in terms of the secondary earners' employment rates (in p.p.) and percentage change in household consumption. We also report the average wages and earnings across housing tenure. Own calculations based on the same set of 10,000 simulations.

While before we had the aggregate level a slight decrease in the employment of married women and a big increase in household consumption, we now observe the opposite. This is driven by the need for (potential) homeowners to to save more due to the more restricted borrowing constraint. Next, it is of course the more interesting to zoom in on the effects for new renters in Tables 5 and 6. We note that, though under both policy scenarios the housing ladder has become steeper, only under the tightened LTV-limit we find increased savings from the group affected most. More specifically, we find that the group of new renters facing higher downpayment requirements now reduce their private consumption by about 12 percent. This contrast with our finding for tightening the LTI-limit. There are several reasons for this. First, the composition

[25]This corresponds to a decrease of $\lambda_H = 0.9$ to $\lambda_H = 0.77$.

of both groups is different, with the new renters in the tightened LTI-limit being characterized by secondary earners with larger potential earnings. Consequently, the persistence of the drop in access to property ownership is somewhat dampened, as the income limit could be surpassed later in the lifecycle.

Second, the more persistent adverse effects for the expected trajectory of housing wealth implies a more persistent decrease in the expected value of marriage and consequently a change in the intra-household distribution of resources earlier in the lifecycle. Table 7 illustrates these effects. We should note that, given the higher (estimated) preference for housing for women, their Pareto weight will likely increase. Indeed, compared to the baseline we find that married women have about 2.59 % higher Pareto weights at age 25 for the scenario of a tightened LTV-limit. In contrast, for the LTI tightening the women's Pareto weight is only about 0.15 % higher compared to the baseline economy.[26] The higher relative bargaining power is consistent with new renters in Table 6 using a decrease in private consumption to increase savings, rather than relying on the secondary earner's labor supply.

In addition to the effects discussed, we also note that the more persistent decrease in marriage surplus in the case of an LTV tightening interacts with commitment issues within the household. Indeed, we find that in the case of a tightened LTV-limit the frequency of renegotiations within the household is almost double from that under a tightened debt-to-income limit. All his demonstrates once more the importance of limited commitment in determining the value of marriage and its impact on household decisions.

Table 7: Intra-household commitment.

| | LTI tightening | LTV tightening |
|---|---|---|
| *Relative change female Pareto weight at age 25 (%)* | 0.15 | 2.59 |
| *Frequency of renegotiations* | 0.036 | 0.079 |

Notes: average relative changes in Pareto weight is expressed relative to the baseline economy. Frequency represents the (average) number of revisions in the Pareto weights over the lifecycle. Own calculations based on the same set of 10,000 simulations.

[26]Given that secondary earners among new renters in the tightened LTI-economy have higher potential wages, we observe their Pareto weight is also on average higher than the secondary earners in the group of new renters under the tightened LTV scenario, about 0.3 %.

# 7 Conclusion

To analyze the impact of changes in the value of marriage on household behavior, we presented a dynamic model of household behavior in which the household makes decisions on housing demand, labor supply and private consumption in a limited commitment setting. We used quasi-natural variation in the post-divorce asset division rule to identify and estimate our model.

We then conducted three quantitative exercises with our estimated dynamic model. First, we considered a permanent income shock to the primary earner and highlighted how the insurance value of marriage is affected by both limited commitment and the presence of borrowing constraints. More specifically, we showed how the amount of self-insurance via the labor supply channel (the added worker effect) can be quite severely overestimated. Next, we documented the welfare effects of a sudden (yet transitory) shock to house prices on individuals differentiated by gender and marital status, where a substantial fraction of single women seem to incur welfare losses from such shocks. Finally, we illustrated how access to credit affects intra-household behavior in the presence of limited commitment. In particular we showed that changes in credit policies based on LTI or LTV tightening have opposite effects on household savings and labor supply of married women.

We believe that our rich structural model of household behavior is the beginning of an interesting research agenda that focuses on different research questions and offers scope for further extensions or our approach. One such extension is the inclusion of raising children and fertility decisions, which is tied to both housing demand and labor supply. Two alternative examples are giving by a proper treatment of the retirement stage in order to better grasp the insurance aspects and wealth effects of marriage related to this phase of life. Or, while divorce was endogenous in our approach, we did not model the marriage market (in particular, choice of one's partner). While all this received ample attention in the literature, it has not been done in a rich context as ours. As such this offers scope for further improving our understanding of how changes in the value of marriage impact household behavior.

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# For online publication: Appendix

## A Validity of our Difference-in-Difference approach

Several of the exercises in this appendix are similar to the approach taken by Piazzalunga (2017). We refer to that paper for a more extensive analysis of the empirical results (including a discussion on simultaneous policy changes occurring with the White v. White case).

### A.1 Summary statistics

Table 8: Summary statistics of the regression sample.

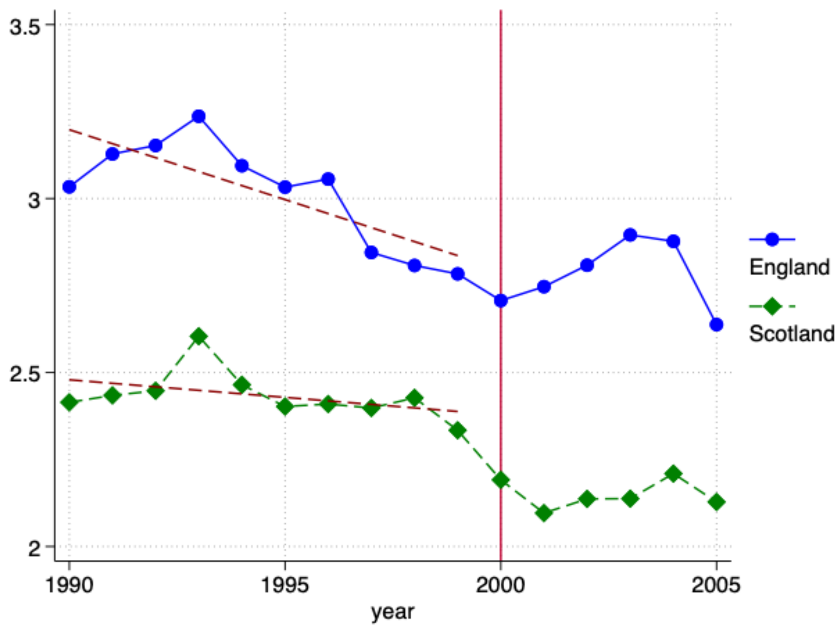
| Variable | Mean | St. deviation |
|---|---|---|
| *Age* | 42.50 | 9.60 |
| *Higher educated* | 0.31 | 0.46 |
| *Wage* | 9.80 | 8.42 |
| *Non-labor income* | 4,470.22 | 6,450.06 |

Notes: estimation on BHPS sample, married women in the age range of 25-60 years old during the period 1992-2005. We have a total of 27,699 observations. Non-labor income and wage levels are deflated by the CPI with 2014 as reference year. Higher educated refers to having at least obtained A-levels. Cross-sectional weights have been used.

### A.2 Standard tests

**Parallel trends.** We formally test for the parallel trends assumption on our main outcome variables (in particular married women's hours worked and employment status), by regressing the outcome variables on a full set of interactions between a dummy indicating whether the respondent is living in Scotland and the year dummies. We then test common trends by statistically testing the null hypothesis that the interaction effects are null for the years before 2000 against the alternative hypothesis they are not null. This is similar to the approach taken by Ohinata and Picchio (2020). The p-value for the test with *Hours* equals 0.15, and for *Employment* it is 0.86. Hence, we cannot reject the null hypothesis and therefore we cannot reject the common trends assumption. Due to the limited number of observations, we cannot directly use the same procedure for the crude divorce rates, but we present the pre-*White v. White* trends here below:

Figure 9: Crude divorce rates.




Notes: Office for National Statistics , 'Vital statistics: Population and Health Reference tables', sample range 1990-2005.

**Placebo tests.** To verify for the validity of the DiD estimates, we conduct a placebo test by checking for any labor supply effects of *White v. White* on women who are either cohabiting, never married or single (never married or divorcees) throughout our years of observations. For all these groups, there should not be any discernible labor supply responses, given that these are not treated by the case. Table 9 presents these results and confirm that there are no significant labor supply responses at the intensive margin. The same conclusions hold at the extensive margin.

Table 9: *White v. White* and labor supply of cohabiting and single women.

| | $Hours_{i,c,t}$ | $Hours_{i,c,t}$ | $Hours_{i,c,t}$ |
|---|---|---|---|
| $Post \times Treated_{c,t}$ | 4.115 | -1.375 | -0.319 |
| | (2.520) | (1.961 ) | (1.428) |
| Observations | 5,018 | 4,575 | 9,648 |
| R-squared | 0.224 | 0.343 | 0.328 |
| Sample | Cohabiting | Never married | Never married & divorcees |
| Demographic (incl. spouse) controls | ✓ | ✓ | ✓ |
| Year | ✓ | ✓ | ✓ |
| Region | ✓ | ✓ | ✓ |
| Local female unemployment rate | ✓ | ✓ | ✓ |

Notes: estimation on BHPS sample, never married, divorcees and cohabiting women in the age range of 25-60 years old during the period 1992-2005. Standard errors clustered at the individual level, *** p<0.01, ** p<0.05, * p<0.1. Demographic controls include the age and age squared of husband and wife, the education level of husband and wife both defined as their highest qualification received, number of young children ($\leq$ 15 age old) and the partner's non-labor income in case of cohabitation. Non-labor income is deflated by the CPI with 2014 as reference year. Cross-sectional weights have been used.

## A.3 Extensions and robustness

**Male labor supply & Panel estimation.** We can also estimate the effect of the *White v. White* case for married men. From a theoretical perspective, given that the case induced a higher bargaining power for women, together with the fact that a majority of married men work full time, we do not expect any significant changes in male labor supply. This is indeed confirmed in Table 10. We also re-estimated (1) by exploiting the panel dimension in the data, which allows us to include individual fixed effects to control for unobserved heterogeneity that does not change over time. To do this, we only preserve those respondents in the sample which we observe at least once before the year 2000 and once after. The results are also presented in Table 10. The qualitative results are similar to the DiD results in Table 1. The coefficient of the effect of *White v. White* is estimated with more noise and the point estimate reduces in size (to a reduction of about 1.6 hours worked per week). We also conducted the same regressions for employment status of married men and employment status of married women incl. individual FEs, but did not find any significant effects.

Table 10: *White v. White*: extensions and robustness.

| | $Hours_{i,c,t}$ | $Hours_{i,c,t}$ |
|---|---|---|
| $Post \times Treated_{c,t}$ | -0.696 | -1.60* |
| | (1.296) | (0.899) |
| Observations | 25,151 | 24, 415 |
| R-squared | 0.132 | 0.094 |
| Sample | Married men | Married women |
| Individual FE | | ✓ |
| Demographic (incl. spouse) controls | ✓ | ✓ |
| Year | ✓ | ✓ |
| Region | ✓ | ✓ |
| local male unemployment rate | ✓ | ✓ |

Notes: estimation on BHPS sample, married men in the age range of 25-60 years old during the period 1992-2005. Standard errors clustered at the individual level, *** p<0.01, ** p<0.05, * p<0.1. Demographic controls include the age and age squared of husband and wife, the education level of husband and wife both defined as their highest qualification received, number of young children ($\leq$ 15 age old) and the household's non-labor income. Non-labor income is deflated by the CPI with 2014 as reference year. Cross-sectional weights have been used.

**Household work.** The more egalitarian distribution of assets upon divorce following *White v. White* has had a negative effect on married women's labor supply. Given that our structural model does not include domestic work, we need to know whether there is any evidence of substitution of this freed up time towards domestic work. The BHPS asks respondents how much time they spend (on average) per week on domestic chores, which we can use as a proxy for household work. We then run a regression of household work on the same set of controls as in our main DiD specification as represented in (1). Table 11 presents the results for both the OLS and fixed effects regression.

Table 11: *White v. White* and household work.

| | $Household\ work_{i,c,t}$<br>OLS | $Household\ work_{i,c,t}$<br>Fixed effects |
|---|---|---|
| $Post \times Treated_{c,t}$ | 1.284** | 0.004 |
| | (0.555) | (0.515) |
| Observations | 26,853 | 24,415 |
| R-squared | 0.129 | 0.056 |
| Individual FE | | ✓ |
| Demographic (incl. spouse) controls | ✓ | ✓ |
| Year | ✓ | ✓ |
| Region | ✓ | ✓ |
| local female unemployment rate | ✓ | ✓ |

Notes: estimation on BHPS sample, married women in the age range of 25-60 years old during the period 1992-2005. Standard errors clustered at the individual level, *** p<0.01, ** p<0.05, * p<0.1. Demographic controls include the age and age squared of husband and wife, the education level of husband and wife both defined as their highest qualification received, number of young children ($\leq$ 15 age old) and the household's non-labor income. Non-labor income is deflated by the CPI with 2014 as reference year. Cross-sectional weights have been used.

Though the pooled OLS estimate in column 1 suggests a slight increase in domestic work (hence suggestive for a substitution between market and domestic work time), this effect vanishes (both in size and statistically) after controlling for individual fixed effects, i.e., unobserved heterogeneity at the individual level. All in all this suggests that not including domestic work should not be too influential.

# B Further details on the structural model

## B.1 Optimization problems for singles

**Preferences.** Single men and women are very similar to their resp. married counterparts:

$$u^{i,s}\left(c_t^i, l_t^i, H_t\right) = \frac{(c_t^i)^{1-\sigma^i}}{1-\sigma^i} + \omega_l^{i,s}\frac{(l_t^i)^{1-\psi^i}}{1-\psi^i} + \mathbf{1}\left[H_t > 0\right]\bar{\omega}_H^i.$$

Note that singles do not experience match quality shocks and hat we allow for the preferences for leisure to be different between single and married women (that is, we allow $\omega_l^{F,s} \neq \omega_l^{F,m}$).

**Budget and borrowing constraints.** Single women face the following budget constraint:

$$\begin{aligned} &A_t + c_t^F + p_t H_t + \Omega\left(H_t, H_{t-1}\right) + q_t \mathbf{1}\left[H_t = 0\right] \\ &= (1+R)\, A_{t-1} + w_t^F n_t^F - \delta^s(t)\, \mathbf{1}\left[n_t^F > 0\right] + p_t H_{t-1}. \end{aligned} \tag{9}$$

Note that obviously singles no longer have economies of scale in private consumption. We also allow for different monetary cost of participating on the labor market, compared to their married counterparts (that is, we allow $\delta^s(t) \neq \delta^m(t)$). This is motivated by differential employment rates of women by marital status as highlighted in Figure 1, panel c.

Similarly, single men their budget constraint is given by:

$$\begin{aligned} &A_t + c_t^M + p_t H_t + \Omega\left(H_t, H_{t-1}\right) + q_t \mathbf{1}\left[H_t = 0\right] \\ &= (1+R)\, A_{t-1} + y_t^M e_t^M + b_u\left(1 - e_t^M\right) + p_t H_{t-1}. \end{aligned} \tag{10}$$

Finally, the borrowing constraint for single women is given by

$$Debt_t \leq \max\{Debt_{t-1}, \min\{LTV_t, LTI_t\}\} \tag{11}$$

$$LTV_t = \lambda_H p_t,$$

$$LTI_t = \lambda_Y n_t^F \times w_t^F.$$

and for single men by

$$Debt_t \leq \max\{Debt_{t-1}, \min\{LTV_t, LTI_t\}\} \tag{12}$$
$$LTV_t = \lambda_H p_t,$$
$$LTI_t = \lambda_Y (y_t^M e_t^M + b_u \left(1 - e_t^M\right)).$$

The main difference between (5) and the above constraints is of course the absence of a second earner, which implies that the loan-to-income borrowing limit becomes more stringent compared to married individuals, who have an additional source of income through their spouse's labor income.

**Optimization problems.** Let $\mathbf{S}_t^{F,s} = \left(A_{t-1}, H_{t-1}, w_t^F\right)$ and $\mathbf{S}_t^{M,s} = \left(A_{t-1}, H_{t-1}, y_t^M\right)$ denote the respective state variables relevant for the singles' decision problem in period $t \leq T_r$ and $\mathbf{a}_t^{F,s} = \left(c_t^F, l_t^F, A_t, H_t\right)$ and $\mathbf{a}_t^{M,s} = \left(c_t^M, A_t, H_t\right)$ the corresponding choice variables. We then obtain the following optimization problem for women

$$V_t^{F,s}\left(\mathbf{S}_t^{F,s}\right) = \max_{\mathbf{a}_t^{F,s}} u^{F,s}\left(c_t^F, n_t^F, H_t\right) + \beta \mathbb{E}\left[V_{t+1}^{M,s}\left(\mathbf{S}_{t+1}^{M,s}\right)\right],$$

subject to (9) and (11). Similarly, for men

$$V_t^{M,s}\left(\mathbf{S}_t^{M,s}\right) = \max_{\mathbf{a}_t^{M,s}} u^{M,s}\left(c_t^M, H_t\right) + \beta \mathbb{E}\left[V_{t+1}^{M,s}\left(\mathbf{S}_{t+1}^{M,s}\right)\right],$$

subject to (10) and (12).

## B.2 Retirement phase

In retirement, individuals no longer work and no longer face earnings shocks. Instead of their labor income, they receive a pension, $y_r^i, i = M, F$. This is defined as a replacement rate, $b_r$, that is multiplied by the earnings in the last period in which the individual was working. Formally this means that preferences no longer include leisure for women. The state variables for $T_r \leq t \leq T_d$ are $\mathbf{S}_t = \left(A_{t-1}, H_{t-1}, \theta_t^M, \theta_t^F, \tilde{\mu}_t^M, \tilde{\mu}_t^F\right)$ and the choice variables are $\mathbf{a}_t = \left(c_t^M, c_t^F, A_t, H_t, D_t\right)$. The budget constraint then becomes

$$A_t + x_t + p_t H_t + \Omega\left(H_t, H_{t-1}\right) + q_t \mathbf{1}\left[H_t = 0\right]$$
$$= \left(1 + R\right) A_{t-1} + y_r^M + y_r^F + p_t H_{t-1},$$

and the borrowing constraint

$$Debt_t \leq \max\{Debt_{t-1}, \min\{LTV_t, LTI_t\}\}$$
$$LTV_t = \lambda_H p_t,$$
$$LTI_t = \lambda_Y y_r^M + \lambda_Y^F y_r^F.$$

# C Estimation details for house prices, wages and earnings

## C.1 House prices

We use data from the UK House Price Index (UKHPI) from 1968-2008 to obtain a nominal price series and use the retail price index (RPI, all items) to deflate these nominal prices to obtain a real price series. We then estimate the house price process as presented in the main paper (i.e. an AR(1) process including a linear trend).

Using $a_0 = \left(1 - \rho_H\right)\tilde{a}_0 + \rho_H \tilde{a}_1$, $a_1 = \left(1 - \rho_H\right)\tilde{a}_1$ and $\eta_t^H = \rho_H \eta_t^H + \epsilon_t^H$, we can rewrite the house price process from the main text as follows:

$$\ln p_t = \tilde{a}_0 + \tilde{a}_1 t + \eta_t^H.$$

If we then define $\widetilde{\ln p_t} = \ln p_t - \tilde{a}_0 - \tilde{a}_1 t$, we can use our times series to identify $\sigma_H^2$ from the following single second moment:

$$\sigma_H^2 = Cov\left(\Delta\widetilde{\ln p_t}, \Delta\widetilde{\ln p_{t-1}} + \Delta\widetilde{\ln p_t} + \Delta\widetilde{\ln p_{t+1}}\right).$$

## C.2 Wages and earnings

For the estimation of the variances for permanent productivity shocks we rely on the identification arguments in Meghir and Pistaferri (2004) and Blundell et al. (2008). In particular, let us define

$$\widetilde{\ln y_t}^M = \ln y_t^M - \alpha^M(t),$$

and

$$\widetilde{\ln w_t}^F = \ln w_t^F - \alpha^F(t).$$

This gives us the unexplained parts of earnings and wages as

$$\Delta\widetilde{\ln y_t}^M = \epsilon_t^M,$$

and

$$\Delta\widetilde{\ln w_t}^F = \epsilon_t^F.$$

The variance of the innovations $\epsilon_t^M$ for men's earnings can then be identified using the single second moment

$$\sigma^2_{\epsilon^M} = Cov\left(\Delta\widetilde{\ln y_t}^M, \Delta\widetilde{\ln y_{t-1}}^M + \Delta\widetilde{\ln y_t}^M + \Delta\widetilde{\ln y_{t+1}}^M\right).$$

Similarly for the variance of innovations to women's wages:

$$\sigma^2_{\epsilon^F} = Cov\left(\Delta\widetilde{\ln w_t}^F, \Delta\widetilde{\ln w_{t-1}}^F + \Delta\widetilde{\ln w_t}^F + \Delta\widetilde{\ln w_{t+1}}^F\right).$$

These equations can be directly estimated from panel data on male earnings and female wages, after removing the age-profiles from the wage and earnings dynamics. We use a 2-step Heckman selection to estimate the wage process of women.

# D Computational details for solving the model

**Details on discretization.** For housing prices, we use the Tauchen discretization method (Tauchen, 1986). We use 12 nodes for the house price grid. To approximate the wage and earnings processes, we need to take into account the age-dependent distribution generated through the presence of unit roots in the productivity shocks. To accommodate for this, we discretize the wage and earnings distributions at each age separately. We use 10 nodes for both female wages and male earnings. The grid for male earnings is also doubled to allow for the contingency of unemployment.

**Model solution.** We solve the model using backwards recursion. For each of the grid points, agents make decisions given that values for the next time period, $t + 1$, are predetermined. We first solve the model for single individuals denoted as $V^{F,s}$ and $V^{M,s}$. These values are then used to compute the value functions for married individuals. Solving the value function on each grid is slower than alternative methods (e.g., the endogenous grid point method), but the specific form of the borrowing constraint complicates its usage, given the potential for non-differentiabilities in the value functions. Given that the constraint set for $(A_{t+1}, H_t)$ is not rectangular, and the constraint on $H_t$ is endogenous on $A_{t+1}$, we adjust the state space following Bajari et al. (2013) such that debt levels satisfy the LTV-limit and the optimization runs over a rectangular space. Conditional on $H_{t-1}$ and $H_t$, we then solve for consumption and female labor supply, subject to the debt-to-income limit and given these conditional choices, we then find the optimal values for $H_t$ by selecting the level which yields the highest value. We use the *Nelder-Mead* algorithm to minimize the distance between the estimates of the auxiliary models on the observed and simulated data. We run 10,000 simulations of all the exogenous stochastic processes, incl. the joint earnings and wage process for individuals, as well as match qualities. To assure a global solution, we conducted multiple runs by varying the initial parameter values in our optimization procedure.

# E Further results from the estimated model

## E.1 Matched moments

Table 12 shows that we fit the moments quite well, which implies that average outcomes in terms of the key household decisions such as (female) labor supply and housing demand are captured well by our structural model. Unfortunately, we underestimate the response in the (crude) divorce rates due to *White v. White*. This may be due to the fact that the implied distribution of net wealth post-divorce in expression (8) still underestimates the degree of inequity in post-divorce division, compared to the effective inequity between spouses under the pre-*White v. White* (discretionary) regime. This lower response of the reform on the (crude) divorce rate then also translates in a (slightly) lower estimate of the labor supply response.

Table 12: Model simulations and data.

| | Simulations | Data |
|---|---|---|
| *White v. White* response in hours worked | -1.8 | -2.4 |
| Employment rate women 25-29 | 0.70 | 0.70 |
| Employment rate women 30-34 | 0.70 | 0.70 |
| Employment rate women 35-39 | 0.78 | 0.75 |
| Employment rate women 40-44 | 0.80 | 0.80 |
| Employment rate women 45-49 | 0.84 | 0.83 |
| Average hours worked married women 25-29 | 22 | 23 |
| Average hours worked married women 30-34 | 20 | 20 |
| Average hours worked married women 35-39 | 20 | 20 |
| Average hours worked married women 40-44 | 22 | 22 |
| Average hours worked married women 45-49 | 23 | 23 |
| Average hours worked single women 25-29 | 30 | 28 |
| Average hours worked single women 30-34 | 27 | 25 |
| Average hours worked single women 35-39 | 27 | 24 |
| Average hours worked single women 40-44 | 26 | 24 |
| Average hours worked single women 45-49 | 27 | 25 |
| Homeownership rate married 30-50 | 0.86 | 0.86 |
| Homeownership rate single women 30-50 | 0.56 | 0.55 |
| Homeownership rate single men 30-50 | 0.67 | 0.68 |
| Median housing value married 30-50 | 4.67 | 4.51 |
| Median housing value singles 30-50 | 3.64 | 3.64 |
| Crude divorce rate 30-50 | 0.002 | 0.003 |
| The effect of *White v. White* on crude divorce rate 30-50 | 0.00011 | 0.00021 |

Notes: own calculations based on the same set of 10,000 simulations.

## E.2 Housing wealth and labor supply

We also analyzed the relationship between (married) female labor supply and (net) housing wealth, the latter being defined as the difference between the housing value and (outstanding) debt. Table 13 presents the average hours worked by married women by 5 year age groups.[27] Note that our simulated model matches quite well the expected negative gradient in the data between housing wealth and female labor supply. These findings on the relationship between housing wealth and female labor supply are also in line with empirical findings in Henley (2004), Milosch (2014) and Disney and Gathergood (2018).

Table 13: Hours worked married women by quantiles (net) wealth.

| | Q1 | | Q2 | | Q3 | | Q4 | |
|---|---|---|---|---|---|---|---|---|
| Age | Data | Simulations | Data | Simulations | Data | Simulations | Data | Simulations |
| 30 - 34 | 23 | 22 | 20 | 20 | 18 | 20 | 18 | 15 |
| 35 - 39 | 22 | 23 | 21 | 20 | 19 | 21 | 15 | 19 |
| 40 - 44 | 25 | 29 | 23 | 24 | 22 | 22 | 18 | 19 |
| 45 - 49 | 26 | 28 | 25 | 23 | 22 | 22 | 20 | 17 |
| 50 - 54 | 25 | 29 | 20 | 23 | 19 | 21 | 18 | 16 |

Notes: own calculations based on the same set of 10,000 simulations.

# F Details on computation of welfare costs

We use the Hicksian equivalent compensation measure to calculate the welfare costs and benefits of changes in the economic environment (see, e.g., Fehr and Kindermann, 2018). To do so we first fix a set of simulated paths for match quality, male earnings and female wages. Then, for a given household we can compute the resulting (simulated) paths for the outcome variables $c_t^M, c_t^F, x_t, H_t, l_t^F$. With these we can compute, for each individual within each household their expected (lifetime) utility, as follows:

$$U^i = \sum_{t=1}^{T_d} \beta^{t-1} u^i \left( c_t^i, l_t^i, H_t, \theta_t^i \right).$$

Similarly, the expected lifetime utility can also be computed in the counterfactual

[27] We focus on the early part of the lifecycle between 30 and 54, given the absence of a realistic retirement dynamics in the model.

case. That is, for the new house prices simulate new consumption, leisure and housing demand paths $\tilde{c}_t^M, \tilde{c}_t^F, \tilde{x}_t, \tilde{H}_t, \tilde{l}_t^F$ (for the same set of simulated paths of match quality, male earnings and female wages). This gives us the expected (lifetime) utility in the counterfactual situation:

$$\tilde{U}^i = \sum_{t=1}^{T_d} \beta^{t-1} u^i \left( \tilde{c}_t^i, \tilde{l}_t^i, \tilde{H}_t, \theta_t^i \right).$$

To evaluate the impact on individual welfare, we then find a value $z$ such that:

$$\sum_{t=1}^{T_d} \beta^{t-1} u^i \left( (1+z)c_t^i, (1+z)l_t^i, H_t, \theta_t^i \right) = \tilde{U}^i.$$