Household Formation, Female Labor Supply and Savings

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Abstract

This paper aims at quantifying the impact of changing family structures on labor supply and savings in western societies. For this reason we develop a dynamic general equilibrium model with both genders, which takes into account changes of the marital status as a stochastic process. Individuals respond to these shocks by adjusting savings, market labor supply and home production. Our simulation model is calibrated to the German economy. We show that on the aggregate level changes in household formation may partly explain the reallocation of male and female labor supply observed during the last decades. In addition, we find a negative impact on capital accumulation. On the individual level, changes in marital risk had a significant impact on the life cycle labor supply and savings profile of singles, while that of married couples is hardly influenced. Finally we show that a combination of higher marital risk and a narrowing gender wage gap can explain the changes in hours ratios between single and married men and women over the last 40 years.

JEL Classifications: J12, J22

Keywords: marital risk, home production, stochastic general equilibrium, life cycle model

1 Introduction

Almost all western societies are currently experiencing an unprecedented two-dimensional demographic transition. On the one hand, low fertility and reduced mortality rates change the age structure of the population. On the other hand, declining marriage and increasing divorce rates radically alter the traditional family structure within cohorts. While numerous studies have already evaluated the economic consequences of population aging, much less research has focused on the impact of the changing household structure for various economic aggregates. Changes in the number of couples and singles in an economy will alter the respective income distribution as well as the structure of tax payments and public transfers. In addition, precautionary behavior will be adjusted, since families offer an (incomplete) insurance contract against lifespan (Kotlikoff and Spivak, 1981) and income risk (Attanasio et al., 2005; Halla and Scharler, 2012). Consequently, the actual and the perceived future household structure will affect life-cycle labor supply, consumption and savings behavior which in turn may have severe effects on labor and capital markets.

The present study attempts to quantify such macroeconomic repercussions of the changing family structure. We therefore develop a two-gender life-cycle family model with endogenous labor supply, which accounts for income and lifespan uncertainty and distinguishes between market work and home production. Throughout their life cycle individuals are exposed to the (exogenous) risk of getting married and divorced. When being single, individuals choose consumption, labor supply at the market, the production of home goods and savings. When married, two partners have to decide about whether and how to make use of specialization within the household.

We calibrate our model to the German economy, which has experienced a transformation of household structures in the last decades that is typical for Western societies. In order to so, we use macroeconomic statistics as well as microeconomic data on time use and labor productivity. Our analysis then proceeds in three distinct steps. First, we identify the driving forces that determine behavioral differences between married and single men and women. Second, we quantify the impact of a change in marriage and divorce probabilities on both individual behavior and the macroeconomy. We therefore run the model with two sets of probabilities: one set is derived from the marital and divorce behavior observed in 1970, one from current behavior. Third, in order to put our results into perspective, we use our model to clarify the effects of changes in the gender wage gap during the same period on different types of households.

Our quantitative results indicate that differences in eduction and wages between men and women as well as the fact that married partners can make use of joint filing in the tax system are the major determinants of specialization within the marriage. We also find that differences in life expectancy mainly explain the disparities in savings behavior of men and women.

When we alter marriage and divorce probabilities, macroeconomic aggregates are affected by both a compositional and a behavioral effect. Since married women work less than single women, aggregate female labor supply increases when the share of married couples in the population declines. The same argumentation applies to the labor supply of men, but vice versa. As married couples have a higher savings rate, capital accumulation is negatively affected by the changes in household structure. In terms of individual behavior, we find that changes in marital risk had an impact on the life cycle labor supply and savings profiles of singles, while labor supply of married couples is almost unaltered. This finding is related to the implicit insurance provision of the family. In a marriage, partners can adapt their labor supply and home production effort so as to absorb idiosyncratic productivity shocks that are uncorrelated between the two spouses. Beneath this implicit insurance against labor market uncertainty, inheritances from one partner to the other provide insurance against longevity risk. If marriage becomes less likely, single individuals anticipate the loss of this implicit insurance mechanisms. As a consequence, they increase their labor supply in the market at early stages in life to build up precautionary savings. However, they in turn decrease their labor supply towards the end of the working life and start living off their savings earlier, so that labor supply effects are mostly intertemporal. In total the change in marital and divorce risk therefore comes along with an increase in aggregate female labor supply and a decline in male labor supply. In terms of asset accumulation, the negative compositional effect is almost washed out by the strong increase in single individuals' savings, so that aggregate savings decline only slightly.

What the change in marital risk does not explain are the empirically observed changes in hours ratios between men and women. Our simulations reveal that these changes can mostly be attributed to the narrowing of the gender wage gap between 1970 and 2010. Interestingly, our model is able to capture the empirical fact that the hours ratio between married and single women has significantly increased over the last decades, meaning that the change in the gender wage gap had a much stronger impact on married women's labor supply than on single women. The reason for this asymmetry is that a narrowing gender wage gap crowds out specialization within the family and increases the ability of women to participate in risk sharing, see Heathcote et al. (2010).

Our approach is related to several strands of the recent literature using calibrated models. First, it builds on Rogerson (2009) and Olovsson (2009) who analyze labor supply issues in models with home production. Second, it is linked to the large literature that tries to explain the long run changes in labor supply of married women such as Greenwood et al. (2005), Olivetti (2006), Attanasio et al. (2008), Kaygusuz (2010) or Guner et al. (2012). Finally, it is connected to family models such as Caucutt et al. (2002), Chade and Ventura (2002), or Greenwood and Guner (2009) which either deal with marriage issues or concentrate on the relationship between fertility and labor supply decisions. While these studies explicitly model marriage and fertility decisions, other papers have introduced changes in marital status as exogenous shocks and focus on the interaction between marital risk and individual decisions. For example, Love (2010) includes marriage and divorce risk in a partial equilibrium model with labor income and investment uncertainty in order to analyze optimal portfolio choice. Our approach mainly builds on the general equilibrium studies of Domeij and Klein (2002), Hong and Rios-Rull (2007) as well as Cubeddu and Rios-Rull (2003) who extend the standard overlapping generations model in the Auerbach and Kotlikoff (1987) tradition by explicitly accounting for marital transitions during the life-cycle. Domeij and Klein (2002) as well as Hong and Rios-Rull (2007) keep marriage patterns constant and analyze the long-run impact of social security privatization in Sweden and the US. Cubeddu and Rios-Rull (2003) study the long-run consequences of alternative marriage transitions for aggregate savings. They find that rising divorce risk increases precautionary savings but the aggregate savings impact depends on specific institutional features such as asset splitting rules, divorce costs and remarriage patterns. Our study extends this approach in various directions. First, while Cubeddu and Rios-Rull (2003) abstract from labor supply issues, our model allows for endogenous labor supply and household production of both partners in the marriage. Second, we introduce income and lifespan uncertainty as well as mating across education types in order to capture and isolate the insurance provision of marriages.

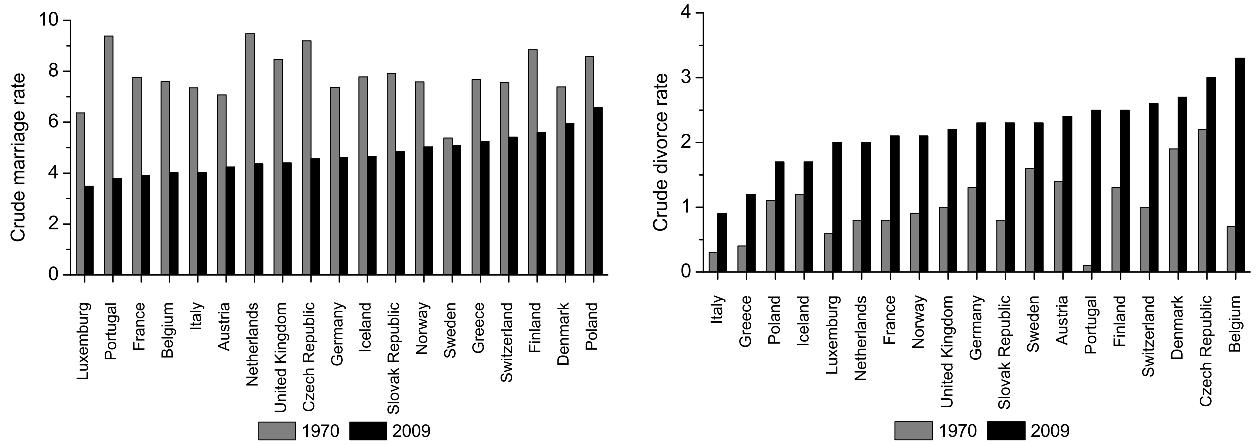
The next section documents recent changes in household formation as well as the corresponding changes in labor supply and savings patterns in Europe and Germany and discusses previous empirical studies analyzing its impact on economic activity. Section 3 describes the structure of the simulation model, while section 4 explains the calibration and simulation approach. Finally, section 5 presents the simulation results and the last section offers some concluding remarks.

2 Changes in household formation and economic activity

Various statistical concepts are available which measure the dynamics of marital transitions and household formation. In Figure 1 we compare changes in crude marriage and divorce rates between 1970 and 2009 for some selected European countries. The crude marriage (divorce) rate is the number of marriages (divorces) formed each year as a ratio of 1000 people. Both measures only account for official changes in formal partnerships, i.e. the marriage rate disregards formal cohabitation contracts and informal partnerships while the divorce rate neglects separations where partners remain married officially and breakdowns of unofficial partnerships.[1]

The left part of Figure 1 illustrates the significant decline in the crude marriage rate since 1970, which took place in almost all European countries. The downward trend was especially substantial in countries such as the Czech Republic, Finland, the Netherlands and Portugal where in 1970 marriage rates were exceptionally high, while it was limited in Denmark or Sweden where marriage rates were already relatively low. While marriage rates differed substantially across European countries 35 years ago, it seems that they have converged to roughly 5.0 marriages per 1000 inhabitants in recent years. The decline of the marriage rates could be interpreted more clearly, if the age-specific first marriage rates of a specific year were aggregated in order to indicate the probability of marriage of a person during his or her lifetime. Whereas for European women this so-called "total first marriage rate" was above 90 percent during the 1960s, nowadays only about 58 percent of women get married during their lifetime in Europe.

Figure 1: Crude marriage and divorce rates in Europe



Source: OECD (2011a)

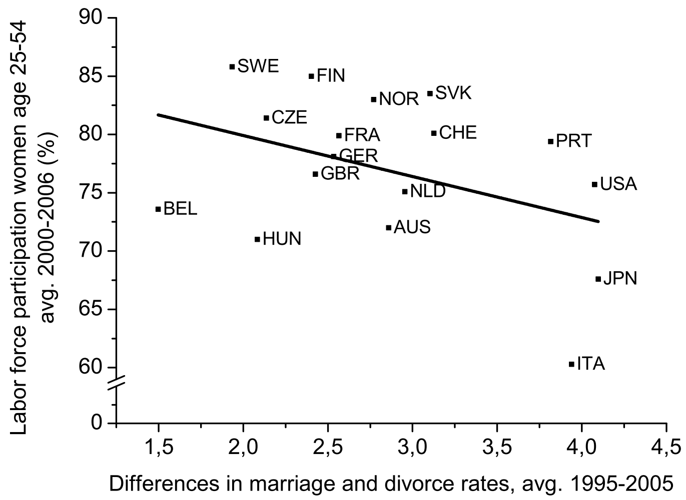
But not only marriage rates have decreased, also divorce rates have increased significantly in all countries. As shown in the right part of Figure 1, cross-national differences still remain important

[1] There is a rising proportion of cohabiting couples (i.e. larger than 10% of all couple households) in most European countries. Since cohabitation may have been used as substitute for marriage in the past, the figures might slightly overstate the changes in household structures.

in 2009. While low divorce rates still prevail in countries such as Greece, Italy or Poland, countries like Belgium, the Czech Republic and Denmark stand out with three times higher numbers. Overall, the average European total divorce rate, which indicates the probability of a married person being divorced, has increased from roughly 10 percent to 32 percent in 2004. Compared to Europeans, Americans marry and divorce at higher rates, but the time trend is quite similar, see Stevenson and Wolfers (2007).

During the same period, female employment and labor force participation has increased strongly in most OECD countries. While in 1970 only about 45 percent of women in OECD countries were employed in the labor market, employment rates in year 2008 amounted to 61 percent, see OECD Database. In order to get a first intuition that family formation may have an impact on female employment rates, Figure 2 compares cross-sectional data of a family formation indicator and female labor market participation rates. Obviously there exists a clear negative relationship, which intuitively reflects the fact that married women mainly work at home while single women work more on the labor market. However, the connection between female labor supply and marriage and divorce risk is much more complex. Even the causality is not undisputed. While sociologists mostly investigate the so-called "independence hypothesis", according to which rising female employment increases marital instability, economists are typically interested in the reverse relationship. Özcan and Breen (2012) discuss the methodological issues in establishing causality and summarize the empirical findings of the two literature strands.

Figure 2: Family formation and female labor market participation



Source: own calculations based on OECD (2009) and OECD (2011b)

Regarding the economics literature, Johnson and Skinner (1986) already argued in the context of a static household model that increased divorce probabilities have a significant positive impact on female participation rates in the USA. Stevenson (2008) as well as Bargain et al. (2012) confirm this finding by analyzing the past changes in divorce law (which decreased marriage stability) and by using the legalization of divorce introduced in 1996 in Ireland as a natural experiment. In principle, marriage and divorce can be viewed as costly events, so that increased marital risk induces – similarly as rising income risk – precautionary behavior. Therefore, the positive relationship between divorce probability and female labor supply is significant in the intertemporal labor supply model of Papps (2006), where married partners both choose their labor supply simultaneously. Surprisingly, this study also finds that higher marriage probabilities have a positive effect on singles' labor supply. Especially for women who expect to marry a partner with higher income, one would expect the opposite. But – as suggested by Papps (2006, p. 30) – maybe these women already take into account the possible divorce after marriage.

In the recent past, Germany has experienced very similar changes in marital transition rates as well as female labor market participation. As shown in Figure 1, crude marriage rates declined since 1970 from 7.4 to currently 4.6 marriages per 1000 inhabitants while divorce rates roughly doubled. At the same time the labor market participation of women has changed dramatically. Table 1 compares the ratios of working hours for women and men with different marital status calculated from German Microcensus data for the years 1975 and 2010. The numbers clearly document that especially married women have increased their labor supply in recent decades. While married women worked about 60 percent less in 1975 than married men, this ratio has increased by 15 percentage points in 2010. Single women have also increased their relative labor supply compared to single men, but the change is much less profound. For that reason the gap in working hours between married and single women has been reduced quite significantly. Finally, the last line of Table 1 shows that the difference in hours ratios of married and single men has remained quite stable over time.

Table 1: Hours ratios in 1975 and 2010 (in %)

	1975	2010	Change
single women / single men	78.5	83.7	5.2
married women / married men	39.5	54.5	15.0
married women / single women	60.9	78.0	17.1
married men / single men	121.0	119.8	-1.2

Source: own calculations based on Stabu (2013).

In Table 2 we compare the changes in intertemporal labor supply patterns for low-skilled single and married men and women. In order to neutralize the impact of children on labor supply, we only consider childless singles and couples. Except for married women all profiles have a typical humped-shaped pattern which peaks in the high-productive middle-age years. Comparing the profiles of 1975 and 2010 a clear pattern emerges. While single men and women substitute from working at later ages towards working at younger ages, the opposite occurs with married individuals. Especially married women reduce labor supply at young ages significantly, in order to work more at the end of the employment phase.[2] The question is to what extent this asymmetric pattern of the intertemporal labor supply schedule could be explained by changes in marital risk.

The literature cited above explains the large changes in female participation and employment with innovations in household production technologies (Greenwood et al., 2005), rising educational attainment of females (Olivetti, 2005), decreases in child care cost (Attanasio et al., 2008) or changes in the tax system (Kaygusuz, 2010; Guner et al., 2012). Of course, changes in household structures are also typically brought forward as an explanation, but the exact mechanism which is at work has not been analyzed in a household model so far. The issue is complicated by the fact that changes in household structures and rising marital risk may affect labor supply and savings simultaneously, while the

[2] However, these observations have to be interpreted with some care, since the German Microcensus only provides cross-sectional data.

Table 2: Labor hours for the low-skilled and childless in 1975 and 2010 (dev. from mean in hours)

	1975	2010	Change	1975	2010	Change
	Single men			*Married men*		
20-29	-7.6	-3.0	4.6	-1.5	-2.0	-0.5
30-39	4.0	4.0	0.0	1.5	1.1	-0.4
40-49	4.2	2.5	-1.6	1.9	2.6	0.7
50-59	-0.6	-3.5	-2.9	-2.0	-1.7	0.2
	Single women			*Married women*		
20-29	-4.9	-3.7	1.1	9.2	1.5	-7.7
30-39	2.9	4.1	1.3	5.2	4.0	-1.2
40-49	3.5	2.3	-1.2	-3.5	0.4	3.9
50-59	-1.4	-2.6	-1.2	-10.9	-5.9	5.0

Source: own calculations based on Stabu (2013).

direction of the savings effect is not clear at all. On the one hand, since marriage is a risk-reducing institution (Attanasio et al., 2005), precautionary savings should be higher for single households than for married couples. In addition, Glazer (2008) points out that under-saving may be a problem in a noncooperative family context, where savings by one member may induce additional consumption by another member. On the other hand, there also are economies of scale in consumption (i.e. shared cost for housing, food preparation etc.), so that married couples could achieve the same utility with less combined expenditure than the sum of their individual consumption if living apart. These economies of scale induce a positive wealth effect but also a price effect, since specific consumption items such as housing may become more expensive in future years if a marriage breaks up by divorce. As it seems, the positive savings effect of marriage has dominated in the past.[3] Lupton and Smith (2003) as well as Zissimopoulos (2009) find that married individuals in the U.S. have more than twice the wealth of single individuals on average. In a recent study Sierminska et al. (2010) confirm this result for Germany. They found an average married-single wealth gap of roughly 130 percent. But even if there is a consensus that marriage increases asset accumulation, it is not clear a priori how divorce risk affects the pattern of savings. Since assets of the couple are typically split after a divorce, one would assume that rising divorce risk may reduce saving rates of married couples. However, a recent study by Gonzalez and Özcan (2013) comes to the opposite conclusion. After the introduction of divorce law in Ireland in 1996 divorce rates and consequently divorce risk for married couples rose significantly. While at the same time the Irish savings rate increased significantly stronger than in other European countries, the reaction of the savings rate was especially strong for non-religious married couples who experience the most significant increase in divorce risk. Consequently, Gonzalez and Özcan (2013) argue that divorce risk increases savings. Pericoli and Ventura (2012) derive a similar conclusion analyzing household data for Italy. Consequently, there is some evidence that rising marital risk increases individual savings, but at the same time there is a composition effect (due to the lower fraction of married couples) which reduces aggregate savings. The question is therefore, whether it is possible to decompose behavioral and composition effects on savings.

[3] There are several other effects of marriage that may impact savings decisions. For example, marriage may increase life expectancy and thereby encourage more wealth accumulation. Children in a family should enhance savings as well due to reduced divorce probabilities and bequest motives.

Summing up there seems to exist significant empirical evidence that changes in household structures affect factor markets. The following section introduces a numerical life-cycle simulation model with families that allows to quantify specific economic effects of changing household structures and to identify the specific channels through which economic behavior is affected.

3 The model economy

3.1 Overview

Our model consists of four interacting sectors: households, firms, the government and the "outside", i.e. the sum of all other countries in the world. We assume a small open economy and let capital be the only mobile factor. Consequently, the economy is a price taker and the capital market interest rate is determined by the world capital market.

At any point in time the household sector is populated by J overlapping generations. We model individuals of both genders, men m and women w. At each successive age individuals decide about how much to consume and save. They are endowed with one unit of time, which they can either supply to the market, use for home production or consume as leisure. Beyond a mandatory retirement age J_R, agents are not allowed to work at the market anymore. Individuals make their choices under a series of risks. Specifically, there is uncertainty about:

(i) *future marital status:* There are two marital statuses. Individuals are either single or they are married to an individual of the other gender. In the latter case, the married couple constitutes a decision unit with pooled resources, i.e. the two partners make a joint decision about the allocation of consumption, assets, labor supply, home production and leisure consumption. At any age j there is a certain probability π_j^m for a single agent to get married to a same age single of the other gender. There likewise is a probability π_j^d for a married couple to get divorced.

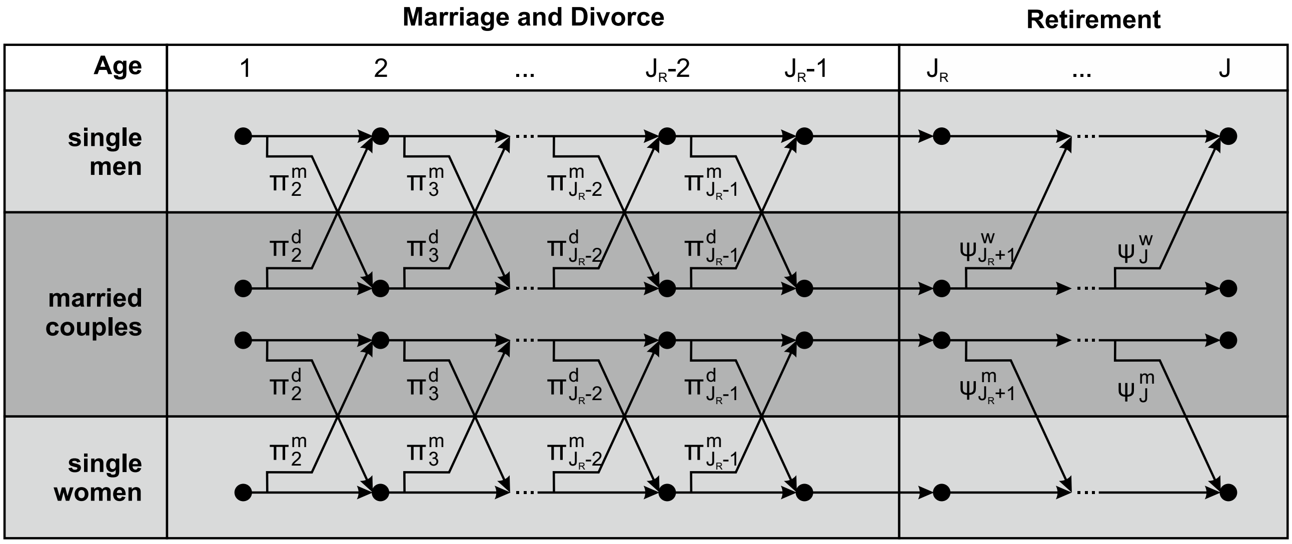
(ii) *the number of children:* Children are another "risk factor" in our model, meaning that their birth also is due to an exogenous probability π^c. Childbirth only takes place at the age J_C. The kids then live with their parents until they reach adulthood. Children can either be born into a marriage or out of wedlock. In the latter case they will stay with their mother and the father will have to pay alimonies.

(iii) *individual labor productivity:* Beneath following a gender, age and education dependent trend, individual labor productivity is due to idiosyncratic transitory shocks.

(iv) *survival to the next period:* Individuals will only survive to the next period with a certain probability ψ_j^g depending on their gender. Married couples thereby constitute a special case, as it might be that only one of the two partners dies. In this case, the surviving spouse will inherit all the assets of the partner. If both partners die at once or if a single agent dies, they leave accidental bequests to their children's generation.

Figure 3 summarizes the transition of individuals between different marital statuses. For the sake of simplicity, we restrict marriage and divorce to working ages and uncertain survival to the period of retirement. By assumption there is no private insurance market against neither of the risks mentioned above. Agents will therefore have to adapt their individual choices to their current set of economic shocks.

Figure 3: The transition of family status



Firms produce a single good under perfect competition employing labor from households and capital from both households and foreign investors. Capital depreciates at a certain rate.

The government runs two systems with separate budgets. The tax system collects taxes on individual labor and asset income as well as consumption in order to finance the provision of a public good, child benefit payments as well as interest payments on existing debt. In addition, a pay-as-you-go pension system collects contributions from working agents and pays old-age benefits depending on individuals' earnings history to retirees.

After this very general description of our model, we now define the behavior of all actors in a more technical way.

3.2 Demographics and intracohort heterogeneity

At the beginning of each period, a new generation – populated in equal size by men (m) and women (w) – is born. Individuals face gender-specific lifespan uncertainty, where $\psi_j^g \leq 1$ denotes the conditional survival probability of gender $g \in \mathcal{G} = \{m, w\}$ from age $j-1$ to age j with $\psi_{J+1}^g = 0$.

Our model is solved recursively. The individual state vector of an age-j agent is

$$z_j = (g, s, \eta_j, m_j, \eta_j^*, k_j, a_j, p_j). \tag{1}$$

Entries two and three of this vector describe the labor productivity of the individual. $s \in \mathcal{S} = \{1, \ldots, S\}$ thereby is agent's skill level and η_j the idiosyncratic shock to labor income. In case of a married couple, m_j and η_j^*[4] denote the labor productivity of the respective partner. In case the individual is a single we set $m_j = \eta_j^* = 0$, consequently $m_j \in \mathcal{M} = \{0, \ldots, S\}$. $k_j \in \mathcal{K} = \{0, 2\}$

[4] Variables with a * indicate variables concerning the spouse.

indicates the number of children that have not yet reached adulthood. Finally, $a_j \in \mathcal{A} = [0, \infty]$ and $p_j \in [0, \infty]$ are agents' beginning of period asset holdings and pension claims.

While assets and pension claims are influenced by individual decisions, the other state variables are determined exogenously. Gender and skill level can be interpreted as one-time persistent shocks, the realization of which is revealed at the beginning of the life-cycle. While the two realizations of gender occur with equal probability, there is a probability distribution π_g^s conditional on gender. As stated in the previous section, marriage and divorce occur at age j with probabilities π_j^m and π_j^d.[5] Yet, we additionally have to define a probability distribution $\pi_{g,s}^{s^*}$ indicating the probability of a gender g and skill level s agents to become married to a s^* spouse. This probability is conditional on getting married and will be age invariant. Therefore we have $\sum_{s^*=1}^{S} \pi_{g,s}^{s^*} = 1$. Labor productivity is transitory and by assumption follows a first-order Markov process. Therefore the probability distribution of future labor productivity η_{j+1} only depends on the current labor market status η_j, i.e. there exists a probability distribution $\pi_{g,s}^{\eta}(\eta_{j+1}|\eta_j)$ which by assumption depends on gender and skill level. Finally at age J_c, a fraction π^c of all men and women are assigned two children (i.e. $k_j = 2$). Children remain in the household until reaching adulthood, afterwards the household status returns to $k_j = 0$.

3.3 The household decision problem

All agents value streams of consumption and leisure according to the standard expected utility function

$$E\left[\sum_{j=1}^{J} \beta^{j-1} u(c_j, \ell_j)\right], \tag{2}$$

where β is a time discount factor. There is no altruism, neither towards the partner in marriage nor towards children. Due to additive separability over time, we can formulate the decision problem recursively. Yet, since individual resources are pooled mandatorily upon marriage and split evenly at divorce, the decision problems of singles and married couples differ slightly.

3.3.1 The problem of single men and women

The single consumer at age j and state $z_j = (g, s, \eta_j, 0, 0, k_j, a_j, p_j)$ solves the individual problem

$$V(z_j) = \max_{x_j, h_j, \ell_j} \quad u(c_j, \ell_j) + \beta \psi_{j+1}^{g} E\big[V(z_{j+1})\big], \tag{3}$$

where – similar to the static model of Rogerson (2009) – individual consumption $c_j = c_j(x_j, h_j, 0)$ is produced within the household by means of market goods x_j and home labor h_j. Since lifespan is uncertain, future utility is weighted with the gender-specific survival probability ψ_{j+1}^{g}. Future utility is computed over the distribution of future states of productivity η_{j+1}, marital status m_{j+1} and η_{j+1}^* as well as the amount of children k_{j+1}. If the agent stayed single with probability $1 - \pi_{j+1}^m$, his state would move to $z_{j+1} = (g, s, \eta_{j+1}, 0, 0, k_{j+1}, a_{j+1}, p_{j+1})$. However, if he was to get married to an agent

[5] Note that marriage and divorce probabilities in the model are independent of skill-class and do not depend on previous marriage experience. Since divorce probabilities tend to increase in a second or higher-order marriage, this might affect women's labor supply, but only at the intensive and not the extensive margin, see Aughinbaugh (2010).

of same age with probability π^m_{j+1}, his future state would change to

$$z_{j+1} = \left(g, s, \eta_{j+1}, s^*, \eta^*_{j+1}, k_{j+1}, \frac{a_{j+1} + a^*_{j+1}}{2}, \frac{p_{j+1} + p^*_{j+1}}{2} \right). \tag{4}$$

Single agents take into account the mating probabilities $\pi^{s^*}_{g,s}$ and form expectations over future spouses' productivity η^*_{j+1}, assets a^*_{j+1} and pension claims p^*_{j+1} according to the distribution of singles of gender g^* and skill group s^* over the state space at age j. Note that, if two agents get married, their assets and earning points will be pooled, which highlights the risk sharing aspect of a marriage.[6]

Singles maximize (3) subject to the budget constraint

$$a_{j+1} = (1+r)a_j + y_j + \tilde{p}_j + cb_j + al_j + b_j - \tau \min[y_j; 2\bar{y}] - T(y_j, \tilde{p}_j, ra_j) - (1+\tau_x)x_j. \tag{5}$$

Agents are endowed with zero assets at the beginning of life $a_1 = 0$ and do not value bequests, i.e. $a_{J+1} = 0$. In addition to interest income from savings ra_j, unmarried individuals receive gross income from supplying labor to the market $y_j = we_j\eta_j l_j$ during their working period as well as public pensions $\tilde{p}_j$ during retirement.[7] w defines the wage rate for effective labor while e_j denotes gender- and skill-specific productivity at age j. Besides working at home and in the market, all women and married men have to spend time φ_j on educating their children when those are living in the household. Consequently, market labor is given by $l_j = 1 - h_j - \ell_j - \varphi_j$. The government pays child benefits cb_j to mothers. If children were born out of wedlock, fathers have to pay income-dependent alimonies ($al_j < 0$) which are received by the children's mother as a lump-sum payment ($al_j > 0$). Since we cannot trace the father of a child born out of wedlock, single mothers receive the average alimony paid by single fathers of the same age. Households may also inherit accidental bequests b_j from their parents' generation. They contribute at a rate τ to the public pension system up to a ceiling which amounts to the double of average income $\bar{y}$. Taxes on labor, pensions and asset income are payed according to the progressive schedule $T(\cdot,\cdot,\cdot)$. Finally, the price of market goods x_j includes consumption taxes τ_x.

Pension claims are fully earning related. Specifically, they evolve according to

$$p_{j+1} = p_j + \kappa \min[y_j, 2\bar{y}], \tag{6}$$

where κ denotes the accrual rate, pension claims are earned up to a maximum of twice the average income and $p_1 = 0$.

3.3.2 The problem of married couples

We assume a collective model of household decision making. Consequently, married couples of skill groups s and s^* at age j maximize a joint welfare function with equal weights in order to obtain efficient outcomes

$$\max_{x_j, h_j, h^*_j, \ell_j, \ell^*_j} \left\{ u(c_j, \ell_j) + \beta\psi^g_{j+1} E[V(z_{j+1})] \right\} + \left\{ u(c_j, \ell^*_j) + \beta\psi^{g^*}_{j+1} E[V(z^*_{j+1})] \right\} \tag{7}$$

[6] The pooling of resources could be a necessary precondition for marriage when marriage partners play a Nash-bargaining game on the wedding day, see Wrede (2003, p. 208).

[7] Note that $\tilde{p}_j = p_j$, if $j \geq J_R$ and $\tilde{p}_j = 0$ otherwise.

with $c_j = c_j(x_j, h_j, h_j^*)$. The respective household budget constraint reflects the fact that both assets and pension claims are pooled within a marriage.[8] In addition, the income splitting method of family taxation is applied here. Consequently, the household budget constraint reads

$$2a_{j+1} = 2(1+r)a_j + y_j + y_j^* + 2\tilde{p}_j + 2b_j + cb_j$$
$$- \tau\ \left(\min[y_j; 2\bar{y}] + \min[y_j^*; 2\bar{y}]\ \right) - 2T\left(\frac{y_j + y_j^*}{2}, \tilde{p}_j, ra_j\right) - (1+\tau_x)x_j. \quad (8)$$

Note again that married couples in our benchmark are not altruistic and don't receive direct utility from being married. Consequently, they still value consumption and leisure according to the function (2).

Beneath the productivity processes for both partners, married agents takes into account three different scenarios: The first of them reflects the situation when the marriage continues with probability $1 - \pi_{j+1}^d$ in the next period and the spouse survives. In this case, the future state is simply $z_{j+1} = (g, s, \eta_{j+1}, s^*, \eta_{j+1}^*, k_{j+1}, a_{j+1}, p_{j+1})$. The second case covers the situation when one of the spouses dies. In this case the the surviving partner, e.g. the partner of gender g, inherits the assets of the partner completely and his state turns into $z_{j+1} = (g, s, \eta_{j+1}, 0, 0, k_{j+1}, 2a_{j+1}, p_{j+1})$. Finally, the third case describes the situation when the marriage is divorced. Here, the individual status changes to $z_{j+1} = (g, s, \eta_{j+1}, 0, 0, k_{j+1}, a_{j+1}, p_{j+1})$, where we assume that assets and pension claims are split equally upon divorce.

3.4 Instantaneous utility, scale effects, home production and accidental bequests

The period utility function is defined as

$$u(c_j, \ell_j) = \frac{1}{1-\frac{1}{\gamma}}\left(c_j^{1-\frac{1}{\rho}} + \alpha \ell_j^{1-\frac{1}{\rho}}\right)^{\frac{1-\frac{1}{\gamma}}{1-\frac{1}{\rho}}}, \quad (9)$$

where γ denotes the intertemporal elasticity of substitution between consumption at different ages, ρ defines the intratemporal elasticity of substitution between consumption and leisure at each age j and α is an age-independent leisure preference parameter.

The needs of a household generally do not grow in proportion to the number of household members. We therefore model scale effects in household consumption. Let $n_j \in \{1, 2\}$ denotes the number of adult household members. Consumption for each adult family member is then derived from

$$c_j(x_j, h_j, h_j^*) = \underbrace{\left(\frac{1}{n_j + \phi \hat{k}_j}\right)^{\omega}}_{\text{scale effect}} \cdot \underbrace{\left\{ v x_j^{1-\frac{1}{\chi}} + (1-v)\Phi\left[(h_j)^{1-\frac{1}{\sigma}} + (h_j^*)^{1-\frac{1}{\sigma}}\right]^{\frac{1-\frac{1}{\chi}}{1-\frac{1}{\sigma}}} \right\}^{\frac{1}{1-\frac{1}{\chi}}}}_{\text{home production}}.$$

The production of the consumption good within the household follows a CES home production technology combining market goods x_j and aggregate home labor. The latter itself is again derived using a CES production function, where σ measures the elasticity of substitution between time spent in

[8] The pooling of pension claims approximates both the German pension rights adjustment and widow's pension benefit system.

home production by the two partners. v is a share parameter for market goods x_j, Φ is a scale parameter and χ defines the substitution elasticity between market goods x_j and effective working time in home production. The scale effects in household consumption are captured by the parameters ϕ and ω. With $0 < \phi, \omega < 1$ a child costs less than an adult and the second adult and each additional child are cheaper to feed and cloth than the one before. Since children always stay with the mother, single men who have children do not realize child cost in consumption, i.e. $\hat{k}_j = 0$.

Our model abstracts from annuity markets. Consequently, private assets of agents who died are aggregated and then distributed equally among all agents of their children's generation. Note, that couples' assets are only passed on to younger cohorts if both partners die at the end of the same period. If a spouse survives, she inherits the complete assets of the partner.

3.5 The production side

Firms in this economy use capital and labor to produce a single good according to a Cobb-Douglas production technology. Firms maximize profits renting capital and hiring labor from households such that the marginal product of capital is equal to the sum of the interest rate r and the depreciation rate δ and the marginal product of labor equals the the wage rate for effective labor w, i.e.

$$\max_{K,L} \; \theta K^{\varepsilon} L^{1-\varepsilon} - wL - (\delta + r)K \tag{10}$$

where K and L are aggregate capital and labor, respectively, ε is capital's share in production and θ defines a technology parameter.

3.6 The government sector

Our model distinguishes between the tax and the pension system. In each period of the long-run equilibrium, the government collects taxes from households in order to finance general government expenditure G which is fixed per capita as well as interest payments on existing debt[9] and child benefits CB, i.e.

$$T_L + T_X = G + rB_G + CB, \tag{11}$$

where T_L and T_X define revenues from income and consumption taxation, respectively. The consumption tax rate balances the budget periodically.

In each period, the pension system pays old-age benefits and collects payroll contributions from labor income below the contribution ceiling of $2\bar{y}$. The pension budget is balanced in every period by adjustments of the contribution rate.

3.7 Equilibrium conditions

In addition to factor prices being equal to marginal products, for a long-run equilibrium, we need households to maximize (3) and (7) with respect to the respective constraints (5) and (8), an invariant distribution of households over the whole state space and market clearance for capital, labor and

[9] Since we assume a population growth rate of zero, the government can't issue new debt in a long-run equilibrium.

goods market. Most of the following simulations assume a small open economy with net exports of goods and international capital flows that balance the capital market.[10]

4 Calibration

4.1 Demographic structure

Table 3 reports the central parameters of the model. In order to reduce computational time, each model period covers five years. Agents reach adulthood at age 20 ($j = 1$) and may give birth to two children at age 30 ($J_c = 3$) which is the average age of mothers at birth of children in Germany in 2010, see BiB (2013). Since children stay in the household for twenty years, we have $k_1 = k_2 = k_7 = \ldots = 0$. Individuals retire mandatorily at age 60 ($J_R = 9$) and face a maximum possible life span of 100 years ($J = 16$). In order to generate the German average of 1.4 children per mother, we set the childbirth probability $\pi^c = 0.7$.

Table 3: Parameter selection

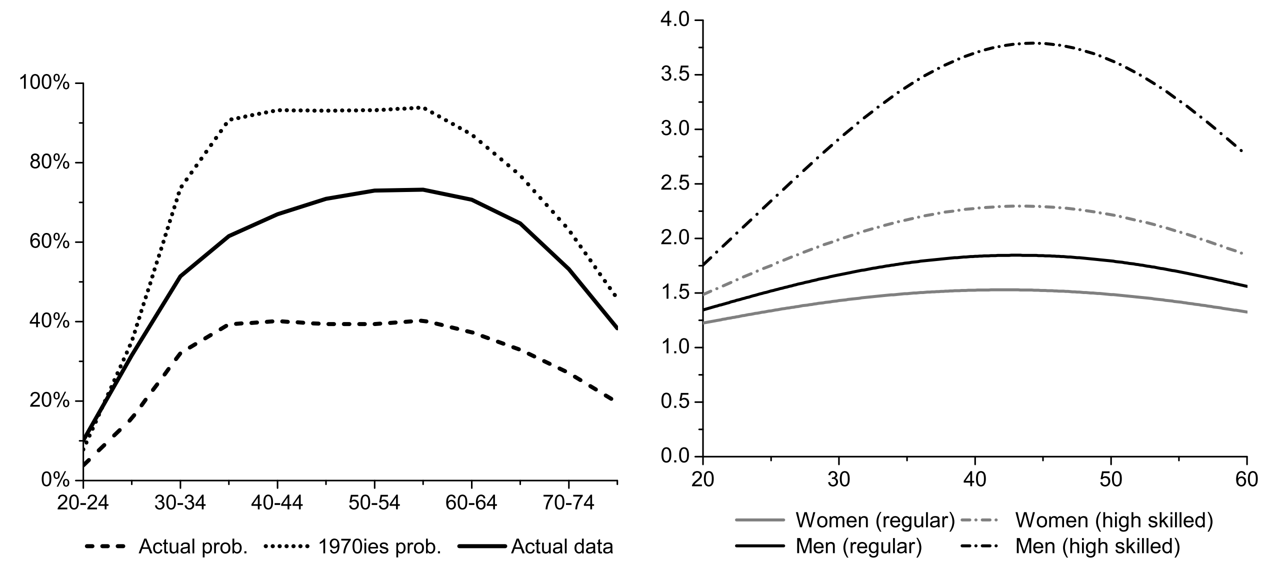
Demographic parameters		*Preference parameters*	
(Adult) Life span (J)	16	Intertemporal elasticity of substitution (γ)	0.50
Retirement period (J_R)	9	Intratemporal elasticity of substitution between	
Child birth period (J_c)	3	... consumption and leisure (ρ)	0.60
Childhood periods	4	... market goods and home work (χ)	0.50
Skill levels (S)	2	... male and female home work (σ)	0.90
Childbirth probability (π^c)	0.7	Coefficient of leisure preference (α)	0.90
		Share parameter for market goods (v)	0.52
		Scaling factor consumption (ω)	0.50
		Scaling factor children (ϕ)	0.30
		Discount factor (β)	0.95
Technology/Budget parameters		*Government parameters*	
Factor productivity (θ)	1.50	Debt-to-output (B_G/Y)	0.60
Capital share (ε)	0.35	Consumption tax rate (τ_x)	0.20
Depreciation rate (δ)	0.26	Contribution rate (τ)	0.199
Education time male (φ^m)	0.05		
Education time female (φ^f)	0.175		

Conditional survival probabilities ψ_j^g are computed from the year 2008/2010 Life Tables for Germany reported in Statistisches Bundesamt (2012). However, in order to simplify the demographic transition, we restrict uncertain survival to retirement years, i.e. $\psi_j^w = \psi_j^m = 1, j < j_R$. We also limit (mainly for computational reasons) marriage, divorce and re-marriage to working periods. After retirement, single individuals remain single until death while married couples could only become widows/widowers. Age-specific marriage and divorce probabilities π_j^m and π_j^d are derived from cohort data of year 2005 reported in the Statistical Yearbook of the Statistisches Bundesamt (2007). The

[10] More information on the equilibrium conditions is available upon request. The computational algorithm is described in Fehr et al. (2008).

average age difference of German couples at first marriage and at remarriage after divorce is currently 2.9 and 3.3 years, respectively. In 1970 it was even slightly smaller, see BiB (2013). Given the period length of five years we assume in all simulations that marriage only takes place between same age individuals.[11] The left panel of Figure 4 shows the fraction of married women in each cohort we obtain when applying our estimated actual marriage and divorce probabilities to the model. Due to low marriage probabilities and high divorce rates we see only a modest increase of married couples in the early years of life until age 35. Passing age 35, the fraction of married couples within the cohort stays roughly constant at about 40 percent. Finally, with survival probabilities being lower than one at retirement, the fraction of married women again declines as the number of widows/widowers increases. Figure 4 also shows the fraction of married women we obtain when applying estimated probabilities for the 1970ies, i.e. from a time with much more marriages and less divorces. In this case almost the whole cohort is married at middle ages. The solid line represents the actual data on married couples in Germany we also computed from Statistisches Bundesamt (2007) data. Of course, this line lies somewhat in between the ones with actual and 1970 probabilities, since the current household structure of the elderly reflects past marital behavior while the model compares two steady states with different marriage and divorce probabilities.

Figure 4: Fraction of married women / Estimated productivity profiles



We distinguish high-skilled and low-skilled or regular individuals (i.e. $S = 2$) and assume that 29 percent of men and 24 percent of women are high-skilled which reflects the current attainment of 25-64 year-old in tertiary educational programs in Germany, see OECD (2013, p. 40). Mating probabilities $\pi_{g,s}^{s^*}$ were estimated from German Socio-Economic Panel (SOEP) data of the years 1995-2007 and are reported in the appendix.[12]

[11] The age difference at marriage rises up to nine years for those partners who were previously widowed. However, in our model such marriages do not exist by assumption.

[12] The SOEP data base is described in Wagner et al. (2007).

4.2 Preference parameters, labor market participation and time use

Most microeconomic estimates on the intertemporal elasticity of substitution fall between zero and one, see the discussion in Auerbach and Kotlikoff (1987) or İmrohoroğlu and Kitao (2009). We use in our benchmark $\gamma = 0.5$. The intratemporal elasticity of substitution between consumption of goods and leisure is set to $\rho = 0.6$, which yields an uncompensated labor supply elasticity for men of 0.14 and for women of 0.15. Evers et al. (2008) survey labor supply estimates from 30 different studies and find a mean elasticity of 0.07 for men and of 0.34 for woman. Table 4 also illustrates that while single men and women have quite similar labor supply elasticities, married women's labor supply is significantly more elastic than that of men. The latter reflects the fact that labor supply at the extensive margin is more flexible than at the intensive margin for married women. In order to calibrate the participation rates and the split-up of time use, we assume $\chi = 0.5$. Rogerson (2009, p. 596) surveys the literature and concludes that typical estimates of the substitution elasticity between market goods and home work lie between 0.4 and 0.6. In addition, we take $\phi = 0.3$ and $\omega = 0.5$ from Greenwood et al. (2003) to capture the scale effects in household consumption. Then we calibrate the leisure preference parameter $\alpha = 0.9$ and the share parameter for market goods $v = 0.52$ in order to match realistic overall time use shares for Germany. Burda et al. (2008) report that on average men and women spend about 43.2, 25.5 and 31.2 percent of their time endowment as leisure time, market work and home work, respectively. Next, the intratemporal elasticity of substitution between male and female home work $\sigma = 0.9$ is calibrated such that we obtain a time difference in home labor for married men and women reported similar to the one reported in Burda et al. (2008). We chose a scaling factor Φ in order to guarantee that aggregate household home labor never exceeds two. Finally, time costs of males and females for the education of children φ_j are chosen in order to match gender-specific time use data for mothers and fathers reported in Statistisches Bundesamt (2003).

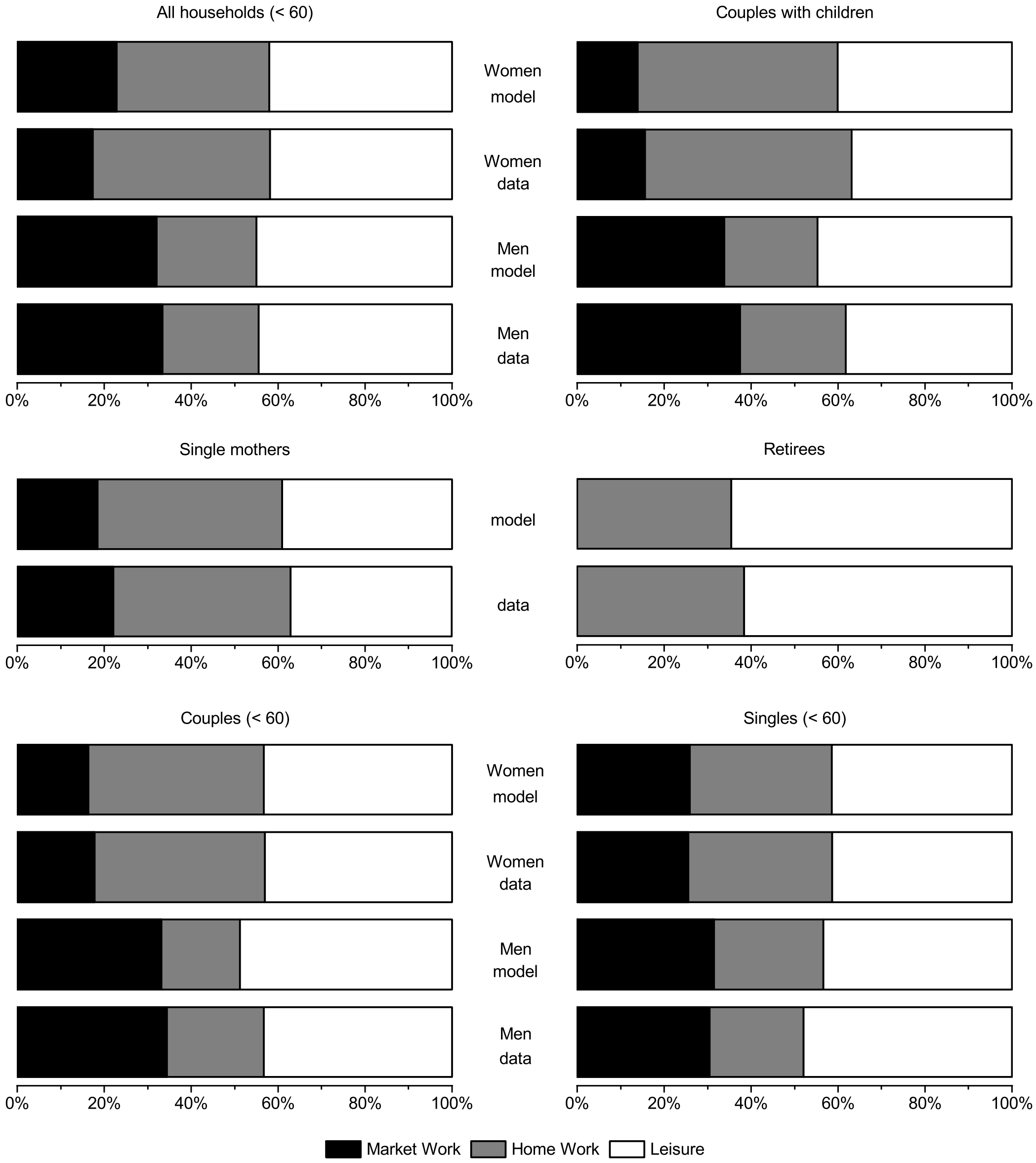
Table 4: Labor supply elasticities in the initial equilibrium

	Total		*Single*		*Married*	
	Men	*Women*	*Men*	*Women*	*Men*	*Women*
uncompensated	0.135	0.148	0.182	0.133	0.052	0.189
compensated	0.488	0.575	0.562	0.584	0.357	0.552

Figure 5 compares the fractions of market work, home work and leisure for different marital statuses and genders generated by the model with those from the data. The first block on the left side reveals that men and women spend roughly the same time on leisure consumption, but they are quite different with respect to their shares of market work and home work. Even single men work much less at home then women, which is mainly due to the gender wage gap described below. Specialization increases in a marriage and during the years of child rearing. Note that single mothers work more on the market than married mothers. Finally, time spend in home production increases after retirement. On average, retirees devote about 40 percent of their time to home production and 60 percent to leisure consumption.

Finally, in order to calibrate a realistic capital to output ratio of 3.5, the discount factor β is set at 0.95 which implies an annual discount rate of about 1 percent.

Figure 5: Time use for specific population groups: model vs. data



Source: Burda et al. (2008) and Statistisches Bundesamt (2003).

4.3 Technology and government parameters

On the production side we let the capital share in production be $\varepsilon = 0.35$ reflecting the average share of capital income in Germany. The annual depreciation rate for capital is set at 4.75 percent (i.e. the periodic depreciation rate is $\delta = 0.26$) which yields a realistic investment share in output. Finally we specify the general factor productivity $\theta = 1.5$ in order to normalize the initial wage rate to unity.

We chose an accrual rate κ such that the replacement rate of net income amounts to 50 percent, which yields a realistic pension contribution rate for Germany. The progressive income tax schedule is oriented towards German tax practice. Specifically, we let pension contributions be exempt from tax and assume pension benefits to be fully taxed. Taxable labor income is due to gross labor earnings minus a fixed allowance of 2400 € per person and an additional deduction of 10 percent of y_j. The sum of labor and pension income is taxed according to the German tax schedule introduced in 2005. After a basic allowance of 7800 € per person, the marginal tax rate increases from 15.8 to 44.3 percent when taxable income passes 52000 €. Capital income is taxed at a rate of 31.7 percent (which includes the corporate taxes and solidarity surcharge) after a basic allowance of 9000 €. Child benefits cb_j reflect current German law which states that on average 2400 € are paid as transfers per child ('Kindergeld') by the government. Finally, if parents are not married, the father has to pay an alimony al_j which amounts to 10 percent of his net income per child.

In the initial long-run equilibrium, we assume a debt-to-output ratio of 60 percent and fix the consumption tax rate at 20 percent in order to generate a realistic public consumption ratio G/Y.

4.4 Estimation of productivity profiles and income uncertainty

We estimate productivity profiles for men and women of different skill classes using inflated hourly wages w_{ijt} of primary household earners from the German SOEP. Our unbalanced panel data covers full-time workers between ages 20 and 60 of the years 1984 to 2006 who were divided into secondary and tertiary educated subgroups according to the International Standard Classification of Education (ISCED) of the UNESCO of 1997. This approach leads us to a total of 130 693 observations with 61 798 low-skilled males, 49 438 low-skilled females, 10 636 high-skilled men and 8 821 high-skilled women.

With this data, we estimate a simplified version of the Storesletten et al (2004) model. Specifically, we assume log wages to follow a gender, skill group and age dependent trend and let shocks to individual wages be of AR(1) type. In addition we estimate time fixed effects to rule out business cycle components and technical change. Consequently we estimate the equations

$$\log(w_{ijt}) = e_j + \text{time}_t + \log(\eta_{ij}) \tag{12}$$

with

$$\log(\eta_{ij}) = \varrho \log(\eta_{ij-1}) + \epsilon_{ij} \quad , \quad \epsilon_{ij} \sim N(0, \sigma_\epsilon^2). \tag{13}$$

We specify the time trend to

$$e_j = \beta_0 + \beta_1 \cdot j + \beta_2 \cdot j^2/100 \tag{14}$$

and estimate four separate equations, one for each gender and skill combination. Our parameter estimates are shown in Table 5 (standard errors are reported in parentheses).

Note that we find a strong AR(1) correlation of around $0.8 - 0.9$ for the error term. Bayer and Juessen (2012) document similar values using SOEP data. The estimated productivity profiles can be seen in the right part of Figure 4. For computational reasons, we finally approximate the shock η by a first order discrete Markov process with three nodes using a discretization algorithm as described in Tauchen (1986).[13]

5 Simulation results

Given the parameter choices of the previous section we compute an initial equilibrium which is reported and discussed in the first subsection below. This benchmark equilibrium shows a fairly

[13] We have also used a Markov process with five nodes. This approximation yields almost the identical equilibrium but increases computational time dramatically.

Table 5: Parameter estimates for individual productivity

	Men		*Women*	
	low-skilled	*high-skilled*	*low-skilled*	*high-skilled*
Intercept β_0	1.4256	06894	1.7431	1.3639
	(0.0351)	(0.1384)	(0.0397)	(0.1426)
age term β_1	0.0671	0.1225	0.0405	0.0735
	(0.0018)	(0.0067)	(0.0021)	(0.0072)
age^2 term β_2	-0.0721	-0.1324	-0.0459	-0.0810
	(0.0023)	(0.0079)	(0.0027)	(0.0088)
AR(1) correlation ϱ	0.8665	0.9187	0.8044	0.8637
	(0.0016)	(0.0026)	(0.0023)	(0.0042)
transitory variance σ_ϵ^2	0.0396	0.0380	0.0648	0.0556
	(0.0017)	(0.0070)	(0.0020)	(0.0062)

strong specialization of married men and women in market work and home work, respectively. In order to understand the driving economic forces behind this process, we successively eliminate all differences between genders and between singles and couples in the second subsection. Next we quantify and compare the impact of a changing household structure as well as a narrowing gender wage gap on macroeconomic variables and individual behavior. The last subsection finally reports some sensitivity analysis of the benchmark simulation with respect to central modeling assumptions. If not stated otherwise, we always consider a small open economy, where the capital-output ratio remains constant over time.

5.1 The initial equilibrium

Table 6 reports the calibrated benchmark equilibrium and the respective figures for Germany in 2010. On average, the probability to get married at least once in your life is nowadays below 60 percent. The mean age at first marriage is clearly above 30 years and once you are married the chance of getting divorced again is almost 40 percent. Life expectancy of women (at birth) is around 82 years while men expect to live more than four years less on average.

We have already discussed the current ratios in market hours by gender and family status in Table 1 above. Table 6 again reports these numbers as percentage differences. Our model is capable of replicating the observed patterns in the data. Yet, it slightly overstates the market hours difference between married and single women. Differences in home hours for non-retired men and women were already discussed in Figure 5. As one can see, our model underestimates the specialization of single women and men but exaggerates the specialization of married couples. However, differences between married and single women are captured quite well. In terms of wealth holdings for different types of individuals, we compute average wealth levels of single and married men and women from Table 2 in Sierminska et al. (2010, p. 681). We then calculate the wealth ratios between single women and men as well as between married and single women like we did for market hours and home work. Table 6 shows that our model is able to generate these relative wealth holdings. Sierminska et al. (2010, p. 681) also report that married women in Germany on average hold 36 percent less wealth than married men. Here our model fails completely, since we assume that the joint wealth of a couple is split up perfectly. The initial equilibrium also reflects the current fiscal situation as well

Table 6: The initial equilibrium

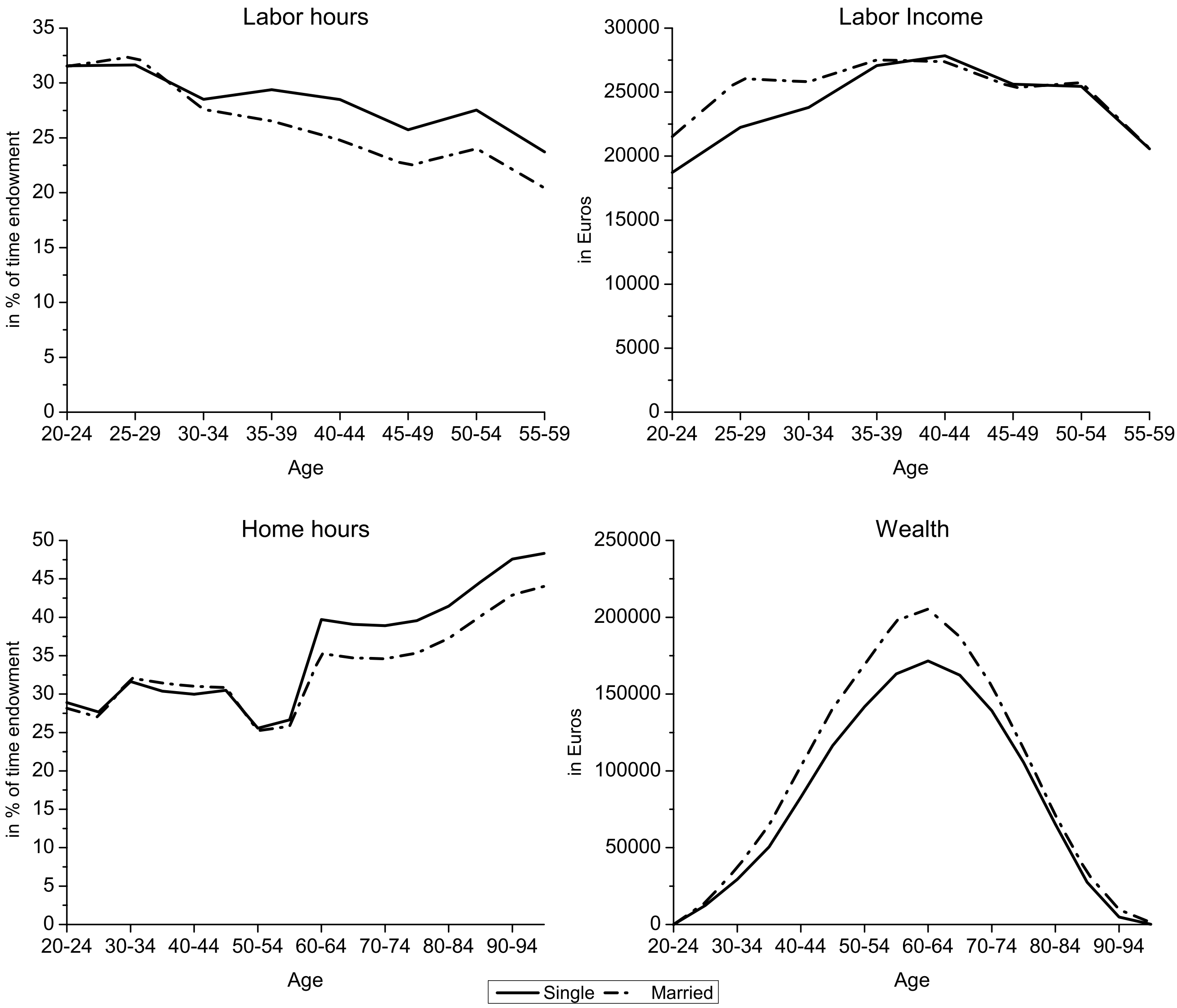
	Model solution	*Germany 2010*
	Calibration targets	
Total first marriage rate (in %)	58.7	56.4[a]
Mean age at first marriage (in years)	31.1	30.3/33.2[a]
Total divorce rate (in %)	37.7	38.9[a]
Life expectancy (women) (in years)	81.1	82.6[a]
Life expectancy (men) (in years)	76.8	77.8[a]
Differences in market hours (in %)		
... single w/ single m	-17.8	-16.3
... married w/ married m	-50.7	-45.5
... married w/ single w	-36.6	-22.0
Differences in home hours of employed (in %)		
... single w/ single m	30.1	53.7
... married w/ married m	124.4	75.5
... married w/ single w	23.5	18.6
Differences in asset holdings (in %)		
... single w/ single m	9.8	10.7[b]
... married w/ married m	0.0	-36.0[b]
... married w/ single w	43.9	59.7[b]
Pension benefits (% of GDP)	11.8	11.6[c]
Tax revenues (in % of GDP)	20.9	22.7[c]
Capital-output ratio	3.5	3.5[c]
	Other benchmark coefficients	
Interest rate p.a. (in %)	4.3	–
Bequest (in % of GDP)	6.1	4.7-7.1[d]
from which are intergenerational	4.2	–
Gini-coefficient for net income	31.0	29.0[e]
Gender wage gap (in % of male wage)	25.0	26.0[f]

Source: [a]BiB (2013), [b]Sierminska et al. (2010), [c]IdW (2011), [d]DIA (2002, p. 19), [e]SVR (2009), [f]Maier (2012, p. 3).

as intergenerational transfers in Germany quite acurately. Finally, given the productivity profiles reported in the right part of Figure 4, the resulting gender wage gap of the model is also quite realistic.

Figure 6 depicts the behavior of married and single individuals over the life-cycle. The upper left panel shows that married and singles start into employment with an almost identical amount of labor hours. Afterwards hours slightly decline over the life cycle for singles and much stronger for married individuals. The upper right panel documents the relation between labor hours and labor income. Initially, when married and single individuals work the same hours, married partners per person earn more income than a single household. Later on they earn the same on average although they work less. The two figures clearly indicate that specialization effectively acts as a risk sharing and income smoothing device for couples. If a partner within a marriage experiences a negative productivity shock, he/she substitutes away from market work and vice versa. Singles are not able to react as flexible to productivity shocks so that on average they have to work more for the same income. The lower part of Figure 6 shows that during the employment phase married

Figure 6: Average life cycle profiles for single and married individuals



and single households work similar hours at home. Throughout retirement homework increases for all households but significantly less for married partners. The reason is that the latter have more available income than the former. Due to economies of scale they can save more and accumulate more assets (right lower part of Figure 6). In addition, they on average receive higher pension benefits due to higher employment income. Consequently, they substitute market purchased goods for home produced goods and enjoy more leisure.

5.2 What drives specialization in our model?

In the previous section we showed the specialization patterns with respect to labor supply and home production in the initial equilibrium. The question is of course, which economic forces or specific features of our model are responsible for the behavioral differences between single and married men and women. In order to isolate the causes of specialization, we successively shut down economic differences between men and women and between singles and married individuals. For each specification we compute the resulting initial equilibrium assuming a small open economy with constant factor prices. Column (1) of Table 7 again reports the differences in hours and asset holdings of different population groups in the benchmark initial equilibrium of Table 6.

Table 7: Different model specifications and their impact on specialization

	Benchmark model (1)	*Joint filing (2)*	*Children (3)*	*Scale Effects (4)*	*Wage differences (5)*	*Gender mortality (6)*	*Uncertain life span (7)*
Differences in market hours (in %)							
... single w / single m	-17.8	-19.9	-5.2	-5.1	2.4	0.0	0.0
... married w / married m	-50.7	-38.0	-32.5	-34.5	18.2	0.0	0.0
... married w / single w	-36.6	-24.4	-25.5	-24.0	1.4	-5.5	-3.9
Differences in home hours (in %)							
... single w / single m	30.1	32.8	11.7	11.6	-1.2	0.0	0.0
... married w / married m	124.4	93.5	98.1	87.8	8.7	0.0	0.0
... married w / single w	23.5	15.7	19.5	26.4	5.6	0.5	1.6
Differences in asset holdings (in %)							
... single w / single m	9.8	6.4	3.9	1.9	25.3	0.0	0.0
... married w / single w	43.9	40.3	48.6	41.0	23.9	39.9	26.5

In column (2) we eliminate joint filing within a marriage and move towards individual taxation. Higher income tax revenues (compared to the benchmark) are balanced by adjustments of the marginal tax schedule. Not surprisingly, the elimination of income splitting does hardly affect the differences in time use patterns and asset holdings of single women and men. Yet it induces a significant shift towards a more balanced time allocation within the marriage and therefore also between married and single women, since marginal income tax rates are now lower for the secondary earner in the family. In column (3) of Table 7 we in addition abstract from child birth. Since single men had no children by assumption anyway, single women are the ones affected by this feature. Obviously, they work more hours in the market when there are no children, so that the market hours ratio between single women and men declines. Changes in time allocation within the marriage are less pronounced, because women and men partly share home hours with children. However, married couples now have more time available for specialization in market work. For that reason they accumulate more assets than singles. When scale effects within a marriage are eliminated in column (4), consumption becomes more expensive for couples. They compensate for this by increasing both market and home work. In addition, they will reduce their life cycle savings. In column (5) all wage differences between genders are eliminated, i.e. we assume an identical skill distribution, marriage within the same skill class and no more gender wage gap. Not surprisingly, this has the strongest impact on time allocation patterns and asset accumulation. The remaining gender differences in behavior are due to the higher life expectancy of women compared to men. Consequently, single women now work more on the market than single men and accumulate more assets. In the marriage this effect is amplified by that fact that women will (tend to) be the receivers of inheritances at old age. They "pay" for these transfers by both supplying more labor to the market and working more at home during the employment period than their husbands. When we assume unisex mortality rates in column (6), gender differences disappear completely. By shifting market hours towards the high productive partner (i.e. the one who experiences a positive productivity shock) married couples are less exposed to income risk. Therefore, they have to work less on the market on average but still receive higher incomes than singles. Married couples also save more than singles in order to reduce life span risk for the surviving spouse. Consequently, asset accumulation of married partners is reduced in the last column (7) where we eliminate life span risk. Differences between married couples and singles in time use patterns and assets accumulation are now only due to the successful specialization within the marriage in order to balance productivity shocks.

Summing up Table 7, the two last columns (6) and (7) indicate a strong insurance provision from marriage. Eliminating all differences between genders, married partners in our model accumulate on average about 40 percent higher assets (per person) than singles. About two thirds of this difference is due to the fact that families can better hedge against productivity shocks during employment. The remaining difference in asset accumulation is driven by the incentive to save more in order to hedge against lifespan risk.

5.3 The impact of rising marital risk

In this subsection we quantify the consequences of changing marital risk. We start from the initial equilibrium reported in Table 6 that mimics the situation in Germany in 2010. We then re-run the model with the marriage and divorce rates of the 1970ies, i.e. we simulate how the economy would have looked like in 1970, if only the marriage and divorce probabilities had changed. We then compare the two economies in terms of both aggregate variables and individual behavior. When we employ the 1970 marriage and divorce probabilities, the total divorce rate falls from 37.7 to 15.7 percent while the total first marriage rate increases from 58.7 to 99.2 percent. This change implies that the mean age at first marriage decreases by two years from 31.1 to 29.1 years.

Of course, higher marriage and lower divorce rates change the aggregate household structure of the economy in the counterfactual equilibrium completely. For this reason we have to decompose the changes of macroeconomic variables into changes that are due to a shift in household composition and changes due to behavioral reactions. Consequently, in the left part of Table 8 the column "composition" reports the macroeconomic effects when we keep the individual behavior unchanged as in the initial equilibrium of Table 6, but apply the new household structures when aggregating. Note that we report changes in variables from 1970 to 2010, i.e. our counterfactual economy serves as basis here and we report the consequences of rising marital risk.

When less people marry and more couples get divorced then each cohort consists of more singles and less couples. Single individuals save less than their married counterparts. Furthermore, married women supply less labor to the market and more home labor services than single women and vice versa for men. Consequently, with a larger share of single individuals in the population in 2010 than in 1970, assets and male labor supply decline while female labor supply increases. In order to understand the compositional effect on hours and wealth ratios, one has to recall what the change in marital and divorce probabilities does to the fraction of single households over the life cycle, see Figure 4. In 1970, singles were mostly young people between the ages 20 and 30 or widows. During the child rearing years however (almost) every woman was married. This has changed in 2010, where a large fraction of women is unmarried during the time they care for children. Since single mothers' labor supply is fairly low, the average labor supply of single women declines and the amount of home hours (which also includes time spent on educating children) increases from 1970 to 2010. Consequently, the labor hours ratio between single women and men declines while that between

Table 8: Macroeconomic effects of marital risk and the gender wage gap

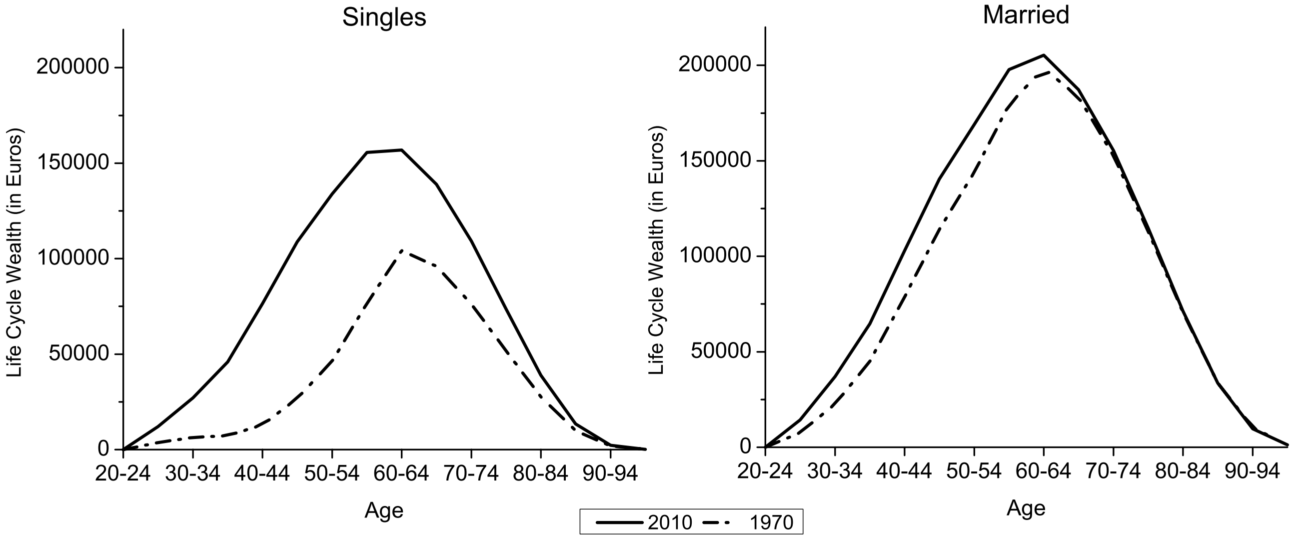
	Changes in marital risk compo-sition	Changes in marital risk total	+ gender wage gap	Data
Macroeconomic effects (in %):				
Assets (m)	-16.6	-1.2	3.7	
Assets (w)	-18.1	-4.4	1.1	
Market labor (m)	-4.5	-5.2	-11.0	
Market labor (w)	9.6	8.9	77.3	
Home labor (m)	19.5	17.7	21.9	
Home labor (w)	-4.3	-5.2	-13.5	
Output	–	-0.6	7.9	
Consumption tax	–	0.3	-6.1	
Individual effects (in percentage points):				
Differences in market hours ratios				
single w / single m	-9.6	-7.8	1.9	5.1
married w / married m	0.2	-1.4	17.6	14.9
married w / single w	7.7	-0.8	13.5	17.1
Differences in home hours ratios				
single w / single m	14.8	14.1	1.7	
married w / married m	0.0	0.1	-63.4	
married w / single w	-6.9	-3.8	-4.1	
Differences in wealth ratios				
single w / single m	-37.8	-37.9	-41.3	
married w / single w	9.4	15.3	13.1	

Changes from 1970 to 2010

married and single women increases, vice versa for the home labor ratio. Single moms don't have a lot of resources to accumulate assets either. Consequently, the wealth ratio between single women and men also declines. Finally and not surprisingly, changes in household structure have hardly any compositional impact on the relative time use of married couples.

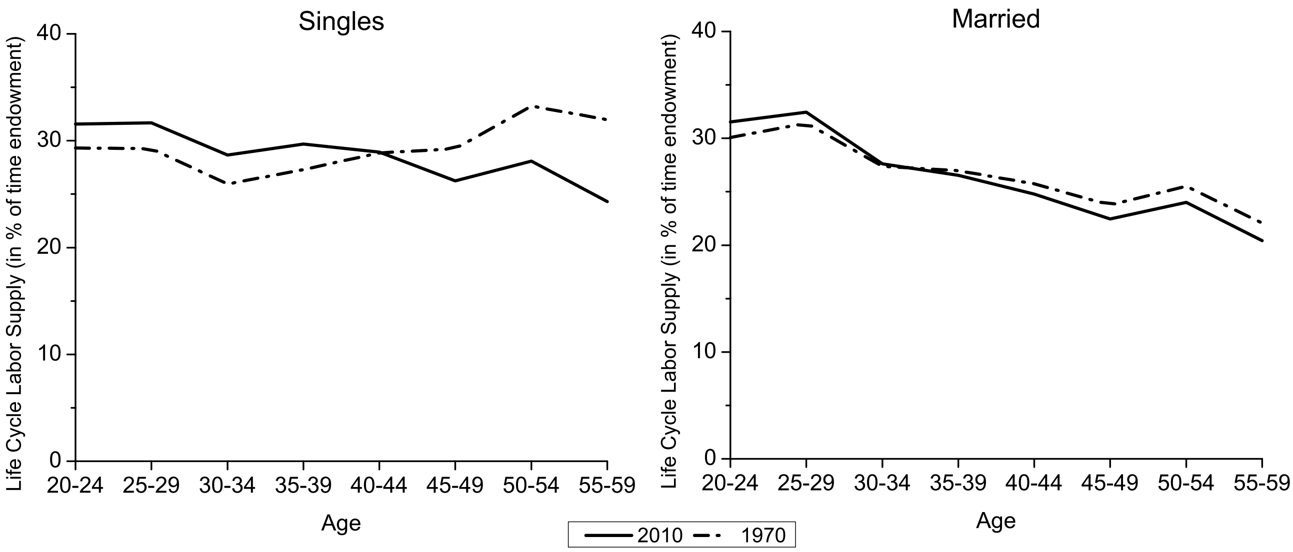
As already argued above, marriage provides insurance against labor productivity and longevity risk. Furthermore, it lowers the price of consumption through economies of scale. When the probability to get married declines, single individuals at young ages foresee that they will potentially not enjoy the benefits of a marriage. As a consequence, they have to provide for their own insurance against life-cycle risks by building up precautionary savings. Necessarily, they will then also increase their labor supply (at least early in life). Figures 7 and 8 show exactly this behavior. The left panel of Figure 7 depicts the savings profiles of individuals that were never married in 1970 and 2010. Especially for this group, the savings reaction is enormous. In the right panel we see that married couples also increase their savings, since with a higher divorce risk they might loose the insurance provision of the family. Yet, as married couples already save a lot anyway, their savings adjustment is much smaller. In terms of life-cycle labor supply, Figure 8 reveals an intertemporal shift. In 1970, single individuals had a high chance to get married and enjoy the benefits of insurance provision and economies of

Figure 7: Life cycle savings in 1970 and 2010



scale. Consequently, they didn't have to save a lot at the beginning of the life cycle, but rather enjoyed leisure consumption. When not getting married after age 35, however, the few singles that were left over had to compensate for this initial behavior by increasing labor supply and building up some life cycle savings. In 2010, the situation is completely different. The chances of getting married decreased dramatically, so that individuals already save for precautionary reasons early in life. Therefore labor supply needs to be higher during this time. As a compensation, labor supply decreases towards the end of working life, when single individuals already start living off their assets. A similar behavior, but at a much lower scale, can be found for married couples.

Figure 8: Changes in life cycle labor supply



The second column of Table 8 which includes behavioral reactions shows what this exactly means for the aggregate measures of our economy. Compared to the previous column, private savings significantly increase. However, the behavioral reaction does not completely neutralize the compositional effect, so that in 2010 assets are still slightly lower than in 1970. Labor supply decreases compared to the previous column. The reason is the intertemporal reallocation of labor supply for both singles and married towards young ages, meaning from years of higher towards years of lower productivity, see Figure 4. As all individuals save more in 2010 than in 1970, they also have more resources available at retirement which crowds out home production. Finally, since aggregate labor supply is slightly lower in 2010 than in 1970, output is smaller and the consumption tax has to increase in order to compensate for missing labor income tax revenue.

On the individual level we see that both women and men are similarly affected by the change in marital risk. Consequently, hours ratios between single women and men as well as married women and men stay roughly the same compared to the previous column. Total labor hours of singles however increase compared to their married counterparts. This indicates that there is not only an intertemporal shift in labor supply of singles. Note that, although labor hours of singles increase, this can not compensate the negative effect of reallocation towards less productive years. Home labor of singles on the other hand declines when they work more in the market. Finally, the wealth ratio between single women and men declines further, as men are the more productive in the labor market and will therefore build up more precautionary savings.

Summing up, our model indicates that rising marital risk might be responsible for the observed changes in the intertemporal employment pattern in Germany between 1970 and today, which was already discussed in the introduction. Furthermore, it leads to a huge increase in precautionary savings especially for single individuals. The question however is to what extent our model is able to explain the observed rise in labor market participation of especially married women. The left lower part of Table 8 indicates that changes in marital risk can hardly explain that. When comparing the model results to the data, the changes in hours ratios do even have the wrong sign. Higher female labor force participation from higher marital risk is then a pure result of a changed composition of the work force, i.e. there are more single women in the economy in 2010 than in 1970 and single women work more than married women.

5.4 What explains changes in female labor supply: the gender wage gap

The last section has shown that the observed increase of labor market participation especially of married women can not be reproduced with our model so far. Of course, during the past forty years many other demographic, social and economic changes have happened which might have influenced labor supply of women. In this subsection we pay specific attention to the narrowing of the so-called gender wage gap. According to Maier (2012), the difference between male and female wages in Germany was roughly 40 percent during the early 1970ies, whereas nowadays the gender wage gap has narrowed to about 26 percent, see last line of Table 6.

We simulate the narrowing of the gender wage gap as a simple shift in the productivity profiles of women in the right part of Figure 4. The right column in Table 8 simulates the changes in marital risk in combination with the reduction in the gender wage gap from 40 percent to 25 percent. It is not surprising that the rising productivity of women induces a massive shift from home work towards market work, while at the same time especially married men substitute into the opposite direction. Since women become more productive, their income rises and so do their savings. Men also profit from higher female productivity when married, so their savings increase as well. With society as a whole becoming more productive, output rises and due to additional labor income tax revenues the consumption tax rate can be lowered by more than 6 percent.

The more interesting things however happen in the lower right part of Table 8. Both single and married women increase their labor supply at the market when the gender wage gap narrows. Yet, the change in labor hours is much more pronounced for married than for single women. As a consequence, the labor hours ratio between single women and men increases by about 10 percentage points compared to the previous column while that between married women and men rises by almost 20 percentage points. In addition, the labor hours ratio between married and single women is significantly higher than in the previous simulation. The reason for this asymmetry between single and married women is that the narrowing of the gender wage gap reduces specialization and increases the ability of women to participate in risk sharing within the family, see Heathcote et al. (2010). These observations are broadly in line with the empirical observations derived from the German Microcensus data in 1975 and 2010. In Germany, the hours ratio between single women and men has increased by only 5 percentage points in the last decades, while that between married women and men has increased by roughly 15 percent. Interestingly, it is the combination of an adjustment in marital risk and the gender wage gap that leads our model to this prediction. Appendix B shows what happens when we in addition also allow for variations in life expectancy, birth rates and age of childbirth between 1970 and 2010.

Certainly, our model slightly understates the reaction in hours ratios of single women and men and overstates that of married couples. This might partly be explained by the fact that we assume the same fertility rates for married and single women. By making this assumption, we can abstract from changes in population growth that are due to changes in marital risk. A more thorough analysis of changes in fertility rates with different fertility rates for singles and married couples would however go beyond the scope of this paper and should therefore be left for future research.

Summing up, we can conclude that a change in marital risk alone is not able to account for the observed changes in labor supply behavior of women over the last decades. If we however complement this change in marital risk with a narrowing of the gender wage gap, we get a pretty good match of the change in hours ratios. Specifically, our model can account for the fact that the labor hours ratio between single women and men haven't changed a lot over the last 40 years whiles that between married women and men has increased a lot.

5.5 Sensitivity analysis

Of course, all these simulation results have to be taken with caution since they are based on various restrictive assumptions and parameter selections. Table 13 in Appendix C therefore reports the results of two sensitivity simulations. Up to now we assumed a small open economy with constant factor prices. When we simulate the last simulation (i.e. higher marital risk and lower gender wage gap) in a closed economy setting, the interest rate slightly increases and the wage rate declines, as the labor supply effect is stronger than the effect on private savings. Consequently, the positive savings reaction is amplified and the substitution from home work towards market work is damped. Yet, the impact on relative market hours and asset holdings is only minor.

Finally, one might argue that marriage was partly replaced by cohabitation in the last 40 years. In order to address this issue, we do the following simulation: we assume that marriage probabilities between 1970 and 2010 have changed in a way that the decline in the total first marriage rate is only half as large, meaning the total first marriage rate declines from 99.2 to about 79 percent and not to 58.7. Yet, we still assume that the divorce rate increases to 37.7. We therefore implicitly assume that the separation rate between cohabiting partners is the same as the divorce rate of couples. This certainly is a lower bound estimate, since formal divorce usually comes along with higher costs than separation of cohabiting couples. Furthermore, we treat cohabiting couples and married couples equally in terms of taxation. In such a scenario more people live as couples than in our benchmark simulation but they split up their partnerships very frequently. This somewhat dampens the increase in savings and the reallocation of time between market and home work, but it hardly has an impact on relative market hours and asset holdings. We can therefore conclude that our results are fairly robust to central modeling assumptions.

6 Conclusion

Summing up the results from the previous section, we have developed a family formation model which accounts for the observed behavioral differences between genders and between married partners and singles in Germany. Our model indicates that these differences are mostly due to the tax treatment of couples as well as gender differences in productivity and mortality. We also find a strong role of the family in providing insurance against productivity and life span risk. In a marriage, partners can adapt their labor supply and home production effort so as to absorb idiosyncratic productivity shocks that are uncorrelated between the two spouses. Beneath this implicit insurance against labor market uncertainty, inheritances from one partner to the other provide insurance against longevity risk. Consequently, when we eliminate all tax distortions and gender differences in productivity and longevity, married couples will still save on average 40 percent more than singles. About two thirds of this fraction are due to the implicit provision against income risk, the remaining share is due to insurance provision against lifespan risk.

We find that an increase in marital risk can only partly explain the changes in male and female labor supply patterns observed over the past 40 years. While it might explain an intertemporal reallocation of labor supply towards younger ages, overall labor supply especially of married women is hardly affected by changes in household formation. Our results however indicate that the combination of a change in marital risk and a narrowing of the gender wage gap may account for a fall in specialization within the marriage and for the increase in labor hours of both single and married women. In line with the data, our model predicts that labor supply of single women was much less affected by these changes than labor supply of married women. The reason for this asymmetry between single and married women is that the narrowing of the gender wage gap reduces specialization and increases the ability of women to participate in risk sharing within the family. Our analysis also indicates that rising marital risk had a significant impact on individuals savings. When the probability to get married declines, single individuals at young ages foresee that they will potentially not enjoy the benefits of a marriage, i.e. insurance provision and economies of scale. As a consequence, they have to provide for their own insurance against life cycle risks by building up precautionary savings. This positive effect on private savings however is washed out by the negative household composition effect (i.e. more single households, less couples).

Of course, the above analysis could be easily extended into various directions. For example, Bredemeier and Juessen (2013) analyze the impact of changing female skill composition in the U.S. on female labor supply since 1970ies. They find that the rise in assortive mating explains most of the observed increase in labor supply of wives who are married to high-skilled men. Alternatively, Merz

(2005) links changes in hours worked by married women with small children to changes in parental leave policies in Germany. Especially the last extension is beyond the scope of the present paper. In the future we plan to extend the model by introducing a transition path together with a Lump-Sum Redistribution Authority in the spirit of Auerbach and Kotlikoff (1987). This will allow us to simulate policy reforms and analyze their intra- and intertemporal redistribution as well as the aggregate efficiency effects. More specifically, we plan to follow Kaygusuz (2010) or Guner et al. (2012) and simulate the macroeconomic, efficiency and welfare effects of different income tax reforms and family policies in Germany. Since in our model households provide some form of income insurance, we can compare optimal tax structures in economies with single households and double earners. In addition, following Hong and Rios-Rull (2007) we also plan to simulate the intergenerational welfare and efficiency consequences of social security privatization. Compared to the traditional model with single individuals the role of social security becomes unclear when families are taken into account, since the benefits of social security from it's provision of longevity insurance (Fehr et al., 2008) will decrease when marriages provide some form of implicit insurance.

Of course, a general drawback of our approach is the assumption that families are modeled as shocks, i.e. there is no real choice about marriage or divorce. As discussed by Anderberg (2007), tax and social security reforms may as well affect household formation. Consequently, an obvious extension for future work will be to endogenize marriage and divorce probabilities along the lines of Chade and Ventura (2002), Caucutt et al. (2002), Greenwood et al. (2003) and Greenwood and Guner (2009).

A general drawback of our approach certainly is the assumption that families are modeled as shocks, i.e. there is no real choice about marriage or divorce. Since tax and social security reforms may as well affect household formation, an obvious extension for future work will be to endogenize marriage and divorce probabilities along the lines of Chade and Ventura (2002), Caucutt et al. (2002), Greenwood et al. (2003) and Greenwood and Guner (2009).

Appendix A: Survival/marriage probabilities

Table 9: Age-specific survival probabilities

Age	2010 ψ_j^m	2010 ψ_j^w	1970 ψ_j^m	1970 ψ_j^w
60-64	0.927	0.966	0.879	0.940
65-69	0.882	0.944	0.805	0.896
70-74	0.821	0.904	0.708	0.821
55-99	0.726	0.831	0.596	0.700
80-84	0.590	0.706	0.457	0.535
85-89	0.423	0.522	0.307	0.357
90-94	0.269	0.330	0.166	0.209
95-99	0.154	0.182	0.061	0.111
Life expectancy	76.76	81.12	72.85	76.64

Table 10: Age-specific marriage and divorce rates

Age	2010 π_j^m	2010 π_j^d	1970 π_j^m	1970 π_j^d
(15-19	0.038	–	0.078	–)
20-24	0.143	0.491	0.307	0.147
25-29	0.249	0.291	0.641	0.087
30-34	0.194	0.187	0.807	0.056
35-39	0.098	0.131	0.649	0.039
40-44	0.049	0.091	0.352	0.027
45-49	0.035	0.053	0.236	0.016
50-54	0.031	0.027	0.212	0.008

Table 11: Mating probabilities $\pi_{g,s}^{s^*}$

		females low-skilled	females high-skilled
males	low-skilled	0.887	0.113
	high-skilled	0.450	0.550

		males low-skilled	males high-skilled
female	low-skilled	0.828	0.172
	high-skilled	0.335	0.665

Appendix B: Changes in survival and birth rates

In this appendix we show what happens to our model result if we also allow for changes in life expectancy, fertility rates and age of childbirth. Life tables for the years 1970/1972 of Statistische Bundesamt (2012) show a life expectancy of 67.4 years and 73.8 years for men and women, respectively. Consequently, people nowadays live about four years longer on average. The aggregate birth rate in Germany fell between 1968 and 1977, i.e. within 9 years, from 2.4 to 1.4 children per mother. Since then it remained fairly stable. Women not only had more children in the 1970ies, the average age of mothers at birth was also significantly lower at 26.6 years in 1970. Table 12 shows what happens when we successively add these features to the model.

Table 12: Macroeconomic effects of gender wage gap, ageing and birthrate

	Changes in			
	marital risk + gender wage gap	+ life expectancy	+ fertility rates	+ earlier children
Macroeconomic effects (in %):				
Assets (m)	3.7	25.4	29.5	30.3
Assets (w)	1.1	23.3	27.2	27.3
Market labor (m)	-11.0	-8.8	-8.0	-9.0
Market labor (w)	77.3	80.8	91.2	94.3
Home labor (m)	21.9	32.4	29.9	31.1
Home labor (w)	-13.5	-5.4	-4.7	-5.4
Output	7.9	10.5	12.6	11.9
Consumption tax	-6.1	-7.3	-15.3	-13.8
Individual effects (in percentage points):				
Differences in market hours ratios				
single w / single m	1.9	0.6	4.0	17.2
married w / married m	17.6	17.6	19.4	18.7
married w / single w	13.5	15.0	16.4	5.8
Differences in home hours ratios				
single w / single m	1.7	3.0	-0.5	-16.6
married w / married m	-63.4	-58.2	-49.0	-54.5
married w / single w	-4.1	-4.1	-4.7	10.8
Differences in wealth ratios				
single w / single m	-41.3	-38.2	-37.9	-39.3
married w / single w	13.1	4.8	5.8	10.2

Changes from 1970 to 2010

The second column in Table 12 shows that the rise in life expectancy induces a massive increase in assets of both genders in our model. Since market purchased and home produced goods are complements, home production of both genders has to rise too. Individuals work more in order to be able to form additional savings and consequently output increases while the consumption tax rate falls compared to the previous simulation. When we also consider a reduction in birth rates from 2.4 to 1.4 children per women in the next column single women and married partners have more time available for market work during child rearing years. Consequently, aggregate labor supply especially of women increases. In addition, more available resources also come along with higher savings of single women and married partners. Overall, our model can now almost exactly reproduce the relative changes in market hours observed in the data and reported in Table 8 above. Finally, when we also assume that children are born at later ages in 2010, this has only minor aggregate effects but some major effects on hours and asset ratios of single and married women. In our model this assumption implies that in 1970ies more children were born out of wedlock than nowadays. Of course, this implication is empirically not justified.

Appendix C: Sensitivity analysis

Table 13: Sensitvity analysis: Closed economy and cohabition

	Benchmark	*Closed economy*	*Cohabitation*
Macroeconomic effects (in %):			
Assets (m)	3.7	5.1	1.0
Assets (w)	1.1	2.6	-0.8
Market labor (m)	-11.0	-11.4	-9.4
Market labor (w)	77.3	75.9	73.9
Home labor (m)	21.9	22.2	17.5
Home labor (w)	-13.5	-13.4	-12.2
Output	7.9	6.3	8.4
Consumption tax	-6.1	-5.2	-5.8
Interest rate (in %p p.a.)		0.2	
Wage rate		-1.0	
Individual effects (in percentage points):			
Differences in market hours			
single w / single m	1.9	1.5	3.2
married w / married m	17.6	17.4	18.2
married w / single w	13.5	13.4	15.2
Differences in home hours			
single w / single m	1.7	1.9	-0.6
married w / married m	-63.4	-65.1	-64.1
married w / single w	-4.1	-4.5	-3.3
Differences in asset holdings			
single w / single m	-41.3	-41.2	-37.3
married w / single w	13.1	11.9	10.4

Changes from 1970 to 2010

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