Household Formation, Female Labor Supply and Savings[‡]

Hans Fehr[a,b,*], Manuel Kallweit[a], and Fabian Kindermann[a,b]

October 2010

Abstract

The present paper aims to quantify 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, where female labor market participation increased significantly while male employment decreased slightly during the last decades. Our quantitative results indicate that changes in household formation were an important driving force behind this process. However, they had little impact on aggregate capital accumulation since it mainly affected the composition of gender-specific assets. Finally, we find that changes in household composition also explain at least partly the increase in net income inequality.

JEL Classification: J12, J22
Keywords: marital risk, home production, stochastic general equilibrium, life cycle model

[‡] An earlier version of this paper circulated as "Marital risk, family insurance, and public policy" and was presented at the Netspar Pension Workshop in Stockholm, the FNA Graduiertenkolloquium in Berlin, the annual conference of the Verein für Socialpolitik in Magdeburg, the 6th Norwegian-German Seminar on Public Economics in Munich and the Ausschuss für Bevölkerungsökonomik in Bamberg. We thank Karl Ove Aarbu, Johann Brunner, Lex Meijdam and other seminar participants for helpful comments. Financial support from NETSPAR is gratefully acknowledged.

[a] Department of Economics, University of Würzburg, Sanderring 2, D-97070 Würzburg
[b] Netspar, The Netherlands * Corresponding author (hans.fehr@uni-wuerzburg.de)

1 Introduction

Almost all western societies are currently experiencing an unprecedented two-dimensional demographic transition. On the one side, low fertility and reduced mortality rates change the age structure of the population. On the other side, declining marriage and increasing divorce rates radically alter the traditional family structure within cohorts. Whereas in the past long-term marriage combined with gender specialization was a near-universal adult experience, only a minority follows this role model nowadays.

While numerous studies have already evaluated the economic consequences of population aging, much less research has focussed 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). 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 concentrate on Germany since it experienced in the last decades a transformation of household structures which is typical for Western societies. In addition, time allocation in Germany seems to be a mixture of that in typical European countries and in the U.S. Finally, Germany is interesting in this context, since it's income tax system is very specific with respect to family status. For our quantitative analysis we develop a two-sex life-cycle family model with endogenous labor supply which accounts for income, lifespan and marital risk and distinguishes between market work and home production. Our approach is related to several strands of the recent literature with 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. (2010). 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. We abstract from endogenous marriage and fertility and model changes in marital status as exogenous shocks. We then focus on the interaction between marriage and divorce rates and individual labor supply and savings. Some attempts have already been made in order to introduce marital risk in stochastic life-cycle simulation models. 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 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. Hong and Rios-Rull (2007) keep marriage patterns constant and analyze the long-run impact of social security privatization. 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 of 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. Finally, we model a detailed government sector with progressive income taxes and joint filing in order to analyze the interaction between the tax system and the household's labor supply and saving decision. Starting from an initial long-run equilibrium which reflects current German marriage and divorce probabilities, we simulate the economic consequences if Germany would still have household structures as in the 1970s. Our quantitative results indicate that the ongoing transformation of household structures in Germany may explain a significant fraction of the past increase in female labor market participation and income inequality in Germany. Our model also indicates that male labor supply as well as aggregate savings are hardly affected by these demographic developments.

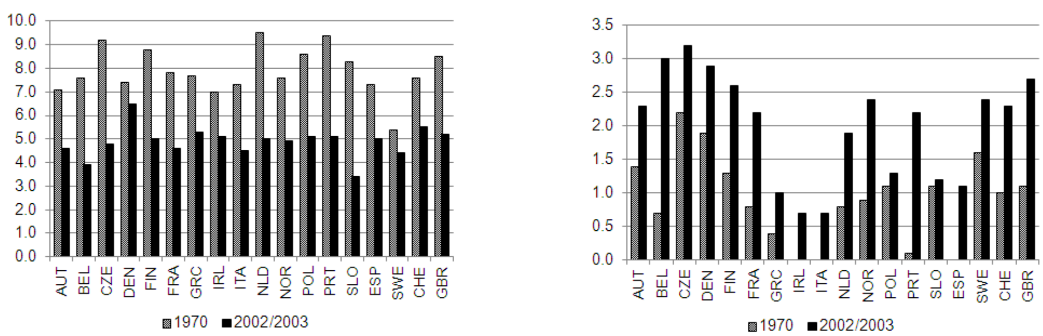
The next section documents recent changes in household formation in Europe and Germany and discusses previous studies which analyze it's impact on economic activity. Section 3 describes the structure of the simulation model, while section 4 explains the calibration and simulation approach. Finally, section 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 2002/2003 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 are 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 58 percent of women get married during their lifetime in Europe, see CEP (2006).

Figure 1: Crude marriage and divorce rates in Europe



Source: Council of European Publishing (2005).

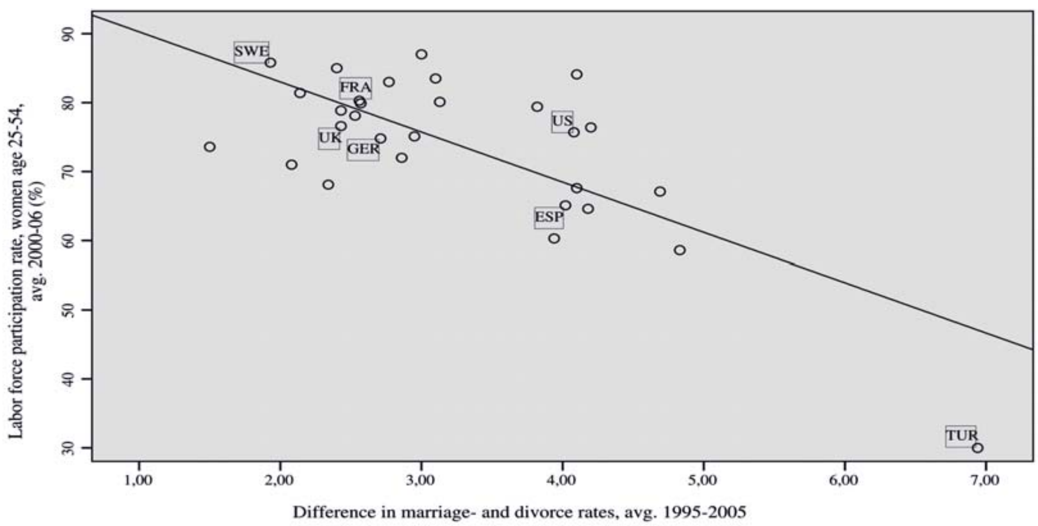
But not only marriage rates have decreased, also divorce rates have increased significantly in all countries. As shown in the right part of Figure 1, cross-national differences still remain important in 2002/2003. While low divorce rates still prevail in countries such as Greece, Ireland, Italy or Spain, countries such as Belgium, the Czech Republic and Denmark stand out with three to five 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, see CEP (2006). Compared to Europeans, Americans marry and divorce at higher rates, but the time trend is quite similar, see Stevenson and Wolfers

[1]There is a rising proportion of cohabiting couples (i.e. larger than 10% of all couple households) in most European countries. However, despite cohabitation may have been used as substitute for marriage in the past, it does not cause the same economic consequences as marriage. Therefore it can be disregarded in the following discussion.

(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.

Figure 2: Family formation and female labor market participation



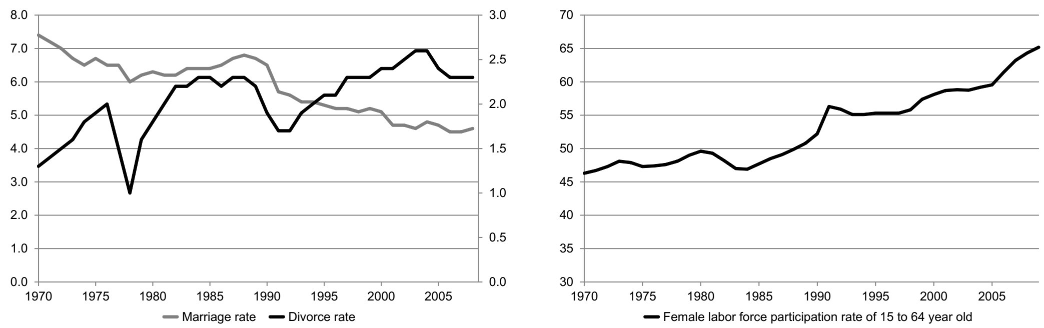
Source: OECD Database.

However, the connection between female labor supply and marriage and divorce risk is much more complex, so that various studies have explored this relationship in the past. Already Johnson and Skinner (1986) argued in the context of a static household model that the increased divorce probability has a significant positive impact on female participation rates in the USA. Stevenson (2008) confirms this finding by analyzing the past changes in divorce law (which increased marriage instability). 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 by 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 martial transition rates as well as female labor market participation. As shown in the left part of Figure 3, crude marriage rates declined since 1970 from 7.4 to currently 4.6 marriages per 1000 inhabitants while during the same time span divorce rates roughly doubled.[2] The left part of Figure 3 documents that since 1970 the labor market participation of women has also increased dramatically from 46.3 to 65.2 percent in 2008. During the same time span, participation rates of males in Germany have declined or remained stable, see Fitzenberger et al. (2004) or Apps and Rees (2005).

Figure 3: Family formation and female labor supply in Germany 1970-2008



Source: German Statistical Office.

The literature cited above explains the large changes in female 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., 2010). 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 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-savings 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

[2]The two interruptions in the divorce rate trend are due to changes in divorce law (1975) and the German reunification (1990).

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 long as the intertemporal price elasticity is below one both the wealth effect and the price effect due to economies of scale will produce higher saving rates for married couples. 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 (2008) 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 (2008) argue that divorce risk increases savings.

Finally, changes in household composition may also affect the income distribution. Since it relies on equivalence-weighted incomes which take into account household size, there is a direct link between the two variables. In Germany, income inequality has increased steadily during the last decades. As documented by the Council of Economic Advisors (SVR) (2009, 313), the Gini-coefficient for household net income increased from 0,261 in year 1990 to 0,290 in year 2007. Peichl et al. (2010) decompose the total change of the Gini-index into the effect due to income changes and due to changes in household structure. Their findings suggest that roughly one quarter of the increase in the net income Gini-index is due to changes in household structures.

Summing up this section, we conclude that there exists significant empirical evidence that changes in household structures affect factor markets and the income distribution. The following section introduces a numerical life-cycle simulation model with families that allows to isolate specific economic effects of changing household structures and clarify the results from existing empirical studies.

[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.

3 The model economy

3.1 Demographics and intracohort heterogeneity

We consider an economy populated by overlapping generations of individuals which may live up to a maximum possible lifespan of J periods. At the beginning of each period, a new generation – half of them are male m, half of them female f – is born. Individuals face gender-specific lifespan uncertainty, where $\psi_j^g \leq 1$ denotes the conditional survival probability of gender $g \in \mathcal{G} = \{m, f\}$ from age $j-1$ to age j with $\psi_{J+1}^g = 0$.

Our model is solved recursively. Consequently, an age-j agent faces the state vector

$$z_j = (g, s, m_j, k_j, e_j, e_j^*, \mathrm{a}_j, ep_j), \tag{1}$$

where $s \in \mathcal{S} = \{1, \ldots, S\}$ denotes agent's skill level and $m_j \in \mathcal{M} = \{0, \ldots, S\}$ his marital status, i.e. if $m_j = 0$, the agent is single, if $m_j \in \mathcal{S}$, he is married to a spouse of educational group $s^* \in \mathcal{S}$. $k_j \in \mathcal{K} = \{0, 2\}$ is the number of children, which is either zero or two children. $e_j \in \mathcal{E} = (0, \infty)$ and $e_j^* \in \mathcal{E}$ state the agent's and the possible partner's productivity. $\mathrm{a}_j \in \mathcal{A} = [0, \bar{\mathrm{a}}]$ and $ep_j \in \mathcal{P} = [0, \overline{ep}]$ define assets and accumulated earnings points of the pension system held at the beginning of age j, respectively.

At the beginning of the life-cycle working period, each agent is assigned to an educational group and a marital status, where the educational background remains constant over time and the marital status m_j changes due to exogenously specified demographic parameters. At the end of each period, surviving married individuals get divorced with probability π_j^d, while single individuals get married with probability π_j^m. Since we distinguish different educational backgrounds, we specify the probability $\pi_{ss^*}^g$ which indicates the likelihood that an individual of gender g and education class s gets married to a spouse of gender g^* and skill group s^* with $\sum_{s^*=1}^{S} \pi_{ss^*}^g = 1$ for $g \in \{m, f\}$. If a married individual gets divorced or his/her spouse dies his/her marital status returns to single.[4]

Children in our model are exogenous and stochastic. At age j_C a fraction of π^c of all men and woman are assigned two children (i.e. $k_j = 2$). Children remain in the household until reaching adulthood, afterwards the household status is adjusted again (i.e. $k_j = 0$). If parents are married, they receive child benefits (cb) from the government. If they are not married (or divorced) the child lives with the mother, who receives the governmental child transfers and alimonies (al) from the father. Agent's productivity e_j, as well as the productivity of

[4]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 increase in a second or higher-order marriage, this tends to affect women's labor supply, see Aughinbaugh (2010).

the possible spouse, is stochastic, where we assume $\pi_s(e_{j+1}|e_j)$ to be the probability density function of a skill group s household's productivity e_{j+1} at age $j+1$ if current productivity is e_j.

The productivity as well as the marital state are assumed to follow first-order Markov processes described in more detail below. Consequently, each age-j cohort is fragmented into subgroups $\xi(z_j)$, according to the initial distribution at age $j=1$, mortality, the Markov processes and optimal household decisions. Let $X(z_j)$ be the corresponding cumulated measure to $\xi(z_j)$. Hence,

$$\int_{\mathcal{G}\times\mathcal{S}\times\mathcal{M}\times\mathcal{E}\times\mathcal{E}} \mathrm{d}X(z_1) = 1 \qquad \text{with} \quad z_1 = (g, s, m_1, 0, e_1, e_1^*, 0, 0) \tag{2}$$

must hold, since we have normalized the cohort size of newborns to be unity.

In the following, we will omit the state index z_j for every variable whenever possible. Agents are then only distinguished according to their age j.

3.2 The problem of single men and women

Our model assumes a preference structure that is represented by a time-separable, nested CES utility function. Similar as in the static model of Rogerson (2009), the single consumer at age j and state $z_j = (g, s, 0, k_j, e_j, 0, a_j, ep_j)$ solves the individual problem

$$V(z_j) = \max_{x_j, h_j, \ell_j} \quad u[c_j(x_j, h_j), \ell_j] + \delta\psi^g_{j+1} EV[z_{j+1}|z_j] \tag{3}$$

by choosing market goods x_j, working time in home production h_j and leisure consumption ℓ_j. Expected utility in future periods is discounted with δ and, since lifespan is uncertain, weighted with the gender-specific survival probability ψ^g_{j+1}. The parameter γ defines the intertemporal elasticity of substitution between consumption in different years. The expectation operator E in (3) indicates that future utilities are computed over the distribution of e_{j+1} and m_{j+1}. If the agent stays single with a probability of $1-\pi^m_{j+1}$ his state moves to $z_{j+1} = (g, s, 0, k_{j+1}, e_{j+1}, 0, a_{j+1}, ep_{j+1})$ and he enjoys regular single utility. However, if he gets married to an agent of same age with probability π^m_{j+1}, his future state changes to

$$z_{j+1} = \left(g, s, s^*, k_{j+1}, e_{j+1}, e^*_{j+1}, \frac{a_{j+1} + a^*_{j+1}}{2}, \frac{ep_{j+1} + ep^*_{j+1}}{2}\right), \tag{4}$$

where a^*_{j+1} and ep^*_{j+1} denote assets and earning points of the possible future spouse. Single agents take into account the mating probabilities $\pi^g_{ss^*}$ and form expectations over future spouses productivity, assets and earning points according to the distribution of singles of gender g^* 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 marriage.[5]

Singles maximize (3) subject to the budget constraint (5),

$$\mathrm{a}_{j+1} = (1+r)\mathrm{a}_j + w_j + p_j + cb(k_j) + al(\cdot) + b_j - \tau \min[w_j; 2\bar{w}] - T(y_j) - (1+\tau_x)x_j \tag{5}$$

with $\mathrm{a}_1 = \mathrm{a}_{J+1} = 0$. In addition to interest income from savings $r\mathrm{a}_j$, unmarried individuals receive gross labor income $w_j = w(1 - h_j - \ell_j)e_j$ during their working period as well as public pensions p_j during retirement. As time endowment is normalized to one, w defines the wage rate for effective labor. The government pays child benefits $cb(k_j)$ to the mother if there are children in the household. If children were born out of wedlock, fathers have to pay alimonies ($al(\cdot) < 0$) which depend on his income and are received by the children's mother ($al(\cdot) > 0$). Households may also receive accidental bequests b_j and have to pay social security contributions and income taxes. Contributions at a rate τ are paid to the public pension system up to a ceiling which amounts to the double of average income $\bar{w}$. Income taxes depend on taxable income y_j and the tax schedule $T(\cdot)$ which is explained below. Finally, the price of consumption goods x_j includes consumption taxes τ_x.

Accumulated earning points of the pension system depend on the relative income position $w_j/\bar{w}$ of a worker at working age $j < j_R$. Since the contribution ceiling is fixed at the double of average income $\bar{w}$, maximum earning points collected per year are 2. Therefore, for a single, earning points accumulate according to

$$ep_{j+1} = ep_j + \min[w_j/\bar{w}; 2], \tag{6}$$

where $ep_1 = 0$. For married couples, earning points are split during the whole marriage, which approximates both the German pension rights adjustment and widow's pension benefit system.

3.3 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

$$\max_{x_j, h_j, h_j^*, \ell_j, \ell_j^*} u[c_j(x_j, h_j, h_j^*), \ell_j] + \delta\psi_{j+1}^{g} EV[z_{j+1}|z_j] + u[c_j(x_j, h_j^*, h_j), \ell_j^*] + \delta\psi_{j+1}^{g^*} EV[z_{j+1}^*|z_j^*] \tag{7}$$

subject to the household budget constraint (8) for married couples which reflects the pooling

[5] 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). However, as Siermiska et al. (2010) report, only roughly 15% of couples in Germany experience equal sharing within their households.

of resources during marriage and the income splitting method of family taxation, i.e.

$$2\text{a}_{j+1} = (1+r)2\text{a}_j + w_j + w_j^* + p_j + p_j^* + b_j + b_j^* + cb(k_j) \\ - \tau\ \big(\ \min[w_j; 2\bar{w}] + \min[w_j^*; 2\bar{w}]\ \big)\ -2T\left(\frac{y_j + y_j^*}{2}\right) - (1+\tau_x)x_j. \quad (8)$$

Note that married couples in our benchmark are not altruistic and don't receive direct utility from being married. Consequently, utility of married individuals is derived from

$$V(z_j) = u[c_j(x_j, h_j, h_j^*), \ell_j] + \delta\psi_{j+1}^g EV[z_{j+1}|z_j]$$

We assume that married couples split their savings during marriage equally. If one of the partners dies at the end of the period, the surviving spouse receives all of the couple's assets. 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 $z_{j+1} = (g, s, s^*, k_{j+1}, e_{j+1}, e_{j+1}^*, \text{a}_{j+1}, ep_{j+1})$. The second case covers the situation when one of the spouses dies. The status of the surviving partner, e.g. the partner of gender g, then turns into $z_{j+1} = (g, s, 0, k_{j+1}, e_{j+1}, 0, 2\text{a}_{j+1}, ep_{j+1})$, i.e. assets are completely inherited to the remaining spouse. Finally, the third case describes the situation when the marriage is divorced. Here, the individual status changes to $z_{j+1} = (g, s, 0, k_{j+1}, e_{j+1}, 0, \text{a}_{j+1}, ep_{j+1})$, where we assume that assets and earning points are split equally.

3.4 Instantaneous utility, scale effects and home production

The period utility function is defined by

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

where ρ denotes the intratemporal elasticity of substitution between consumption and leisure at each age j while α defines the age-independent leisure preference parameter.

Since the needs of a household grow not in proportion with each additional household member, we model scale effects in household consumption. If $n_j \in \{1, 2\}$ denotes the number of parents in a household, the consumption for the adult family member is derived from

$$c_j(x_j, h_j, h_j^*) = \Psi(n_j, k_j)\cdot\left[\upsilon x_j^\kappa + (1-\upsilon)\left(h_j^m + \varphi h_j^f\right)^\kappa\right]^{\frac{1}{\kappa}} \quad \text{with } \Psi(n_j, k_j) = \left(\frac{1}{n_j + \phi k_j}\right)^\omega.$$

Household consumption is derived from a CES home production technology which combines market goods x_j and homework. The parameter φ measures the magnitude of female's advantage in home production, υ is the share parameter for market goods x_j and κ defines the substitution elasticity between market goods x_j and effective working time in home production. The function Ψ translates household consumption into consumption realized by adult family members. The scale effects in household consumption are captured by the parameters ϕ and ω. Since $0 < \phi, \omega < 1$ a child costs less than an adult and the second adult and each additional child cost less to feed and cloth than the one before.

Our model abstracts from annuity markets. Consequently, private assets of agents who died are aggregated and then distributed equally among all working age cohorts $j < j_R$. 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

$$Y = \theta K^{\varepsilon} L^{1-\varepsilon} \tag{10}$$

where Y, K and L are aggregate output, capital and labor, respectively, ε is capital's share in production and θ defines a technology parameter. Capital depreciates at a rate δ_k. Firms maximize profits renting capital and hiring labor from households such that net marginal products equal r the interest rate for capital and w the wage rate for effective labor.

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 its debt and child benefits CB, i.e.

$$T_y + \tau_x X = G + rB_G + CB, \tag{11}$$

where T_y defines revenues from income taxation and X aggregate consumption of market goods.

We assume that contributions to public pensions are exempted from tax while benefits are fully taxed. Consequently, taxable income y_j is computed from gross labor income net of pension contributions, a flexible work related allowance $d(w_j)$, capital income above a specific allowance level d_s and – after retirement – public pensions:

$$y_j = \max[w_j - \tau \min[w_j, 2\bar{w}] - d(w_j); 0] + \max[ra_j - d_s; 0] + p_j.$$

Given taxable income, we apply the German progressive tax code of the year 2005 and balance the budget of the government by adjusting the consumption tax rate.

In each period, the pension system pays old-age benefits and collects payroll contributions from wage income below the contribution ceiling of $2\bar{w}$. Individual pension benefits p_j of a retiree at age $j \geq j_R$ in a specific year are computed from the sum of accumulated earning points ep_{j_R} which are multiplied by the actual pension amount (APA) per earning point. The budget of the pension system must be balanced in every period.

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 measure of households $\xi(z_j)$ over the whole state space and market clearance for capital, labor and goods market.[6]

4 Calibration of the initial equilibrium

4.1 Demographic structure

Table 1 reports the central parameters of the model. In order to reduce computational time, each model period covers five years. Agents start life at age 20 ($j = 1$) and may give birth to two children at age 25 ($j_C = 2$). Since children stay in the household for twenty years we have $k_1 = k_6 = k_7 = \cdots = 0$. Agents are forced to retire 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 $\pi^c = 0.7$.

The conditional survival probabilities ψ_j^g are computed from the year 2000 Life Tables for Germany reported in Bomsdorf (2003). However, in order to simplify the demographic transition, we assume gender-invariant survival probabilities up to retirement, i.e. $\psi_j^f = \psi_j^m = \psi_j, j < j_R$. We also restrict (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 up to retirement are derived from cohort data reported in the Statistical Yearbook of the Federal Statistical Office Germany (2007). Figure 4 shows the fraction of married couples in

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

Table 1: Parameter selection

	Values	Comments
Demographics	$J = 16, j_C = 2, j_R = 9$	5 year periods
	$\pi^c = 0.7$	1.4 children per woman
	ψ_j^g	Bomsdorf (2003)
	π_j^m, π_j^d	Stabu (2007)
	$\pi_{ss^*}^g$	SOEP-Data
Tastes	$\gamma = 0.5, \rho = 0.6$	Auerbach/Kotlikoff (1987), İmrohoroğlu/Kitao (2009)
	$\alpha = 0.6, \delta = 0.95$	calibrated, see text
	$\kappa = 0.5$	Rogerson (2009)
	$\phi = 0.3, \omega = 0.5$	Greenwood et al. (2003)
	$\varphi = 2.0, \upsilon = 0.65$	calibrated, see text
Technology	$\varepsilon = 0.3, \delta_k = 0.29$	calibrated; see text
	$\theta = 1.55$	normalization of wage
Government	$\tau_x = 0.17, B_G/Y = 0.6,$	see text

each cohort we obtain when applying our estimated marriage and divorce probabilities for 2005 to the model. We see an increase of married couples in the early years of life until age 35 due to high marital risk. Passing age 35, the number of married couples stays roughly constant. Finally, with survival probabilities being lower than one at retirement, the number again declines as the number of widows/widowers increases. Figure 4 also shows the fraction of married couples we obtain when applying estimated probabilities for the 1970s, i.e. from a time with much more marriages and less divorces. The solid line represents the actual data on married couples in Germany we also computed from Federal Statistical Office Germany (2007) data. Of course, this line lies somewhat in between the ones for 1970 and 2005, since the current household structure of elderly reflects past marital behavior while the model compares two steady states with the 2005 and 1970 probabilities.

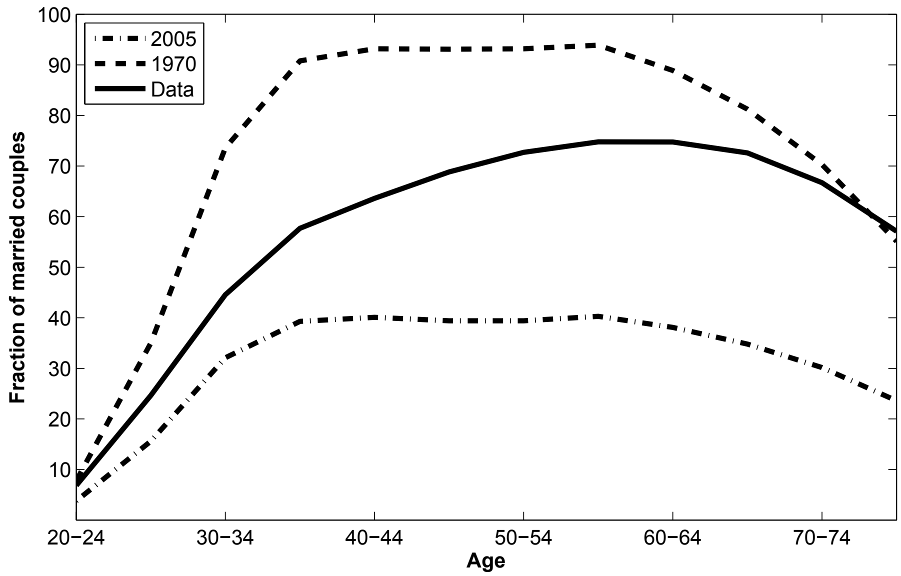
We distinguish $S = 3$ educational classes and assume that the initial distribution of men and women over the groups follows the one reported in the appendix. The respective mating probabilities $\pi_{ss^*}^g$ were estimated from German Socio-Economic Panel (SOEP) data of the years 1995-2007 and are reported in the appendix as well.[7]

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).

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

Figure 4: Fraction of married couples in every cohort



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 0.18 and for women of 0.37. 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 2 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 $\kappa = 0.5$. 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 $\alpha = 0.6$, the share parameter $\upsilon = 0.65$ in home production and the woman productivity advantage in home production ($\varphi = 2.0$) in order to match gender-specific participation rates and time use data.

Apps and Rees (2005) analyze full time employment rates and participation rates for men and women in Germany in year 2000. While participation rates rise from 63.7 (women) to 68.7 (men), only 35.5 percent of married women work full time while 78.3 percent of married men work full time. Overall they conclude that women work roughly half the market hours of men. Table 2 reports similar full time employment rates for married couples, but the overall participation rates are much higher in our model than in the data. At least partially this is due

Table 2: Labor market behavior and time use in the initial equilibrium*

	Male			Female			Σ
	married	single	total	married	single	total	
Labor supply elasticity	0.11	0.21	0.18	0.56	0.29	0.37	–
Labor market participation (in%)							
Full time	81.0	90.8	87.7	38.3	55.5	50.1	68.9
Part time	13.4	8.6	10.1	24.2	41.3	35.9	23.0
No employment	5.6	0.6	2.1	37.5	3.3	14.0	8.1
Time use (in %)							
Market work	45.9	42.7	43.7	31.9	30.8	31.0	37.8
Home work	6.4	21.8	17.1	32.7	29.6	30.3	23.3
Leisure consumption	47.7	35.5	39.2	35.4	39.6	38.7	38.9

*Ages 20-60. Full-time employment when working more than 30 hours per week.
No employment when earning less than 400 € per month.

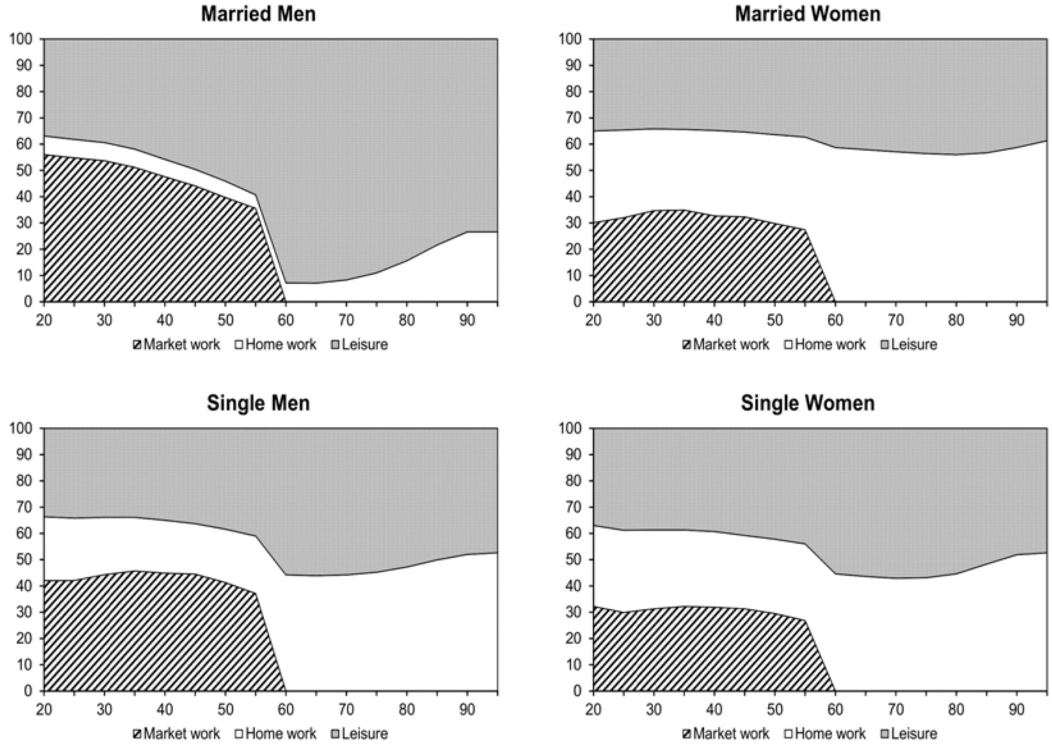
to the fact that our model only considers employment ages 20-60 years, whereas Apps and Rees (2005) also include ages below 20 and above 60 where employment is lower. The lower part of Table 2 reports the fractions of market work, home work and leisure for different marital status and sexes. Typically, U.S. studies assume that 1/3 of available time is used for market work while 1/4 is used for home production, see Rogerson (2009). The right column of Table 2 shows that we roughly match these figures. Freeman and Schettkat (2001) report how men and women in West Germany split their mean hours per week in the early 1990s. While husbands on average spend 38 percent of available time for market work and 19.3 percent at home, the split for women is 19.5 and 39.5 percent respectively. Given the fact that female employment rates have increased significantly since then, we feel that our match in Table 2 is quite close to these figures. Of course, we can also look at the split-up of time use over the life cycle. Figure 5 shows that home work increases for both genders when they enter retirement. In addition, married men mainly work at home during retirement.

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

4.3 Technology and government parameters

At the production side we have to specify the capital share in production which is set at $\varepsilon = 0.3$ which roughly reflects the average share of capital income in Germany. The annual depreciation rate for capital is set at 5.25 percent (i.e. the periodic depreciation rate is set at $\delta_k = 0.29$) which yields a realistic investment share in output. Finally we specify the general

Figure 5: Time use over the life cycle



factor productivity $\theta = 1.55$ in order to normalize the initial wage rate to unity.

The annual APA value is chosen in order to derive a replacement rate of net income of 70 percent, which yields a realistic contribution rate for Germany. As already explained, the taxation of gross income (from labor, capital and pensions) is close to the current German income tax code and the marginal tax rate schedule $T05$ which was introduced in 2005. In addition, we consider a special allowance for labor income of $d(w_j)$ which combines a fixed amount of 3000 € and an additional deduction of 4 percent of labor income. With respect to capital income we assume a tax allowance of $d_s = 1800$ €. Given taxable income y_j, the marginal tax rate rises linearly after the basic allowance of 7800 € from 15 percent to a maximum of 42 percent when y_j passes 52.000 €. Child benefits $cb(k_j)$ 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 $al(w_j, k_j)$ which amounts to 10 percent of his net income per child. Since we cannot identify the specific mother in our model, the alimony is distributed equally among single mothers who raise a child.

In the initial long-run equilibrium, we assume a debt-to-output ratio of 60 percent, which is realistic for the year 2005. In addition, we fix the consumption tax rate at 17 percent in order to generate a realistic public consumption ratio G/Y.

4.4 Estimation of productivity profiles and income uncertainty

In order to estimate productivity profiles, we use inflated income data y_{it} 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 and was divided into different educational groups according to the International Standard Classification of Education (ISCED) of the UNESCO of 1997. In order to receive three groups, we merge levels 0 to 2 (primary and lower secondary education), levels 3 and 4 (higher secondary and post-secondary education) as well as levels 5 and 6 (tertiary education) to one group each. This approach leads us to a total of 83893 observations, where we have 11789, 55015 and 17089 observations in groups one to three, respectively.

Following Love (2007), we assume household's log-productivity to follow a deterministic trend $g_j(s)$ that only depends on agent's age and income class s plus some shock ζ that is described by an AR(1)-process, i.e. for a class s household, we have

$$\log(e_j) = g_j(s) + \zeta_j \tag{12}$$

with

$$\zeta_j = \varrho\zeta_{j-1} + \epsilon_j \quad , \quad \epsilon_j \sim N(0, \sigma_\epsilon^2) \quad \text{and} \quad \zeta_0 = 0. \tag{13}$$

Concerning our data, we therefore estimate the equation

$$\log(y_{it}) = \beta_0 + \beta_1 \text{age}_{it} + \beta_2 \text{age}_{it}^2/100 + \beta_3 \text{type}_{it} + \nu_i + \zeta_{it} \tag{14}$$

with an individual effect $\nu_i \sim N(0, \sigma_\nu^2)$ separately for any of the three educational groups s by means of GLS, assuming ζ to follow an AR(1) process as in (13). In equation (14) the regressor type_{it} is a vector of dummy coded variables for the type of job of the individual, i.e. blue collar, white collar, etc. This approach leads us to the parameter estimates shown in Table 3 (standard errors are reported in parenthesis).

There are two things to notice. First, we find a strong AR(1) correlation of around 0.8 for the error term, which lies in the range of typical values for these types of models, see e.g. Love (2007) or İmrohoroğlu and Kitao (2009). Second, except for group 3, we see a small persistent variance, which means that our groups are strongly homogeneous. In the highest educational group, however, there is a certain chance of climbing up into the area of extraordinary high salaries. This makes the group somewhat more heterogeneous and explains a higher variance of the individual effect. The estimated income profiles can be seen in Figure 6.

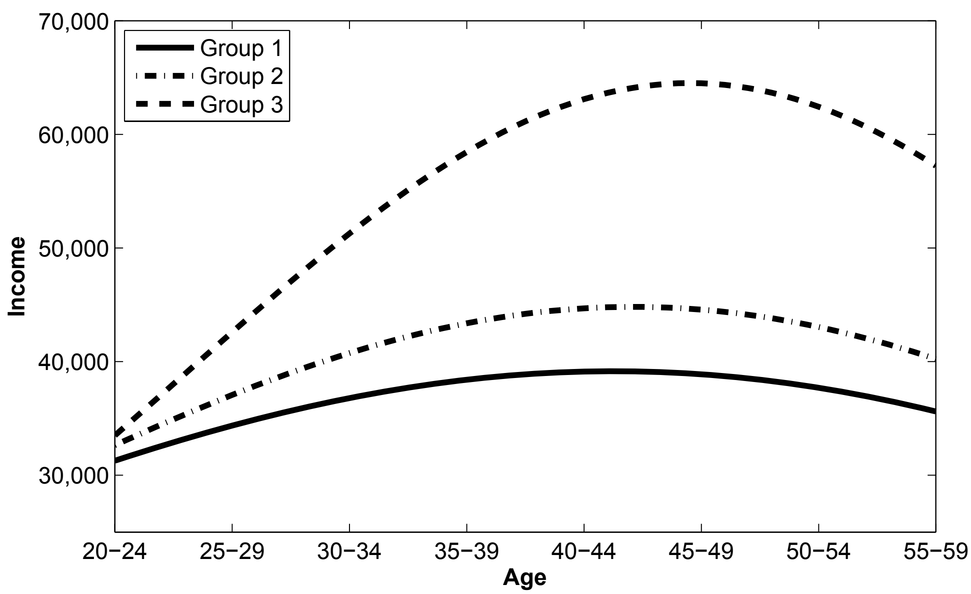
For computational reasons, we finally approximate the shock ζ by a first order discrete Markov process with two nodes using a discretization algorithm as described in Tauchen (1986).[8]

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

Table 3: Parameter estimates for individual productivity

	Group 1	Group 2	Group 3
Intercept and type	9.6207	9.4190	8.6649
	(0.2662)	(0.1494)	(0.3116)
age term β_1	0.0437	0.0579	0.1025
	(0.0041)	(0.0025)	(0.0064)
age^2 term β_2	-0.0500	-0.0649	-0.1090
	(0.0052)	(0.0031)	(0.0074)
AR(1) correlation ϱ	0.7244	0.7826	0.7770
	(0.0119)	(0.0046)	(0.0088)
persistent variance σ_ν^2	0.0196	0.0320	0.0914
	(0.0053)	(0.0036)	(0.0083)
transitory variance σ_ϵ^2	0.0646	0.0737	0.0790
	(0.0056)	(0.0039)	(0.0076)

Figure 6: Estimated income profiles



4.5 The initial equilibrium

Table 4 reports the calibrated benchmark equilibrium and the respective figures for Germany in 2007. Since men have lower survival probabilities than women after retirement, their life expectancy (at age 20) is 76.8 years while women on average become 4.3 years older. As one can see, the initial equilibrium reflects quite realistically the current macroeconomic situation in Germany.

Table 4: The initial equilibrium

	Model solution	Germany 2007
Calibration targets		
Total first marriage rate	0.587	0.550[a]
Mean age at first marriage (in years)	31.1	29.6/32.6[b]
Total divorce rate	0.391	0.410[a]
Life expectancy (women) (in years)	81.1	81.3[a]
Life expectancy (men) (in years)	76.8	76.5[a]
Pension benefits (% of GDP)	12.8	12.3[c]
Pension contribution rate (in %)	19.5	19.5[c]
Tax revenues (in % of GDP)	23.1	20.2[c]
Capital-output ratio	3.0	2.9[c]
Other benchmark coefficients		
Interest rate p.a. (in %)	4.7	–
Bequest (in % of GDP)	4.8	4.7-7.1[d]
Gini-coefficient for net income	26.8	27.0[e]
Wealth-Gap Married/Single (in %)	63.1	127.9[f]

Source: [a]CEP (2006), [b]Gude (2008), [c]IdW (2008), [d]DIA (2002, p. 19), [e]SVR (2010). [f]Sierminska et al. (2010).

Note that although our model generates a positive wealth gap between married couples and singles, the actual difference is much lower than the one reported by Sierminska et al. (2010). Mainly this is due to a composition effect. Older cohorts have more assets than younger cohorts and in the model the fraction of older married couples is significantly lower than in reality, see Figure 4. In addition, it may also be important that in our model marriage and divorce rates are independent of labor income, whereas in reality rich people have higher marriage rates and more stable marriages than poor people.

5 Simulation results

This section presents our simulation results. In order to quantify the impact of a changing household structure on macroeconomic variables and the income distribution, we compute a new long-run equilibrium that results from the introduction of marriage and divorce probabilities of the 1970s and compare it with the initial equilibrium reported in Table 4 above. Given these benchmark results we simulate the changes in household structures in an artificial model economy with certain lifespan, no gender differences, a linear income tax, no scale effects and no children. Introducing these features step by step we can isolate and quantify how important insurance and scale effects, the tax system and women's productivity advantage in home work are. Finally we report some sensitivity analysis of the benchmark simulation with respect to central parameters of the model.

5.1 The benchmark scenario

In order to highlight the importance of income uncertainty, we compare the benchmark scenario with productivity shocks with a situation where productivity is deterministic over the life cycle. In order to keep the capital-output ratio constant in both model scenarios we assume a small open economy if not stated otherwise.

In the left part of Table 5 the divorce probability is reduced to a total divorce rate of 15.7 percent. Consequently, people still marry at low probabilities but if they get married, their marriage is more stable. In the right part of Table 5 divorce probabilities are reduced and marriage probabilities are at the same time increased to a total first marriage rate of 99.2 percent. Consequently, the mean age at first marriage decreases from 31.1 to 29.1 years. All these figures reflect the situation during the 1970s in Germany, see CEP (2006).

Table 5: Macro effects of family formation in the benchmark[a]

	Lower divorce		Lower divorce, higher marriage		
Labor income Economy	certain open	uncertain open	certain open	uncertain open	uncertain closed
A^m	2.4	1.2	20.7	**10.3**	8.3
A^f	-0.1	-0.6	-4.3	**-7.3**	-9.2
L^m	-1.2	-0.3	-4.6	**0.1**	0.6
L^f	-0.4	-1.3	-5.5	**-10.3**	-10.3
H^m	-6.2	-8.3	-27.4	**-36.7**	-37.4
H^f	2.1	2.7	10.4	**13.5**	13.5
Y	-0.9	-0.7	-5.0	**-4.0**	-2.2
τ_x^b	0.3	0.3	1.8	**2.1**	2.1
Gini-index[b]	0.0	-0.2	-0.3	**-1.3**	-1.2

[a] In percent of initial equilibrium, [b] in percentage points.

When the divorce rate falls and marriages become more stable, adult consumption increases due to stronger scale effects. This leads to higher leisure demand and a stronger specialization in home work due to the higher productivity of women in home production. The labor market behavior of women is in line with the results from Johnson and Skinner (1986) and Stevenson (2008) discussed above. While male increase their asset accumulation, women reduce savings slightly since they expect benefits from the bequest they receive as widows. Note that in the situation with uncertain income, assets accumulation is dampened since now precautionary savings are reduced when the marriage becomes more stable. Probably due to higher wage dispersion, specialization in home production is even stronger when income is uncertain. Overall, output falls as well as income tax revenues (due to income splitting), so that the consumption tax rate has to increase slightly. On the other hand, the Gini-index of net income falls slightly, so that the distribution of net income becomes more equal.

All effects become significantly stronger, when also the marriage rate increases in the right part of table 5. Now husbands have significantly higher savings while wives reduce their savings strongly. Since almost everybody gets married at least once, the reallocation of the home work/market work mix changes dramatically. Again, specialization is even stronger with income uncertainty. Female market labor supply falls by roughly 10 percent while home work increases by 13.5 percent. The overall output reduction is 4 percent while the consumption tax rate increases by more than two percent. Note that the Gini coefficient now reduces to 25.6 which implies a significant improvement. Our study therefore confirms the results from Peichl et al. (2010) who argue that the recent change in household structure has deteriorated the income distribution significantly. Finally, the right column shows that endogenous factor prices only dampen the effects slightly. While male employment rises due to higher wages, asset accumulation is depressed by the falling interest rate.

Table 6: Labor market behavior and time use in the benchmark simulation*

	Male			Female			Σ
	married	single	total	married	single	total	
Labor market participation (in%)							
Full time	81.7	95.2	85.4	41.7	48.3	43.5	64.5
Part time	13.7	4.7	11.2	21.3	50.8	29.4	20.3
No employment	4.6	0.1	3.4	37.0	0.9	27.1	15.2
Time use (in %)							
Market work	45.8	40.2	45.0	32.8	28.2	30.6	38.7
Home work	6.5	24.4	11.4	33.1	32.0	33.0	20.9
Leisure consumption	47.7	35.4	43.6	34.1	39.8	36.4	40.4

*Ages 20-60. Full-time employment when working more than 30 hours per week.
No employment when earning less than 400 € per month.

Table 6 illustrates that married and single males and females hardly change the structure of their time use. The changes in the aggregates are mainly due to changes in the fractions of married and single individuals. Since the chances for single males increase to get married, they move from part-time to full-time employment. The opposite happens with single women. Since the risk of divorce is reduced for married women, they increase their full-time work at the expense of part-time work. Nevertheless aggregation within the two genders shows that most of the reduced employment rate of women is due to the different weights of married and single females.

5.2 Mortality, productivity and the income tax system

Next we try to disentangle different economic effects that are at work in the fourth column of Table 5. In all cases discussed in the following, we consider the model with income uncertainty and assume that both marriage and divorce rates adjust simultaneously.[9] The left column of Table 7 reports the situation when both genders are completely identical. Males and females have a certain lifespan of 80 years (i.e. $\psi^g = 1.0$ and $J = 12$), they are distributed uniformly across skill-classes, marry only within their own skill class and have no children.[10]

Table 7: Decomposition of macro effects from family formation[a]

	Certain lifespan (1)	Unisex mortality (2)	Gender-related mortality (3)	Education/ mating (4)	Home production (5)	Scale effects (6)
A^m	-9.1	-5.5	-3.2	-4.7	1.5	5.2
A^f	-9.1	-5.5	-9.2	-8.6	-16.2	-11.0
L^m	0.2	-0.1	-2.3	0.0	2.7	-1.3
L^f	0.2	-0.1	2.2	0.1	-6.3	-7.5
H^m	4.4	3.1	-0.8	-2.0	-32.5	-38.3
H^f	4.4	3.1	6.7	8.5	16.3	14.0
Y	0.2	-0.1	0.0	0.1	-0.9	-3.8
τ_x^b	1.3	0.5	0.6	0.6	2.2	1.6

[a] In percent of initial equilibrium, [b] In percentage points.

In this situation both genders react absolutely in the same way when marital risk changes. Now stronger household formation decreases savings quite significantly and increases market work and home work. This result is due to two different behavioral reactions. On the one hand, marriages provide income insurance so that precautionary savings of singles and couples can be reduced when marriage rates increase and divorce rates fall. On the other hand, singles will also reduce their old-age savings. Since assets are pooled when agents get married and singles take the savings of possible spouses as given, this works like a prisoner's dilemma and leads

[9]Results for the model with certain income and isolated parameter adjustments are available upon request.

[10]The case with certain income would be close to the situation analyzed in Cubeddu and Rios-Rull (2003).

to a reduction in the purchase of assets.[11] Consequently, households have to increase labor supply at older ages in order to compensate the savings reduction. Assuming a small open economy, GDP obviously has to move in the same manner as labor supply. As the increase in labor supply cannot offset the fall in interest income, income tax revenues decline and the consumption tax rate increases.

Next, we introduce lifespan uncertainty in order to quantify the longevity insurance effect. In the second column of Table 7, we assume unisex, averaged survival probabilities that lead to a life expectancy of roughly 80 years for both genders. Since lifespan now is uncertain and annuity markets are absent, assets of singles and partners that both die in the same period are given as accidental bequests to working generations, whereas surviving spouses receive the whole estate if only one partner dies. Consequently, building up assets in a marriage now provides longevity insurance (Kotlikoff and Spivak, 1981), so that assets are reduced much less compared to the respective previous simulation. Labor supply is hardly affected, as the prisoner's dilemma and, consequently, under-saving in the early periods of life is still present.

In the third column of Table 7, we let survival probabilities differ between genders, i.e. obtain life expectancies as reported in Table 4. While the impact on GDP and the tax rate is only modest, there is now a clear difference between the decisions of both genders. Single women work and save more compared to single men, as their expected life span is about 5 years longer. When they now get married, they may receive assets from their husband at old age, which explains the strong reduction in their own assets. Surprisingly on first sight, differential life expectancy also leads to specialization in home production although women have no productivity advantage. The reason is that women can only consume their increased resources at old age if they increase home work as well.

So far, the two genders only differed in mortality rates. However, in reality, there is also some difference in educational backgrounds and mating behavior. In the forth column of Table 7 the uniform skill distribution and strict marriage homogamy is abandoned and the skill distribution and mating matrices from the benchmark simulation of the previous section are applied. Taking a look at those, we notice that men are slightly more skilled than women and, consequently, women tend to marry singles from higher educational classes. The forth column of Table 7 shows that due to gender-specific education and marriage behavior the specialization in home production increases further compared to the previous setting. While men reduce their savings even more, women reduce their savings less than in the previous simulation. At the same time market labor supply of both genders is now hardly affected by changes in household formation. Probably the differences in macroeconomic aggregates between columns (3) and (4) reflect the higher asset transfers from men to women after the marriage. Again at the aggregate level, one

[11]The same effect is analyzed by Glazer (2008) in a non-cooperative family model.

can hardly observe an impact on GDP or tax rates.

Up to now, the model has not accounted for children and productivity advantages of women in home production. In column (5) of Table 7, children and child benefits are introduced and women have a higher productivity in home work (i.e. $\varphi = 2.0$). Households with children experience a reduction of adult consumption during ages 25-45. As a consequence, the household will increase its labor supply during that period. In this context, the presence of children would already lead to a stronger specialization when marriage rates increase. This is reinforced by the fact that women now have a productivity advantage in home work. Consequently, specialization in marriage is quite dramatic in column (5). Many women leave the labor force when they get married, so that GDP and income tax revenues decrease significantly. In addition, higher marriage rates decrease alimony transfers from men to women, which in turn increases male assets and decreases female assets compared to column (4).

In the last column (6) of Table 7 we introduce scale effects in household consumption (i.e. $\omega = 0.5$). Now marriage alone increases the adult consumption of the couple. As a consequence, when marriage probabilities increase, both partners will consume more leisure and save more compared to the previous simulation. The implied reduction in labor supply reduces GDP. Compared to the previous simulation, tax revenues are less affected since losses in labor income are mostly compensated by higher capital income.

Given the model specification in column (6) of Table 7, the introduction of progressive income taxes and income splitting within a marriage yields the benchmark simulation in the bold column of Table 5. Higher marriage rates now further dampen female labor supply since low-skilled wives face higher marginal tax rates. At the same time marriage increases labor supply of the high-skilled husbands since their marginal tax rate decreases. As marriage reduces tax burdens due to income splitting, progressive income taxation has a strong positive effect on asset accumulation.

Summing up the results of this section, we conclude that gender-specific mortality, productivity advantages of women in home production and the German income tax system are the main driving forces of the macro effects reported in Table 5. Next, we analyze how robust the benchmark results are.

5.3 Sensitivity analysis

This subsection reports the sensitivity of our benchmark results with respect to the parameter specification. In order to isolate risk aversion from intertemporal substitution, we follow the approach of Epstein and Zin (1991) and rewrite the preference structure of the representative consumer as

$$V(z_j) = \max_{x_j,h_j,\ell_j} \left\{ u[c_j(x_j,h_j),\ell_j] + \delta\psi^g_{j+1} E\left[V(z_{j+1}|z_j)^{1-\eta} \right]^{\frac{1-1/\gamma}{1-\eta}} \right\}^{\frac{1}{1-\frac{1}{\gamma}}}.$$

The parameter η defines the degree of (relative) risk aversion. When we apply the special case $\eta = \frac{1}{\gamma}$, we are back at the traditional expected utility specification discussed above, see Epstein and Zin (1991, p. 266). Consequently, setting relative risk aversion $\eta = 2.0$ yields the benchmark equilibrium reported in Table 5. Typically, values between 1 and 5 for η are perceived as reasonable in the literature, see Meyer and Meyer (2005).

Table 8: Sensitivity analysis of benchmark calibration[a]

	Benchmark calibration	$\eta = 0$ ($\beta = 0.961$)	$\gamma = 0.3$ ($\beta = 0.971$)	$\rho = 0.8$ ($\alpha = 0.7$)	$\kappa = 0.3$ ($\upsilon = 0.63$)	$\omega = 0.75, \phi = 0.5$ ($\beta = 0.963$)
A^m	10.3	19.7	13.0	9.4	8.5	8.4
A^f	-7.3	-6.5	-3.9	-8.8	-8.1	-7.3
L^m	0.1	-0.4	0.8	-1.3	3.0	2.0
L^f	-10.3	-9.9	-12.6	-5.4	-10.9	-10.4
H^m	-37.0	-37.7	-30.8	-43.3	-38.9	-34.2
H^f	13.5	13.5	11.7	17.1	14.2	14.2
Y	-4.0	-4.1	-4.3	-2.8	-2.5	-2.8
τ_x^b	2.1	1.7	1.9	1.7	1.8	1.6

[a] In percent of initial equilibrium, [b] in percentage points.

In the first column of Table 8 we replicate the respective macro effects from the bold column of Table 5. Next, we assume an economy with risk neutral individuals (i.e. $\eta = 0$) and recalibrate the discount factor in order to generate the same capital-output ratio as in Table 4. Since risk neutral agents do not save for precautionary reasons, one of the negative savings effects due to higher marriage rates – namely insurance against income uncertainty – disappears. Consequently, rising marriage rates induce higher savings for both genders compared to the benchmark case. However, the labor supply reaction is hardly affected. Setting η back at 2.0 and reducing the intertemporal elasticity of substitution from 0.5 to 0.3 flattens the consumption profile and strengthens liquidity constraints at the beginning of the life cycle. As now there are nearly no savings before singles marry, the prisoner's dilemma caused by asset pooling in marriages is reduced which explains why savings increase stronger than in the benchmark. Next, the intratemporal elasticity of substitution is increased which leads to a stronger specialization in home production and a reduction (an increase) of male (female) market work compared to the benchmark simulation. As shown in the following column, the elasticity of substitution between home work and market goods κ has only negligible specialization effects but increases males labor supply at the market after marriage. Finally, we adjust the scale parameters for household size in order to match OECD-modified equivalence scales. Again, compared to the benchmark parametrization, household specialization is hardly affected while market work of males increases.

Overall, Table 8 shows that the reported quantitative figures from the benchmark table are quite robust to parameter changes.

6 Conclusion

Summing up the results from the previous section, we have shown that changes in household structure during the last decades may explain most of the increase in female labor market participation and the stable (or slightly falling) participation rates of men in Germany. In addition, our analysis indicates that rising marital risk had only little impact on aggregate capital accumulation since increased savings rates of males were neutralized by decreased savings of females. Our decomposition highlights, that differences in mortality, productivity advantages of women in home production and the taxation of couples are the most important determinants of household labor supply when marital risk changes. Finally, we find that changes in household composition also explain at least partly the increase in net income inequality.

Of course, the above analysis could be easily extended to include changes in the skill composition, child birth behavior and/or mortality of both genders since the 1970s. However, this is beyond the scope of the present paper which only concentrates on changes in household composition. In the future we plan to extend the model in various directions. A natural future refinement concerns the introduction of 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. (2010) 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. On the one hand, the benefits of social security from it's provision of longevity insurance (Fehr et al., 2008) will decrease since marriages provide some form of implicit insurance. On the other hand, since marriages may reduce savings in a model with household formation, the introduction of a forced savings system (such as social security) may overcome this savings slump, see Glazer (2008).

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. 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: Probabilities and skill composition

Table 9: Age-specific marriage and divorce rates

	2007		1970	
Age	π_j^m	π_j^d	π_j^m	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 10: Initial distribution over educational backgrounds

Group	1	2	3
men	0.21	0.56	0.23
women	0.32	0.53	0.15

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

males

		s^*		
		1	2	3
	1	0.56	0.40	0.03
s	2	0.31	0.61	0.08
	3	0.10	0.46	0.43

females

		s^*		
		1	2	3
	1	0.37	0.55	0.08
s	2	0.16	0.64	0.20
	3	0.05	0.29	0.67

References

Apps, P. and R. Rees (2005): Gender, Time Use, and Public Policy over the Life Cycle, *Oxford Review of Economic Policy 21(3)*, 439-461.

Attanasio, O., H. Low, and V. Sanchez-Marcos (2005): Female Labor Supply as Insurance against Idiosyncratic Risk, *Journal of the European Economic Association 3(2-3)*, 755-764.

Attanasio, O., H. Low, and V. Sanchez-Marcos (2008): Explaining Changes in Female Labor Supply in a Life-Cycle Model, *American Economic Review 98(4)*, 1517-1552.

Auerbach, A.J. and L.J. Kotlikoff (1987): *Dynamic Fiscal Policy*, Cambridge University Press, Cambridge.

Aughinbaugh, A. (2010): The Effects of Remarriage on Women's Labor Supply, *Journal of Population Economics 23(4)*, 1151-1176.

Bomsdorf, E. (2003): Sterbewahrscheinlichkeiten der Periodensterbetafeln für die Jahre 2000 bis 2100, Eul Verlag, Köln.

Caucutt, E.M., N. Guner and J. Knowles (2002): Why Do Women Wait? Matching, Wage Inequality, and the Incentives for Fertility Delay, *Review of Economic Dynamics 5(4)*, 815-855.

Chade, H. and G. Ventura (2002): Taxes and Marriage: A Two-sided Search Analysis, *International Economic Review 43(3)*, 955-985.

Council of Europe Publishing (CEP) (2005): Recent Demographic Developments in Europe 2004, Strasbourg.

Council of Europe Publishing (CEP) (2006): Recent Demographic Developments in Europe 2005, Strasbourg.

Cubeddu, L. and J.V. Ríos-Rull (2003): Families as Shocks, *Journal of the European Economic Association 1(2-3)*, 671-682.

Deutsches Institut für Altersvorsorge (DIA) (2002): Erben in Deutschland, Köln.

Elvers, M., R. de Mooij and D. van Vuuren (2008): The Wage Elasticity of Labor Supply: A Synthesis of Empirical Estimates, *De Economist 156*, 25-43.

Epstein, L.G. and S.E. Zin (1991): Substitution, Risk Aversion, and the Temporal Behavior of Consumption and Asset Returns: An Empirical Analysis, *Journal of Political Economy 99(2)*, 263-286.

Federal Statistical Office of Germany (Stabu) (2007): Statistical Yearbook 2007, Wiesbaden.

Fehr, H., C. Habermann and F. Kindermann (2008): Social Security with Rational and Hyperbolic Consumers, *Review of Economic Dynamics 11(4)*, 884-903.

Fitzenberger, B., R. Schnabel, and G. Wunderlich (2004): The Gender Gap in Labor Market Participation and Employment: A Cohort Analysis for West Germany, *Journal of Population Economics 17(1)*, 83-116.

Freeman, R.B. and R. Schettkat (2001): Marketization of Production and the US-Europe Employment Gap, *Oxford Bulletin of Economics and Statistics 63(S1)*, 647-670.

Glazer, A. (2008): Social Security and Conflict within the Family, *Journal of Population Economics 21(2)*, 331-338.

Gonzalez, L. and B. Özcan (2008): The Risk of Divorce and Household Saving Behavior, IZA Discussion Paper No. 3726, Bonn.

Greenwood, J., N. Guner and J.A. Knowles (2003): More on Marriage, Fertility and the Distribution of Income, *International Economic Review 44(3)*, 827-862.

Greenwood, J. and N. Guner (2009): Marriage and Divorce since World War II: Analyzing the Role of Technological Progress on the Formation of Households, in: D. Acemoglu, K. Rogoff and M. Woodford, eds., NBER Macroeconomics Annual 2008, University of Chicago Press, 231-276.

Greenwood, J., A. Seshadri, and M. Yorukoglu (2005): Engines of Liberation, *Review of Economic Studies 72(1)*, 109-133.

Gude, J. (2008): Ehescheidungen 2006, *Wirtschaft und Statistik 4/2008*, 287-297.

Guner, N., R. Kaygusuz, and G. Ventura (2010): Taxation and Household Labor Supply, Working Paper, Universitat Autonoma de Barcelona.

Hong, J.H. and J.-V. Rios-Rull (2007): Social Security, Life Insurance and Annuities for Families, *Journal of Monetary Economics 54(1)*, 118-140.

İmrohoroğlu, S. and S. Kitao (2009): Labor Supply Elasticity and Social Security Reform, *Journal of Public Economics 93(7-8)*, 867-878.

Institut der deutschen Wirtschaft (IdW) (2008): Deutschland in Zahlen, Köln.

Johnson, W.R. and J. Skinner (1986): Labor Supply and Marital Separation, *American Economic Review 76(3)*, 455-469.

Kaygusuz, R. (2010): Taxes and Female Labor Supply, *Review of Economic Dynamics 13(4)*, 725-741.

Kotlikoff, L. und A. Spivak (1981): The Family as an Incomplete Annuities Market, *Journal of Political Economy 89(2)*, 372-391.

Love, D. (2007): What Can the Life-cycle Model Tell Us About 401(k) Contributions and Participation, *Journal of Pension Economics and Finance 6(2)*, 147-185.

Love, D. (2010): The Effects of Martial Status and Children on Savings and Portfolio Choice, *Review of Financial Studies, 23(1)*, 385-432.

Lupton, J.P. and J.P. Smith (2003): Marriage, Assets and Savings, in: S. Grossbard-Shechtman, ed., Marriage and the Economy, Cambridge University Press, 129-152.

Meyer, D. and J. Meyer (2005): Relative Risk Aversion: What Do We Know? *Journal of Risk and Uncertainty 31(3)*, 243-262.

Olivetti, C. (2006): Changes in Women's Hours of Market Work: The Role of Returns to Experience, *Review of Economic Dynamics 9(4)*, 557-587.

Olovsson, C. (2009): Why Do Europeans Work so Little? *International Economic Review 50(1)*, 39-61.

Papps, K.L. (2006): The Effects of Divorce Risk on the Labour Supply of Married Couples, IZA Discussion Paper No. 2395, Bonn.

Peichl, A., N. Pestel and H. Schneider (2010): Does Size Matter? The Impact of Changes in the Household Structure on Income Distribution in Germany, IZA Discussion Paper No. 4770, Bonn.

Rogerson, R. (2009): Market Work, Home Work, and Taxes: A Cross-Country Analysis, *Review of International Economics 17(3)*, 588-601.

Sachverständigenrat zur Begutachtung der gesamtwirtschaftlichen Entwicklung (SVR) (2009): Die Zukunft nicht aufs Spiel setzen, Jahresgutachten 2009/2010, Wiesbaden.

Siermiska, E.M., J.R. Frick, and M.M. Grabka (2010): Examining the Gender Wealth Gap, *Oxford Economic Papers 62(4)*, 669-690.

Stevenson, B. (2008): Divorce Law and Women's Labor Supply, *Journal of Empirical Legal Studies 5(4)*, 853-873.

Stevenson, B. and J. Wolfers (2007): Marriage and Divorce: Changes and their Driving Forces, *Journal of Economic Perspectives 21(2)*, 27-52.

Tauchen, G. (1986): Finite State Markov-Chain Approximations to Univariate and Vector Autoregressions, *Economics Letters 20(2)*, 177-181.

Wagner, G.G., J.R. Frick and J. Schupp (2007): The German Socio-Economic Panel Study (SOEP) - Scope, Evolution and Enhancements, *Journal of Applied Social Science Studies 127(1)*, 139-169.

Wrede, M. (2003): The Income Splitting Method: Is it Good for Both Marriage Partners? *German Economic Review 4(2)*, 203-216.

Zissimopoulos, J. (2009): Gain and Loss - Marriage and Wealth Changes over Time, Working Paper 2009-213, Michigan Retirement Research Center.