Fertility, Female Labor Supply, and Family Policy‡

Hans Fehr
University of Würzburg
CESifo
Netspar

Daniela Ujhelyiova
University of Würzburg

Abstract. The present paper develops an overlapping generations general equilibrium model for Germany in order to study the impact of public policy on household labor supply and fertility decisions. Starting from a benchmark equilibrium which reflects the current German family policy regime we introduce various reforms of the tax and child benefit system and quantify the consequences for birth rates and female labor supply. Our simulations indicate three central results: First, higher transfers to families (either direct, in-kind or via family splitting) may increase birth rates significantly, but they may come at the cost of lower female employment. Second, the introduction of individual taxation (instead of joint taxation of couples) would increase female employment but might further reduce current birth rates in Germany. Third, it is possible to increase birth rates and female employment rates simultaneously if the government invests in child care facilities for children of all ages.

JEL classification: J12, J22.

Keywords: Stochastic fertility; general equilibrium life cycle model.

1. INTRODUCTION

During the past decades most industrialized countries of the Western world have experienced declining fertility rates combined with an increase in female labor market participation (FLMP). From 1970 to 2006 total fertility rates1 Total fertility rates (TFRs) within OECD countries decreased from above 2.6 children per woman to 1.6 children (OECD, 2009a). This negative trend was even more distinct in West Germany where the TFR dropped from its peak of 2.5 children per woman in the mid-1960s to 1.3 children in the mid-1980s (StaBu, 2007). After German reunification it increased slightly to 1.4 children per woman. While the numbers of children per woman declined, the mean age of mothers at

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1. The average number of children that would be born alive to a woman during her lifetime if she were to pass through her childbearing years conforming to the age-specific fertility rates of a given year.
first childbirth increased from 23.8 to 27.7 years on average during the last three decades.

Since women are giving birth to fewer children and later in life, it seems natural that they would increase their participation in the labor force at the same time. Not surprisingly, participation rates of prime-age women rose significantly within OECD countries from 48.3% in 1974 to 61.3% in 2008, see OECD (1995, 2009b). The inverse relationship between fertility and FLMP can also be observed in cross-section data with respect to the individual skill level. For example, in 2007 lower educated women in Germany had a participation rate of 57% and 1.9 children on average, whereas high-skilled women had a higher participation rate (85%) and only 1.1 children on average (StaBu, 2009b,c).

At first glance, both trends could be explained quite well by Becker’s (1965) seminal work on household time allocation. According to this model, rising female earnings power has induced a fertility decline and an increase in female employment, because the positive income effects on fertility and leisure demand were dominated by negative substitution effects induced by the increased opportunity costs of child bearing and leisure. This preference-based theory fits quite well with empirical studies that document the positive correlation between women’s education and their labor market participation (OECD, 2009b), postponed maternity (Gustafsson and Kalwij, 2006) and childlessness (Hoem et al., 2006).

However, the Beckerian theory requires a specific preference structure that assures that the substitution effect dominates as income rises. For example, if preferences are homothetic, the income effect and the substitution effect exactly cancel one another. Becker’s argument also generates testable predictions that appear inconsistent with the empirical evidence. As pointed out by Galor (2012), the demographic transition across Western Europe in the nineteenth century does not support a negative correlation between income and fertility. In addition, recent time series data of OECD countries indicate a much more complex relationship between women’s fertility and labor supply decisions. First, the trend that women give birth to fewer children and later in life is not uniform among all OECD countries. In countries such as Belgium, France, the Scandinavian countries and the United States the TFR has either remained at or has recently recovered to above 1.8 children per woman, while in countries such as Germany, Italy or Spain fertility rates have constantly remained below 1.4 children for many years.

Second, several recent studies (Ahn and Mira, 2002; Del Boca et al., 2009) have stressed that across many OECD countries the relationship between female employment and fertility has changed over the last 25 years. While in 1980 there was a clear negative correlation between female employment and total fertility rates, in 2005 some OECD countries with higher rates of female employment also had relatively high birth rates, so that the correlation in these countries is now positive. Finally, the relation between education and fertility has changed its sign recently as well. In the past, OECD countries with higher rates of women’s enrollment in tertiary education were also those featuring lower fertility rates. In the 1990s, however, countries with a higher level of women’s education also reported higher fertility rates (D’Addio and d’Ercole, 2005).
Since many industrialized countries are facing an enormous pressure due to their ageing populations and the corresponding decline in population size, increasing TFRs and FLMPs jointly is extremely important for future labor markets and the sustainability of social security systems. Not surprisingly, family policy is increasingly attracting public attention while at the same time a substantial amount of both theoretical and empirical research aims to uncover the central determinants of a woman’s joint childbearing and labor supply decisions. Extending the overlapping generations model of Galor and Weil (1996), Martinez and Iza (2004) focus on labor market conditions, technological change and private child care provision in order to explain the interaction between differential birth rates and female labor supply in a growing economy. On the other hand, Apps and Rees (2004) discuss differences in the public child care systems and family taxation in order to explain the described heterogeneity in fertility rates and labor market outcomes across countries. Recent empirical studies by Björklund (2006), Del Boca et al. (2009), Kalwij (2010), Laroque and Salanie (2004), Lalive and Zweimüller (2009) indicate that various policies that reduced the opportunity cost of children were indeed successful in increasing fertility rates and FLMP.

The present study is related to the recent literature of calibrated models on the economics of the family. In this context, Caucutt et al. (2002), Greenwood et al. (2003) or Guner and Knowls (2009) distinguish two sexes and analyze the interaction between marital status, employment, childbearing and human capital investment in a three-stage decision process. In these models, fertility declines with women’s educational level since children are time intensive and thus more costly for women with a high productivity. The models are applied to analyze the impact of changes in women’s productivity or of different government policies on marriage, fertility, employment, education and the overall income distribution.

Erosa et al. (2002) abstract from the marital decision in order to study the impact of fertility and labor market decisions on human capital accumulation in a search theoretic framework with job mobility and different job qualities. The study finds that fertility decisions generating long lasting employment and wage effects mainly explain the observed gender wage gap in the U.S. while firm-specific human capital plays only a minor role. Da Rocha and Fuster (2006) apply a similar search model but they consider an overlapping generations economy where only females make childbirth and labor market decisions. Due to labor market frictions the model is able to generate the observed positive correlation between fertility and employment among OECD countries mentioned above.

All calibrated family models discussed so far are partial equilibrium analyses since they mainly consider the household side and abstract from capital accumulation, public budgets and endogenous factor price repercussions. In contrast, the present study builds on Conesa (2000) or Doepke et al. (2008) who abstract from labor market search and analyze the household’s fertility and women’s labor supply decisions within a dynamic general equilibrium framework. Conesa (2000) focusses on intragenerational differences in fertility behavior and replicates the delayed childbirth and lower birth rates of higher educated women. Doepke et al. (2008) consider only one representative household per cohort and generate a baby boom by restricting labor market access for women.
However, both studies mostly neglect the government sector. This is where the present study steps in.

In particular, we analyze reform options for child benefits and family taxation in Germany, since this country has an extremely negative past record regarding TFRs and FLMPs. Our simulation analysis indicates three major results. First, higher transfers to families alone may increase birth rates but would come at the cost of lower female employment. Second, a move towards individual taxation alone may increase FLMP but would come at the cost of lower fertility. Third, in principle it is possible to increase birth rates and female employment rates simultaneously if the government invests in child care facilities for children of all ages. While a move towards individual taxation is currently precluded by the German constitutional law, the paper also highlights the positive effects of such a reform.

The next section motivates the quantitative approach by considering a simple static model of fertility choice. Section 3 describes the structure of the simulation model. Section 4 explains the calibration and simulation design. Finally, Section 5 presents the numerical results and Section 6 offers some concluding remarks.

2. THE STATIC MODEL OF FERTILITY CHOICE

In order to discuss some central mechanisms that motivate our quantitative approach, this section introduces the most basic model of fertility choice in which children provide direct utility benefits.\(^{2}\) Households maximize utility subject to a budget constraint where women divide their time endowment (normalized to unity) into working and child-rearing. Assuming separable utilities and the constant elasticity of substitution (CES) case we have

\[
\max_{c,n} U(c, n) = \alpha_c c^{\frac{1}{1-\rho}} + \alpha_n n^{\frac{1}{1-\rho}} \quad \text{s.t.} \quad c + b_0 n = w(1 - b_1 n)
\]

where \(c\) and \(n\) denote consumption and the number of children, respectively. The parameters \(\alpha_c\) and \(\alpha_n\) as well as the substitution elasticity \(\rho\) determine the preference structure, \(w\) defines the wage and \(b_0, b_1\) the costs of children in terms of money and time, respectively. Family policy intends to reduce the costs of children either via reducing \(b_0\) (e.g. by direct transfers per child) or indirectly via a reduction of \(b_1\) (e.g. by providing subsidized child care).

The explicit solution for the number of children is given by

\[
n = \frac{w}{\frac{\alpha_n}{\alpha_n} (b_0 + wb_1)^{\rho} + b_0 + wb_1}.
\]

As it turns out, a clearly negative relationship between income and fertility could be generated by ignoring monetary costs of children (\(b_0 = 0\)) and setting \(\rho > 1\). If only time costs of children mattered then high-wage families would face higher opportunity costs of having children. With a high elasticity of

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2. See Jones, Schoonbroodt and Tertilt (2010) for a discussion of such static fertility models. Alternatively, children may also be viewed as an investment providing old-age security, see Boldrin and Jones (2002).
substitution between children and consumption, the substitution effect would dominate so that $n(w)$ would decrease, as in the data. If the monetary cost of children are not ignored ($b_0 > 0$) then the relationship between income and fertility becomes more complicated. In this case fertility declines with rising income only if the elasticity of substitution is very high. It is also obvious that family policy which reduces $b_0$ and/or $b_1$ is able to increase the fertility rate.

However, one has to keep in mind that the financing of family policy reduces net income which may either counteract or strengthen the effects of the policy instruments on fertility. In addition, changes in the cost parameters may affect fertility decisions of various income classes differently. While direct payments per child may have a strong income effect on low-skilled households, they might have only a negligible impact on high-skilled parents. Quite the opposite applies to family policy instruments that reduce the time costs of children. The simple static model also neglects leisure demand and the interaction between the fertility choice and female labor supply decision. Although the utility from leisure consumption could also be considered in the static model, the labor supply decision in the present context has to account for the timing of births and the accumulation and depreciation of female human capital during child rearing. Consequently, the joint fertility and labor supply decision has to be analyzed in a dynamic framework. In such a setup it is also possible to quantify the macro-economic growth effects resulting from the adjusted fertility pattern. The next section discusses the structure of such a simulation model.

3. THE DYNAMIC MODEL ECONOMY

3.1. Demographics and intracohort heterogeneity

We consider an economy populated by overlapping generations of married couples who live for $J$ periods indexed by adult ages $j \in J = \{1, \ldots, J\}$ . The life cycle of a representative household is described in Figure 1. We assume that both adult members of the household belong to the same skill level $s \in S = \{1, \ldots, S\}$ . Men work continuously until age $J_R - 1$, afterwards they retire. All women retire at the same age as men, but they can choose in every period before retirement how much they work. Apart from the labor supply and savings decision, couples face the decision about the number and timing of their children. Women can give birth to children until age $J_F$. We abstract from twins, triplets etc., so that only one child per period can be born. Consequently, the total number of children of the age-$j$ household is $n_j \in \mathcal{N} = \{0, \ldots, J_F\}$ . Parents raise their children for $J_K$ periods, so that $k_i \in J$ indicates the age of the $i$-indexed child of the household. After birth, all children of a cohort are identical until they reach adulthood.

Our model only considers long-run equilibria so that we can omit a time index for all variables. It is solved recursively and an age-$j$ household faces the state vector

$$z_j = (s, a_j, D_j),$$

(1)

where $a_j \in A = [0, \infty)$ defines the household’s assets held at the beginning of age $j$. The vector $D_j = (k_1, \ldots, k_{n_j}) \in \mathcal{N}^l$ with $0 \leq k_1 \leq k_{n_j}$ contains the demographic characteristics of all children of the household. More specifically, $k_1$ and $k_{n_j}$
denote the age of the youngest and the oldest child of the age-\( j \) household, respectively. Given \( D_j \) we can compute the number of children currently living in the household \( m_j \leq n_j \) (i.e. those children where \( k_i \leq J_R \)) or the number of children with ages equal to or less than six years (\( m_{6j} \)). Finally, \( m_{1j} \in \{0, 1\} \) indicates whether the age-\( j \) household currently has a newborn child or not.

Each age-\( j \) cohort is fragmented into subgroups \( \xi(z_j) \), according to the initial distribution (i.e. at \( j = 1 \)), the fertility process and optimal individual decisions. Let \( X(z_j) \) be the corresponding cumulated measure to \( \xi(z_j) \). Hence,

\[
\int_C dX(z_j) = 1, \quad \text{for all} \quad j \in J
\]

must hold, as \( \xi(z_j) \) is not affected by cohort sizes but only gives densities within cohorts. For the sake of simplification, we define \( C = \mathcal{S} \times A \times \mathcal{N}^f \) as the set of states. Let \( N_j \) denote the number of (2-person-) households in the age-\( j \) cohort, then

\[
M = \sum_j N_j \int_C m_j(z_j) \, dX(z_j)
\]

measures the aggregate number of children living in households while the endogenous (native) population growth rate \( \eta \) can be computed from

\[
(1 + \eta)^{J_R} = \frac{1}{2} \sum_j N_j \int_C m_{1j}(z_j) \, dX(z_j)
\]

where we have normalized the number of the youngest households to unity, i.e. \( N_1 = 1 \). In order to have zero or positive population growth, we add an exogenous population growth rate from immigration \( \bar{\eta} \) so that in equilibrium cohort numbers can be computed from

\[
N_j = (1 + \eta + \bar{\eta})N_{j-1}.
\]

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

### 3.2. The households’ problem

Since we consider the steady state, households maximize utility at the initial age choosing a contingent plan for consumption, labor supply, the number of children and the timing of births. Following Conesa (2000), in every period during the fertile years the household decides whether to have an additional child in the subsequent period or not. Conditional on having decided to have a newborn...
next period, this event will only happen with a certain probability. Our model assumes a preference structure that is represented by a time-separable, nested CES utility function. Consequently, the problem can be written recursively so that the household at age $j$ and state $z_j$ solves

$$V(z_j) = \max_{c_j, \ell_j, \hat{n}_j} \left\{ u(c_j, \ell_j, \hat{n}_j) + \beta E\left[ V(z_{j+1}|z_j)\right] \right\}^{1-\frac{\gamma}{c}}$$

(5)

by choosing per capita consumption of goods $c_j$, leisure consumption of the mother $\ell_j$ and the family size $\hat{n}_j$. With $n_j$ being the number of children, we define $\hat{n}_j = 2 + n_j$. Expected utility in future periods is discounted by $\beta$ and the intertemporal elasticity of substitution is defined by $\gamma$. The expectation operator $E$ in (5) indicates that future utilities are computed over the distribution of $D_{j+1}$.

Households maximize (5) subject to the budget constraint (6),

$$a_{j+1} = (1 + r)a_j + (1 - \tau)w_j + m_j b^c - m_0 p_l l_j^f + p_l - T(y_j) - (1 + \tau_c) f(m_j)c_j$$

(6)

with $a_1 = a_{j+1} = 0$. The constraint (6) reflects how children affect resources of the family in the model. In addition to interest income from savings $r a_j$, households receive gross labor income

$$w_j = w e_j (l^h + e_j l_j^f)$$

with $e_j^f = \begin{cases} 1 & n_j = m_j = 0 \\ (1 - \delta_c) e_{j-1}^f & n_j, m_j > 0 \\ e_{j-1}^f & n_j > 0, m_j = 0 \end{cases}$

during their working periods. Given the wage rate for effective labor $w$ and $e_j$ as the age-$j$ productivity, labor supply of the husband $l^h$ is exogenously predetermined while the working time of the mother $l_j^f$ is endogenously chosen given the husband’s income, and the number of children in the household. We assume that children in the household reduce productivity of the mother where $\delta_c$ measures the depreciation rate which determines the depreciation factor $e_j^f$. The time endowment of the mother is normalized to one and allocated to working, childcare and leisure consumption.

$$1 = l_j^f + \Psi(D_j) + \ell_j$$

(7)

The time required for childcare measured by the function $\Psi(\cdot)$ depends on the age structure of children since we assume – following Da Rocha and Fuster (2006) or Doepke et al. (2008) – that younger children are more time intensive than older children. Depending on the number of children, households may also receive direct monetary support $b^c$ such as child benefits or parental leave benefits per child. In addition, they have to pay a fee of $p_c$ per (younger than six year) child for external child care during the time the mother is working. Households have

3. We do not consider this as a strong assumption given the large body of empirical evidence suggesting very limited reaction of men’s labor supply to tax changes, see Heckman (1993) or Eissa and Hoynes (2004).

4. Of course, public policy instruments are oversimplified. In Germany, the price paid for non-parental child care may vary significantly with the income level of households and the value of parental leave benefits depends on the mother’s income from working previous to the child’s birth.
to pay social security contributions at a rate $\tau$ on gross family income, income taxes that depend on (family-size related) taxable income $y_j$, and receive public pensions $p_j$ during retirement. Finally, the price of consumption goods $c_j$ includes consumption taxes $\tau$ and total consumption of the household is given by multiplying per capita consumption with $f(m_j) = 1.7 + 0.5m_j$, see Conesa (2000).

### 3.3. Instantaneous utility and the decision to have children

Similarly to Conesa (2000) or Doepke et al. (2008) we define the period utility function by

$$u(c_j, \ell_j, \hat{n}_j) = \left\{ \left[ \frac{c_j^{\alpha_1} \ell_j^{1-\alpha_1}}{1-\alpha_1} + \alpha_2 \hat{n}_j^{1-\alpha_2} \right] \right\}^{\frac{1}{1-\alpha}}$$

where $\alpha_1$ denotes the coefficient of consumption in the subutility function and $\rho$ defines the intratemporal elasticity of substitution between consumption and leisure on the one hand and family size on the other hand, while $\alpha_2$ defines the age-independent preference parameter for family size.

The fertility decision is modeled similarly to the college choice in Heckman et al. (1998). In every period during fertile years $j < J_F$ each household has to decide whether to have one additional child in the subsequent period or not. The welfare change of having an additional child for household $z_j$ measured by the equivalent variation can be written as

$$\frac{V(z^1_j)}{V(z^0_j)} - 1 - \varepsilon_z$$

where $V(z^1_j)$ and $V(z^0_j)$ measure utilities from having an additional child or not, respectively. Additional non-pecuniary (i.e. psychological) gains or costs from additional children, which are not observed by the model, are captured by $\varepsilon_z \sim N(0, \sigma^2)$. We assume that the latter are normally distributed within each skill class with mean zero and variance $\sigma^2$. Due to the law of large numbers, we can now compute the fraction of households that decide to have an additional child from

$$P\left( \left\{ \frac{V(z^1_j)}{V(z^0_j)} - 1 - \varepsilon_z \right\} \right) = \Phi_{0,\sigma^2} \left[ \frac{V(z^1_j)}{V(z^0_j)} - 1 \right]$$

where $\Phi_{0,\sigma^2}$ defines the cumulative normal distribution function with mean zero and variance $\sigma^2$. Conditional on having decided to have a baby next period, this event will happen with probability $0 \leq \pi \leq 1$. Following Conesa (2000), we assume that fertility uncertainty is independent of age and skill classes during fertile ages. Note that there is no uncertainty if the household decides not to have a newborn.

### 3.4. The production side

Firms in this economy use capital and labor to produce a single good according to a Cobb-Douglas production technology $Y = \theta K^x L^{1-x}$ where $Y$, $K$ and $L$ are
aggregate output, capital and labor, respectively, $\varepsilon$ is capital’s share in production and $\theta$ defines a technology parameter. Capital depreciates at a rate $\delta_k$. 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.

### 3.5. The government sector

Our model distinguishes between the general government budget and the pension system. In each period of the long-run equilibrium, the government issues new debt $(\eta + \tilde{\eta})B_G$ and collects taxes from households in order to finance general government expenditure $G$ (which is fixed per capita), in-kind benefits or services for families $G_c$ and direct monetary support $Mb^c$ to families, as well as interest payments on its debt, i.e.

$$(\eta + \tilde{\eta})B_G + T = G + G_c + Mb^c + rB_G,$$

where $T$ defines tax revenues from income and consumption taxation

$$T = \tau C + \sum_j N_j \int_C T(y_j) \, dX(z_j)$$

with $C$ as aggregate consumption. We assume that contributions to public pensions are exempted from income tax while benefits are fully taxed. Consequently, taxable income $y_j$ is computed from gross labor income net of pension contributions, capital income and – after retirement – public pensions, i.e.

$$y_j = (1 - \tau)w_j + ra_j + p_j.$$  \hspace{1cm} (11)

Given taxable income, we apply the German progressive tax code of the year 2005. In-kind benefits for families are modeled as a a fixed cost per child $\kappa$ that covers childcare institutions and the provision of schools and universities minus payments of parents for public childcare, i.e.

$$G_c = \kappa M - p_c \sum_j N_j \int_C m_{6j}(z_j) l^F_j(z_j) dX(z_j).$$  \hspace{1cm} (12)

In each period, we assume a fixed debt to output ratio and balance the public budget by adjusting the consumption tax rate.

Finally, the pension system pays old-age benefits and collects payroll contributions from wage income. Pension benefits $p_j$ of a retiree household at age $j \geq J_R$ in a specific year are uniform across age and skill classes and computed as a fixed replacement rate of average income $\bar{w}$. Since the budget of the pension system must be balanced in every period by payroll contributions, we have

$$\tau w L = p \sum_{j=J_R}^{\infty} N_j \int_C dX(z_j)$$

where $L$ denotes aggregate labor supply defined in (16) below.
3.6. Welfare calculation

In order to assess the welfare effects of a policy reform for different skill levels we compare welfare for a respective household living before and after the introduction of the policy reform. More specifically, we compute the proportional increase (or decrease) in consumption, leisure and family size $W(s)$ which would make a young household of skill level $s$ in the initial equilibrium as well off as after the reform. Due to the linear homogeneity of the utility function the necessary increase (or decrease) for skill level $s$ in percent of lifetime resources is

$$W(s) = \left[ \frac{V^1(z_1)}{V^0(z_1)} - 1 \right] \times 100 \quad \text{with} \quad z_1 = (s, 0, 0) \quad (14)$$

where $V^0(\cdot)$ and $V^1(\cdot)$ denote the expected lifetime utility of the household of skill level $s$ in the initial steady state and after the reform, respectively. Consequently, a value of $W(s) = 1.0$ implies that this household would need 1% more resources in the initial equilibrium to attain the same utility he receives after the introduction of the reformed system.

3.7. Equilibrium conditions

Our initial long-run equilibrium is computed in a closed economy so that factor prices are endogenous and the trade balance is zero. Then we implement a policy reform and compute the resulting long-run equilibrium where we keep the factor prices of the initial steady state constant.

In addition to factor prices being equal to marginal products, we need households to maximize (5) with respect to the respective constraints (6) and (7), an invariant measure of households $\xi$ over the whole state space and market clearance for the capital, labor and goods market in the closed or small open economy:

$$K + B_G + B_F = \sum_j N_j \int_C a_j(z_j) dX(z_j) \quad (15)$$

$$L = \sum_j N_j \int_C e_j \left[ l^h + e_j^f l^f_j(z_j) \right] dX(z_j) \quad (16)$$

$$Y = C + G + (\eta + \bar{\eta} + \delta_k)K + TB \quad (17)$$

where $B_F$ measures foreign debt and $TB$ denotes the trade balance.

4. CALIBRATION OF THE INITIAL EQUILIBRIUM

4.1. Parameterizing the model

Table 1 reports the central parameters of the model. In order to reduce computational time, each model period covers two years. Therefore, children are at home until age 20 ($J_K = 10$), then they start adult life ($j = 1$), women can have children until age 36 ($J_F = 8$), households are forced to retire at age 66 ($J_R = 23$) and face a
life span of 80 years ($J = 30$). Since we adjust in our initial equilibrium the exogenous growth rate of households in order to have zero growth (i.e. $\bar{g} = 0$), this cohort structure yields a quite realistic dependency ratio between pensioners and working cohorts of 36.4%.

We distinguish $S = 3$ educational classes and assume that households only marry within the same skill-class. Based on data estimated from German Socio-Economic Panel (SOEP) of the years 1995–2007 we assume that 25%, 55% and 20% of the cohort are low-, middle- and high-skilled, respectively. These shares also fit in quite well with the shares reported in StaBu (2009a). SOEP data are also used to compute the efficiency profiles $e_j$ for skill classes across the life-cycle. Finally, following Conesa (2000) we assume that 80% of those households that wish to have a child will actually receive one.

With respect to preference parameters, we set the intertemporal elasticity of substitution $\gamma$ as well as the consumption preference in the Cobb-Douglas subutility function $x_1$ to 0.5. The chosen value for the intertemporal elasticity of substitution is within the range of commonly used estimates, see the discussion in İmrohoroglu and Kitao (2009). The consumption preference parameter yields quite realistic female labor force participation rates, see Table 3 below. The fertility choice parameters $\rho$ and $z_2$ are calibrated such that the model is consistent with completed fertility and timing of fertility as observed in the data. As explained above, the higher the intratemporal elasticity of substitution between ordinary utility (from goods and leisure consumption) and family size $\rho$, the larger is the difference in completed fertility between the high-skilled and the low-skilled class. The preference for family size $z_2$ determines the level of completed fertility. We set $\rho$ at 0.65 and $z_2$ at 0.35, which yields both the negative relationship between income and children and the target level for the total

Table 1  Parameter selection

<table>
<thead>
<tr>
<th>Demographic parameters</th>
<th>Preference parameters</th>
</tr>
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<tbody>
<tr>
<td>(Adult) Life span ($J$)</td>
<td>30</td>
</tr>
<tr>
<td>Retirement period ($J_R$)</td>
<td>23</td>
</tr>
<tr>
<td>Last fertile period ($J_F$)</td>
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</tr>
<tr>
<td>Childhood periods ($J_K$)</td>
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<tr>
<td>Skill levels ($S$)</td>
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<td>Fertility uncertainty ($\pi$)</td>
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<table>
<thead>
<tr>
<th>Technology/Budget parameters</th>
<th>Government parameters</th>
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<tbody>
<tr>
<td>Factor productivity ($\theta$)</td>
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<tr>
<td>Capital share ($\epsilon$)</td>
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<tr>
<td>Depreciation rate ($\delta_k$)</td>
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</tr>
<tr>
<td>Husband working time ($L_h$)</td>
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</tr>
<tr>
<td>Pension benefit ($p$)</td>
<td>0.55$w$</td>
</tr>
</tbody>
</table>

$w$: average labor income.

5. The SOEP database is described in Wagner et al. (2007). See Fehr et al. (2009) for detailed explanations of the estimation procedure and results.
fertility rate in the initial equilibrium. Finally, in order to calibrate a realistic capital-to-output ratio, the discount factor is set at 1.0.

With respect to technology parameters we specify the general factor productivity $\theta = 1.17$ in order to normalize labor income and set the capital share in production $\varepsilon$ at 0.3. The annual depreciation rate for capital is set at 5.9\% which yields a periodic depreciation rate of $\delta_k = 0.122$. Husbands are assumed to work 40\% of their time endowment which is typically assumed in quantitative studies, see Auerbach and Kotlikoff (1987). We assume that the time costs $\Psi(D_j)$ decrease.

Table 2 The initial equilibrium

<table>
<thead>
<tr>
<th>Calibration targets</th>
<th>Model solution</th>
<th>Germany 2007/2008$^a$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total fertility rate (TFR)</td>
<td>1.46</td>
<td>1.38$^b$</td>
</tr>
<tr>
<td>Total mean age at childbirth (in years)</td>
<td>29.9</td>
<td>29.8$^b$</td>
</tr>
<tr>
<td>Total mean age at first child (in years)</td>
<td>27.9</td>
<td>26.1$^c$</td>
</tr>
<tr>
<td>Skill-specific fertilities (TFR (s = 1/2/3))</td>
<td>1.96/1.34/1.11</td>
<td>1.94/1.35/1.14$^c$</td>
</tr>
<tr>
<td>Skill-specific share of childless households (in$%$)</td>
<td>8/21/27</td>
<td>11/16/26$^c$</td>
</tr>
</tbody>
</table>

Government indicators (in$\%$ of GDP)

| Direct monetary support ($b'M/Y$)                  | 3.0           | 3.0$^d$               |
| In-kind benefits and services ($G_c/Y$)           | 3.0           | 3.0$^d$               |
| General government expenditure ($G/Y$)            | 15.1          | 15.0                  |
| Interest payments ($rB_{G}/Y$)                    | 3.1           | 2.7                   |
| Tax revenues ($T/Y$)                              | 24.2          | 22.5                  |
| Consumption tax rate ($\tau_c$) (in$\%$)         | 19.0          | –                     |
| Pension contribution rate ($\tau$) (in$\%$)       | 19.9          | 19.9                  |
| Pension benefits ($\tau wL/Y$)                    | 13.5          | 11.5                  |

Other benchmark coefficients

| Skill-specific mean age at first child (in years)  | 27.4/28.2/27.9| –                     |
| Capital-output ratio ($K/Y$)                      | 2.8           | 3.3                   |
| Interest rate p.a. (in$\%$)                       | 5.2           | –                     |
| (Native) Population growth rate p.a. (in$\%$)     | –1.5          | –                     |


Table 3 Female labor market participation rates (FLMP)

<table>
<thead>
<tr>
<th></th>
<th>20–33</th>
<th>34–53</th>
<th>54–64</th>
<th>Total</th>
<th>Germany 2007$^a$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low-skill ($s = 1$)</td>
<td>54.1</td>
<td>64.1</td>
<td>26.9</td>
<td>51.4</td>
<td>56.7</td>
</tr>
<tr>
<td>Medium-skill ($s = 2$)</td>
<td>67.8</td>
<td>87.0</td>
<td>58.4</td>
<td>73.7</td>
<td>75.1</td>
</tr>
<tr>
<td>High-skill ($s = 3$)</td>
<td>76.5</td>
<td>96.5</td>
<td>78.1</td>
<td>85.6</td>
<td>84.4</td>
</tr>
<tr>
<td>Total</td>
<td>65.9</td>
<td>82.8</td>
<td>53.9</td>
<td>70.5</td>
<td>69.7</td>
</tr>
<tr>
<td>Germany 2006$^b$</td>
<td>61.0</td>
<td>73.0</td>
<td>45.0</td>
<td>–</td>
<td>–</td>
</tr>
</tbody>
</table>

linearly with the age of children. Every mother spends 25% of the time endowment with a newborn, 8% with every child below school age and 5% with every remaining child. These figures are in line with Da Rocha and Fuster (2006).

Finally, the depreciation of women’s productivity $\delta_c$ depends on the respective skill level. We assume rising depreciation rates of 1.2%, 1.7% and 2.0% for low-, medium and high-skilled mothers, respectively. These figures are somewhere between the depreciation rates applied by Da Rocha and Fuster (2006) and Doepke et al. (2008). Figure 2 shows the resulting productivity differences associated with motherhood for the different skill classes.

The solid lines show the skill-specific life cycle productivity profiles for males derived from the SOEP data, while the dashed lines display the average productivity of women of the respective skill class. Since our model abstracts from other institutional factors that affect the gender wage gap, male and female productivity (and wages) are identical at the beginning of the career. While childless women keep receiving the same wages as men, productivity (and wage) growth of mothers is dampened significantly. In later years the wage penalty of motherhood amounts to more than 20% which is roughly in line with the results of Beblo et al. (2009) who quantify this so-called ‘family wage gap’ for Germany.

With respect to the government sector we assume a debt-to-output ratio of 60% and that taxation of gross income (from labor, capital and pensions) is close

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*Figure 2* Skill-specific gender productivity (and wage) gaps

6. The consideration of such additional institutional factors would not alter the results. Since the husbands labor supply is fixed, the same income could be generated with alternative wage/working time combinations.
to the current German income tax code and the marginal tax rate schedule T05 which was introduced in 2005. Consequently, given taxable income $y_j$ of the household and applying the income splitting method, the marginal tax rate rises linearly after the basic allowance of €16,600 from 15% to a maximum of 42% when $y_j$ passes €104,000. In addition, we also account for the solidarity surcharge of 5.5% so that we get

$$T(y_j) = 1.055 \times 2 \times T05(y_j/2).$$

In the initial equilibrium we set $p_c = 0.2$, which yields a realistic revenue of private fees to public childcare and is also close to the figures used by Da Rocha and Fuster (2006). In addition, we assume that 6.5% of average income is transferred as child benefits. This figure is quite realistic for Germany, where roughly €2,000 is paid per child per annum and average income amounts to roughly €30,000. The same figure is also assumed for in-kind benefits per capita. Finally, we assume that pensions of each household amount to 55% of average wages and fix the per capita costs of general public consumption ($G$) in order to get realistic figures in our benchmark.

### 4.2. The initial equilibrium

Table 2 and Figure 3 report some central indices of the calibrated benchmark equilibrium and the respective figures for Germany in 2007/2008. The upper part of Table 2 shows that the model’s total fertility rate, mean age at childbirth and the skill-specific fertility rates match the German situation quite well. However, first child birth occurs too late in the model compared to reality. Figure 3 compares the actual and the model’s distribution of family sizes at age 36–38 (i.e. when childbirth is completed). Our model replicates the fact that about 50% of German families have either one or no child. However, the fraction of families without children is higher in reality compared to the model. Families with more than one child are captured by the model quite well, though. With respect to the different skill classes, our model reflects the fact that fertility rates decrease with income (i.e. skill level). In Figure 3 the shares of childless families increase and the shares of families with three or more children decrease with the skill level.

With respect to the calibration of family policy, we follow the comprehensive study of Rosenschon (2006), where overall public expenditures for families in Germany accumulate to 10.7% of GDP. However, many family transfer instruments, which are listed there, are not taken into account by the model. With respect to direct transfers to families including child benefits and parental leave benefits, Rosenschon (2006) reports a figure of roughly 3% of GDP. In addition, in-kind transfers such as public childcare services and schools also add up to roughly 3% of GDP. The remaining figures are calibrated in order to arrive at a realistic government tax structure and macroeconomic situation.

We fix public debt to 60% of GDP, so that annual interest payments amount to 3.1% of GDP. Since we abstract from growth and deficit financing, tax revenues add up to 24.2% of GDP. Private consumption amounts to 64.7% of GDP and the endogenous consumption tax rate is 19%, so that consumption tax revenues are slightly higher than income tax revenues. The average and marginal tax
rate of the latter across the total population are 8.9% and 22.6%, respectively. However, skill-specific average income tax rates increase from 2.1 to 9.1% and 17.4% and marginal income tax rates increase from 13.3 to 23.7% and 32.0%. We also match the current pension contribution rate in Germany, but pension benefits are too high in the model. Note that due to the low fertility rate we end up with a negative native population growth rate of 1.5% per annum. In the initial equilibrium we assume that immigration completely neutralizes this effect so that total population growth is zero.

Table 3 reports the participation rates of women in the model and in the German labor force. We assume that women are participating in the labor market when they work more than 5% of their time endowment. Given this definition, our model replicates the situation of women in the German labor market quite well. First, we match the average participation rate of 69.7% almost perfectly. Second, as in reality, participation rates increase with skill level. Third, the model also yields a close approximation of the life-cycle behavior of female labor supply, which increases in the years when children attend school and decreases sharply before retirement. This pattern is similar in all skill classes but the profile is very steep in the low-skill class while it is fairly flat in the high-skill class. Of course, this reflects the differences in the numbers of children.

Figure 3  Aggregate and skill-specific family structures
Source: StaBu (2009b).
5. SIMULATION RESULTS

This section presents our simulation results for the small open economy. The first subsection discusses alternative reforms of the family benefit structure whereas the second subsection concentrates on reforms of the tax system. In order to quantify the impact of a changing family policy on fertility, female labor supply, other macroeconomic variables and welfare, we compute a new long-run equilibrium after the introduction of alternative policy reforms and compare it to the initial equilibrium discussed in Table 2. In all simulations we assume a constant general government expenditure per capita, a constant debt-to-output ratio and balance the public budget by adjusting the consumption tax rate.

In order to separate the short-run (i.e. where the adult population structure is constant) from the long-run consequences when the population structure has adjusted, we split each reform simulation into two scenarios. In the first scenario we adjust the immigration rate $\bar{\eta}$ in order to keep the aggregate population growth rate of the economy constant. Then we simulate the same reform with an unaltered immigration rate. In this scenario a change in native fertility affects the aggregate population growth rate of the economy so that the long-run population structure changes. The latter has a direct impact on per capita labor supply, on pay-as-you-go financed social security and also on the structure of public consumption and tax revenues.

The last subsection concentrates on FLMP and compares the long-run changes in participation rates for all considered reforms.

5.1. Reform scenarios for family benefits

With respect to direct and indirect family benefits we consider three different policy reforms. First we increase the direct monetary transfers $b^c$ by roughly 25%. We compare this reform with an alternative policy that increases the per capita outlays for in-kind benefits by the same amount. If public care facilities for preschool age children and schoolchildren increase, children stay at home less so that time costs for their mothers decrease. Consequently, we assume in this scenario that the time costs for a preschool child fall from 8 to 4% and the time costs for a pupil decrease from 5 to 2.5% of the available time. While both these reforms imply an increase of per capita transfers to families, the third thought experiment keeps the aggregate benefits per child constant but changes their structure. In this case the increase of in-kind benefits from the second policy reform is combined with an equivalent reduction in direct transfers per child. Table 4 reports the changes of some central variables which result from these reforms.

When we increase child benefits (left part of Table 4), the total fertility rate rises significantly to $(1.46 + 0.36 = ) 1.82$ in the short-run. However, this increase differs substantially over the three skill classes. As one would expect, child benefits have a very strong impact on low-skilled households whose total fertility rate TFR($s = 1$) increases to $(1.96 + 0.62 = ) 2.58$ children (i.e. by 32%). At the same

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7. We have also simulated the reforms in a closed economy, but the resulting repercussion effects from changing factor prices are not significant. Simulation results are available on request.
time, high-skilled families increase fertility only slightly from 1.11 to 1.24 children (i.e. by 12%). In order to isolate the short-run effects we reduce immigration so that the overall population growth rate remains unchanged.

Due to higher fertility, aggregate female labor supply per capita (measured in hours worked) falls by almost 11%. As one would expect, the reduction in hours worked depends on skill level. While high-skilled women reduce their labor supply by only 4.6%, low-skilled women reduce labor supply by 31%.

Child benefits rise from 3.0 to 4.8% of GDP due to the reform. About half of this increase is due to the direct effect of higher benefits (with a constant number of children) and the other half is due to the increase in the number of children. Of course, when the number of children rises, in-kind benefits have to...
increase as well. Due to higher outlays on children the consumption tax rate has to increase by 4.1 percentage points. At the same time, social security contributions remain constant in the short-run since the population structure is not altered. Implicitly, the reform transfers resources from old age, when consumption is high, towards younger ages when households have children. Therefore, savings per capita increase, which (at least) partly neutralizes government policy. The reduction in female employment induces an outflow of capital so that output decreases by about 3%.

Not surprisingly, higher taxes induce a welfare loss for all households. Note, however, that high-skilled households are hurt the most by the reform. Due to their low fertility and high wages the positive effect from additional benefits is small so that they lose almost 2% of lifetime resources. Low-skilled households only lose 0.63% of their lifetime resources due to more children and lower wages.

The next column displays the long-run effects where we keep immigration constant. While the fertility effects of the reform are the same as before, the aggregate population growth rate increases to 0.7% per annum. Consequently, the dependency ratio decreases from 36.4 to 29.3%. The change in the population structure increases per capita male and female employment and reduces the social security contribution rate by 3.9 percentage points. Lower contribution rates improve female labor supply so that overall the initial reduction is dampened significantly in the long-run.8 The change in the population structure also reduces the consumption share of GDP and increases the investment share. Nevertheless, the long-run consumption tax rate is lower than the one in the short-run for two reasons. First, now the government has to run a deficit in order to keep the debt-to-output ratio fixed. Second, the share of general public consumption in GDP falls since output per capita increases while the government consumption per capita remains constant. The output per capita increases due to higher male and female employment per capita. Lower tax and contribution rates have a positive impact on welfare. Consequently, long-run welfare for low-skilled households increases by roughly 1% of lifetime resources, while middle- and high-skilled households lose slightly.

The middle part of Table 4 reports the consequences of an equivalent increase in in-kind benefits which reduces child-related costs for mothers. In our calibration, this reform increases aggregate fertility rates even more strongly compared to the previous simulation. In contrast to the last reform, the fertility rate of the high-skilled class shows a slightly higher relative increase than that of the low-skilled class (i.e. 32% vs. 30%). Note that aggregate female labor supply falls less than in the previous experiment. Only high-skilled women work significantly less than before since they have more children.

With respect to the government budget, in-kind benefits relative to GDP now increase by 2.0 percentage points while direct monetary transfers to households only increase by 1.1 percentage points due to the rise in the number of children. Since fertility effects are stronger, consumption taxes have to increase compared to the previous simulation. Since women work more, savings increase less and

8. Since male labor supply is fixed the change in male employment is only due to the change in the population structure.
output falls less. Finally, higher consumption taxes induce higher welfare losses in all skill classes. High-skilled households are still hurt the most, but now also low-skilled lose significantly.

Considering the long-run effects where we keep immigration constant as shown in the fourth column of Table 4, the aggregate population growth rate now rises to 0.9% per annum. Compared to the respective previous reform experiment, female labor supply and employment per capita is much higher especially for low- and middle-skilled women. The change in the population structure now reduces the contribution rate by almost 5 percentage points. In addition, it again dampens the increase in consumption taxes and reduces savings significantly. Since employment per capita now shows a higher increase, output per capita rises by 2.4 percentage points. Finally, low-skilled families prefer a child benefit increase compared to an in-kind benefit increase in the long run. High-skilled households lose slightly with both reforms in the long run.

In the right part of Table 4 we combine an increase of in-kind benefits with an identical reduction of direct child benefits per child. Not surprisingly, the rise in total fertility is only modest, since now especially high-skilled women increase childbirth while low-skilled families even reduce childbirth compared to the benchmark situation in Table 2. As a consequence of the increased available time, female labor supply rises quite significantly in the short run by 1.7%. Whereas low-skilled women have less children, they work substantially more while the opposite applies to high-skilled women.

Since the increase in birth rates is only modest, the considered reform increases in-kind benefits only from 3 to 3.8% of GDP while child benefits now decrease by 0.6 percentage points. Similarly, the consumption tax rate only rises by 0.8 percentage points so that government policy now mainly transfers resources across younger cohorts. The higher employment reduces aggregate savings so that capital inflows increase while short-run output per capita rises by 0.5%. As before, all skill levels experience short-run welfare losses. However, welfare losses are much smaller than before and low-skilled households are now hurt the most.

When we keep the immigration rate constant in the last column of Table 4, aggregate population growth only rises by 0.1 percentage points. Even this small figure has a significant positive impact on female and male employment per capita. The contribution rate decreases by 0.8 percentage points, while output per capita now rises by 1.3%. Therefore, similar as in Apps and Rees (2004) or in Da Rocha and Fuster (2006), our model allows to generate a joint increase in fertility and female employment by adjusting the family benefit structure. However, as one can see in the lower part of Table 4, such a policy may have some distributional costs. In the long run, mainly middle- and high-skilled families benefit from such a reform while low-skilled households are slightly hurt.

5.2. Tax reform scenarios

The existing system of jointly taxing married couples in Germany has been under critique for quite some time. First, it has strong negative incentive effects for the second earner, since marginal income tax rates are identical for both partners in a marriage. In this view there is a direct link between the income tax
system and the low labor force participation rate of married women in Germany. Second, the system is not an adequate means of family policy since it subsidizes married couples and not families with children. For both political and constitutional reasons it seems very unlikely that Germany introduces a system of individual taxation in the near future. Nevertheless, various reform proposals with respect to family taxation have been put forward recently.

This section compares two alternatives. More specifically, we consider a system of ‘Family taxation’ such as practiced in France, which comprises splitting factors for each spouse equal to 1 (as in Germany) and additional splitting factors of 0.5 per child for the first and the second child and 1 for each additional child. We contrast the reform towards the French tax system with two alternatives which yield significantly higher income tax revenues. In the scenario ‘Individual taxation’ both family members are taxed separately, while in the scenario ‘Individual taxation/In-kind benefit increase’ the higher tax revenues from individual taxation are used to increase in-kind benefits for children as described in the previous section. Table 5 reports the simulation results of the experiments with alternative family taxation reforms.

The introduction of child splitting factors as in the French income tax system generates higher fertility. Since income tax reductions rise with income, especially high-skilled families increase the number of children. At the same time, female labor supply falls by 12.4% in the short run. Note that the adjustment is asymmetric across skill classes. Low-skilled women with two or more children increase labor supply during child-rearing years since their marginal tax rate may even fall to zero due to the reform. Medium- and high-skilled women increase fertility and significantly reduce their hours worked by 14.5% and 13%, respectively.

Higher fertility rates now induce direct child benefits and in-kind benefits to increase by the same amount. Since the reform reduces income tax revenues significantly, the consumption tax rate has to increase by 3.6 percentage points in the short run. Compared to the previous subsection, aggregate savings now show a much stronger increase since mainly high-skilled families benefit from the redistribution towards younger cohorts. As before, aggregate employment and output fall due to the reduction in female labor supply. Surprisingly, families from the high-skilled class are hurt the most despite the fact that they benefit the most per child. Since this class has the highest fraction of childless families, their total (average) tax benefit might still be smaller than that of low-skilled families.

The second column reports the long run effects where the higher fertility increases the population growth rate. As before, this increases female employment per capita in all skill classes (compared to the short run) and decreases the social security contribution rate by 3.6 percentage points. The now younger total population results in higher male employment per capita so that per capita output rises slightly in the long run. Low-skilled households slightly gain in the long run due to lower income taxes and social security contributions. For high-skilled families the negative effect from higher consumption taxes still dominates so that they experience a welfare loss even in the long run.

The introduction of individual taxation shifts the tax burden from elastic female labor supply towards the inelastic male labor supply. Due to rising family
income tax burdens, women give fewer birth and increase their labor supply by more than 22% in the short run. Again, the three skill classes react quite differently. Low-skilled women who face the lowest marginal income tax rates reduce their fertility only modestly but increase their labor supply the most. Medium- and high-skilled women, however, reduce the number of their offspring more but increase labor supply less than the low-skilled due to higher marginal tax rates.

The reduction in fertility rates reduces benefits for families significantly. Since individual taxation also generates higher income tax revenues, the consumption tax rate could be reduced by almost 4 percentage points in the short run. The rise in employment induces capital inflows so that output increases by 6.4%. The

### Table 5  Fertility, macro and welfare effects of family tax reforms

<table>
<thead>
<tr>
<th></th>
<th>Family taxation</th>
<th>Individual taxation</th>
<th>Individual taxation/in-kind benefit incr.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>short-run</td>
<td>long-run</td>
<td>short-run</td>
</tr>
<tr>
<td><strong>Fertility effects</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>TFR</td>
<td>0.30</td>
<td>0.30</td>
<td>−0.23</td>
</tr>
<tr>
<td>TFR (s = 1)</td>
<td>0.04</td>
<td>0.01</td>
<td>−0.19</td>
</tr>
<tr>
<td>TFR (s = 2)</td>
<td>0.38</td>
<td>0.38</td>
<td>−0.25</td>
</tr>
<tr>
<td>TFR (s = 3)</td>
<td>0.45</td>
<td>0.47</td>
<td>−0.20</td>
</tr>
<tr>
<td>Growth rate p.a. ( (\eta + \bar{\eta})^c )</td>
<td>0.0</td>
<td>0.7</td>
<td>0.0</td>
</tr>
<tr>
<td><strong>Female labor supply effects</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>( L_f )</td>
<td>−12.4</td>
<td>−7.4</td>
<td>22.1</td>
</tr>
<tr>
<td>( L_f (s = 1) )</td>
<td>4.3</td>
<td>12.9</td>
<td>42.9</td>
</tr>
<tr>
<td>( L_f (s = 2) )</td>
<td>−14.5</td>
<td>−7.6</td>
<td>22.9</td>
</tr>
<tr>
<td>( L_f (s = 3) )</td>
<td>−13.0</td>
<td>−10.6</td>
<td>17.7</td>
</tr>
<tr>
<td><strong>Macroeconomic effects</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Direct support ( (b^r \Delta M/Y) )</td>
<td>0.8</td>
<td>0.9</td>
<td>−0.6</td>
</tr>
<tr>
<td>In-kind benefits ( (G/CY) )</td>
<td>0.8</td>
<td>0.9</td>
<td>−0.6</td>
</tr>
<tr>
<td>Consumption tax rate ( (\tau_c) )</td>
<td>3.6</td>
<td>3.0</td>
<td>−3.9</td>
</tr>
<tr>
<td>Contribution rate ( (\tau) )</td>
<td>0.0</td>
<td>−3.6</td>
<td>0.0</td>
</tr>
<tr>
<td>Assets ( (K + B_G + B_F) )</td>
<td>8.4</td>
<td>6.2</td>
<td>1.6</td>
</tr>
<tr>
<td>Male employment ( (L_m) )</td>
<td>0.0</td>
<td>3.1</td>
<td>0.0</td>
</tr>
<tr>
<td>Output/ employment ( (Y/L) )</td>
<td>−3.6</td>
<td>0.1</td>
<td>6.4</td>
</tr>
<tr>
<td><strong>Welfare effects</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>( W(s = 1) )</td>
<td>−1.45</td>
<td>0.08</td>
<td>1.68</td>
</tr>
<tr>
<td>( W(s = 2) )</td>
<td>−1.45</td>
<td>−0.02</td>
<td>2.17</td>
</tr>
<tr>
<td>( W(s = 3) )</td>
<td>−1.64</td>
<td>−0.20</td>
<td>2.15</td>
</tr>
</tbody>
</table>

\( ^a \) Total change  
\( ^b \) Percentage change per capita  
\( ^c \) Change in percentage points  
\( ^d \) As a percentage of the present value of remaining resources
reduced labor market distortions increase welfare roughly by 2% of lifetime resources in the short run. Medium- and high-skilled households gain more since their labor supply was distorted more in the initial equilibrium.

In the long run, the fall in fertility reduces the population growth rate by 0.5%. Since now the share of retired individuals in the total population increases, female employment per capita falls compared to the short run. In addition, the contribution rate of the pension system increases by 3.4 percentage points in the long run. The reduction in employment reduces income tax revenues so that the consumption tax rate has to increase compared to the short run. Low-skilled households now experience a welfare loss while the medium- and high-skilled realize significant long-run welfare gains.

In the last simulation of Table 5 we combine the introduction of individual taxation with an increase in in-kind benefits as in the previous subsection. This combination yields a simultaneous increase in fertility and female employment. In the short run, female labor supply increases by more than 13% and the fertility rate rises to almost 1.7 children per woman. Note that especially low-skilled women work more and have more children. For the public budget this implies that in-kind benefits increase by 1 percentage point whereas direct support payments rise by 0.4 percentage points. Since the additional income tax revenues are not sufficient to cover this increase in outlays, the consumption tax rate has to rise by 0.4 percentage points in the short run. Higher employment induces capital inflows so that output rises by 3.8%. Finally, while all skill classes experience welfare gains, low-skilled families are significantly better off since they benefit the most from the change in marginal tax rates and the increase in family benefits.

When immigration is kept constant, the population growth rate increases to 0.5 percentage points. As before, female employment per capita rises significantly and the contribution rate decreases by 2.7 percentage points. This last experiment has the strongest long-run effect on output per capita which rises by 6.7%. Similarly, this policy reform induces the highest long-run welfare gains which amount to roughly 1.5% of aggregate resources. Consequently, our simulation results confirm the theoretical analysis of Apps and Rees (2004) who also find a simultaneous increase of female employment and fertility after a revenue neutral switch towards individual taxation.

5.3. Female labor market participation

In the two previous subsections we have reported the per capita female labor supply effects measured as aggregate changes in hours worked. This measure does neither isolate the changes in labor market participation nor does it explain which cohorts are especially effected by a specific reform. In order to get a better understanding of the long-run female labor supply effects, Table 6 compares the changes in labor market participation rates for specific cohorts for all reform

9. Note that the long run changes in female labor supply of 16.3% are roughly in line with the 11.4% computed in Steiner and Wrohlich (2004). However, the latter study applies a partial equilibrium microsimulation model and allows for a joint labor supply reaction of both spouses after a switch towards individual taxation.
experiments considered. Note that we can not directly compare the figures in Table 6 with the respective numbers in Tables 4 and 5 since the former changes are measured in percent, whereas we now report changes compared to Table 3 measured in percentage points.

With respect to the increase in child benefits Table 6 reveals a very similar pattern of changes in participation rates as the respective changes in hours worked in Table 4. Females of all skill levels decrease labor market participation but the reaction of low-skilled women is much more pronounced. As one can see, labor market participation rates of the low-skilled fall dramatically during child-rearing years 34–53 which directly mirrors the increase in fertility. Nevertheless many low-skilled women also stay at home after the children have left the household which might be due to positive income effects.

In contrast, the increase in in-kind benefits induces a much lower fall in female participation rates. Especially middle-aged women with children attending school work more than before. Note that participation rates for medium-skilled women fall while hours worked increase slightly. Consequently, women who are already in the labor force increase their labor supply since they have more time available during child-rearing years.

The next block of Table 6 reveals that the reform of the benefit structure increases participation rates of women in all skill classes except the medium and high-skilled elderly cohorts. Again the effect is especially strong for low-skilled females in the child-rearing years 34–53. Note that high-skilled women increase labor market participation by 0.7 percentage points while the already working

<table>
<thead>
<tr>
<th>Table 6</th>
<th>Changes in long-run female labor market participation rates (FLMP)</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>20–33</td>
</tr>
<tr>
<td>Low-skill (s = 1)</td>
<td></td>
</tr>
<tr>
<td>Child benefit increase</td>
<td>−8.4</td>
</tr>
<tr>
<td>In-kind benefit increase</td>
<td></td>
</tr>
<tr>
<td>Low-skill (s = 1)</td>
<td></td>
</tr>
<tr>
<td>Benefit structure reform</td>
<td>3.3</td>
</tr>
<tr>
<td>Low-skill (s = 1)</td>
<td></td>
</tr>
<tr>
<td>Individual taxation</td>
<td>1.5</td>
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<tr>
<td>Low-skill (s = 1)</td>
<td></td>
</tr>
<tr>
<td>Family taxation</td>
<td></td>
</tr>
<tr>
<td>Medium-skill (s = 2)</td>
<td></td>
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<tr>
<td>Benefit structure reform</td>
<td>1.7</td>
</tr>
<tr>
<td>Medium-skill (s = 2)</td>
<td></td>
</tr>
<tr>
<td>Individual taxation</td>
<td>7.4</td>
</tr>
<tr>
<td>Medium-skill (s = 2)</td>
<td></td>
</tr>
<tr>
<td>Benefit structure reform</td>
<td>1.9</td>
</tr>
<tr>
<td>Medium-skill (s = 2)</td>
<td></td>
</tr>
<tr>
<td>Individual taxation</td>
<td>11.8</td>
</tr>
<tr>
<td>Medium-skill (s = 2)</td>
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<tr>
<td>Benefit structure reform</td>
<td>2.2</td>
</tr>
<tr>
<td>Medium-skill (s = 2)</td>
<td></td>
</tr>
<tr>
<td>Individual taxation</td>
<td>6.6</td>
</tr>
</tbody>
</table>

All changes in percentage points.
women decrease their labor supply significantly. This explains why respective aggregate hours worked per capita fall by 1.4% in Table 4.

The introduction of child splitting factors as in the French income tax system results in an intertemporal substitution of labor supply. Marginal income tax rates decrease during child-rearing years so that labor market participation rates change only slightly. When the children have left the family, marginal tax rates increase again so that labor market participation rates fall significantly before retirement.

The changes of the intertemporal labor supply patterns are even more interesting in the next reform experiment where individual taxation is implemented. All skill classes and all considered cohorts increase their participation rates. However, low-skilled females work more especially in older ages when the children have left the house. In contrast, high-skilled women work more especially at young ages when marginal tax rates are lower.

Finally, the bottom right side of Table 6 shows the changes in participation rates when the move towards individual taxation is combined with an increase in in-kind benefits. The increase in fertility reduces participation rates of younger women in all skill classes compared to the previous experiment. Compared to the initial equilibrium, they now even fall for low-skilled women in the youngest cohort. When the children have left the family, participation rates of all women increase dramatically. Consequently, this policy reform has the strongest positive effects on labor market participation rates of older cohorts before retirement.

6. SUMMARY AND DISCUSSION

The present paper attempts to introduce a simulation model that captures the central elements of the joint decision of female labor supply and fertility. In a dynamic framework, adult couples decide each period on consumption, female labor supply and, during fertile years, whether or not to have an additional child in the following period. We apply the so-called ‘male chauvinist’ assumption, i.e. the wife is assumed to adjust her labor supply to that of the husband. According to our model, the diversion of time away from the labor market into child care within the household results in a loss of female human capital. At the same time there is an option for families to raise children in government provided child care facilities in order to facilitate compatibility of family and career.

With respect to family policy our simulations indicate three central results. First, higher direct or indirect transfers to families may increase the total fertility rate, but they also reduce female labor supply. Main beneficiaries are low-skilled families since they have many children. Second, the introduction of individual taxation significantly increases female employment, but it further reduces fertility rates especially of medium- and high-skilled women. The redistribution of tax burdens deteriorates long-run welfare of low-skilled households while medium- and high-skilled experience significant welfare gains. Finally, a joint increase in female employment and fertility is possible if the government provides additional child care facilities. If the latter are financed by a reduction of direct family transfers, the fertility increase is extremely modest and it may hurt especially low-skilled households. If additional outlays are financed by the
introduction of individual taxation, both fertility and female employment increase significantly and all households realize significant long-run welfare gains. Due to having more children, low-skilled households benefit more than high-skilled.

Of course, one has to be careful not to draw too many policy conclusions from the reported quantitative results. We did not provide an extensive sensitivity analysis with respect to parameter choices and budget balancing assumptions. One also has to keep in mind that our model captures various government instruments in an oversimplified way. In addition, the model structure still abstracts from many real world features that are very relevant for fertility and female labor supply decisions. First, we assume that all households are formed by men and women from the same skill class. A more realistic family structure would also consider singles (with and without children) and distinguish couples with different skill-combinations in order to reveal distribution effects of family policy in more detail. Following Fehr et al. (2009) one could also derive the joint labor supply of both spouses. Most likely, these extensions would dampen the impact of family policy on long-run macroeconomic variables and welfare.

Second, the present approach considers uncertainty only with respect to child-birth whereas employment is always certain. In reality, depending on individual experience, effort and education characteristics, employment outcomes are highly uncertain. Consequently, in future work we plan to follow Da Rocha and Fuster (2006) and model labor market search and uncertainty of future employment opportunities. In such a more realistic framework the human capital depreciation would depend mainly on actual employment breaks and not solely on the number of children in the household. Such extensions would also generate differential fertility and female labor supply patterns across skill classes comparable to the present model, but also most likely dampen the effectiveness of family policy.

Third, the present approach (implicitly) neglects the intergenerational transmission of human capital. Both skill-specific fertility rates and policy-induced changes in fertility rates do not alter the long-run distribution of skill classes and aggregate productivity. As shown in Heineck and Riphahn (2009), the parental background is very important for educational outcomes in Germany indicating that skill-specific changes of birth rates will also affect the distribution of skill classes in the long run. Furthermore, our approach could be extended along the lines of De la Croix and Doepke (2003) where parents face a quantity–quality trade-off in their fertility decision. Richer families have less children than poorer families but they invest more in the education of their offspring. In such a framework government family policy faces an important trade-off between growth and inequality as soon as skill-specific fertility rates change differently.

As this discussion shows, the relation between family policy and individual decisions on fertility and labor supply is very complex. In order to disentangle various intertwined effects we develop a simple general equilibrium model. We point out the primary driving forces clarifying the reasons why women with different skill levels may decide differently on the timing of children and the adjustment of their labor supply. Despite its limitations, our approach yields
some interesting insights and may serve as a starting point for more elaborate models which quantify the macroeconomic and welfare effects of family policies.

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Address for correspondence: Hans Fehr, Department of Economics, University of Würzburg, Sanderring 2, D-97070 Würzburg, Germany. Tel.: +49 931 3182972; fax: +49 931 3187129; e-mail: hans.fehr@uni-wuerzburg.de

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