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The Demographic Dilemma: Fertility, Female Labor Force Participation and Future Growth in Germany 2007-2060

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The Demographic Dilemma: Fertility, Female Labor Force Participation and Future Growth in Germany 2007-2060

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Abstract

The aim of this paper is to show possible consequences of changes in labor force participation of women and the connection between fertility and labor force participation on the future demographic and economic development in Germany. For this purpose a projection model based on micro-data covering the population development as well as the development of the labor force is computed for different scenarios, varying in the extent of changes in female participation rates. The results point to a sharp decline in size of the total population and labor force as well as on negative effects of demographic development on growth, mediated through incompatibility of fertility and participation. It is argued that this incompatibility leads to a demographic dilemma, imposing negative effects on growth either in short or in long term.

Keywords: Demographic forecast, labor supply, fertility, economic growth
JEL Classification: J11, J21, O40

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1 Introduction

The causes and consequences of what has been coined the process of "double-aging" (Börsch-Supan 1991) – low fertility and increases in life expectancy – have become a major field of research in the social sciences as nearly all developed countries are affected. A vast body of literature deals with a broad array of topics, ranging from studies on determinants of fertility and mortality to studies linking demographic change with economic development.

One route of research deals with the effect of population change on labor supply, analyzing past and forecasting future trends. A multitude of national and cross-national projections concerned with the German labor supply – the example in interest here – can be found (e.g. Bijak et al. 2007; Börsch-Supan 2003; Burniaux et al. 2004; Carone 2005; Fuchs et al. 2008; Lisiankova and Wright 2005; McDonald and Kippen 2001). Though these studies differ in methodology and assumptions for the future development, it is generally stated that a sharp decline of labor supply and an increase in mean age of labor force participants have to be expected, as well as a decline and aging of the total population, whereas these drastic changes can not be offset by a "reasonable" level of immigration (e.g. Bijak et al. 2007; McDonald and Kippen 2001). As possible measures with a damping effect on labor force decline the increase of labor force participation rates of women and older persons are listed (e.g. Burniaux et al. 2004; McDonald and Kippen 2001).

Indeed, virtually all simulations find significant positive effects of a future increase of female participation rates on the size of the labor force. Specifically these increases are generally seen as the most plausible assumption for future labor force participation of women. Bijak et al. (2007) assume a convergence of female participation rates to those of men, McDonald and Kippen (2001) assume convergence to the high female participation rates of Sweden and Fuchs et al. (2008) assume an increase of female participation rates to about 90% of the level of male participation rates. Though these assumptions differ in scope, the main argument for an increase of women participating in the labor force is derived from past trends since World War II, which can be simplified characterized by a more or less steady increase in female participation.

This is often accompanied by the implicit assumption that changes in participation rates do not affect other modeled processes, viz. fertility, mortality and migration. However, past trends in aggregate fertility and female participation show a significant negative correlation (Engelhardt et al. 2004; Engelhardt and Prskawetz 2005; Kögel 2004). More precisely fertility is assumed to be lower for women in the labor force (Lauer and Weber 2003; Sullivan 2006), while the labor force participation of women with children is lower than the participation of childless women (Anxo and Fagan 2001; Anxo et al. 2007; Geyer and Steiner 2007; for a general overview see Matysiak and Vignoli 2008). A main reason is seen in a lack of compatibility of childrearing and labor force participation and employment respectively (Anxo et al. 2007; Hilgeman and Butts 2004; Kreyenfeld and Hank 2000; Meyers et al. 1999; Schröder 2006). Ceteris paribus a future increase in female participation rates should lower fertility, which in turn could affect population size, size of the labor force and population aging. This leads to the main goal of this paper: a model will be estimated projecting population change, considering possible effects of changes in participation on fertility. Using a scenario approach several projection variants will be calculated and analyzed for effects on population growth, labor force growth and economic growth.

The remainder of this paper is structured as follows. In section 2 theoretical and empirical results on the connection of fertility and labor force participation will be described. Section 3 covers aspects of methodology. Results are presented in section 4, while section 5 contains a summary and concluding remarks.

2 Fertility and Labor Force Participation

Analyzing the macro-level interrelation between fertility and female labor force participation for OECD countries, recent studies concluded that a change of sign of the correlation occurred around 1985: before 1985 the correlation exhibited a negative sign and turned positive afterwards (e.g. Ahn and Mira 2002). However, a reassessment of these studies convincingly points at the spurious nature of these results (Engelhardt et al. 2004; Engelhardt and Prskawetz 2005; Kögel 2004). Kögel (2004) uses estimates accounting for heterogeneity of the countries in consideration and finds a negative correlation after 1985, though it decreased compared to the preceding period. Engelhardt et al. (2004) come to similar results. Using seemingly unrelated regression they estimate slopes of participation on fertility of -1.16 and -0.65 for Germany.

Several theoretical concerns cover the connection between fertility and labor force participation of women. The work of Esping-Andersen (1990) addresses the institutional level of societies. Here different welfare regimes with different institutional settings and policies are assumed to shape the employment opportunities of women. Germany is assigned to the conservative welfare regime type. Policies are oriented towards the model of the male-breadwinner (Honekamp 2008; Leitner et al. 2008; Spieß and Wrohlich 2008), which is expressed in a tax-system and monetary transfers, which especially restrain mothers from labor force participation (Althammer 2002; Esping-Andersen 1990; Iversen and Wren 1998). Besides direct and indirect monetary incentives other restraints are seen in work-time policies and the availability of child and elder care (Anxo et al. 2007). Meyers et al. (1999) analyzed policy efforts for compatibility of fertility and employment in a cross-national perspective focusing on child care and parental leave. In a comparison of 14 countries Germany attained the 8th rank. The effect of access to child care on participation is deemed to be crucial and is discussed in many studies, mainly using micro-data. In work by Hank (2002), Hank and Kreyenfeld (2001) and Kreyenfeld and Hank (2000) no significant effects of the availability of institutional child care on employment and fertility were found. This is explained by the inefficiency of possible institutional child care arrangements, which are not considered in individual decisions on fertility and employment. However, Spieß and Büchel (2003) found a positive effect of the availability of child care for children in pre-school age on employment. A positive, though small effect, was also found for the availability of places in all-day schools for children in school age (Beblo et al. 2005). Though it remains unclear whether a direct or indirect effect can be expected, the overall low availability of child care is out of question. In 2005 only 13.7% of children aged 0 to 3 years had a nursery place (Leitner et al. 2008). It is also assumed that this institutional situation influences attitudes and not only affects realized but also desired fertility (Dobritz 2008). Note that although considerable differences can be found in child care availability between West and East Germany (e.g. Hank et al. 2001; Leitner et al. 2008) and also in attitudes to employment and fertility in general (Bernardi et al. 2006; Lee et al. 2007) as well as employment patterns (Matysiak and Steinmetz 2008), these spatial differences are not of main interest here and will not be considered further.

In the theoretical domain of economics the concepts of the New Home Economics are of importance (see Macunovich 1996 for a general overview). The foundations were laid down by the seminal work of Becker (1981). Children are demanded by parents like durable goods, whereas parents not only decide about the quantity but also about the quality of children by investing in them, deriving utility from both quantity and quality. Childrearing is assumed to be the womens duty. Fertility and womens employment are connected via the wife's wage. The higher the wage women can obtain by working the higher are the opportunity costs of time used for childrearing. Thus given a high wage it may be more profitable for women to work than to rear children, viz. a high level of female wages is accompanied by low fertility. The assumption that childrearing is women's duty, is sometimes criticized as chauvinistic (Macunovich 1996), nevertheless studies of time-use seem to confirm that mainly women care for children (e.g. Beblo 2001; Joshi 1998). Heckman and Walker (1990) find a clear negative impact of wages on fertility using Swedish data, though these results are not uncontested in the light of new data, as Hoem (2000) reported a positive effect of female income. The empirical results of Wang and Famoye (1997) on the other hand support Becker's neoclassical fertility concept. Evidence on aspects of employment in line with the model in consideration is sparse. Empirical testing by Vermeulen (2005) confirms the model for Dutch one-person households, though it is rejected for couples. Although the empirical evidence may seem arguable other empirical results point at the importance of such economic considerations. For example results by Budig and England (2001) set the focus on the so called wage penalty for motherhood: mean wages for mothers are lower than for childless women. Though the reason is unclear, the wage penalty increases the costs of children. Another possibility lies in the consideration of availability and costs of child care affecting the value of time of women given a certain level of wages (e.g. Anderson and Levine 2000; Meyers et al. 1999).

Though there are clear ties between fertility and participation, the direction of causality remains unclear, i.e. whether fertility affects participation, participation affects fertility, both affect each other reciprocally or both are affected by a third variable (Engelhardt et al. 2004). Some studies point to a reciprocal causality (Cramer 1980; Schröder 2006). However, it seems quite certain that fertility and labor force participation are negatively correlated considering the theoretical arguments and the empirical evidence cited here.

3 Methodology

3.1 The Projection Model

Consider a set containing the two sexes $G = \{0, 1\}$, where 0 indicates male and 1 female sex, a set of ages measured in years $A = \{0, 1, \ldots, 99\}$ and a set $L = \{0, 1\}$, with 1 indicating labor force participation and 0 indicating non-participation. Let S denote the state space $G \times A \times L$, with $|G \times A \times L| = k$, and add an additional state representing death, leading to $|S| = k + 1$. For example the state $(0, 27, 1)$ could represent male persons aged 27, who are in the labor force. Now let $\mathbf{P}$ be the transition matrix of a homogeneous first order Markov Chain of size $|S| \times |S|$, containing the probabilities p_{ij} for transition from state $s_j \in S$ at time t to state $s_i \in S$ at time $t+1$, time being discrete and measured in years. Note that the death-state is an absorbing state, all other states are transient with a probability of return to state s_j

starting in s_j after some time $t+x$ of zero, because of the use of age, leading to $p_{jj} = 0$ and $\mathrm{tr}(\mathbf{P}) = 0$, and the Markov Chain in whole is reducible, i.e. starting in s_j not every state s_i can be reached due to the use of sex and age in the construction of the state space. Note further that $\sum_i p_{ij} = 1$.

Given observed transitions between states, e.g. computed from panel micro-data, the probabilities p_{ij} can be estimated as follows. Let $\mathbf{M}$ denote a matrix of size $(k+1) \times (k+1)$, where entry m_{ij} is the count of observed transitions from state s_j to s_i between t and $t+1$. Assuming independence between transition probabilities of state s_j and any other state s_i, the entries of column j of matrix $\mathbf{P}$, $\mathbf{p}_{.j}$, can be interpreted as parameter values of a multinomial random variable. Thus a likelihood function $L(\mathbf{P}) = \prod_j L(\mathbf{p}_{.j})$ with $L(\mathbf{p}_{.j}) = \prod_j p_{ij}^{m_{ij}}$ can be constructed for $\mathbf{P}$. $L(\mathbf{P})$ can be maximized by maximizing $L(\mathbf{p}_{.j})$ for all j. Taking logs and using a Lagrange multiplicator with the restriction $\sum_i p_{ij} = 1$ leads to the solution $\hat{p}_{ij} = m_{ij} / \sum_i m_{ij}$ (e.g. Caswell 2001). Given multiple observations of transitions at times $t = 1, 2, \ldots, z$, $\mathbf{M}_1, \mathbf{M}_2, \ldots, \mathbf{M}_z$, with entries $m_{ij}(t)$, a simple χ^2-distributed test criterion for the feasibility of pooling data is given by (Bickenbach and Bode, 2003; Billingsley, 1961)

$$H_0 : \forall t : \hat{p}_{ij}(t) = \hat{p}_{ij} \tag{1}$$

$$Q = \sum_t \sum_i \sum_{j \in X_i} n_i(t) \frac{(\hat{p}_{ij}(t) - \hat{p}_{ij})^2}{\hat{p}_{ij}} \tag{2}$$

with $\sum_i (y_i - 1)(x_i - 1)$ degrees of freedom, where X_i is a set containing all positive entries in row i from the pooled transition matrix, $x_i = |X_i|$, Y_i is a set containing all times t, for which observations were made for row i, i.e. $\sum_j m_{ij}(t) > 0$, and $y_i = |Y_i|$.

The estimated transition matrix $\hat{\mathbf{P}}$ can be partitioned into

$$\hat{\mathbf{P}} = \begin{bmatrix} \mathbf{T} & \mathbf{0} \\ \mathbf{d} & 1 \end{bmatrix} \tag{3}$$

where $\mathbf{T}$ is a $k \times k$ matrix of transitions $\hat{p}_{ij}$ between states without death, $\mathbf{d}$ is a $1 \times k$ row-vector consisting of probabilities of dying in state s_j δ_j and $\mathbf{0}$ is a $k \times 1$ column-vector of zeros. Note that each column j of $\mathbf{T}$ sums to $1 - \delta_j$.

Further partition $\mathbf{T}$ into two sub-matrices, one for the male sex $\mathbf{T}_m$, dropping transitions to state $(0,0,0)$, and one for the female sex $\mathbf{T}_f$, also without transitions to state $(0,0,0)$, each of size $(|A \times L| - 1) \times (|A \times L|)$. Let $\mathbf{f_m}$ be a $1 \times (|A \times L|)$ row-vector, whose entries f_{mj} represent the expected number of boys born to a women in state $s_j = (1, a, l)$, with $a \in A$ and $l \in L$, and let $\mathbf{f}_f$ be a corresponding vector for the expected number of girls with entries f_{fj}. Then a projection matrix $\mathbf{A}$ is given by:

$$\mathbf{A} = \begin{bmatrix} \mathbf{f}_f & \mathbf{0} \\ \mathbf{T}_f & \mathbf{0} \\ \mathbf{f}_m & \mathbf{0} \\ \mathbf{0} & \mathbf{T}_m \end{bmatrix} \tag{4}$$

This is a more general formulation of the female-dominant projection matrix introduced by Leslie (1945) (e.g. Alho and Spencer 2005; Keyfitz and Caswell 2005).

Given a column vector $\mathbf{n}_t$, whose entries $n_{j,t}$ are the total number of persons in state s_j at time t and $\sum_i n_{j,t}$ is the total population size at time t, and a column vector $\mathbf{m}_t$, whose entries $m_{j,t}$ are the total net migration for state s_j and to simplify matters assuming $m_{j,t} \geq 0$, a population projection starting at time t ranging to time $t + t\Delta$ with $t\Delta$ projection steps can be computed by

$$\mathbf{n}_{t+t\Delta} = \mathbf{A}^{t\Delta}\mathbf{n}_t + \sum_{l=t}^{t+t\Delta-1} \mathbf{A}^{(t+t\Delta-1)-l}\mathbf{m}_l \tag{5}$$

when $\mathbf{A}$ is assumed constant for all t and by

$$\mathbf{n}_{t+t\Delta} = \left(\prod_{g=t}^{t+t\Delta-1} \mathbf{A}_g\right)\mathbf{n}_t + \left[\sum_{l=t}^{t+t\Delta-2}\left(\prod_{e=l+1}^{t+t\Delta-1} \mathbf{A}_e\right)\mathbf{m}_l\right] + \mathbf{m}_{t+t\Delta-1} \tag{6}$$

assuming $\mathbf{A}$ to be different for different t.

Changes in mortality patterns can easily be modeled as well as changes in labor force participation. Remember that for any matrix $\mathbf{A}_t$ $\sum_i \hat{p}_{ij,t} = 1 - \delta_{j,t}$ holds. Given another probability of dying in state s_j $\tilde{\delta}_{j,t}$ a change in mortality can be achieved for s_j by multiplying all $\hat{p}_{ij,t}$ of column j with $\frac{1-\tilde{\delta}_{j,t}}{1-\delta_{j,t}}$.

Changes in labor force participation can be modeled in the following way: assume $Pr(l = 1|s_j)$ denotes the probability of transition from state s_j at time t to any state s_i at time $t + 1$ for which $l = 1$, i.e. the probability of transition from state s_j to any state characterized by participating in the labor force. Further let $Pr(l = 0|s_j)$ denote the probability of transition to any state s_k for which $l = 0$ at time $t + 1$ if being in state s_j. Let $LFPR_t$ be the labor force participation rate at time t given characteristics $g \in G$ and $a \in A$ and let $LFPR_{t+1}$ be the new participation rate. Multiplying all $\hat{p}_{ij,t}$ with $\frac{LFPR_{t+1}}{Pr(l=1|s_j)}$ for all s_j with $l = 1$ and given characteristics g and a at t changes the labor force participation for g and $a + 1$ at $t + 1$ to the desired value when (6) is applied. A similar procedure is applied to change the share of non-participating persons.

Note that after recalibration of the transition probabilities all f_{mj} and f_{fj} remain at their initial values. Thus if transitions are changed in such a way that after the recalibration more persons change to states exhibiting low fertility, overall fertility diminishes. The modeling strategy described in this section starts with participation status and assigns fertility rates to these, viz. fertility is assumed to be depending on labor force status. This is not to presume a certain direction of causality, but merely helpful to keep the size of the state space $|S|$ small and parameters computable.

3.2 Data & Estimation

For the estimation of transition rates between states and state-specific fertility the German Socio-Economic Panel (SOEP) was used. The SOEP is a longitudinal panel-study conducted on an annual basis since 1984, collecting data on private households. All household members at least aged 16 (since 2006 aged 17) in the covered households are interviewed about a broad range of topics covering e.g. demographics, labor force participation and employment as well as education. The only characteristic directly contained in the data, which is of interest here, is sex. Age was computed by subtracting the year of birth from year of observation. A variable indicating labor force participation was constructed following the definitions of the International Labour Organization (International Labour Organization 1982). The ILO defines the labor force as all persons currently employed or actively searching employment aged 15 to 74. Because of the design of the SOEP this age range was slightly narrowed to ages 17 to 74. All persons not exhibiting the mentioned characteristics are handled as not participating in the labor force. The labor force concept of the ILO allows a further distinction of people in the labor force, namely between employed and unemployed, but this distinction is not accounted for in the following analysis. Thus it is of interest if a person participates in the labor force or not and not if a person is employed or unemployed.

Data from the years 2004, 2005, 2006 and 2007 is used, yielding three possibilities to observe transitions between states – 2004 to 2005, 2005 to 2006 and 2006 to 2007, with a total of 73, 446 transitions. Because of the issue of panel attrition, i. e. non-random withdrawal of respondents from the panel between different times of data collection, weighting by inverse sampling probabilities is applied. Foreigners and households in East-Germany are oversampled, for which reason frequency weights have to be used to extrapolate the panel data to population level.

Using the population weights the population vector of the starting year 2007 $\mathbf{n}_{2007}$ can easily be obtained. Following the described procedure in the preceding section, three transition matrices for the mentioned times were estimated as well as a transition matrix using pooled data totaling $73,446$ transitions. The according test statistic described in equation (2) yields a value of 1607.606 at 1636 degrees of freedom, indicating that the estimated transition probabilities for all observed times of transition show no significant differences, meaning that the data can be pooled. Because of panel attrition, for some seldom occupied states transitions into these state were observed, but no transitions out, whereby these states become absorbing states with $\sum_i \hat{p}_{ij} = 0$. To deal with this issue, for a state s_j exhibiting this problem and some characteristics $g \in G$, $a \in A$ and $l \in L$, the transition probability to state s_i with characteristics g, $a+1$ and l was set to the age- and sex-specific survival probability obtained from life-table data of the Human Mortality Database, though these changes only have marginal effects on the projection results. The state-specific fertility rates f_{mj} and f_{fj} were estimated by pooling data of the years 2004, 2005 and 2006 and taking the mean count of births by state.

The vector of net migration $\mathbf{m}$ has to be calculated covering both immigration and emigration. However, the structure of emigration can not be estimated using the SOEP. Insofar only immigration was considered. The structure of immigration was computed by pooling all persons who migrated to Germany since 1995 and using the distribution of characteristics of these persons as an estimate. The entries of the resulting vector $\mathbf{m}$ sum up to 1. Multiplying $\mathbf{m}$ by a scalar m_t, which is the net migration balance at time t, yields net migration by state for time t. Only age and sex are known characteristics for migrants at time of immigration. Labor force status was computed by using the first reported status in the SOEP since immigration.

3.3 Projection Assumptions

Several assumptions are made regarding future changes in mortality patterns, migration, fertility and labor force participation. Different combinations of these assumptions are combined to different scenarios, each starting in the year 2007 and ending in 2060.

For mortality patterns a forecast of age- and sex-specific survival probabilities is made using the method of Lee and Carter (1992) and mortality data for the years 1991 to 2006 obtained from the Human Mortality Database, thus extrapolating current trends. Estimated life expectancies for the years 2007 to 2060 can be found in table 1. The initial difference in life expectancy between men and women diminishes considerably, because of a much steeper

Table 1: Estimated life expectancies at birth by sex for the years 2007 to 2060, truncated values. Source: Calculation by the author

Year	Women	Men
2007	82.407	77.265
2010	83.037	78.145
2015	84.035	79.552
2020	84.971	80.887
2025	85.848	82.153
2030	86.669	83.350
2035	87.437	84.480
2040	88.154	85.545
2045	88.825	86.546
2050	89.451	87.487
2055	90.036	88.370
2060	90.583	89.197

rise of life expectancy for men of about 12 years until 2060, whereas women gain additional 8 years. Compared to mortality assumptions and forecasts of other projections (e.g. Babel et al. 2008; Bijak et al. 2007) the overall increase can be described as medium.

An annual net migration of $+200,000$ persons is assumed. Like many other assumptions about future migration this is somewhat arbitrary, because migration depends on a multitude of different influences like economic development on national and international level or political decisions on immigration law and is thus not easy to predict. For Germany net migration strongly fluctuated in the last years, from about $+272,000$ in 2001 to $+22,000$ in 2006. Comparing the net migration assumed here to other assumptions found in the literature, the value selected here can also be seen as medium (Bijak et al., 2007; Carone, 2005; McDonald and Kippen, 2001).

The state-specific fertility rates remain unchanged. Since the year 2000 the total fertility rate of Germany fluctuated between values of 1.378 and 1.331 (see table 2), exhibiting no obvious trend. Although there are differences between fertility patterns in East and West Germany and specifically a slight East German trend of increasing fertility, these differences are not further investigated, because the trend of increasing East German fertility has no clear effect on the total fertility rate given fertility fluctuations in West Germany. Note again that in the used model the future total fertility

Table 2: Total fertility rate for the years 2000 to 2007. Source: Federal Statistical Office Germany

Year	2000	2001	2002	2003	2004	2005	2006	2007
TFR	1.378	1.349	1.341	1.340	1.355	1.340	1.331	1.370

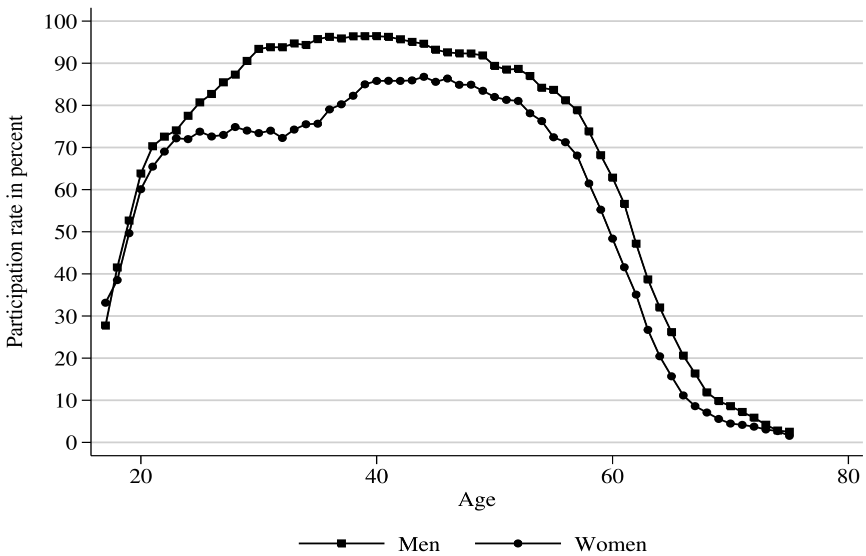

Figure 1: Participation rates by sex and age 2007. Source: SOEP

rate can still be changed by changes in population composition.

Changes in labor force participation can be addressed from the perspective of age and the perspective of differences between the two sexes. Current age- and sex-specific labor force participation rates obtained from the SOEP can be found in figure 1.

Age-specific participation rates can be expected to change due to reforms of the German pension system, which cover an increase in statutory retirement age. This increase is planned to proceed stepwise over the years 2012 to 2029. The present retirement age of 65 will be annually increased by one month in the years 2012 to 2023 and by two months in the years 2024 to 2029, finally reaching a new retirement age of 67. This was modeled following Fuchs (2006) by shifting age-specific participation rates upwards by two years starting with age 55. For example the age specific participation rate of men aged 57 in 2030 will be the same as the age specific participation rate of men aged 55 in 2007. This already hints at the further treatment of the participation rates of men, which will remain unchanged except for changes due to an increasing retirement age, whereas a linear effect according to the two phases of the reform is assumed.

While male participation fluctuated around a value of about 80% between the years 1992 to 2006, female participation rose steadily from 61% in 1992 to 69.3% in 2006. In virtually all labor force projections a future increase of female participation rates is assumed (e.g. Bijak et al. 2007; Carone 2005; Fuchs et al. 2008; McDonald and Kippen 2001), though the extent of the increase varies. Here different possible developments will be modeled. In all cases the modeling strategy assumes equalization of age-specific participation rates of women aged 30 or older to the corresponding age-specific participation rates of men. In a first variant, the female participation rates are supposed to increase to 80% of the participation rates of men until 2040. This year was chosen, because it is often used in a similar manner in other projections (e.g. Fuchs et al. 2008), thus easing comparison. Ages, for which the female participation rate is already around or over 80% of the male participation rate, remained unchanged. The mean ratio of female to male age-specific participation rates is around 0.82, so that just a few female age-specific participation rates were increased. Other variants assume an increase of female participation rates to 85%, 90%, 95% and 100% of the corresponding male participation rates, yielding a range from a very low to a very high increase. For all variants linearity of increase was assumed. The increasing retirement age was not additionally modeled for women, i. e. new participation rates of women were computed before modeling the increase in participation rates of older men.

With these assumptions several scenarios were computed. All scenarios account for an annual net migration of +200,000, the specified change in mortality and the increase of participation rates of older men. A scenario called "status" quo uses no further assumptions. The baseline assumptions were combined with the different variants of increase of participation rates of women to five different scenarios. These allow for changes of total fertility due to population heterogeneity and thus implicitly model the current situation of incompatibility of fertility and labor force participation. Another five scenarios also combine the baseline assumptions with different variants of female participation rates, but for each of these the total fertility rate is assumed to equal the total fertility rate of the status quo scenario for each year of projection. In these scenarios the link between labor force participation and fertility is loosened. Finally, a third group of scenarios was specified, which covers decreasing female participation rates. Though a decline of participation of women is not very likely to happen, this decrease leads to increasing fertility, although state-specific fertility rates remain unchanged. A decline of female participation rates of women to 50%, 55%, 60%, 65% and 70% of the corresponding age-specific participation rates of men was modeled. The first value roughly represents the ratio of female to male participation rates as in 1960, the last value as in 1990 and a value of 60% of the participation rates of men corresponds to 1980. However, male participation was higher in 1960 with a total participation rate for men of around 90%, which decreased until the 1990s. Nevertheless a future increase in participation rates of men seems not plausible, insofar only the ratios were modeled, capturing past female participation only roughly.

The first group and the third group of scenarios will be called scenarios with "changing fertility", the second group will be called scenarios with "constant fertility", though we will see later on that this word choice is not entirely correct. Furthermore the targeted female participation rate is also used to distinguish the scenarios and will be referred to as "LFPR x", where x represents the participation rate, e.g. "LFPR 70".

4 Results

4.1 Population Growth

Projected population size, mean population age and total fertility rate in the different scenarios for the years 2020, 2040 and 2060 can be found in table 3. For 2007 the total population amounts 82 million persons with a mean age of 41.68 years. The total fertility rate is computed to be roughly around 1.3, though the last official reported total fertility rate amounted around 1.38: using SOEP-data from the years 2004 to 2006 leads to an underestimation of the current value, though it fits the values of the corresponding years quite well.

The scenarios with increasing labor force participation of women and fertility equal to the status quo scenario all exhibit similar population changes, which are equal to those of the status quo scenario. In all of these six scenarios the total population size will decrease until 2060 to a value of roughly 73.4 million persons or about 88% of the initial population size. The mean population age increases by 10 years and reaches a value of 51.86 in 2060. For 2007 to 2020 the increase amounts 3.5, for 2020 to 2040 4 years and for 2040 to 2060 about 2.5 years. Thus the increase in mean age decelerates for later projection years. The total fertility rate amounts 1.27 for the year 2060. This change of the initial value is due to slight changes in population composition

Table 3: Population size, mean population age and total fertility rate in the different scenarios. Source: Calculation by the author

	Population Size			Mean Age			TFR
Year	2020	2040	2060	2020	2040	2060	2060
Status Quo	83,656,375	80,711,276	73,412,339	45.15	49.39	51.86	1.27
Constant Fertility	83,656,375	80,711,276	73,412,339	45.15	49.39	51.86	1.27
Changing Fertility							
LFPR 80	83,648,336	80,660,784	73,305,056	45.15	49.41	51.90	1.26
LFPR 85	83,627,336	80,546,968	73,060,784	45.16	49.46	52.01	1.25
LFPR 90	83,597,496	80,384,832	72,711,552	45.17	49.54	52.17	1.24
LFPR 95	83,554,208	80,146,552	72,195,488	45.19	49.65	52.41	1.21
LFPR 100	83,510,496	79,906,048	71,676,816	45.21	49.76	52.64	1.19
LFPR 50	84,315,236	84,248,241	81,327,814	44.82	47.80	48.66	1.66
LFPR 55	84,237,255	83,843,334	80,415,998	44.86	47.97	49.00	1.62
LFPR 60	84,159,090	83,433,464	79,492,542	44.90	48.15	49.35	1.58
LFPR 65	84,080,747	83,019,005	78,559,615	44.94	48.33	49.71	1.54
LFPR 70	84,002,227	82,600,311	77,619,246	44.97	48.52	50.08	1.49

with respect to labor force participation, caused by cohort effects, which are implicitly accounted for by transition rates (see Carone 2005).

For all scenarios with changing fertility and increasing female participation just small effects on population size and mean age due to changes in female participation rates can be found in the short run, i.e. until 2020. In the long run differences to constant fertility scenarios are clearer. The total population size in 2060 ranges from 73.3 million to 71.7 million, corresponding to a decline of 11.6% to 13.6% compared to 2007. Comparing population size in 2060 to the status quo scenario yields differences from about $100,000$ (LFPR 80) to 1.7 million (LFPR 100). Additional effects on mean population age are rather small, showing a difference to status quo in 2060 ranging from 0.04 to 0.78. Finally, effects on the total fertility rate are more distinct. The absolute difference between the status quo scenario and scenarios with changing fertility ranges from 0.01 to 0.08.

Declining participation rates of women lead to a considerable increase in fertility. Already a drop in participation rates to the level of 1990 slows population decline and aging considerably with a relative loss of population of about 5% – the total fertility rate increases to a value of 1.49. The stronger the decline in female participation the lower the decline in population. If participation decreases to the level of 1960, the population size will increase in short and medium term and will decrease only slightly in long term with a relative decline of 1% in 2060 compared to 2007. In this scenario the mean age of the population will increase by around 4 years until 2060, which is 3 years less than in the status quo scenario. Fertility will increase considerably to a value of 1.66. Nevertheless this value is much smaller than the real value observed in 1960, which was 2.36, pointing at a general decline in fertility patterns independent of participation rates, though the connection between these two is still strong.

4.2 Labor Force Growth

The size of the labor force and mean age in the labor force in the years 2020, 2040 and 2060 are shown in table 4. In 2007 the labor force comprised 41.8 million persons with a mean age of 41.1 years.

The status quo scenario is characterized by a sharp decline in the size of the labor force, reaching a value of about 30.9 million in 2060. Absolute decline amounts nearly 11 million persons, relative decline 26%. Mean age of the labor force increases from 2007 to 2060 by 2.1 years to 43.19 years.

If labor force participation of women changes and fertility is held at the level of the status quo scenario, still a significant decline of the size of the labor force can be found, though it is comparatively damped. Compared to

Table 4: Size of labor force and mean age in labor force for the different scenarios. Source: Calculation by the author

	Size of labor force			Mean Age		
Year	2020	2040	2060	2020	2040	2060
Status Quo	40,898,218	35,489,220	30,917,043	42.59	42.78	43.19
Constant Fertility						
LFPR 80	41,278,029	35,869,608	31,324,785	42.75	42.98	43.44
LFPR 85	41,415,270	36,087,337	31,506,620	42.78	43.03	43.48
LFPR 90	41,694,988	36,491,076	31,845,987	42.82	43.09	43.54
LFPR 95	42,113,875	37,073,770	32,343,029	42.88	43.16	43.61
LFPR 100	42,628,207	37,788,232	32,951,333	42.94	43.25	43.69
Changing Fertility						
LFPR 80	41,278,029	35,861,409	31,279,069	42.75	42.99	43.46
LFPR 85	41,415,269	36,058,513	31,357,907	42.78	43.04	43.54
LFPR 90	41,694,988	36,432,819	31,548,661	42.82	43.13	43.67
LFPR 95	42,113,874	36,972,837	31,823,101	42.88	43.22	43.82
LFPR 100	42,628,207	37,644,217	32,201,145	42.94	43.32	43.99
LFPR 50	35,974,802	29,004,451	27,546,720	42.52	42.61	42.36
LFPR 55	36,642,838	29,877,598	28,108,955	42.57	42.68	42.50
LFPR 60	37,311,381	30,749,781	28,652,695	42.61	42.75	42.64
LFPR 65	37,980,448	31,621,117	29,178,002	42.66	42.82	42.79
LFPR 70	38,650,057	32,491,730	29,684,927	42.70	42.89	42.93

2007 the labor force size reached in 2060 marks a relative decline of 25.1% (LFPR 80), 24.7% (LFPR 85), 23.9% (LFPR 90), 22.7% (LFPR 95) and 21.3% (LFPR 100). Compared to the labor force size of the status quo scenario in 2060 the absolute difference ranges from about $400,000$ to $2,000,000$. Short run effects differ in size, though still lead to considerable absolute differences ranging from about $380,000$ to $1,730,000$ in 2020 and $380,000$ to $2,230,000$ in 2040. Especially scenarios with a high increase in female participation are accompanied by a notable increase of labor force size for the first years of projection compared to 2007. The increase in mean age of the labor force is slightly higher than in the status quo variant with a maximum additional increase of 0.5 years until 2060.

Increasing female labor force participating and allowing for changes in fertility results in an absolute decline of labor force size ranging from 10.6 million to 9.6 million persons and an relative decline from 25.2% to 23.1%. Differences compared to scenarios with constant fertility depend on the increase of female participation. If an increase to 80% is assumed, the absolute difference in labor force size in 2060 between the scenario with constant and the scenario with changing fertility amounts about $48,000$ and the relative difference is about 0.1%. If female participation is set to increase to 100% of the level of male participation, differences amount $750,000$ and 2% respectively. Additional effects on aging of the labor force are small and range from an additional increase in mean age of 0.02 to 0.30 years.

Whether or not fertility is hold constant an increase in female participation rates can damp the decrease of labor force size, though in all scenarios a considerable decline can be found accompanied by an additional increase in mean age of labor force participants. If female participation increases and fertility is allowed to change, the size of the labor force is smaller and the mean age of the labor force is higher than in scenarios with constant fertility, because the increase in participation leads to a decline of fertility as shown in the preceding section. Nevertheless the ratio of labor force participants to total population is nearly equal for scenarios with constant and changing fertility, e.g. the ratio amounts 42.6% in 2060 for both LFPR 80 scenarios and 44.8% in the LFPR 100 scenario with constant fertility and 44.9% in the LFPR 100 scenario with changing fertility, i.e. in scenarios with changing fertility the share is slightly higher.

As could be expected, decreasing female participation rates lead to decreasing size of the labor force with absolute decline ranging from 14 to 12 million persons and relative decline ranging from 34% to 29%. Nevertheless aging of the labor force is slightly decelerated, because of a comparatively large number of younger persons entering the labor force. The share of persons in the labor force in the total population ranges from 34% to 38%.

4.3 Economic Growth

Effects of demographic change on economic growth make up a broad topic, whereas a large part of research focuses on effects of labor force aging on productivity (e.g. Feyrer 2007; Mason 2006; Thießen 2007; Werding 2008). However, here the method used by Leibfritz and Roeger (2008), who analyze future effects of demographic change on economic growth implied by projections of the EU and the OECD, will be applied, allowing to analyze effects of changes of population size, share of population in working age in the total population and of labor force participation in the total population on real output.

Consider the identity

$$Y \equiv \frac{Y}{L} \cdot \frac{L}{E} \cdot \frac{E}{N_{LF}} \cdot \frac{N_{LF}}{N_{WA}} \cdot \frac{N_{WA}}{N} \cdot N \tag{7}$$

with Y being real output, N being the total population size, $\frac{Y}{L}$ the labor productivity per hour, $\frac{L}{E}$ the number of hours worked per worker, $\frac{E}{N_{LF}}$ the employment rate, $\frac{N_{LF}}{N_{WA}}$ the labor force participation rate (of the total population in working age) and $\frac{N_{WA}}{N}$ the share of population in working age in the total population. Growth of the gross domestic product can be proxied by taking logs as

$$\Delta y = \Delta p + \Delta h + \Delta e + \Delta LFPR + \Delta n_{WA} + \Delta n \tag{8}$$

Adding up the percentage changes of productivity per hour Δp, hours worked per worker Δh, employment rate Δe, labor force participation rate $\Delta LFPR$, share of population in working age Δn_{WA} and total population size Δn yields the percentage change of the GDP. Changes in productivity, hours worked and employment rate are not modeled here and are assumed to equal zero to keep analysis of effects simple.

To assess the total impact on growth, the annual effects on growth of the three factors in interest were added up. These total effects can be found in figure 2 for scenarios with constant and in figures 3 and 4 for scenarios with changing fertility. The development depicted in figures 2 and 3 is more or less equal until 2040. For the first years of projection a high increase in female participation and a temporary increase in population size lead to an overall positive effect on growth, though it differs considerably depending on the amount of increase of female participation rates. This positive effect has decreased and turned negative until 2015 for all scenarios. Around 2020 the total effect turns slightly positive for both LFPR 100 scenarios. After this point of time the total effect turns negative again and has considerable

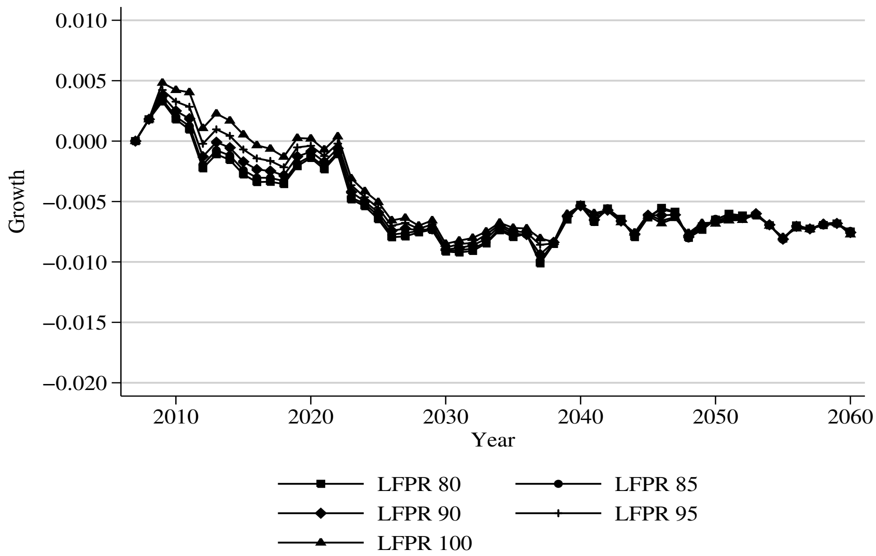

Figure 2: Total effect on annual growth in scenarios with increasing female participation, constant fertility. Source: Calculation by the author

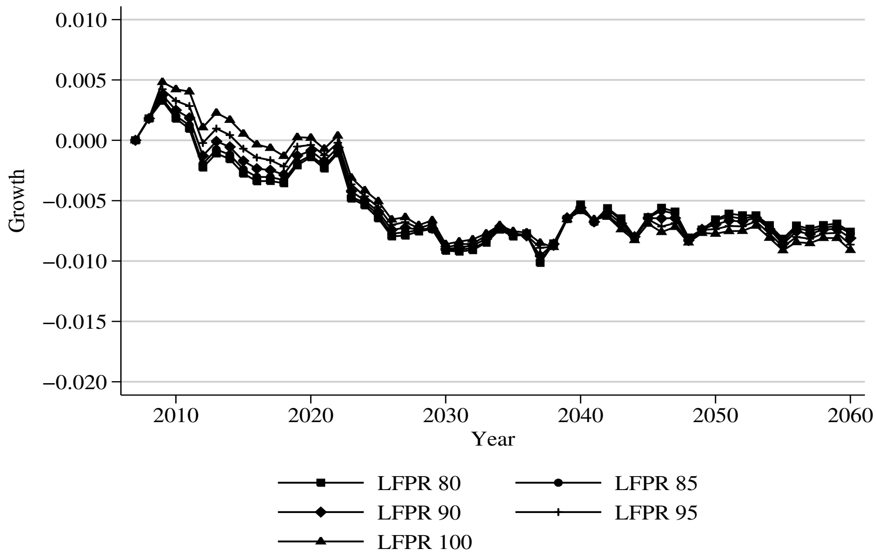

Figure 3: Total effect on annual growth in scenarios with increasing female participation, changing fertility. Source: Calculation by the author

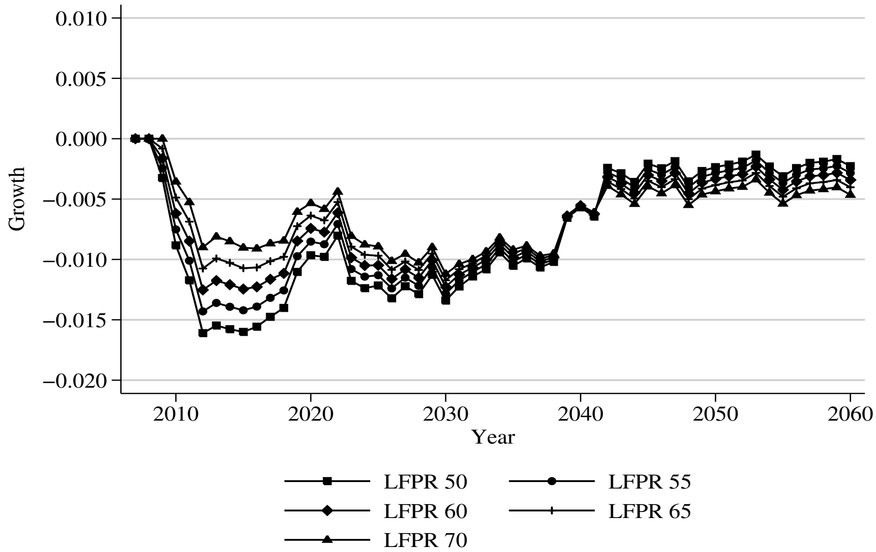

Figure 4: Total effect on annual growth scenarios with decreasing female participation, changing fertility. Source: Calculation by the author

influence on growth. The scenarios differ only slightly until 2040, though the negative effect turns smaller with increasing female participation rates. For scenarios with constant fertility the total effect on growth converges to a uniform pattern after 2040. For scenarios with changing fertility the pattern of the years 2020 to 2040 is reversed: the higher the assumed increase in female participation the higher the negative effect on growth. If female participation rates are assumed to decrease, the overall pattern is nearly inverted. A strong negative effect can be found until around 2030, for some scenarios amounting more than 1.5% annually for some years. After 2030 the total effect remains negative, but nevertheless diminishes considerably and is smaller than for scenarios with increasing female participation. For example the total effect in 2050 is −0.002 for the LFPR 50 and −0.008 for the LFPR 100 scenario with changing fertility.

5 Conclusion

In this paper the future development of the size of the total population and the labor force in Germany were analyzed as well as possible effects of these on growth. For this purpose a flexible model was used and projections were made using model parameters estimated from micro-data of the SOEP. In particular the procedure in use allowed for linking labor force participation of women and fertility and thus accounting for population heterogeneity.

Projecting scenarios differing in assumptions about the future increase of female participation rates shows a consistent pattern of decline of population size, whereas increases in female labor force participation lead to a clear additional loss of population. The size of the labor force will also encounter a drastic decline. Increasing labor force participation rates of women can only offset a smaller part of this development, though the scenarios considerably differ in this aspect. The higher the increase in female participation rates the higher the positive effect on growth in the short run. Nevertheless this effects diminish with time. In scenarios, in which fertility is linked with female participation, the additional positive effect of an increase switches sign to an additional negative effect in the long run, though small in scope. Nevertheless changes in aggregated fertility affect the population size only in long term, so that stronger effects could be expected for years after 2060. If the link between fertility and participation is loosened all scenarios converge to a uniform pattern of negative effects on growth mainly caused by population decline. All in all an increase in female participation rates can only delay what has been coined the "demographic burden" (e.g. Mason 2006).

Scenarios modeling a decrease in participation rates exhibit an inverted pattern of development: For the first years of projection a considerable negative effect on growth was found. Nevertheless declining participation rates are accompanied by a noticeable increase in fertility, which diminishes the negative effect in the long run. Though the starting point for these scenarios was a decrease in participation rates, for a rough orientation they can be interpreted with respect to fertility as well, e.g. an increase to a fertility rate of around 1.65 in 2060 will go along with a decrease of female participation to the female/male participation ratio of 1960, given the present incompatibility of fertility and employment.

The negative dynamics mediated through demographic development can only be countered by a high increase in female participation rates and an increase in fertility, which in turn could positively influence the size of the labor force. However, it could be shown that an increase of female participation rates could lead to a decreasing total fertility rate, thus imposing additional constraints on measures to stimulate fertility. In more general terms the situation can be characterized as follows: future increases in female participation rates prohibit increases in fertility, only allowing for positive growth effects in the short run. Increases in fertility could only be reached by a decline of participation, because states not attributed with labor force participation exhibit higher fertility rates, only diminishing negative growth effects in the long run. Thus Germany will have to face a demographic dilemma if current incompatibility of fertility and employment remains: given current incompatibility of fertility and labor force participation either increasing fertility or increasing participation can be reached, imposing restraints on future growth either in short or in long term.

Policy options include a broad range of measures. A key role can be seen in the availability of child care. Though a slight increase of availability in West Germany can be noticed (Leitner et al. 2008) and future expansions are planned, the actual situation can be characterized by a constrained availability in available places as well as the daily time children are taken care of (Honekamp 2008). Other problematic aspects can be seen in inflexible work-time schedules (e.g. Anxo and Fagan 2001; Anxo et al. 2007) and still common traditional gender roles, which ascribe childrearing to women (Joshi 1998; Puur et al. 2008). On the other hand simulation of the effects of the reform of the parental leave benefit show an increase in the participation of mothers (Spieß and Wrohlich, 2008).

Though a clear position is favored here some restrictions of the results have to be considered. The discussion was based entirely on the future development of the population and the labor force and effects of these on economic growth. First, a decrease of the number of labor force participants does not necessarily lead to a decline of labor supply, if hours worked per worker increase. Though a decline of labor supply seems plausible given the results presented here and in other publications, the exact extent of this decline can not be assessed. Second, other crucial influences on growth have been missed out completely. Employment and unemployment respectively have not been considered, though they play an important role in assessment of growth and are also likely to influence fertility (Meron and Widmer 2002; Tölke and Diewald 2003). In addition the performance of the labor market is often assumed to be affected by the age structure of labor supply (Hetze and Ochsen 2006; Shimer 2001; Skans 2005). Furthermore growth of productivity and resulting effects on economic growth have not been considered. One reason for this can be seen in conflicting results on the connection between population aging and productivity delivered by empirical studies. While sometimes a negative connection between the two of them is detected, other times no significant influences are found (e.g. Feyrer 2007; Myck 2007; Thießen 2007; Werding 2008). Finally, changes in labor force participation can lead to feedback effects disregarded here. For example, Hank and Buber (2009) assume that increases in participation rates of older women can lead to a reduction of time they can spend caring for grandchildren, in turn lowering participation of younger women, viz. employment of grandmothers could affect employment of mothers. Nevertheless the author is confident that despite the incomplete coverage of influences on economic growth the results presented here allow a first glimpse on future challenges for Germany.

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