Family Policies and low Fertility: How does the social network influence the Impact of Policies

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Abstract. The aim of this paper is to compare the impact of fixed versus income dependent family allowances in the context of different assumptions regarding the social structure of a society. We investigate societies that differ in the structure of the underlying social networks. We use an agent based simulation model to analyse the impact of family policies on cohort fertility, intended fertility, and the gap between intended and realised fertility. The crucial features of our simulation model are the agents' heterogeneity with respect to age, income, parity, and intended fertility, the social network and its influence mechanism acting via that network. Our results indicate that both fixed and income dependent child support have a positive and significant impact on fertility.

1 Introduction

The continuation of recent trends towards low fertility rates in most developed countries may lead to population shrinkage and ageing over the long run. Consequently, governments are increasingly concerned to adapt family policies targeted towards possible causes underlying these fertility trends. Kohler et al. (2002) identify demographic distortions of period fertility measures, economic and social changes, social interaction processes, institutional changes, and postponement-quantum interactions as the main causes of low fertility in Europe. Social interactions are relevant since individuals may imitate their friends, siblings, or parents in their childbearing decisions (Fernandez and Fogli, 2006). Therefore, policies that have only a moderate direct effect on individual fertility decisions may result in a strong impact at the macro level due to peer effects. The social structure may not only influence individual childbearing preferences but also individual feasibility of realising these preferences due to the provision of informal childcare. Nevertheless, most empirical studies comparing the impact of family policies in different countries ignore differences in the societal structure in the countries under consideration.

Family policies can affect fertility through their influence on the costs of children, on individuals' income, and on preferences. Most governments nowadays refrain from universal cash benefits and rather aim to reduce the structural barriers of combining work and childcare. Individuals differ in their needs, tastes, and objectives but public policy makers face the challenge to establish a uniform set of policies to serve a heterogeneous population. Neither the micro nor the macro level alone may explain the influence of family policies (imposed on the macro level) on individual childbearing decisions (taken at the micro level) and the resulting period and cohort fertility patterns (observed on the macro level) to its full extent. Therefore, modelling the impact of family policies on fertility decisions requires to include the decision mechanism at the micro level, the society at the macro level, the interaction between the micro and macro level, and the interaction among individuals within their peer groups.

The aim of our paper is to apply agent based models (ABMs) to evaluate the impact of alternative family policies on fertility in the context of social and institutional structures which differ across countries. Unlike formal mathematical models ABMs offer the opportunity to capture individual heterogeneity with respect to several characteristics. Moreover, these models allow us to test hypotheses regarding fertility behaviour in the context of different cultures and different types of family policies. While the focus is on the aggregate level (completed fertility), our model is based on the micro level and explains how aggregate level properties emerge from the behaviour of the agents on the micro level. As the recent literature argues for social interaction as a key factor in shaping fertility decisions and preferences, we explicitly account for peer group effects in our model.

2 The model

We consider a one–sex model (only female agents) to investigate the impact of family policies on individual fertility decisions and on aggregate fertility. The crucial features of our agent based simulation model are the agents' heterogeneity with respect to age, income, parity, and intended fertility, the social network which links the agents to a small subset of the population and the influence mechanism acting via that network. Our aim is to get general insights into the impact of fixed versus income dependent family allowances on fertility under different assumptions regarding the social structure of a society.

2.1 Initial population

At time t each agent i is characterised by her age $x_{i,t}$, household income $w_{i,t}$, parity $p_{i,t}$, the number of her dependent children $n_{i,t}$, and her desired/intended fertility $f_{i,t}$. We use Austrian census data to obtain an initial age and parity distribution. The age of the children is based on Austrian data on age at birth in 2008[3]. Moreover, we apply data from the Austrian income tax statistics[4] for the distribution of household income. We use age–specific data on the 25% quantile, the median value, and the 75% quantile of the annual net income and interpolate the data. Agents get assigned a value z_i determining the quantile in

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the age specific income distribution they belong to. Due to simplicity we assume that agents remain in the same quantile during their entire life but progress to higher income levels as they age. Then we use data from the Austrian Gender and Generation Survey (GGS) to estimate the distribution of the desire for additional children given the agents age and parity. We define the probability π_i^m that agent i wants at least m children ($1 \leq m \leq 8$) and use the logit model

$$\operatorname{logit}(\pi_i^m) = \beta_0^m + \beta_1^m x_i + \beta_2^m p_i \tag{1}$$

for each m to estimate the according probabilities from the GGS data for our initial population.

2.2 Simulation steps

The agents own consumption, $c_{i,t}$, is assumed to be a concave function of the household income,

$$c_{i,t} = \sigma \sqrt{w_{i,t}},$$

and the consumption level of $n_{i,t}$ dependent children is defined as

$$c_{i,t}^n = n_{i,t}\, \tau \sqrt{w_{i,t}}.$$

Therefore, the disposable income $y_{i,t}$—the difference between household income $w_{i,t}$ and expenditures for consumption—becomes

$$y_{i,t} = w_{i,t} - c_{i,t} - c_{i,t}^n.$$

If the intended fertility exceeds the actual parity,

$$f_{i,t} > p_{i,t}, \tag{2}$$

and the disposable income is equal or greather than the estimated costs of an additional child,

$$y_{i,t} \geq \tau \sqrt{w_{i,t}} \iff \sqrt{w_{i,t}} \geq \sigma + (n_{i,t} + 1)\tau, \tag{3}$$

the agent is exposed to the biological probability (fecundity) of having another child (Leridon, 2004, 2008). In case of a successful live birth a new agent is generated with a probability depending on the Austrian sex ratio at birth since our simulation only keeps track of female individuals. This new agent k with age $x_{k,t} = 0$ is mutually linked to her mother and her sisters (see subsection 2.4). Male children are not represented as agents within the artificial population but they contribute to the parity and the number of dependent children of their mother.

Each time step each agent ages by one year, $x_{i,t+1} = x_{i,t} + 1$ and, therefore, children may eventually turn adults. The probability of this transition is based on age specific labour force participation rates observed in Austria in 2008[5]. After the child's transition the number of dependent children of the mother, $n_{i,t}$,

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is decreased by one but her parity $p_{i,t}$ remains unchanged. Moreover, the new adult agent gets assigned her own income level $z_{i,t}$ determining her household income $w_{i,t} = w_{i,t}(z_i, x_{i,t})$ and her own social network (see subsection 2.4). The household income increases with age but agents remains at the same quantile z_i of the age specific income distribution during their entire life. The agents intended fertility is assigned according to (3) where $\beta^m_{0,t}$ is updated every fifth simulation step to capture changing fertility intentions within the population. Thereafter she evaluates her fertility intentions according to the inequalities (2) and (3). Finally, agents die off with a probability according to the Austrian female life table.

2.3 Impact of family policies

In general family policies comprise three components: monetary transfers, the structural framework, and norms and values. In this simulation model we investigate only cash benefits. However, nonmonetary components of family policies like the provision of subsidised childcare may be transformed into their monetary equivalent. We allow for any combination of fixed family allowances b^f and cash benefits that are proportional to the household income $w_{i,t}$. Considering family allowances the mother experiences a decrease in the consumption level of her $n_{i,t}$ dependent children,

$$c^n_{i,t} = n_{i,t}\left(\tau\sqrt{w_{i,t}} - b^f - b^v w_{i,t}\right),$$

and her disposable income can be expressed as

$$y_{i,t} = w_{i,t} - \sigma\sqrt{w_{i,t}} - n_{i,t}\left(\tau\sqrt{w_{i,t}} - b^f - b^v w_{i,t}\right).$$

The necessary condition for having an additional child becomes

$$\sqrt{w_{i,t}} \geq \sigma + (n_{i,t}+1)\left(\tau - \frac{b^f}{\sqrt{w_{i,t}}} - b^v\sqrt{w_{i,t}}\right).$$

2.4 Endogenous social network

The agents are closely linked to a set of other agents with whom they communicate about their fertility intentions and realisations. We refer to this group as an agents social network or peer group. The similarity of agents' characteristics have an impact on the probability of being chosen into an agents social network. Moreover, we assume a certain degree of network transitivity or clustering, i.e. the tendency that two agents who are connected to a third party establish a mutual relationship over time (the friends of my friends are also my friends). We consider age, income and intended fertility as those characteristics determining an agent's social background and compute the social distance between agents i and j,

$$d_{ij} = |x_i - x_j| + \epsilon\,|z_i - z_j| + \epsilon_2\,|f_i - f_j|.$$

The parameter ϵ determines the weight of the income level z and the parameter ϵ_2 denotes the weight of the intended fertility f. To build up the social network an agent chooses a distance d with probability

$$pr_1(d) = c \exp(-\alpha d) \tag{4}$$

and then picks a friend with distance d. For this choice we define another probability pr_2 determining whether this new friend is chosen among those individuals who are not linked to any of the agents peers or only among those individuals who are linked to at least one of the agents friends. This second probability pr_2 is a predefined numerical parameter allowing us to determine the degree of transitivity in the social network. The constant c is a normalisation parameter to make sure that the probabilities of all feasible distances sum up to one and the parameter α determines the agents level of homophily. If α is assigned high values, the chance of a connection between similar individuals becomes high. The selecting agent is also added to the network of the selected agent. Thus, we assume a mutual friendship relation which means that the underlying network topology is represented by an undirected graph. This procedure is repeated until the desired number of peers, s, is found. This desired network size is drawn from a log-normal distribution (see for instance Dunbar and Spoors, 1995, Fig. 1) with mean $\bar{s}$ and rounded to the nearest integer.

2.5 Social influence and intended fertility

At each time t each agent i has an intended fertility $f_{i,t}$, which may be altered due to social influence imposed by the peer group. We compute π_i^+ (π_i^-) the number of agents j within i's social network whose parity p_j is higher (lower) than i's intended fertility $f_{i,t}$. Then, similar to (Goldenberg et al., 2007), we model the probability that agent i is influenced by agents with higher (lower) parity $p_{i,t}^+ = 1 - (1 - pr_3)^{\pi_i^+}$ ($p_{i,t}^- = 1 - (1 - pr_4)^{\pi_i^-}$). Finally we compute the probabilities, that agent i adapts or confirms her own fertility intentions,

$$\begin{aligned} p_i(f_{i,t+1} = f_{i,t} + 1) &= (1 - p_{i,t}^-)p_{i,t}^+ + \gamma p_{i,t}^+ p_{i,t}^- \\ p_i(f_{i,t+1} = f_{i,t} - 1) &= (1 - p_{i,t}^+)p_{i,t}^- + (1 - \gamma) p_{i,t}^+ p_{i,t}^- \\ p_i(f_{i,t+1} = f_{i,t}) &= (1 - p_{i,t}^+)(1 - p_{i,t}^-). \end{aligned}$$

This update of intended fertility is executed for all agents who already passed transition to adulthood until the age of 50 which we consider to mark the end of the reproductive period. We need different probabilities for the increase and decrease since the actual parity within the network is usually lower than the desired fertility of the peers. Using the same probability for increase and decrease would result in a steady bias towards lower levels of intended fertility.

3 Simulation Results

Since we are interested in the impact of family policies with respect to social structure we vary the parameters b^f and b^v determining the amount of cash benefits given to families as well as pr_2, α, and ϵ_2 specifying the structure of the social network. Starting with an initial population based on Austrian demographic data we ran the simulation with each parameter combination for 100 years. Each parameter set was held constant during the simulation. In particular we used $\sigma = 2.5$, $\tau = 2.3$, $pr_3 = 0.12$, $pr_4 = 0.08$, $\gamma = 0.7$, $\alpha = 0.2 : 0.4 : 1.0$[6] $\epsilon_2 = 0 : 3 : 3$, $b^f = 0 : 0.25 : 2$, $b^v = 0 : 0.05 : 0.3$, and $pr_2 = 0.1 : 0.3 : 0.7$ which can be interpreted as applying 63 different sets of family policies (determined by the parameters b^f and b^v) on 18 different societies (represented by pr_2, α, and ϵ_2). To reduce the impact of randomness we repeated each parameter set 7 times resulting in a total of 7938 simulations. In this section we summarize the results obtained from these simulations.

Figure 1 depicts completed cohort fertility of those birth cohorts finishing their reproductive period during the last ten years of the simulation vs. fixed (left column) and income dependent (right column) child supports. Here and in the following figures the solid red line always represents the average over all simulations and the grey shaded area indicates the range capturing the outcome of 95% of the simulations. In the first panel the additional lines represent the average over all simulations with the same b^v, in the second panel they represent the average over all simulations with the same b^f. The graphs in the second row depict the average completed cohort fertility for a given policy mix and a given level of network transitivity. The third row depicts the results when combing policy mix with homophily and the fourth row indicates results obtained from combining policy mix with the weight of intended fertility.

Both, fixed and income dependent family allowances appear to have a positive influence on cohort fertility. The panels combining family allowances with numerical parameters determining the structure of the social network indicate that the impact of family policies depends on the social network.

Fig. 1. Completed cohort fertility

4 Summary and conclusions

We study the impact of fixed and income dependent family allowances on completed cohort fertility. In particular we investigate whether the structure of a

[6] This means the parameter α is varied from 0.2 to 1 by increments of 0.4

society represented by the underlying social network has the potential to alter these results.

In our modelling framework individuals are characterised by their sociodemographic characteristics age, household income, parity, the number of dependent children, and intended fertility. The agents are closely linked to a set of other agents with whom they communicate about their fertility intentions and realisations. We refer to this group as an agents social network. The whole agent population constitutes the society. The agents are not directly linked to those agents who do not belong to their social network but any agent may somehow indirectly influence any other agent via intermediaries. The agents' characteristics influence her social network (a set of agents) which links her to the society. The above mentioned characteristics as well as family policy measures and the social influence exerted by the social network have an impact on the agent's fertility intentions and behaviour.

Agent based models allow us to carry out experiments to test various combinations of childcare benefits and combine them with different assumptions regarding social structure. Our simulations reveal a positive (and presumably diminishing) impact of both fixed and income dependent family allowances on completed cohort fertiliy. We further conclude that empirical cross-country comparisons of different types of family policies need to be interpreted with caution for two reasons. Firstly, the impact of a certain policy depends on the subset of policies being investigated and comprehensive experiments taking into consideration any possible combination of subsidies are not possible in the real world. Secondly, many empirical studies do not account for differences in the social structure in the countries under consideration.

Acknowledgements

We would like to thank Isabella Buber-Ennser for helping us with the GGS data. The Austrian GGS was conducted by Statistics Austria with the financial support of the Federal Ministry of Economy, Family and Youth, the Federal Ministry of Science and Research and the Federal Ministry of Labour, Social Affairs and Consumer Protection. The international GGS templates (survey instruments, sample design) were adapted to the Austrian context by the Vienna Institute of Demography and the Austrian Institute for Family Studies. The Austrian Institute for Family Studies has also coordinated the Generations and Gender Programme for Austria.

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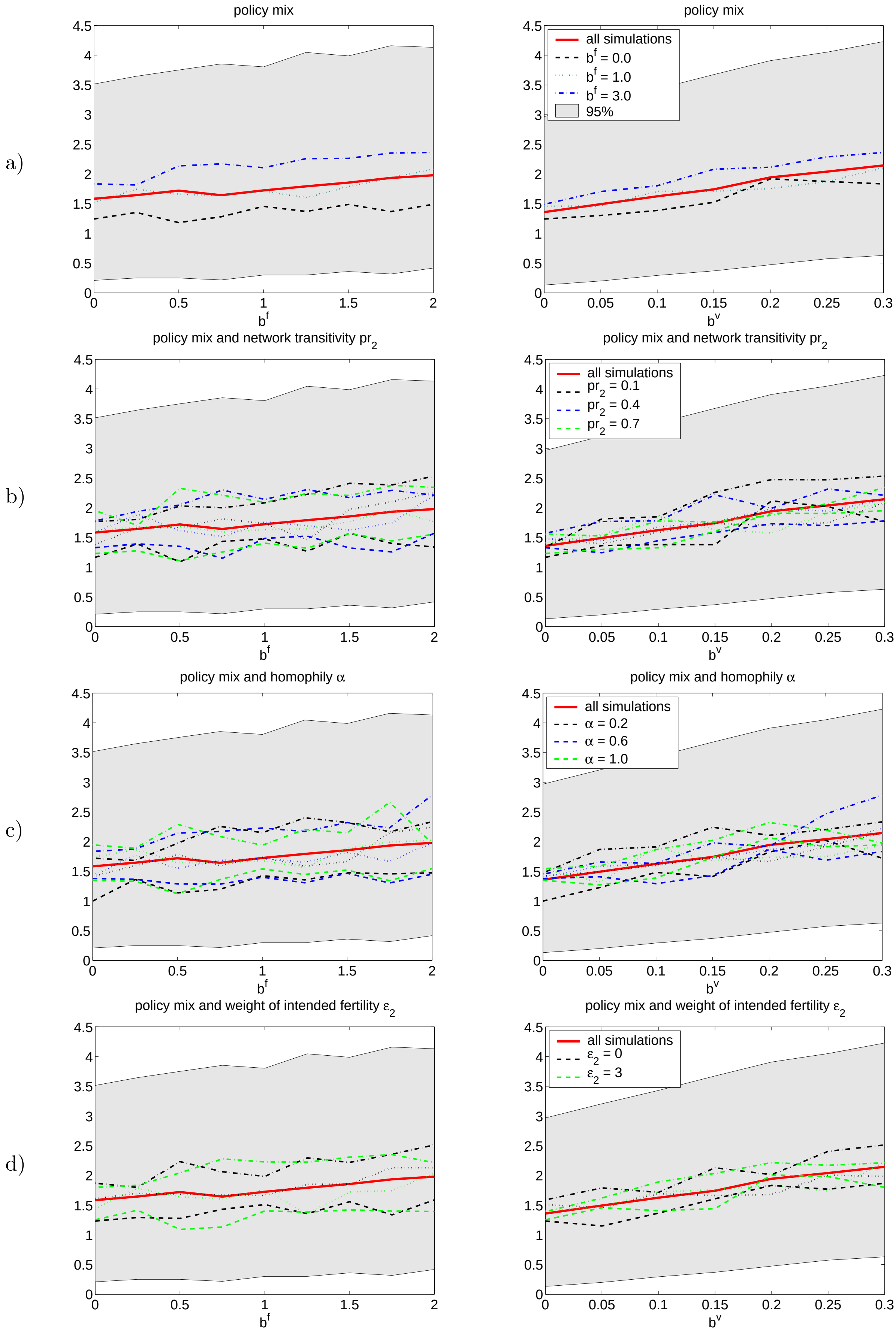

Figure 1: Completed cohort fertility a) combinations of fixed and income dependend family allowances (policy mix), b) policy mix combined with network transitivity, b) policy mix combined with homophily, and d) policy mix combined with the weight of intended fertility