Family Policies in the Context of Low Fertility and Social Structure

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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. 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.

The empirical literature comprises studies based on micro level data (see e.g. Kravdal, 1996; Hoem et al., 2001; Kreyenfeld, 2004; Rønsen, 2004; Milligan, 2005; Köppen, 2006) and macro level data as well (see e.g. Whittington et al., 1990; Hyatt and Milne, 1991; Hoem, 1993; Ahn and Mira, 2002; Rindfuss et al., 2003; Lappegård, 2000; Tomka, 2002; Neyer, 2003; Björklund, 2006; Feyrer et al., 2008). In general, studies using micro level data often find a positive impact of parental and maternity leave schemes on completed cohort fertility while studies using macro level data find that family policies influence the timing of births rather than the total number of children (Gauthier, 2007). Moreover, micro level data often indicate a negative impact of female wages and female education on fertility but a positive impact on female employment. On the contrary, macro level data reveal that in OECD countries the cross–country correlation between total fertility rate and female labour force participation had a negative value until the beginning of the 1980s but turned to a positive value in the 1990s (Ahn and Mira, 2002; Rindfuss et al., 2003; Martínez and Iza, 2004; Kögel, 2004; Engelhardt et al., 2004; Engelhardt and Prskawetz, 2004). Rindfuss et al. (2003) relate this change to the fact that some countries accomplished institutional changes reducing the incompatibility between childrearing and female employment while other countries did not. Kögel (2004) and Engelhardt et al. (2004) attribute this change in the cross–country correlation to the presence of unmeasured country–specific factors and country–heterogeneity in the magnitude of the negative time–series association between fertility and female employment. As this short review indicates, the adequacy of family policies is highly disputed in the empirical literature so far and results vary depending on the study design (micro versus macro frameworks) and the role on timing versus quantum of fertility.

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.

The paper is organized as follows. In section two we present the model structure, in section three we illustrate the numerical findings, and section four concludes.

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. Although we refer to Austrian data to calibrate our model, our framework and focus is different to those of microsimulation models. Our aim is to get general insights into the impact of fixed versus income dependend 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[1]. Moreover, we apply data from the Austrian income tax statistics[2] 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 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

[1]STATISTIK AUSTRIA, Statistik der natürlichen Bevölkerungsbewegung
[2]STATISTIK AUSTRIA, Allgemeiner Einkommensbericht 2008

probability π_i^m that agent i wants at least m additional children ($1 \leq m \leq 8$) and use the logit model

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

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[3]. After the child's transition the number of dependent children of the mother is decreased by one but her parity remains unchanged. Moreover, the new adult agent gets assigned

[3]STATISTIK AUSTRIA, Mikrozensus-Arbeitskräfteerhebung

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 remain at the same quantile of the age specific income distribution during their entire life. The agents fertility intention is initialized as the average fertility intention within her social network. Thereafter she starts to evaluate 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

We investigate two alternative scenarios. In the first scenario the policy maker provides a fixed amount b^f per child to each household, in the second scenario the cash benefit is proportional to the household income $w_{i,t}$. In case of a fixed child support the mother experiences a decrease in the consumption level of her $n_{i,t}$ dependent children,

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

and her disposable income can be expressed as

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

The necessary condition for having an additional child becomes

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

In case of a proportional cash benefit the consumption level of $n_{i,t}$ dependent children becomes

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

and the disposable income can be expressed as

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

resulting in the necessary condition for having an additional child

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

Finally, if the policy maker opts for a policy mix combining fixed and income dependent cash benefits, the necessary condition is

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

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 agent's 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 and income as those characteristics determining an agent's social background and compute the social distance between agents i and j,

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

The parameter ϵ determines the weight of the differences in age x and income level z. 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 normalization parameter to make sure that the probabilities of all feasible distances sum up to one and the parameter α determines the agent's 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 $f_{i,t}$, defined as the sum of current parity $p_{i,t}$ and the intended additional children, which must be integer and nonnegative. This intended fertility may be altered due to social influence imposed by the peer group. Therefore, we compute the average parity within an agent's social network, φ_i, and the average parity in the agents age group within the whole population, Φ_x. If the realised fertility within the agent's social network is higher (lower) than the maximum (minimum) of the agent's own intended fertility and the average parity within the agents age group the intended fertility for the next time step $f_{i,t+1}$ may be increased (decreased) by one with a predefined probability pr_3 (pr_4).

$$\begin{aligned} \varphi_i &> \max\{f_{i,t}, \Phi_x\} \Longrightarrow \begin{cases} f_{i,t+1} = f_{i,t} + 1 & \dots \quad pr_3 \\ f_{i,t+1} = f_{i,t} & \dots \quad 1 - pr_3 \end{cases} \\ \varphi_i &< \min\{f_{i,t}, \Phi_x\} \Longrightarrow \begin{cases} f_{i,t+1} = f_{i,t} - 1 & \dots \quad pr_4 \\ f_{i,t+1} = f_{i,t} & \dots \quad 1 - pr_4 \end{cases} \end{aligned} \tag{5}$$

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 generated initial populations for three different levels of pr_2 determining the degree of network transitivity. For each level of transitivity we ran the simulation without any family allowances, i.e. $b^f = b^v = 0$, for 60 years to obtain approximately stable populations with total fertility rates below replacement level. Thereafter we applied a time invariant mix of fixed, b^f, and income dependent, b^v, family allowances for 100 years on each of these initial populations. To avoid artefacts resulting from peculiar numerical parameters we ran simulations with several sets of numerical parameters. In particular we used $\alpha = 0.5$, $\tau = 2$, $\sigma = 3.5$, $pr_3 = 0.6$, $pr_4 = 0.05$, $\epsilon = 1 : 0.5 : 3$[4], $b^f = 0 : 4 : 24$, $b^v = 0 : 0.25 : 1.25$, and $pr_2 = 0 : 0.4 : 0.8$ which can be interpreted as applying 42 different sets of family policies (determined by the parameters b^f and b^v) on 15 different societies (represented by ϵ and pr_2). To reduce the impact of randomness we repeated each parameter set 12 times resulting in a total of 7560 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 (first and third panel) and income dependent (second and fourth panel) child supports. Here and in the following figures the solid red line always represents the average over all

[4]This means the parameter ϵ is varied from 1 to 3 by increments of 0.5

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, and in the third and fourth panel they represent the average over all simulations with the same level of network transitivity. Both, fixed and income dependent family allowances appear to have a positive influence on cohort fertility but the impact gets smaller with increasing family allowances. The third and fourth panel indicate that networks characterised by a high level of transitivity result in higher levels of fertility but fertility is more sensitive to family policies in case of a low level of transitivity. Since fertility depends on fertility intentions and on the realisation of these intentions we investigate both components independently in the following.

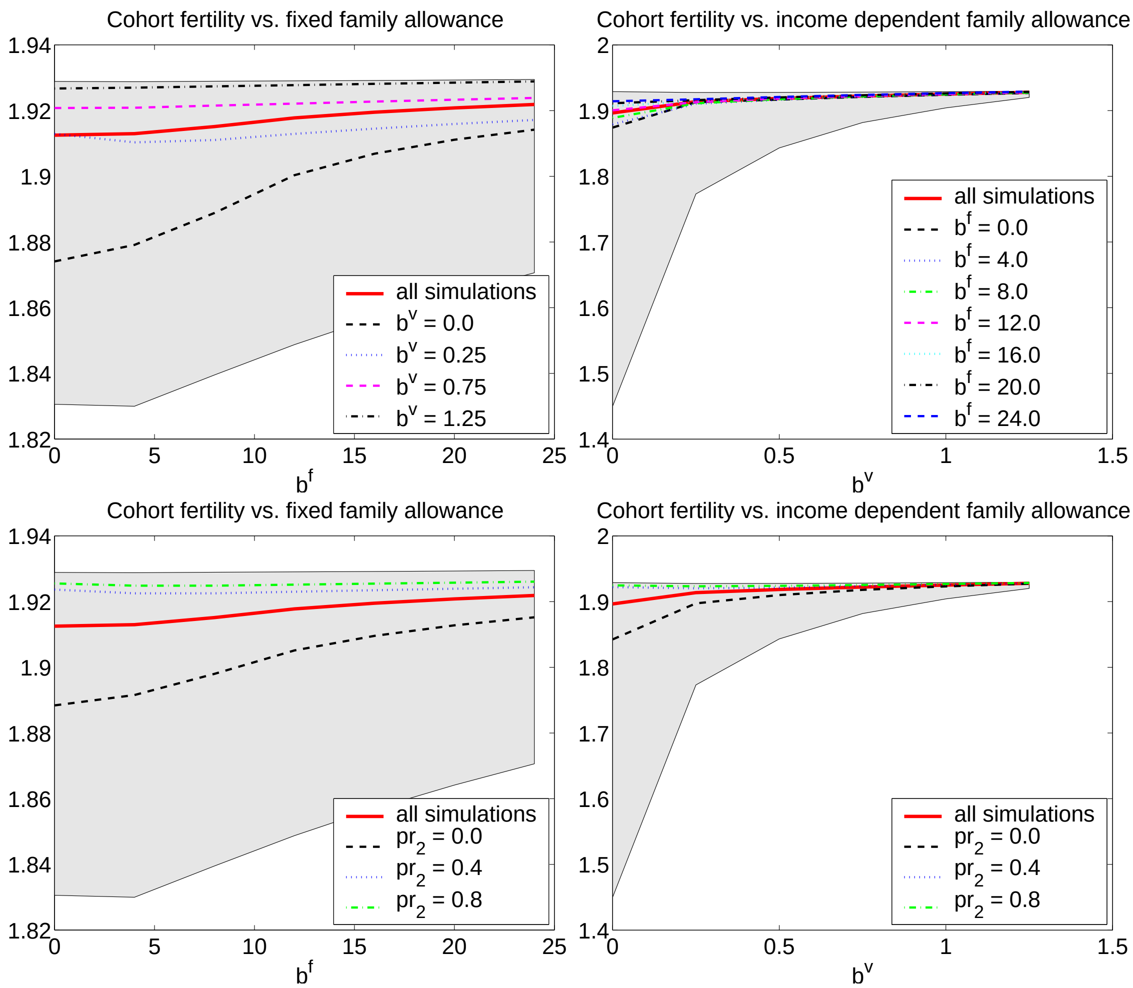

Figure 1: Completed cohort fertility

Figure 2 plots the average intended fertility vs. fixed (first and third panel) and income dependent (second and fourth panel) child supports. The pictures show that fixed and income dependent family allowances have a positive impact on intended fertility and again the impact gets smaller with increasing family allowances. Similarly networks characterised by a high level of transitivity result in higher levels of intended fertility but fertility is more sensitive to family policies in case of a low level of transitivity.

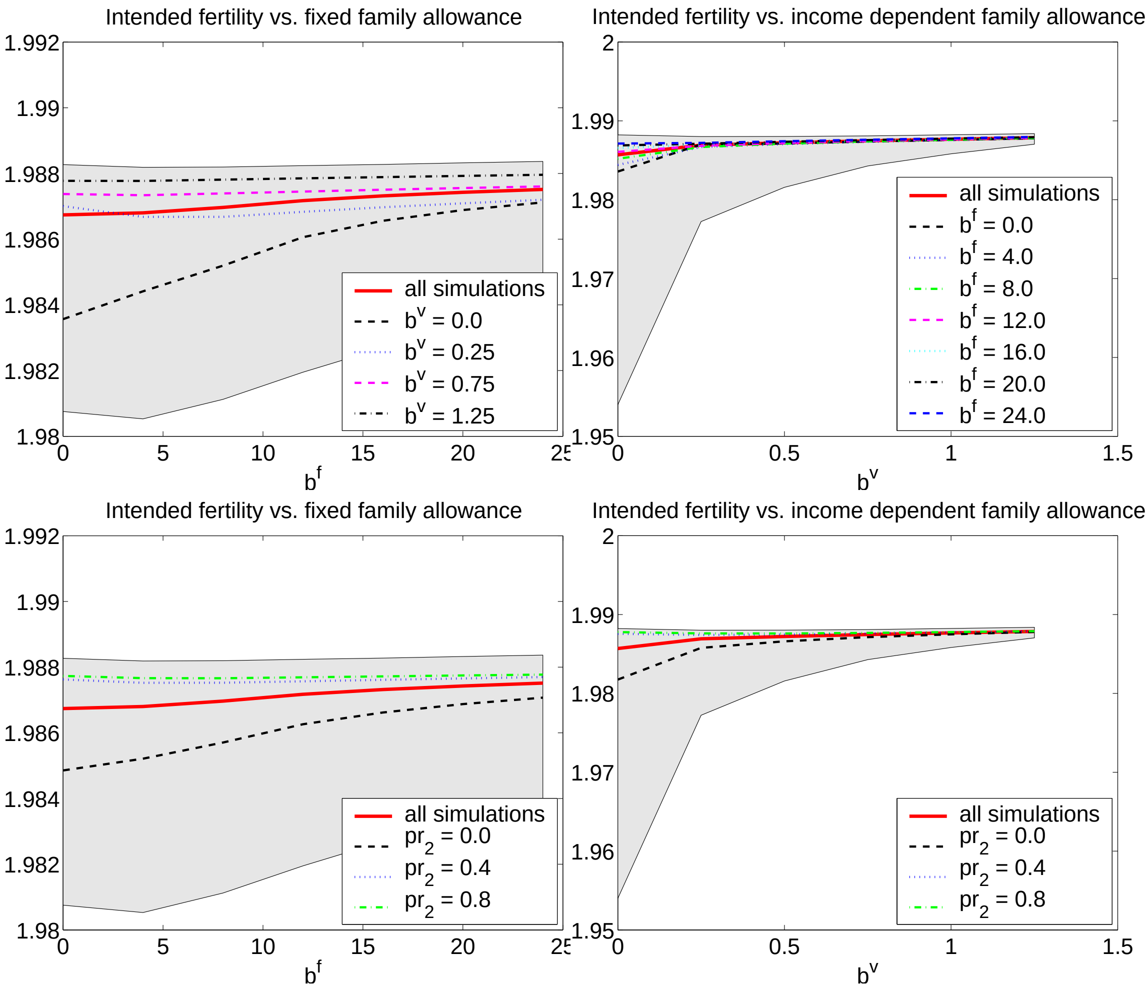

Figure 2: Intended fertility

Figure 3 contrasts the gap between intended fertility and completed cohort fertility with fixed (first and third panel) and income dependent (second and fourth panel) child supports. Fixed and income dependent family allowances have a negative impact on the fertility gap and again the impact gets smaller with increasing family allowances. Networks characterised by a high level of transitivity result in a smaller fertility gap but the results are more sensitive to family policies in case of a low level of transitivity.

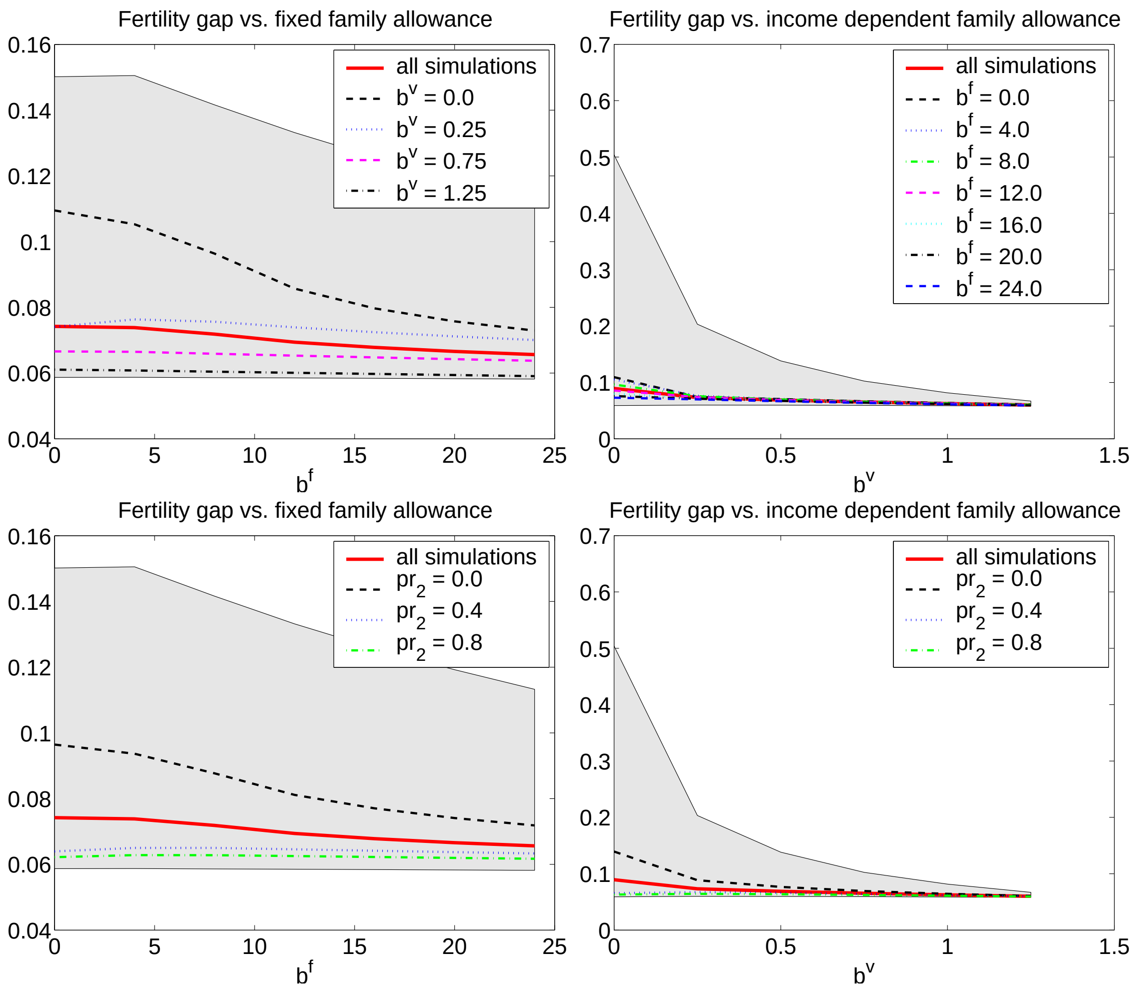

Figure 3: Gap between intended fertility and completed cohort fertility

Although these graphs motivate conclusions regarding the impact of family policies on fertility considering the social structure it is not clear whether this is just a delusion resulting from averaging over many simulation runs. In the following we present empirical estimates on the impact of child supports. The dependent variables are completed cohort fertility (ctfr), intended fertility (f), and the fertility gap (gap) and the explanatory variables are public spending in fixed family allowances (spendingbf) and income dependent family allowances (spendingbv) measured in monetary units per child. Table 1 presents the results of a linear specification. Column (1) summarizes all simulations, column (2), (3), and (4) represent those simulations with $pr_2 = 0, 0.4$, and 0.8. These estimates confirm the results from the

ctfr	(1)	(2)	(3)	(4)
spendingbf	.0004937	.0013666	.0000673	.0000458
	(.0000744)	(.0002119)	(.0000171)	(8.94e-06)
spendingbv	.0008345	.0021758	.0001943	.0001262
	(.0000511)	(.0001454)	(.0000118)	(6.16e-06)
constant	1.896975	1.849185	1.919201	1.92267
	(.0014156)	(.0040294)	(.0003262)	(.0001702)
f	(1)	(2)	(3)	(4)
spendingbf	.0000395	.0001089	6.03e-06	3.45e-06
	(5.66e-06)	(.0000162)	(1.14e-06)	(6.67e-07)
spendingbv	.000057	.000154	.0000116	4.91e-06
	(3.89e-06)	(.0000111)	(7.85e-07)	(4.60e-07)
constant	1.98568	1.982133	1.987329	1.987587
	(.0001077)	(.0003078)	(.0000218)	(.0000127)
gap	(1)	(2)	(3)	(4)
spendingbf	-.0004542	-.0012577	-.0000613	-.0000423
	(.0000688)	(.0001959)	(.0000162)	(8.91e-06)
spendingbv	-.0007774	-.0020217	-.0001826	-.0001213
	(.0000473)	(.0001345)	(.0000112)	(6.14e-06)
constant	.0887053	.1329485	.0681284	.0649171
	(.0013095)	(.0037257)	(.0003092)	(.0001697)

Table 1: Estimates of the impact of family policies on completed cohort fertility using a liner model. Standard errors are in parantheses

preceding graphs. Fixed and income depended child supports have a positive and strongly significant impact on completed cohort fertility and intended fertility and a negative and strongly significant impact on the fertility gap. In agreement with the graphs the impact is stronger if network transitivity is low. The coefficients suggest that one monetary unit spent on income dependent family allowances has a stronger impact than one monetary unit spent on fixed family allowances. However, this result depends on the subset of the parameter space chosen for the simulation. Restricting the simulations to only low levels of fixed child supports can reverse this finding.

In table 2 we presents the results of a nonlinear specification including the squares spbf2 = spendingbf^2 and spbv2 = spendingbv^2 to capture non-linearities. This allows us to draw conclusions regarding an increasing or diminishing impact. If the coefficients of the squares have the opposite sign this indicates a decreasing impact. In columns (1) and (2) the negative coefficients of spbf2 and spbv2 in the regressions explaining completed cohort fertility ctfr and intended fertility f and the positive coefficient in the regression explaining the fertility gap indicate a diminishing impact. However, in column (3) and (4) this does not hold true anymore and even the signs of the coefficients of spendingbf and spendingbv are reversed. Moreover, the coefficients of spendingbf show a lower significance level and the coefficients of spbf2 are insignificant in all the regressions. Again the impact is stronger if network transitivity is low.

4 Summary and conclusions

We study the impact of fixed and income dependent family allowances on intended fertility, on the realisation of this intended fertility and on the resulting completed cohort fertility. In particular we investigate whether the structure of a society represented by the extent of network transitivity 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 agent's 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 combina-

ctfr	(1)	(2)	(3)	(4)
spendingbf	.0006449	.0019801	-.0000395	-.0000147
	(.0002683)	(.000758)	(.0000612)	(.0000316)
spendingbv	.0018177	.0056418	-.0000989	-.0000895
	(.0001772)	(.0005001)	(.0000403)	(.0000209)
spbf2	-7.12e-06	-.0000285	4.69e-06	2.69e-06
	(.0000107)	(.0000303)	(2.45e-06)	(1.26e-06)
spbv2	-.0000286	-.0001005	8.49e-06	6.29e-06
	(4.94e-06)	(.0000139)	(1.12e-06)	(5.86e-07)
constant	1.892056	1.831529	1.920884	1.923839
	(.0018154)	(.005129)	(.0004144)	(.0002136)

f	(1)	(2)	(3)	(4)
spendingbf	.0000512	.0001627	-5.38e-06	-4.17e-06
	(.0000204)	(.000058)	(4.06e-06)	(2.30e-06)
spendingbv	.0001254	.0004041	-.0000104	-.0000175
	(.0000135)	(.0000382)	(2.68e-06)	(1.52e-06)
spbf2	-5.46e-07	-2.45e-06	4.94e-07	3.36e-07
	(8.16e-07)	(2.32e-06)	(1.62e-07)	(9.19e-08)
spbv2	-1.99e-06	-7.25e-06	6.36e-07	6.53e-07
	(3.76e-07)	(1.06e-06)	(7.45e-08)	(4.27e-08)
constant	1.985334	1.980827	1.987467	1.987713
	(.0001381)	(.0003922)	(.0000275)	(.0000155)

gap	(1)	(2)	(3)	(4)
spendingbf	-.0005937	-.0018175	.0000341	.0000105
	(.0002482)	(.0007008)	(.0000581)	(.0000316)
spendingbv	-.0016923	-.0052377	.0000885	.000072
	(.0001639)	(.0004624)	(.0000382)	(.000021)
spbf2	6.57e-06	.000026	-4.20e-06	-2.36e-06
	(9.92e-06)	(.000028)	(2.32e-06)	(1.26e-06)
spbv2	.0000266	.0000933	-7.86e-06	-5.63e-06
	(4.57e-06)	(.0000129)	(1.06e-06)	(5.87e-07)
constant	.0932773	.1492972	.0665834	.0638745
	(.0016794)	(.0047421)	(.0003931)	(.0002139)

Table 2: Estimates of the impact of family policies on completed cohort fertility using a nonlinear. Standard errors are in parantheses

tions 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 and on intended fertility and a negative (and presumably diminishing) impact of fixed and income dependent child supports on the fertility gap. Moreover, the impact is stronger if the level of network transitivity is low and vice versa. Finally, the simulation results reveal that directly comparing the impact of fixed vs. income dependent family allowances is problematic since the results depend on an arbitrary choice of parameters taken into consideration.

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.

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