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Grandparental childcare, family allowances and retirement policies

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Abstract

The paper uses an OLG model to study the interaction between policies designed to ensure the sustainability of the pension system, i.e. child allowances and pensions policies, and grandparental childcare. We find that the rise in grandparenting negatively affects the elderly labour supply hampering the impact of pension policies designed to raise the retirement age and lengthen working lives. Then, we introduce child allowances and find that the impact of child allowances on the fertility rate is influenced by the efficiency of grandparenting in reducing child-rearing costs. Child benefits have a positive impact on fertility only if grandparenting is not very effective at reducing childcare costs. This suggests that the role of grandparents in various countries may partly explain the inconsistency in empirical evidence on the relationship between child benefits and fertility rates. The study also finds that child benefits have a positive impact on the elderly labour supply when grandparenting is efficient.

Keywords PAYG pensions · Endogenous retirement · Endogenous fertility · Child policies

JEL classification J13 · H2 · H8 · H55.

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1 Introduction

In our ageing society, grandparents play a crucial role in providing childcare, especially for working mothers, as a common solution to the problem of childcare needs in many countries. Empirical evidence has demonstrated the significant impact of grandparental childcare on families and the labour market, with studies such as Laughlin (2010) finding it to be a significant source of childcare in the USA, where a quarter of children aged below five benefit from grandparent provided childcare as their main source of day care, and Stella (2017) who finds it to be an important determinant in European countries of children's decisions to leave the parental home and start their own family.

According to the 2004 Survey of Health, Ageing and Retirement in Europe (Börsch-Supan, 2019) in eleven European countries[1] in 2004, 68% of agents between the ages of 55 and 70 are grandparents[2] and about 63% of grandparents state that they look after their grandchildren regularly or occasionally. Of these about 16% take care of at least one of their grandchildren on a daily basis, while about 30% do so on a weekly basis. Grandparenting may be an important source of childcare, especially in the context of low public expenditure on childcare. As shown in Fig. 1, in fact, for most of the countries considered, the share of public spending devoted to childcare is relatively low.

At the same time, in ageing economies, the need for the financial sustainability of pensions systems has led many governments to implement pension policies including raising the retirement age or encouraging agents to work longer. Stylized facts suggest a trade-off between grandparenting and labour force participation (see

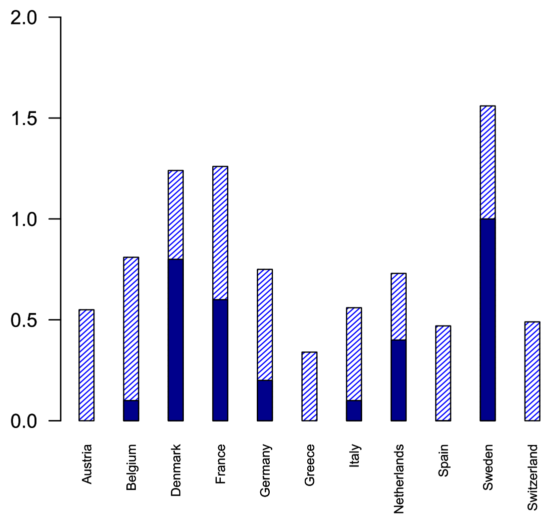


Fig. 1 Public expenditure on childcare and early education services, per cent of GDP, 2019 *Source*: OECD Family Database (http://www.oecd.org/social/family/database.htm)

[1] Austria, Belgium, Denmark, France, Germany, Greece, Italy, the Netherlands, Spain, Sweden and Switzerland.

[2] Grandparents are individuals with at least one grandchild.

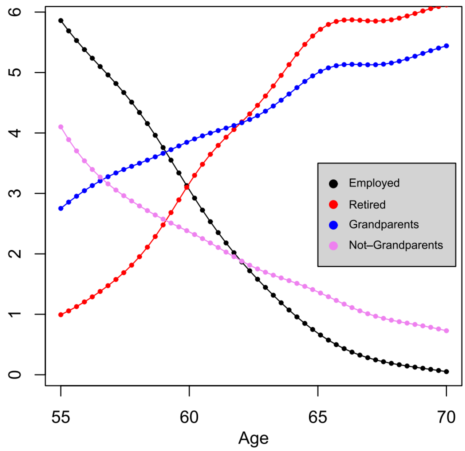


Fig. 2 Labour force participation, grandparents and retirement *Source*: SHARE 2004 (Release 7)

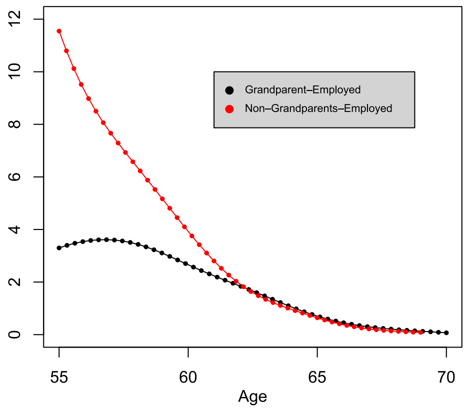


Fig. 3 Employment rates of grandparents and non-grandparents by age *Source*: SHARE 2004 (Release 7)

Figs. 2 and 3). In particular, as shown in Fig. 2, labour force participation rates and the share of non-grandparents between the ages of 55 and 70 decline monotonically, whereas the shares of grandparents and the retired rise. Figure 3 shows that the employment rates of grandparents between the ages of 55 and 64, which are lower than the employment rate of non-grandparents in the same age range. Overall the employment rate among all grandparents between the ages of 55 and 70 is about 28%, whereas the employment rate of non-grandparents across this age range is about 51% (see also Backhaus and Barslund, 2021). In addition, the time that employed grandparents devote to taking care of at least one of their grandchildren, both on a daily basis and on a weekly basis, is significantly lower than that allocated by retired grandparents (see Table 1).

In this paper, we focus on the interaction between policies designed to ensure the sustainability of the pension system, i.e. child allowances and pensions policies, and grandparental childcare, which is a poorly understood subject. In particular, we fill this gap by exploring the interplay between grandparental

Table 1 Time with grandchildren. *Source*: SHARE 2004 (Release 7), authors' calculations

	Employed grand-parents	Retired grandpar-ents
Share who care daily	0.031	0.124
Share who care weekly	0.099	0.196

childcare, child allowances and pensions, and their implications for fertility and the elderly labour supply. The analysis is based on a dynamic overlapping generations model, where agents live through three periods, can decide when to retire in the last period, and fertility is endogenous.

The two most relevant papers related to our study are by Miyazawa (2021, 2016). Miyazawa (2016) examines the impact of child allowances on fertility, taking into account that fertility rate is a joint product of both parental and grandparental childcare. The findings suggest that small child allowances can increase fertility rate in situations where there is little initial parental childcare, but in situations where grandparental childcare features as a key factor in the decision of a couple to have children, child allowances can actually reduce the fertility rate. Similarly, Miyazawa (2021) analysed the interaction among grandparenting, fertility rate, elderly labour, and public pensions using a three-period overlapping-generations model in which grandparents allocate time to work and informal childcare or grandparenting. The study suggests that increasing the pension contribution rate increases grandparenting, and elderly labour force participation rates are negatively (positively) related to the fertility rates in countries with small (large) public pensions.

Our paper is more related to Miyazawa (2021) to which we add a mandatory retirement scheme and child allowances. This framework enables us, first, to focus on the link between grandparenting and the elderly labour supply and therefore on the impact of pension policies designed to raise the retirement age. The role of grandparents as an important form of affordable childcare for parents, and its implications regarding, for example, the decision to have a child or of mothers to work has received considerable attention in many studies (see for example Hank and Buber, 2009; Bratti et al., 2018). The link between grandparenting, the elderly labour supply and the effectiveness of recent pension reforms, on the other hand, has received little attention. In this paper, in accordance with empirical evidence, we find that the rise in grandparenting negatively affects the elderly labour supply (see Rupert and Zanella, 2018, Backhaus and Barslund 2021). This suggests that in scenarios where grandparenting is the main source of childcare the impact of pension policies designed to raise the retirement age and/or lengthen working lives can be thwarted (see for example Van Bavel and De Winter, 2013). From this point of view, our study is strictly related to the literature on pensions that show how the overall impact of flexible retirement on the elderly labour supply is unclear and in some cases is the opposite of what could be expected (for a detailed analysis of this point, see Börsch-Supan et al., 2018; Price et al., 2018).

Second, we focus on the impact of the size of pensions on the birth rate, grandparenting and the elderly labour supply. According to the empirical evidence the increase in the social security tax rate unambiguously lowers the elderly labour supply. The link between social security and the birth rate is not a new topic (see, for example, Ehrlich and Kim, 2007 and Zhang and Zhang, 1998); however, we emphasize the indirect impact of the size of public pensions on fertility rate through grandparenting which is less often discussed. In fact, we show that an increase in the pension contribution rate has, on the one hand, a direct negative income effect, and on the other hand, it has an indirect positive effect through grandparenting, which in turns increases with respect to the payroll tax rate. Thus, if the elasticity of grandparenting with respect the payroll tax rate is sufficiently high, the increase in the size of the public pension system positively affects the birth rate.

Finally, we consider how the allocation of government funds between child allowances and pensions can affect the sustainability of the pension system. In particular, our focus is on how the introduction of child allowances may act as a substitute for grandparental care, and therefore through this channel how it may affect the elderly labour supply. The idea derives from recent empirical evidence (see Havnes and Mogstad, 2011, Backhaus and Barslund, 2021, Floridi, 2022) suggesting that public childcare may crowd out informal care, such as grandparental care. From this point of view, our paper is also related to the paper of Chen and Miyazaki (2018) that investigates the impact of PAYG pension systems and child allowances on fertility, the elderly labour supply and welfare albeit in a setting without grandparenting.

There are two main new results from the introduction of child benefits. Firstly, in the optimal retirement scenario, the effect of child benefits on fertility rate is non-monotonic and contingent on the efficiency of grandparenting in reducing child-rearing costs. If the efficiency of grandparenting is sufficiently low fertility increases, otherwise it declines with child benefits. This is because this benefit has a direct positive income effect on fertility but also an indirect negative effect, since it decreases pensions and encourages the elderly to retire later, thus reducing grandparenting. When grandparenting is efficient the latter effect prevails and the birth rate declines. Given that the empirical evidence on this topic is inconsistent, this result of our theoretical analysis offers a possible explanation based on the different role of grandparents in the various countries. Thus, in economies where individuals can more easily rely on their parents to take care of their children, such as some developing countries where co-residence with grandparents is more frequent, one would expect the overall effect of a child benefit on fertility to be negligible or negative, whereas this effect is most likely positive in developed countries. Secondly, child benefits might have a positive or negative impact on the elderly labour supply, again depending on how effective grandparenting is in reducing childcare costs. When grandparenting is effective this impact is positive, whilst the effect could be ambiguous when grandparenting is less effective. However, in our simulation, under reasonable parameters, this effect is always positive, thus implying that child benefits may act as a substitute for grandparenting and therefore that population ageing could be contrasted with a child benefit, due to both the impact on the birth rate, especially in more developed countries, and on the elderly labour supply.

The rest of the paper is structured as follows. Section 2 presents the model, and in Sect. 3 we study the effects of pension policies and child benefits. Section 4 sets out a numerical analysis followed by some concluding remarks.

2 The basic model

We consider a small open economy populated by overlapping generations of people who live for three periods: childhood, adulthood and old age. In the first period agents make no decisions; in adulthood individuals work full-time and raise their children. In old age, they allocate their time between working and grandparenting and when they retire they benefit from a state-funded PAYG pension scheme.

2.1 Production

Production occurs according to a constant-returns-to-scale technology, using labour L_t and physical capital K_t. Assuming a Cobb-Douglas production function, output produced at time t is:

$$Y_t = AK_t^{\alpha} L_t^{1-\alpha}, \tag{1}$$

where $\alpha \in (0, 1)$ and $A > 0$ is a technological parameter.

Labour supply in each period t is given by the labour supplied inelastically by young workers, i.e. N_t and the labour supplied by the elderly, i.e. $\lambda l_t N_{t-1}$ where l_t is the endogenous labour supply during old age and the parameter $\lambda \in (0, 1)$ captures the productivity of elderly labour (see Aísa et al., 2012, Nishimura et al., 2018 and Hirazawa and Yakita, 2017). Given $N_t = n_{t-1}N_{t-1}$, the total amount of labour at time t is therefore given by:

$$L_t = N_{t-1}\left(n_{t-1} + \lambda l_t\right) \tag{2}$$

With perfectly mobile capital the interest rate is equal to the world interest rate r, which is assumed to be constant over time. Thus, given a constant-returns-to-scale technology, both capital per unit of effective labour and wage are fixed and constant over time.

2.2 Households

An adult in period t (and therefore elderly in period $t + 1$) derives utility from consumption in adulthood, i.e. c_t^y, the number of children n_t, from consumption in old age, i.e. c_{t+1}^o and the time devoted to grandparenting l_{t+1}^H. During this time the individual is retired and receives a PAYG pension. Therefore, the utility function is given by:

$$U^t = \ln c_t^y + \theta \ln n_t + \beta[\ln c_{t+1}^o + \delta \ln(l_{t+1}^H)], \tag{3}$$

where $\beta \in (0,1)$ is the overall weight attached to utility in old age, $\delta \in (0,1)$ is the weight of time spent on grandparenting and θ reflects fertility preferences.

As adults, parents allocate their wages to consumption c_t^y, savings s_t, raising their children n_t and paying a tax τ in order to contribute to the PAYG pension scheme. Thus the budget constraint of an adult agent in period t is:

$$c_t^y = \left(1 - \tau - \frac{qn_t}{\phi(g_t)}\right)w - s_t, \tag{4}$$

where $0 < q < 1$ is the fraction of the parental wage required to raise each child and $\phi(g_t)$ is a function of grandparenting per child, g_t, that decreases the cost of raising children. In particular, we assume that $\phi(0) > 0$ and $\phi'(g_t) \geq 0$.[3]

In the third period, agents consume their savings, receive a pension benefit b_{t+1} over the period in which they do not work and when they do work their wage is taxed in order to finance the PAYG scheme. Thus the budget constraint in old age is as follows:

$$c_{t+1}^o = Rs_t + (1-\tau)w\lambda l_{t+1} + b_{t+1}(1 - l_{t+1}), \tag{5}$$

where R is the rate of return on savings, l_{t+1} is the elderly labour supply and the parameter $\lambda \in (0,1)$ captures the productivity of elderly labour (see Aísa et al., 2012; 2018 and Nishimura et al., 2017). In particular, we assume that the elderly allocate their total time endowment, which for the sake of simplicity we normalize to 1, to both working and grandparenting:

$$1 = l_{t+1}^H + l_{t+1}. \tag{6}$$

Following Miyazawa (2021) the time transfer within the family l_{t+1}^H is specified as:

$$l_{t+1}^H = n_t g_{t+1}. \tag{7}$$

The government has to maintain a balanced budget and provides a PAYG social security scheme. Thus, the revenue from taxing both the young, i.e $\tau w n_t N_t$ and old, i.e $\tau w \lambda l_{t+1} N_t$ is used to finance current retirement pensions. Thus pension benefits are:

$$b_{t+1} = \frac{\tau w(n_t + \lambda l_{t+1})}{1 - l_{t+1}}. \tag{8}$$

Each household chooses n_t, s_t and g_{t+1} in order to maximize the utility function (3) subject to (4), (5) taking as given the wage, the interest rate, the pension benefit, the tax rate and grandparenting received at time t. The household maximization problem is therefore given as:

[3] Assuming $\phi(0) = 1$, the fraction of the parental wage required to raise each child becomes fixed as is usual in the literature (see, for instance, Wigger, 1999; Boldrin and Jones, 2002 and Fanti and Gori, 2014).

$$\max_{n_t, s_t, g_{t+1}} U^t = \ln c_t^y + \theta \ln n_t + \beta[\ln c_{t+1}^o + \delta \ln(n_t g_{t+1})], \tag{9}$$

After substituting for b_{t+1} from Eq.(8), optimal consumption, fertility and granparenting per child at an interior solution are given by:

$$c_t^y = \frac{w(1-\tau)(R+\lambda)}{R[1+\theta+\beta(1+\delta)]}, \tag{10}$$

$$n_t = \frac{(1-\tau)(R+\lambda)\phi(g_t)\theta}{Rq[1+\theta+\beta(1+\delta)]}, \tag{11}$$

$$g_{t+1} = \frac{\tau}{\lambda} + \frac{qR\{\tau[\lambda(1+\theta+\beta) - \beta\delta R] + \beta\delta(R+\lambda)\}}{\theta(\lambda+R)\lambda(1-\tau)\phi(g_t)}. \tag{12}$$

Thus from Eqs. (6), (7), (11) and (12) the optimal level of the elderly labour supply is given by:

$$l_{t+1} = \frac{(1-\tau)\{qR[\lambda(1+\theta+\beta) - \beta R\delta] - \tau\theta(\lambda+R)\phi(g_t)\}}{qR\lambda[1+\theta+\beta(1+\delta)]}. \tag{13}$$

Some calculations show a positive net wage in old age i.e $(1-\tau)\lambda w - b_{t+1} > 0$. Equations (10) and (11) indicate that a higher productivity of the elderly labour supply positively affects consumption and fertility via a positive income effect Mizuno and Yakita (2013). Moreover, in accordance with Aísa et al. (2012) and Hirazawa and Yakita (2017), Eq.(13) shows, that in the absence of pension benefits agents choose to supply labour in old age if λ is sufficiently high.

From Eqs. (11) and (13) it is evident that an increase in received grandparenting positively affects fertility since it lowers the cost of raising children. From Eqs. (11) and (12), it follows that the total time devoted to grandparenting in period $t+1$, i.e. $n_t g_{t+1}$ increases with respect to grandparenting in the previous period, i.e. g_t, and therefore, the elderly labour supply decreases. In particular, when received grandparenting is sufficiently high, i.e $\phi(g_t) > \phi(\tilde{g_t}) = qR[\lambda(1+\theta+\beta) - R\beta\delta]/\tau\theta(R+\lambda)$ a corner solution for the elderly labour supply arises. The negative relationship between the elderly labour supply and grandparenting is in accordance with empirical evidence (see for example Rupert and Zanella, 2018; Frimmel et al., 2022).

In many countries, agents cannot freely choose their retirement age because it is set by the government. This means that agents in old age work for a fixed amount of time $\bar{l}$. For the sake of simplicity we normalize $\bar{l}$ to zero, in other words we assume that agents retire at the onset of old age and therefore devote their time entirely to grandparenting. i.e $g_{t+1} = 1/n_t$.[4] In the case of this mandatory retirement, optimal choices are therefore given by:

[4] The assumption of $\bar{l} \geq 0$ complicates the analysis but does not affect the qualitative results.

$$c_t^y = \frac{wqR(1-\tau)}{q(1+\beta+\theta)R - \tau\phi(g_t)\theta} \tag{14}$$

$$n_t = \frac{R(1-\tau)\theta\phi(g_t)}{q(1+\beta+\theta)R - \tau\phi(g_t)\theta} \tag{15}$$

where we assume:

Assumption 1 $\phi(g_t) < q(1+\beta+\theta)R/\tau\theta$.

The results in this case are, of course, identical to those obtained in an optimal retirement scheme in the case of a corner solution with full retirement. From Eq. (15) it is easy to note that as in the case of optimal retirement, fertility increases with respect to grandparental childcare.

We can summarize these results in the following proposition:

Proposition 1 *Grandparenting has a positive effect on fertility in both retirement schemes whereas it has a negative effect on the elderly labour supply.*

Note that these results are in accordance with propositions 2 and 4 in Miyazawa (2021).

2.3 Dynamics of Grandparenting

In this subsection, we focus on the dynamics of grandparenting for the two PAYG retirement schemes as defined in the previous section, i.e. mandatory retirement and optimal retirement. In the case of mandatory retirement, from Eqs. (6), (7) and (15), the dynamic equation for grandparenting is given by:

$$g_{t+1} = \frac{qR(1+\theta+\beta) - \tau\theta\phi(g_t)}{R\theta(1-\tau)\phi(g_t)} \tag{16}$$

Simple calculations show that $\partial g_{t+1}/\partial g_t < 0$ which implies the existence of a unique steady state, i.e. g^*_{MR}. If the elasticity of the grandparenting function $\phi(g_t)$ with respect to g_t in the steady state is sufficiently low, then the steady state is locally stable (see Appendix 1 for technical details). The basic intuition behind this result is that a low elasticity of the grandparenting function means that it is less effective at reducing child-rearing cost, i.e. the curve (16) is flatter.

In the optimal retirement pension scheme the dynamic equation for grandparenting is given by Eq. (12). In this case, we can see that $\partial g_{t+1}/\partial g_t < 0$, and therefore a unique steady state exists, i.e. g^*_{OR}. Again, the equilibrium is stable if the elasticity of grandparenting is sufficiently low (see appendix 1 for technical details).

Comparing the steady state level of grandparenting in each retirement scheme, from Eqs. (12) and (16), some calculations show that as long as an interior solution for the elderly labour supply arises i.e. $\phi(g_t) < \phi(\tilde{g}_t)$ agents devote a higher fraction of their time to grandparenting in the mandatory retirement scheme. This implies, therefore, a higher steady state level of grandparenting in the mandatory scheme, i.e. $g^*_{MR} > g^*_{OR}$. Summing up these results, the following proposition arises:

Proposition 2 *In both retirement schemes a unique steady state exists, with a higher level of grandparenting in the mandatory scheme. The equilibrium is locally stable if the elasticity of grandparenting at the steady state is sufficiently low.*

Comparing the two retirement schemes from Eqs. (8), (11), (13), (15) some calculations show that the steady state level of pension payouts is higher in the free retirement than the mandatory scheme (see Appendix 1). This suggests that although the possibility of work in old age involves a lower steady state level of grandparenting and therefore through this channel a lower fertility, the overall impact on pension payout is nevertheless positive. However, as specified above, the rise in grandparenting negatively affects the elderly labour supply and this suggests that in scenarios where grandparenting is the main source of childcare the aim of pension policies designed to raise the retirement age and/or incentivize agents working longer can be thwarted (see for example Van Bavel and De Winter, 2013).

2.4 Effects of the public pension

In this section, we compare the impact of the pension contribution rate on the steady state in the two retirement schemes. From Eqs. (12) and (16), it can be seen that the contribution rate has an ambiguous effect on the steady state level of grandparenting in the mandatory retirement scheme, whereas it has a positive effect in the optimal scheme. In the latter, in fact, a higher contribution rate lowers the opportunity cost of time spent on grandparenting, leading agents to increase grandparenting (see Miyazawa, 2021).

Conversely, in the former, grandparenting increases with respect to the contribution rate only when the raising cost of children is sufficiently high (see Appendix 1 for technical details). The intuition behind this result is that the contribution rate has two opposite effects on fertility: a direct negative income effect because of the fall in disposable income and an indirect positive effect through higher pension benefits. When the raising cost of children is above a certain threshold, as in the case of developed countries, the negative effect on fertility prevails and therefore grandparenting increases. We can summarize these results in the proposition as follows:

Proposition 3 *The rise in public pensions has an ambiguous effect on the steady state level of grandparenting in the mandatory retirement scheme, whereas it has a positive effect in the optimal one.*

Regarding the impact of the tax rate on fertility in the optimal retirement scheme from Eq. (11) we obtain, on the one hand, that an increase in the contribution rate has a direct negative income effect and, on the other, it has an indirect positive effect through grandparenting. Simple calculations show that the contribution rate positively affects the fertility rate if the elasticity of grandparenting with respect the tax rate is sufficiently high, i.e. $\epsilon_{\phi(g)_\tau} > \tau/(1-\tau)$. Note that without grandparenting the impact of the social security tax rate is unambiguously negative in accordance with stylized facts (see Boldrin et al., 2015). Thus, we obtain the following proposition:

Proposition 4 *The impact of the contribution rate on fertility is positive if the elasticity of grandparenting with respect to the payroll tax is sufficiently high, otherwise it is negative.*

We now move on to see how an increase in the contribution rate affects the equilibrium level of labour supply in old age. In particular, from Eqs. (6) and (7) we obtain:

$$\frac{\partial l^*}{\partial \tau} = -g^* \overbrace{\frac{\partial n^*}{\partial \tau}}^{?} - n^* \overbrace{\frac{\partial g^*}{\partial \tau}}^{+} \tag{17}$$

where the contribution rate affects the elderly labour supply through two channels. The first term involves an ambiguous effect of the contribution rate on the elderly labour supply through fertility. The second term involves a negative substitution effect, that is an increase in the payroll tax lowers the opportunity cost of grandparenting leading to a reallocation of elderly labour from the labour market to grandparenting. In accordance with the empirical evidence (see for example Gruber and Wise, 1998, Gruber and Wise, 2002) some calculations show that the second effect always prevails.[5] Thus, we obtain this proposition:

Proposition 5 *The rise in the size of public pensions negatively affects the elderly labour supply.*

3 Introduction of child policies

According to the empirical evidence (see Havnes and Mogstad, 2011 and Backhaus and Barslund, 2021) the provision of formal childcare may act as a substitute for grandparental care. This therefore suggests that public support to child care may stimulate elderly labour supply (see Floridi, 2022).

[5] In particular from Eq.(13) we get:

$$\frac{\partial l^*}{\partial \tau} = \frac{-\{qR[\lambda(1+\theta+\beta)-\beta R\delta] - \tau\theta(\lambda+R)\phi(g^*)\} - (1-\tau)\theta(\lambda+R)\left[\phi(g^*) + \tau\frac{\partial \phi^*}{\partial g^*}\frac{\partial g^*}{\partial \tau}\right]}{qR\lambda[1+\theta+\beta(1+\delta)]} \tag{18}$$

where at the interior solution $qR[\lambda(1+\theta+\beta)-\beta R\delta] - \theta(\lambda+R)\phi(g^*)(1-\tau) > 0$.

From this perspective in this section, we focus on the impact of child allowances on fertility, grandparenting and elderly labour supply. In particular, suppose the government provides a subsidy ϵ_t per child aimed at reducing q. The budget constraint in adulthood, therefore, becomes[6]:

$$c_t^y = \left(1 - \tau - \frac{qn_t(1-\epsilon_t)}{\phi(g_t)}\right)w - s_t. \tag{19}$$

In accordance with Kaganovich and Zilcha (1999) and Glomm and Kaganovich (2008), we assume that the government devotes a fraction $0 < a < 1$ of tax revenues to social security benefits and a fraction $1 - a$ to child benefits. The internal allocation of government expenditure is therefore given by:

$$b_{t+1} = \frac{a\tau w(n_t + \lambda l_{t+1})}{1 - l_{t+1}}, \tag{20}$$

and:

$$\epsilon_{t+1} = \frac{(1-a)\tau(n_t + \lambda l_{t+1})}{qn_t n_{t+1}}. \tag{21}$$

From the first-order conditions, optimal fertility, grandparenting and the elderly labour supply at the interior solution are now given by:

$$n_t = \frac{(1-\tau)(R+\lambda)\phi(g_t)\theta n_{t-1} + R[1+\theta+\beta(1+\delta)]\tau(1-a)[\lambda + n_{t-1}(1-g_t\lambda)]}{qR[1+\theta+\beta(1+\delta)]n_{t-1}} \tag{22}$$

$$g_{t+1} = \frac{a\tau}{[1-(1-a)\tau]\lambda} + \frac{R\beta\delta(1-\tau) + \lambda\{\beta\delta[1-(1-a)\tau] + a\tau(1+\theta+\beta)\}}{\lambda[1-(1-a)\tau][1+\theta+\beta(1+\delta)]n_t} \tag{23}$$

$$l_{t+1} = \frac{[\lambda(1+\theta+\beta) - R\beta\delta](1-\tau)}{\lambda[1+\theta+\beta(1+\delta)][1-(1-a)\tau]} - \frac{a\tau n_t}{\lambda[1-(1-a)\tau]} \tag{24}$$

In the case of the mandatory retirement scheme, from the first-order conditions, optimal fertility is given by:

$$n_t = \frac{R[(1-\tau)\theta\phi(g_t) + \tau(1+\theta+\beta)(1-a)]}{q(1+\beta+\theta)R - a\tau\phi(g_t)\theta}. \tag{25}$$

From Eq. (25), in the case of mandatory retirement, the same considerations, in the absence of child policies, apply to the existence and stability of long-term equilibrium.

[6] In accordance with Miyazawa (2016), we consider the implementation of a child benefit program designed to reduce the overall expenses associated with parental childcare at a rate of ϵ_t, that is $qe_t(1-\epsilon_t)$, where e_t denotes parental childcare. This variable, along with grandparenting, plays a pivotal role in determining the fertility rate. Specifically, the fertility production function is given by $n_t = f(e_t, g_t) = \phi(g_t)e_t$ (see also Apps and Rees, 2004).

Regarding the optimal retirement scheme from Eqs. (22) and (23) a unique and stable steady state exists, under reasonable parameter condition (see Appendix 1 for technical details). In particular, from equation (23) we obtain $g_t = g(n_{t-1})$ which, from Eq. (22) yields the dynamic equation for fertility $n_t = n(n_{t-1})$.

As shown in greater detail in Appendix 1, $\partial n_t / \partial n_{t-1} < 0$ thus, in the phase diagram (n_t, n_{t-1}), the curve intersects the 45-degree line at a single point. This indicates the existence of a unique steady state level of fertility n^* and accordingly a unique steady state level of grandparenting g^* and the elderly labour supply l^*.

Let us now focus on the impact of child benefits for a given payroll tax rate on the steady state of the economy. From Eqs. (25) it is evident that child benefit positively affects fertility and therefore lowers the steady state level of grandparenting in the mandatory scheme.

In the case of the optimal retirement scheme, the impact of child benefits on the steady state level fertility crucially depends on the efficiency of grandparenting in reducing the cost of raising children i.e. $\phi'(g)$.[7] In particular, in order to study the effect of child benefits on the steady state level of fertility let's focus on the right hand side of Eq. (22). We can see that an increase in the child allowance has a direct positive income effect and indirect effect trough grandparenting which, for a given n_{t-1}, decreases in relation to child benefits. Intuitively, an increase in child benefits lowers the amount of total revenues devoted to pensions, leading to an increase in elderly labour supply and therefore to a reduction in grandparental childcare. Some calculations show that if $\phi'(g)$ is sufficiently low, i.e. $\phi'(g) < \hat{\phi(g)}$, when child benefits increase, the right hand side of Eq. (22) increases and therefore the steady state level of fertility increases. (see Appendix 1 for a complete explanation of technical details). On the other hand, if $\phi'(g)$ is sufficiently high, i.e. $\phi'(g) > \hat{\phi(g)}$ the indirect negative effect of child benefits through grandparenting prevails and therefore fertility decreases with respect to child benefits.

The non-monotonic impact of child allowances on fertility is in accordance with the ample international literature, where there is no consensus on whether child benefits impact on the fertility rate. Some contributions find a positive fertility response to child benefit increases, whilst others show small or even negative effects. Gauthier (2007) provides a survey of the international literature on the impact of family policies on fertility and suggests that the evidence either way is conflicting. For example González (2013); Cohen et al. (2013); Milligan (2005); Laroque and Salanié (2014) find an overall positive fertility response to child allowances. Conversely Crump et al. (2011); Baughman and Dickert-Conlin (2009); Riphahn and Wiynck (2017) find an insignificant effect of child allowances on fertility. Finally, Francesconi and Van der Klaauw (2007) find a negative effect on the birth rate.

An increase in the child allowance affects the steady state level of grandparenting through two channels (see Appendix 1 for technical details). Firstly, as specified above, an increase in child benefits, lowers the amount of total revenues devoted to pensions, leading to an increase in the elderly labour supply and therefore to a

[7] Various factors can affect the efficiency of grandparenting in reducing the rising cost of children such as grandparents' health and residing close to grandchildren or in-laws (see for example Garcia-Moran and Kuehn, 2017).

reduction in grandparenting. Secondly child benefits affect grandparenting through fertility. The overall effect of child benefits on the steady state level of grandparenting, therefore, is negative when $\phi'(g) < \phi(\hat{g})$ whereas it is ambiguous when $\phi'(g) > \phi(\hat{g})$ (see Appendix 1). In fact, as explained above, when $\phi'(g) < \phi(\hat{g})$, fertility increases with respect to child benefits and therefore the overall effect of child benefits on the steady state level of grandparenting is negative. Conversely, when $\phi'(g) > \phi(\hat{g})$, fertility decreases with respect to child benefits and thus child benefit has two conflicting effect on grandparenting, a direct positive effect and an indirect negative effect through total tax revenues. It is possible to show that when the negative impact of child benefit on fertility is sufficiently high, grandparenting increases.

Finally, the impact of child benefits on the steady state level of the elderly labour supply depends on the total time devoted to grandparenting. When $\phi'(g) > \phi(\hat{g})$, as discussed above, fertility decreases with respect to child benefits and some calculations show that the total time devoted to grandparenting decreases, thus the elderly labour supply increases. On the other hand when, $\phi'(g) < \phi(\hat{g})$, fertility increases in relation to child benefits whereas grandparenting decreases thus, the overall effect of child benefits on labour supply in old age is ambiguous (see Appendix 1 for technical details). We can summarize these results in the following proposition:

Proposition 6 *In the case of inefficient grandparenting, the introduction of child benefits increases fertility and lowers grandparenting, whereas the impact on the elderly labour supply depends on the marginal effect of child allowances on fertility. If it is sufficiently high, the elderly labour supply decreases otherwise it increases.*

In the case of efficient grandparenting, child benefits lowers fertility and although the effect on grandparenting is ambiguous, the elderly labour supply increases.

Thus the model does not always deliver unambiguous predictions about the effects of the introduction of child benefits on grandparenting and the elderly labour supply. For this reason, in the next section we turn to a numerical example.

4 Numerical exercise

In this section, we conduct a quantitative exercise to simulate the impact of changes in public pensions and the introduction of child benefits under the two regimes both in the transitional dynamics and in the steady state. We assume that one period lasts 30 years. The output elasticity with respect to capital α is set at 0.3 as usually assumed. The annual interest rate is set at 1.2% per year and therefore we obtain $R = 1.4$ over a generation (30 years). Assuming that the productivity level A equals 2, the capital-labour ratio equals $k = 0.3$ and thus $w = 0.98$. Following Blackburn and Cipriani (2002) the annual discount factor is set at 0.99 thus $\beta = 0.74$ over a generation. The other preference parameters are $\delta = 0.2$ and $\theta = 0.1$. The child raising-cost, q, is set at 0.3, in accordance with the empirical literature which estimates

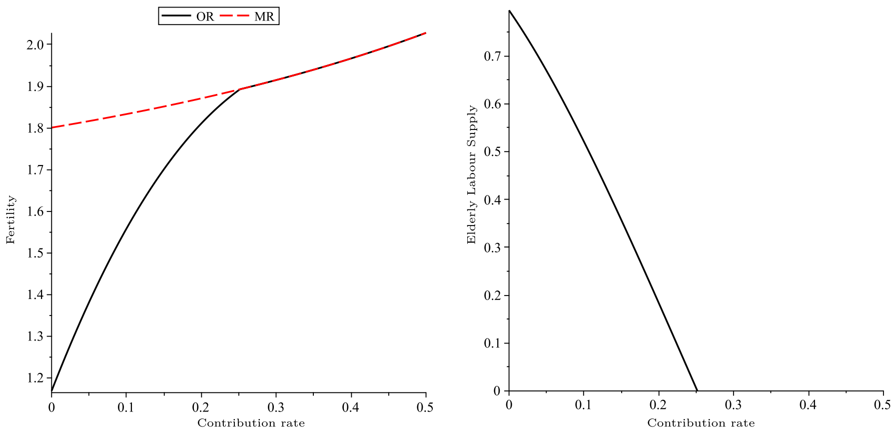


Fig. 4 Fertility and elderly labour supply: efficient grandparenting

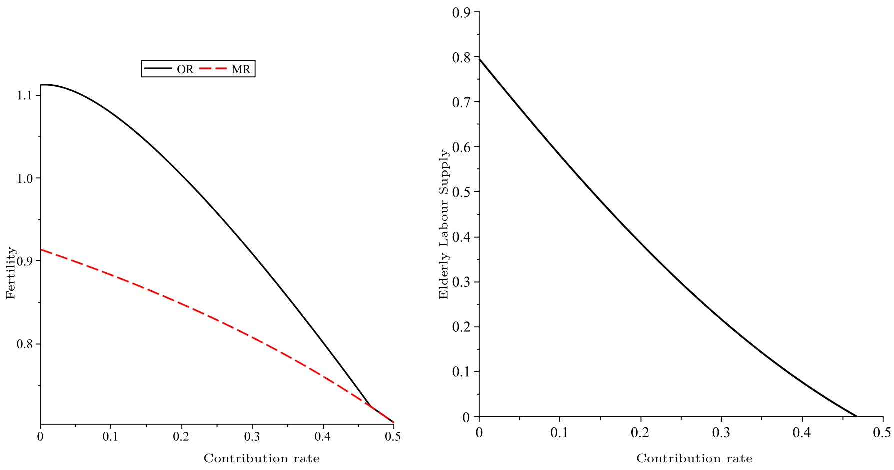


Fig. 5 Fertility and elderly labour supply: inefficient grandparenting

that children's resource share is usually between 20% and 30% of the household budget (see Letablier et al., 2009 and Rees, 2001). According to Ferreira and de Abreu Pessôa (2007) the rate at which labour productivity falls until the worker dies is about 1.5%, thus we set as a benchmark $\lambda = 0.8$. In accordance with Miyazawa (2021), we specify $\phi(g_t) = \gamma g_t^b$ and distinguish between a scenario characterized by a high efficiency of grandparenting in reducing the raising cost of children and a low efficiency scenario. Thus we set $\gamma = 15$ and $b = 0.7$. in the case of effective grandparenting and $\gamma = 5$ and $b = 0.1$ in the case of ineffective grandparenting.

First, we consider the benchmark scenario characterized by a PAYG-pension system and no child allowance, i.e. $a = 1$. Figures 4 and 5 compare, respectively, the steady state values of the elderly labour supply and fertility in the case of mandatory

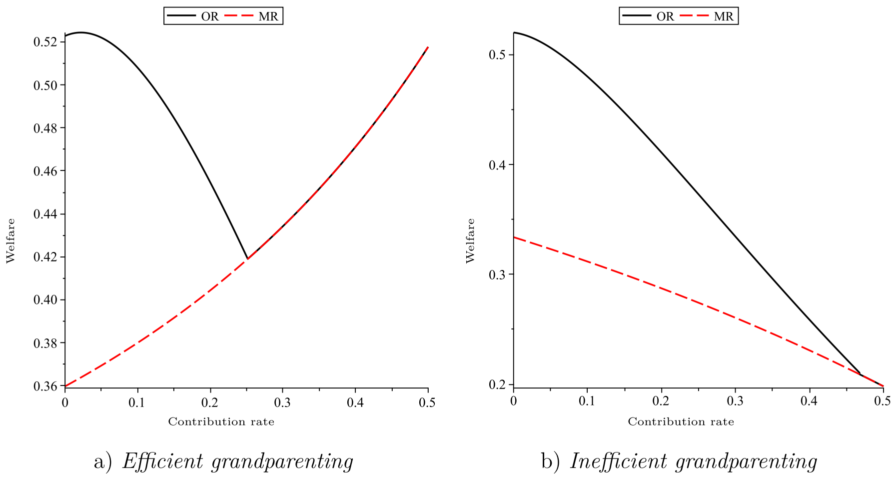


Fig. 6 Welfare

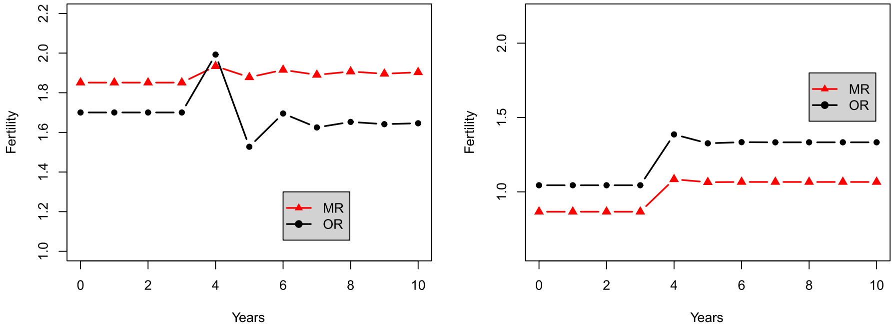
retirement versus optimal retirement when the contribution rate increases from 0.15 to 0.5, in the two scenarios of efficient and inefficient grandparenting.

As shown in the previous section, in the mandatory retirement scheme, fertility increases in relation to the contribution rate if the raising cost of children is below a certain threshold i.e. $q < \tilde{q}$.[8] With our set of parameters $\tilde{q}$ is 0.46 in the case of efficient grandparenting and 0.18 in the case of inefficient grandparenting. In the free retirement scheme, in accordance with the theoretical results, fertility increases with respect to the contribution rate if grandparenting is efficient whereas it declines if grandparenting is inefficient. As shown in the theory, elderly labour supply always declines with the contribution rate.

In Fig. 6, we analyse the impact of the contribution rate on welfare. In accordance with Chen and Miyazaki (2018) welfare is defined as the agent's lifetime utility in the steady state. In the mandatory retirement scheme, both fertility and consumption increase with respect to the contribution rate in the efficient scenario, resulting in a rise in welfare. Conversely, the opposite occurs in the inefficient scenario. In the optimal retirement scheme, opposing effects emerge: grandparenting per child increases, consumption decreases, while the impact on fertility hinges on the efficiency of grandparenting. Some calculations show that welfare increases if the elasticity of the steady-state level of grandparenting per child with respect to the tax rate is sufficiently high.[9] With our parameter settings, in the case of efficient grandparenting, welfare is maximized when the tax rate is very low, i.e. $\tau = 0.02$. In the case of inefficient grandparenting, welfare always decreases.

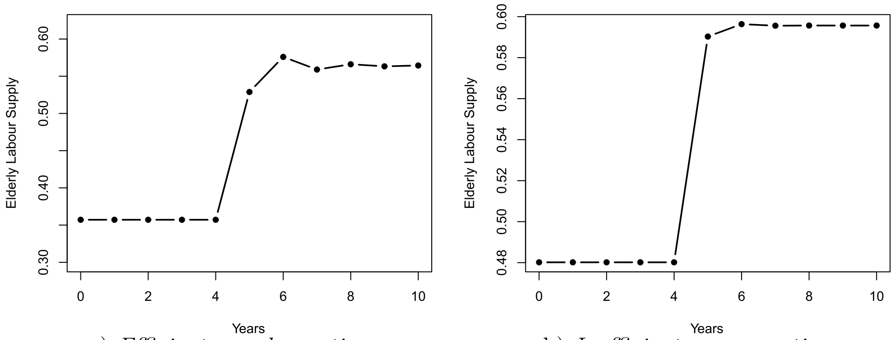
[8] In particular, assuming $\phi(g_t) = \gamma g_t^b$ then $\partial n_t / \partial \tau > 0$ if $q < (1/R)^b[\theta\gamma/(1 + \theta + \beta)R]$.

[9] Specifically, assuming $\phi(g) = \gamma g^b$, the contribution rate has a positive effect on welfare if $\epsilon_{g_\tau} > \tau[1 + \theta + \beta(1 + \delta)]/(1 - \tau)[\theta b + \beta\delta(1 + \beta)]$.



a) *Efficient grandparenting* b) *Inefficient grandparenting*

Fig. 7 Child benefits and Fertility



a) *Efficient grandparenting* b) *Inefficient granparenting*

Fig. 8 Child benefit and elderly labour supply

Let us now consider the effect of the introduction of child benefits on the steady state of the economy. In particular we consider 10 time periods, assume a constant payroll tax rate $\tau = 0.15$ over the entire period and set the introduction of child benefits in period 5, i.e. $a = 0.5$ from period 5 onward. Figure 7 shows that, in the mandatory retirement scheme, child benefits positively affect fertility in both scenarios. In the optimal retirement scheme, on the other hand, fertility decreases with respect to child benefits in the case of efficient grandparenting, whereas it increases in the inefficient scenario.

Figure 8 shows that the introduction of child benefits positively affects the elderly labour supply in both scenarios. In the efficient grandparenting scenario is the direct result of the reduction in both of fertility and grandparenting. For inefficient grandparenting, conversely, this results suggests that the elasticity of fertility in relation to child benefits is lower than the elasticity of grandparenting per child. Overall, these results, are in accordance with empirical evidence which shows that the rise in public childcare provision may act as a substitute for grandparenting, stimulating, therefore, the elderly labour supply through this channel.

5 Conclusion

This paper explores the interplay between grandparental childcare, child allowances and pensions, and their implications for fertility and the elderly labour supply.

Our findings suggest that the introduction of child benefits may be helpful in addressing the challenges posed by an ageing population. The effect of child benefits on fertility is non-monotonic and contingent on the efficiency of grandparenting in reducing child-rearing costs, and child benefits may have a positive or negative impact on the elderly labour supply, again depending on the efficiency of grandparenting. Our simulation results show that, under reasonable parameters, the effect is always positive, suggesting that population ageing could be countered with a child benefit.

The analysis could be extended along several lines. First, for the sake of simplicity, we have assumed a small open economy, i.e. a partial equilibrium environment with a given real interest rate. Second, we have used a common, but specific, functional form for the utility function. Third, we do not consider the role of longevity and morbidity in the elderly population. This last point, in particular, is quite relevant in an ageing society and will be the subject of further analysis.

A Appendix

A.1 Steady state analysis

Differentiating Eq. (16) we obtain:

$$\frac{\partial g_{t+1}}{\partial g_t} = -\frac{q(1+\theta+\beta)\phi'(g_t)}{\theta(1-\tau)[\phi(g_t)^2]} \tag{26}$$

The steady state is locally stable if:

$$\left.\frac{\partial g_{t+1}}{\partial g_t}\right|_{g_t=g^*} > -1. \tag{27}$$

Thus from Eqs.(16) and (26), Eq. (27) holds if:

$$\epsilon_g < 1 - \frac{\tau\theta\phi(g^*)}{q(1+\theta+\beta)} \tag{28}$$

where ϵ_g is the elasticity of grandparenting in the steady state, i.e. $\phi'(g^*)g^*/\phi(g^*)$. Assuming $\phi(g_t) = \gamma g_t^b$ then condition in Eq. (28) is satisfied if the steady state level of grandparenting is sufficiently low, that is:

$$g^* < \left[\frac{(1-b)q(1+\theta+b)}{\tau\gamma b}\right]^{1/b} \tag{29}$$

For the case of optimal retirement, differentiating Eq. (12) we obtain:

$$\frac{\partial g_{t+1}}{\partial g_t} = -\frac{qR\{\tau\lambda(1+\theta+\beta)+\beta\delta[R(1-\tau)+\lambda]\}\phi'(g_t)}{\theta(\lambda+R)\lambda(1-\tau)[\phi(g_t)]^2} \tag{30}$$

Thus:

$$\left.\frac{\partial g_{t+1}}{\partial g_t}\right|_{g_t=g^*} > -1. \tag{31}$$

if:

$$\epsilon_g < \frac{\theta(\lambda+R)\lambda(1-\tau)g^*\phi(g^*)}{qR\{\tau\lambda(1+\theta+\beta)+\beta\delta[R(1-\tau)+\lambda]\}} \tag{32}$$

A.1.1 Mandatory versus optimal retirement

From Eqs. 8, (8), (11), (13), (15) the pension benefit in the optimal and mandatory retirement scheme is, respectively:

$$b_{t+1} = \frac{\tau wR\phi(g_t)\theta(1-\tau)}{q(1+\beta+\theta)R-\tau\phi(g_t)\theta} \tag{33}$$

and:

$$b_{t+1} = \frac{\lambda\tau w(1-\tau)[\theta(1-\tau)(R+\lambda)\phi(g_t)+Rq\lambda(1+\beta+\theta)-R^2q\beta\delta]}{\tau\theta(1-\tau)(R+\lambda)\phi(g_t)+qR[\beta\delta(1-\tau)R+\lambda(1+\beta+\theta)\tau+\lambda\beta\delta)]} \tag{34}$$

where some calculations show that both increases with respect to g_t and the pension benefit is higher in the optimal retirement scheme.

Let us denote by b^*_{MR} and b^*_{OR} the steady state level of the pension benefit in the two retirement schemes.

From Eqs. (12) and (11) grandparenting at time t can be written as:

$$g_t = C + \frac{B}{n_{t-1}} \tag{35}$$

where$C = \tau/\lambda$,$B = qR\{\beta\delta[R(1-\tau)+\lambda)]+\lambda\tau(1+\theta+\beta)\}/\lambda qR[1+\theta+\beta(1+\delta)]$. Thus the steady state level of grandparenting in the optimal retirement scheme can be written as:

$$g^*_{OR} = C + \frac{B}{n^*_{OR}} \tag{36}$$

Let us define the steady state level of grandparenting in the mandatory retirement scheme as:

$$g^*_{MR} = \frac{1}{n^*_{MR}} \tag{37}$$

Thus $g^*_{MR} > g^*_{OR}$ means that:

$$n^*_{OR} - n^*_{MR}(Cn^*_{OR} + B) > 0 \tag{38}$$

Given $l^* = 1 - (Cn^*_{OR} + B)$ the steady state level of the pension benefit in the optimal retirement scheme is given by:

$$b^*_{OR} = \frac{n^*_{OR} + \lambda - \lambda(Cn^*_{OR} + B)}{Cn^*_{OR} + B} \tag{39}$$

Thus from Eq. (38) it follows that $b^*_{OR} > b^*_{MR}$.

A.2 Effects of public pensions

At the steady state eq. 16 yields:

$$(1-\tau)\left(g^* - \frac{1}{R}\right) = \frac{(1+\beta+\theta)q}{\theta\phi(g)} - \frac{1}{R} \tag{40}$$

In the plane with g-axis, the left-hand side represents a positively sloped line which passes a fixed point $(1/R, 0)$. The right-hand side represents a negatively sloped curve, which implies that there is a unique intersection. Denote the g-intercept of the right-hand side by $\hat{g}$:

$$\phi(\hat{g}) = \frac{(1+\beta+\theta)qR}{\theta} \Rightarrow \hat{g} = \phi^{-1}\left(\frac{(1+\theta+\beta)qR}{\theta}\right) \tag{41}$$

Thus if:

$$\hat{g} > \frac{1}{R} \tag{42}$$

when the contribution rate τ increases, the left hand side rotates clockwise around the fixed point. The intersection moves to the right, that is $\partial g^*/\partial\tau > 0$. By contrast if:

$$\hat{g} < \frac{1}{R} \tag{43}$$

as τ increases, the intersection moves to the left, that is $\partial g^*/\partial\tau < 0$.

A.3 Steady state analysis with child policies

From Eqs. (22) and (23) grandparenting at time t can be written as:

$$g_t = C + \frac{B}{n_{t-1}} \tag{44}$$

where $C = a\tau/[1-(1-a)\tau]\lambda$ and $B = \{R\beta\delta(1-\tau) + \lambda\beta\delta[1-(1-a)\tau] + \lambda a\tau(1+\theta+\beta)\}$ $/\{\lambda[1-(1-a)\tau][1+\theta+\beta(1+\delta)]\}$.

Thus from Eqs. (22) and (44) we obtain the following dynamic equation for fertility at time t:

$$n_t = (1-\tau)\left\{Q\phi(g_t) + \frac{(1-a)\tau}{q[1-(1-a)\tau]}X\right\} \tag{45}$$

where $Q = Q(R+\lambda)/\{qR[1+\theta+\beta(1+\delta)]\}$ and:

$$X = 1 + \frac{\lambda(1+\theta+\beta) - \beta\delta R}{n_{t-1}[1+\theta+\beta(1+\delta)]} \tag{46}$$

Thus from Eqs. (44) and (45) it is easy to see that $\partial n_t/\partial n_{t-1} < 0$, in particular:

$$\frac{\partial n_t}{\partial n_{t-1}} = -\frac{(1-\tau)}{n_{t-1}^2}\left\{\frac{\partial\phi(g_t)}{\partial g_t}QB + \frac{(1-a)\tau}{q[1-(1-a)\tau]}\frac{\lambda(1+\theta+\beta)-\beta\delta R}{[1+\theta+\beta(1+\delta)]}\right\} \tag{47}$$

Given that the curve intersects the 45-degree line at a point, there exists a unique steady state n^*.

The steady state is locally stable if:

$$\left.\frac{\partial n_t}{\partial n_{t-1}}\right|_{n_{t-1}=n^*} > -1. \tag{48}$$

From Eq. (48) this condition holds if:

$$\frac{Q\phi(n^*)}{n^*}\left(1 + \frac{\partial\phi(n^*)}{\partial n^*}\frac{n^*}{\phi(n^*)}\right) + \frac{\tau(1-\tau)(1-a)}{[1-(1-a)\tau]n^*} > 0 \tag{49}$$

where assuming $\phi(g) = \gamma g^b$, if $b < 1$ this condition is always satisfied. In particular from Eq. (44), if $b < 1$ we get:

$$1 + \frac{\partial\phi(n^*)}{\partial n^*}\frac{n^*}{\phi(n^*)} = \frac{Cn^* + B(1-b)}{Cn^* + B} > 0. \tag{50}$$

A.4 Impact of child benefits

From Eq. (45) the impact of child benefits is given by:

$$\frac{\partial n_t}{\partial a} = \frac{(1-\tau)\tau X}{\lambda[1-(1-a)\tau]^2}\left[\frac{Q(1-\tau)}{\lambda}\frac{\partial\phi(g_t)}{\partial g_t} - \frac{1}{q}\right]. \tag{51}$$

Let us define $\hat{\phi(g)} = \lambda/Q(1-\tau)q$ From Eq. (51) it follows that if $\phi'(g) < \hat{\phi(g)}$ then the right hand side of equation (45) decreases with respect to a, thus the steady state level of fertility decreases in relation to a, that is child benefits positively affect the steady state level of fertility. Conversely, if $\phi'(g) > \hat{\phi(g)}$ the steady state level of fertility decreases in relation to child benefits.

From Eq. (44) the overall impact of child benefits on the steady state level of grandparenting is given by:

$$\frac{\partial g^*}{\partial a} = \frac{\tau(1-\tau)}{\lambda[1-(1-a)\tau]^2} + \frac{1}{n^{*2}}\left[\frac{\partial B}{\partial a}n^* - \frac{\partial n^*}{\partial a}B\right] \tag{52}$$

where:

$$\frac{\partial B}{\partial a} = \frac{(1-\tau)\tau[(1+\beta+\theta)\lambda - R\beta\delta]}{\lambda[1+\beta(1+\delta)+\theta][1-(1-a)\tau]^2} > 0 \tag{53}$$

Thus if $\phi'(g) < \hat{\phi(g)}$ then $\partial n^*/\partial a < 0$ and therefore $\partial g^*/\partial a > 0$, that is grandparenting decreases with respect child benefits. Otherwise the overall effect is ambiguous.

From Eq. (44) the steady state level of the elderly labour supply is given by:

$$l^* = 1 - n^*C - B \tag{54}$$

Thus the impact of a child benefit is given by:

$$\frac{\partial l^*}{\partial a} = -\left[\frac{\partial n^*}{\partial a}C + n^*\frac{\partial C}{\partial a} + \frac{\partial B}{\partial a}\right] \tag{55}$$

where $\partial C/\partial a > 0$ and $\partial B/\partial a > 0$. Thus if $\partial n^*/\partial a > 0$ it follows that $\partial l^*/\partial a < 0$, that is child benefits positively affect the elderly labour supply. Conversely, if $\partial n^*/\partial a < 0$ the overall effect is ambiguous.

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References

Aísa, R., Pueyo, F., & Sanso, M. (2012). Life expectancy and labor supply of the elderly. *Journal of Population Economics, 25*(2), 545–568.

Apps, P., & Rees, R. (2001). Household production, full consumption and the costs of children. *Labour Economics, 8*(6), 621–648.

Apps, P., & Rees, R. (2004). Fertility, taxation and family policy. *Scandinavian Journal of Economics, 106*(4), 745–763.
Backhaus, A., & Barslund, M. (2021). The effect of grandchildren on grandparental labor supply: Evidence from Europe. *European Economic Review, 137*, 103817.
Baughman, R., & Dickert-Conlin, S. (2009). The earned income tax credit and fertility. *Journal of Population Economics, 22*(3), 537–563.
Blackburn, K., & Cipriani, G. P. (2002). A model of longevity, fertility and growth. *Journal of Economic Dynamics and Control, 26*(2), 187–204.
Boldrin, M., De Nardi, M., & Jones, L. E. (2015). Fertility and social security. *Journal of Demographic Economics, 81*(3), 261–299.
Boldrin, M., & Jones, L. E. (2002). Mortality, fertility, and saving in a Malthusian economy. *Review of Economic Dynamics, 5*(4), 775–814.
Börsch-Supan, A. (2019). Survey of health, ageing and retirement in europe (share) wave 1. *Release version 7.0.0.*.
Börsch-Supan, A., Bucher-Koenen, T., Kutlu-Koc, V., & Goll, N. (2018). Dangerous flexibility-retirement reforms reconsidered. *Economic Policy, 33*(94), 315–355.
Bratti, M., Frattini, T., & Scervini, F. (2018). Grandparental availability for child care and maternal labor force participation: Pension reform evidence from Italy. *Journal of Population Economics, 31*, 1239–1277.
Chen, H.-J., & Miyazaki, K. (2018). Fertility and labor supply of the old with pay-as-you-go pension and child allowances. *The BE Journal of Macroeconomics, 18*(1), 20160182.
Cohen, A., Dehejia, R., & Romanov, D. (2013). Financial incentives and fertility. *Review of Economics and Statistics, 95*(1), 1–20.
Crump, R., Shah Goda, G., & Mumford, K. J. (2011). Fertility and the personal exemption: Comment. *American Economic Review, 101*(4), 1616–1628.
Ehrlich, I., & Kim, J. (2007). Social security and demographic trends: Theory and evidence from the international experience. *Review of Economic Dynamics, 10*(1), 55–77.
Fanti, L., & Gori, L. (2014). Endogenous fertility, endogenous lifetime and economic growth: The role of child policies. *Journal of Population Economics, 27*(2), 529–564.
Ferreira, P. C., & de Abreu Pessôa, S. (2007). The effects of longevity and distortions on education and retirement. *Review of Economic Dynamics, 10*(3), 472–493.
Floridi, G. (2022). Daily grandchild care and grandparents' employment: A comparison of four european child-care policy regimes. *Ageing & Society, 42*(2), 448–479.
Francesconi, M., & Van der Klaauw, W. (2007). The socioeconomic consequences of "in-work'' benefit reform for British lone mothers. *Journal of Human Resources, 42*(1), 1–31.
Frimmel, W., Halla, M., Schmidpeter, B., & Winter-Ebmer, R. (2022). Grandmothers' labor supply. *Journal of Human Resources, 57*(5), 1645–1689.
Garcia-Moran, E., & Kuehn, Z. (2017). With strings attached: Grandparent-provided child care and female labor market outcomes. *Review of Economic Dynamics, 23*, 80–98.
Gauthier, A. H. (2007). The impact of family policies on fertility in industrialized countries: A review of the literature. *Population research and policy review, 26*(3), 323–346.
Glomm, G., & Kaganovich, M. (2008). Social security, public education and the growth-inequality relationship. *European Economic Review, 52*(6), 1009–1034.
González, L. (2013). The effect of a universal child benefit on conceptions, abortions, and early maternal labor supply. *American Economic Journal: Economic Policy, 5*(3), 160–88.
Gruber, J., & Wise, D. (1998). Social security and retirement: An international comparison. *The American Economic Review, 88*(2), 158–163.
Gruber, J., & Wise, D. A. (2002). Social security programs and retirement around the world: micro estimation. *National Bureau of Economic Research Cambridge, Mass., USA*.
Hank, K., & Buber, I. (2009). Grandparents caring for their grandchildren: Findings from the 2004 survey of health, ageing, and retirement in Europe. *Journal of Family Issues, 30*(1), 53–73.
Havnes, T., & Mogstad, M. (2011). Money for nothing? Universal child care and maternal employment. *Journal of Public Economics, 95*(11–12), 1455–1465.
Hirazawa, M., & Yakita, A. (2017). Labor supply of elderly people, fertility, and economic development. *Journal of Macroeconomics, 51*, 75–96.
Kaganovich, M., & Zilcha, I. (1999). Education, social security, and growth. *Journal of Public Economics, 71*(2), 289–309.

Laroque, G., & Salanié, B. (2014). Identifying the response of fertility to financial incentives. *Journal of Applied Econometrics, 29*(2), 314–332.

Laughlin, L. L. (2010). Who's minding the kids? child care arrangements: Spring 2005/Summer 2006. Current Population Reports. *US Census Bureau*, 70–121.

Letablier, M.-T., Luci, A., Math, A., & Thévenon, O. (2009). *The costs of raising children and the effectiveness of policies to support parenthood in European countries: A literature review*. Social Affairs and Equal Opportunities, Brussels European Commission: Directorate-General Employment.

Milligan, K. (2005). Subsidizing the stork: New evidence on tax incentives and fertility. *Review of Economics and Statistics, 87*(3), 539–555.

Miyazawa, K. (2016). Grandparental child care, child allowances, and fertility. *The Journal of the Economics of Ageing, 7*, 53–60.

Miyazawa, K. (2021). Elderly empowerment, fertility, and public pensions. *International Tax and Public Finance, 28*, 941–964.

Mizuno, M., & Yakita, A. (2013). Elderly labor supply and fertility decisions in aging-population economies. *Economics Letters, 121*(3), 395–399.

Nishimura, Y., Pestieau, P., & Ponthiere, G. (2018). Education choices, longevity and optimal policy in a ben-porath economy. *Mathematical Social Sciences, 94*, 65–81.

Price, D., Ribe, E., Gessa, G. D., & Glaser, K. (2018). Grandparental childcare: A reconceptualisation of family policy regimes. *Grandparenting Practices around the World.* Bristol: Policy Press.

Riphahn, R. T., & Wiynck, F. (2017). Fertility effects of child benefits. *Journal of Population Economics, 30*(4), 1135–1184.

Rupert, P., & Zanella, G. (2018). Grandchildren and their grandparents' labor supply. *Journal of Public Economics, 159*, 89–103.

Stella, L. (2017). Living arrangements in Europe: Whether and why paternal retirement matters. *Review of Economics of the Household, 15*, 497–525.

Van Bavel, J., & De Winter, T. (2013). Becoming a grandparent and early retirement in Europe. *European Sociological Review, 29*(6), 1295–1308.

Wigger, B. U. (1999). Pay-as-you-go financed public pensions in a model of endogenous growth and fertility. *Journal of Population Economics, 12*(4), 625–640.

Zhang, J., & Zhang, J. (1998). Social security, intergenerational transfers, and endogenous growth. *Canadian Journal of Economics, 31*, 1225–1241.