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Abstract

A PAYGO system may serve as insurance against not having children and as an enforcement device for ungrateful children who are unwilling to pay their parents a pension. In fact, the latter was Bismarck's historic motive for introducing this system. It is true that the PAYGO system reduces the investment in human capital, but if it is run on a sufficiently small scale, it may nevertheless bring about a welfare improvement. If, on the other hand, the scale of the system is so large that parents bequeath some of their pensions to their children, it is overdrawn and creates unnecessarily strong disincentives for human capital investment.

JEL classification: H55; J1
Keywords: Fertility insurance; Human capital investment; Pension system

1. Introduction

Once Bismarck's social reforms were seen as a major institutional achievement, many countries endeavored to copy them. Now, a century later, the initial enthusiasm has waned, and the pay-as-you-go pension system (PAYGO), in particular, has come under heavy attack. Among others things, the PAYGO system is accused of being unable to provide satisfactory pensions in a time of declining population growth, of reducing labor supply, of offering an inefficiently low rate of return, and of distorting people's fertility choices.

Although some of these accusations against the PAYGO system are justified, the fact that this system may also bring about favorable allocation effects should not be over-

☆ This is a revised version of a paper presented on the occasion of Agnar Sandmo's sixtieth birthday.

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looked, however. Among these effects is the elimination of adverse selection which would be likely to occur with private annuity markets (Townley and Boadway, 1988; Feldstein, 1990), the avoidance of free riding by parents who plan to exploit the altruism of their children (Lindbeck and Weibull, 1988), or intergenerational risk sharing (Smith, 1982; Enders and Lapan, 1982; Gordon and Varian, 1988; Hassler and Lindbeck, 1997). This paper adds two further potentially favorable effects which do not seem to have received any attention in the literature.

First, the PAYGO system may provide insurance against not having children. If every household were able to have children, they could receive their pensions from their own children. However, given the risk of being infertile or not finding an appropriate partner, a pooling system, which makes it possible to receive the pension from other people's children, if necessary, could be welcomed as an insurance device. Clearly, this type of insurance may be useful when there is no capital market and human capital is the only form of intertemporal resource transfer. However, even with such a capital market, human capital investment has the advantage of offering inframarginal returns above the market rate of interest. If these inframarginal returns are available only with a certain probability, risk averse households may gain from pooling and sharing the resource flows provided by their children. A problem arises, however, insofar as pooling reduces the incentive to invest in human capital in the sense of having children and educating them. This is a moral hazard effect which is a typical drawback of any type of insurance. It remains to be seen whether the PAYGO system retains a useful role despite an endogenous decline in human capital investment.

Second, the PAYGO system may serve as an enforcement device for ungrateful children, or 'rotten kids', to use Becker's (1976) language. In fact, it is precisely this enforcement function that induced Bismarck to introduce the old age pension system in Germany. Bismarck wanted the pension system as a substitute for the transfer mechanisms of the traditional family that had been destroyed by the industrial revolution, seeing it mainly as a means to avoid the neglect and mistreatment of old people by their children[1].

Within the traditional family, there may have been sufficiently strong enforcement mechanisms to make sure that children would provide for their old parents. As shown in a seminal paper by Cigno (1993), there is a chance for self-enforcing family constitutions which ensure the necessary intergenerational transfers even in the absence of intergenerational altruism. However, the loosening of family ties that characterizes modern societies

[1] In the seminal speech which Chancellor Bismarck gave to the Reichstag in 1881 to initiate his reforms he said that it was important to preserve a sense of human dignity and to prevent the deprivation involved in living on charity by giving the impoverished old and disabled a pension (see Stein, no year, p. 174). Remarkably, he used the word 'peculium' to characterize this pension. The peculium is the money that a Roman master left to the control of his slaves and that he allowed his slaves to save for the purpose of buying their liberty towards the end of their working life. Bismarck knew what he was saying when he compared the old and disabled with Roman slaves and when he elaborated on the mistreatment of old people in their families extensively in his speech. His goal was to enable the recipients of the peculium to open doors which otherwise would have remained closed and to buy better treatment from their families. He believed that, without the peculium, the impoverished old and disabled would have no weapon against being 'pushed into a corner' and suffering hunger. He mistrusted the benevolence and generosity of the new type of family that had emerged from urbanization and industrialization and saw the pension system as an enforcement device for ensuring a resource transfer to the older generation.

has destroyed these mechanisms, and the legal system has been unable to enforce the corresponding duties. The consequence of this development was an unpleasant situation for those old and disabled people who had to rely on voluntary transfers from their children. All too often a high price in lost dignity and self-determination, or even intra-family work and starvation, had to be paid by the old.

The neglect of old people is not only a problem in its own right, it may also induce adults, who anticipate the future behavior of their children, to underinvest in human capital in the sense of choosing to have a lower number of offspring or of neglecting the offspring's education. A system that imposes the obligation on children to make pension payments to their own parents may reinstall the proper incentives for a human capital investment. However, the existing pension systems do not impose such an obligation. Instead they pool the children's contributions and distribute them to their own parents and other people's parents independently of the individual amount of human capital investment. Whether such a collective enforcement system can nevertheless generate welfare improvements will have to be discussed.

Section 2 of this paper will present a simple two-period model with a capital market, human capital investment, and endogenously determined private pensions, that will serve as a basis for studying the two effects. Section 3 will analyze the problem of fertility risk, and Section 4 is devoted to the enforcement problem. The paper will end with a policy conclusion which may be relevant to the current debate on PAYGO systems.

2. A simple model of fertility choice and intergenerational transfers

Abstract for a moment from public pensions, fertility risk and enforcement problems and consider a household that lives for two periods and can choose between two ways of making an intertemporal resource transfer from the first to the second period. The first is saving in the form of real (or financial) capital, S_K, the other is saving in the form of human capital, S_H, i.e., by raising children. Children are raised in the first period and work in the second. Parents work in the first period and are retirees in the second. Taking second period goods as numeraire, the price of first period goods is R, where R is one plus the rate of interest on a capital market investment. R is fixed for technological reasons or since a small open economy is assumed. For analytical convenience, S_K and S_H are defined in terms of second period goods. While real capital thus defined generates a return S_K which is equal to the investment, human capital generates a return $f(S_H)$, $f' > 0$, $f'' < 0$, in terms of the labor income that children can earn in the second period. Let $f'(S_H) > 1$ for some range $S_H < S_H^*, S_H^* > 0$, to ensure that the inframarginal return on human capital investment may exceed the return on investment in the capital market. It is assumed that $f(S_H)$ is the outcome of an optimal choice with regard to the decision about the quantity of children and the quality of their education[2]. Parents are altruistic and care about aggregate second-period consumption C_C of their children whose number is determined through the

[2] Let n be the number of children and S_H/n stand for the quality of education. The human capital production function can then be defined such that $f(S_H) = \max_n \varphi(S_H/n, n)$. Under reasonable regularity assumptions, n will be an increasing function of S_H, and this is what is assumed.

human capital investment decision[3]. Although the model has only two periods, C_C can be interpreted as an indicator of the infinite flow of consumption which the second and all further generations' optimal investment choices would generate out of the resources which the parents transfer to their children. Let C_{P1} and C_{P2} be the parents' first and second period consumption and let T be a private pension transfer from children to their parents in the second period. E is the family's first period endowment, i.e., the sum of its material wealth and labor income, net of potential transfers paid to the generation of grandparents, again expressed in terms of second period goods.

The family's intertemporal budget constraints are:

$$C_P = E - S_H + T \tag{1}$$

and

$$C_C = f(S_H) - T \tag{2}$$

where

$$C_P = RC_{P1} + C_{P2} \tag{3}$$

is aggregate parent consumption in terms of second period goods. Eq. (1) says that aggregate parent consumption equals the excess of parent endowment over human capital investment plus pensions received from children, and Eq. (2) shows that (second period) child consumption equals the difference between wage income and these pensions. Note that saving in real capital (in terms of second period goods) is given by that part of the endowment not used up for first period consumption and human capital investment, $S_K = E - RC_{P1} - S_H$, and that second period consumption by parents may result from real and human capital investment, $C_{P2} = S_K + T$.

Parents care for themselves and for their children. Parent utility is given by a strictly concave nested function of the type $U[C_C, V(C_{P1}, C_{P2})]$ where V is an increasing, strictly quasi concave sub-function reflecting the egoistic part of utility. Throughout, the paper bases welfare judgments only on altruistic parent utility[4]. The rationale for not respecting children's preferences, other than through their own parents' judgments, is that, in the model, collective decisions in the form of introducing a PAYGO system are taken before the children are born. Even if there were plausible welfare axioms that legitimate a double

[3] In general, the parents' altruistic utility from child consumption can be taken to be a function of per capita consumption and the number of children, $W(C_C/n, n)$. For the sake of simplicity, it is assumed here that $W(C_C/n, n) = (C_C/n)^{\alpha} \cdot n^{\alpha} = C_C^{\alpha}$ where α is a positive constant whose effect is amalgamated with the shape of the overall utility function U. Admittedly, this is not a realistic assumption. However, it has the advantage of delegating the implicit quantity–quality choice to the human capital investment decision (see footnote 2) and separating it from the influence of intergenerational resource transfers. Alternatively, it could be assumed without any change in the formal apparatus developed in this paper and no consequence for the formal propositions that the number of children in the fertility case is fixed and that the human capital investment decision refers to education only.

[4] Thus the paper follows a basic assumption made in the seminal work of Razin and Ben-Zion (1975). See Blackorby and Donaldson (1984), Nerlove et al. (1987) and Razin and Sadka (1995) for extensive discussions of this issue.

inclusion of future generations' preferences in a social welfare function, they would not contribute to an understanding of the motives behind these collective decisions. For the time being, the concentration on parent preferences will be complemented with the assumption that parents and offspring share the same preferences or, alternatively, that parents can enforce transfers from their children to themselves if they so wish. Section 4 will study the implications of giving up this assumption.

Solving the problem:

$$\max_{(C_{P1},C_{P2})} V(C_{P1},C_{P2}) \quad \text{s.t.} \quad (3) \tag{4}$$

yields an indirect utility function $V^*(C_P,R)$, where V^* is strictly increasing in C_P. Given R and adjusting the shape of the overall utility function U, we may set $C_P \equiv V^*(C_P,R)$ without any loss of generality. Thus the remaining optimization problem is:

$$\max_{(C_C,C_P,S_H)} U(C_C,C_P) \quad \text{s.t.} \quad (1) \text{ and } (2). \tag{5}$$

Problem (4) yields the usual condition that the marginal rate of intertemporal substitution be equal to the price of first period consumption:

$$\frac{V_1}{V_2} = R,$$

and problem (5) yields:

$$f'(S_H) = \frac{U_2}{U_1} = 1, \tag{6}$$

which says that the marginal product of a human capital investment and the marginal rate of substitution of child for parent consumption be equal to one. As human capital investment is defined in terms of second-period goods, this implies that, according to the ordinary definition, the marginal rate of return on human capital, $R \cdot f'(S_H) - 1$, equals the marginal rate of return on real capital, $R - 1$.

Fig. 1 illustrates the nature of the two-stage optimization problem solved by the household, including the choice of an investment in the capital market, of an investment in human capital, and of the private pensions paid by children to their parents. The upper part of the diagram shows the household's transformation curve between parent and child resources and an indifference curve with regard to parent and child consumption, assuming that parent consumption is optimally distributed between the first and second periods. The optimal time structure of parent consumption is determined in the lower quadrant whose axes measure the second period value of first period consumption, RC_{P1}, and second period consumption C_{P2}. The budget lines with slope -1 indicate the transformation possibilities given by the capital market and the indifference curves represent the parents' egoistic sub-utility $V(C_{P1},C_{P2})$. The optimal choice is represented by a pair of points in the two parts of the diagram whose coordinates determine C_C, C_P, RC_{P1} and C_{P2}.

The parents could realize $C_P = RC_{P1} = E, C_C = C_{P2} = 0$, by not having children, by not investing in the capital market, and by consuming all of their endowment E in the first period, but there are significantly better strategies for them. One strategy would be giving up some first-period consumption and save real capital in order to enjoy second period

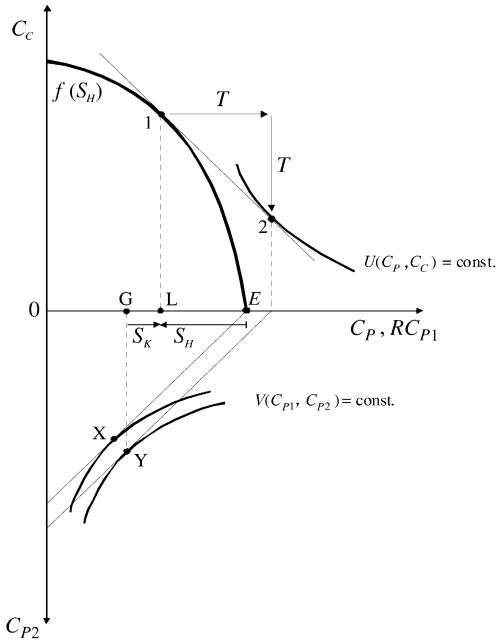

Fig. 1. Optimal investment in human and real capital.

consumption. Doing this, they could thus move along the budget line through E in the lower quadrant and reach point X which indicates the optimal intertemporal distribution of C_P as given by RC_{P1} and C_{P2}. An even better strategy is having children and investing in human capital so as to produce a labor income $f(S_H)$ earned by their children out of which a private transfer, T, can be paid. Call the locus of feasible combinations of child and parent consumption attainable with alternative transfer levels the 'redistribution line'. There is one redistribution line for each point on the human capital production frontier, but clearly the family will choose the most outward of these lines which is tangent to the frontier at point 1, depicting marginal condition (6). The optimal combination of child and parent consumption is given by point 2 where this redistribution line is tangent to a family indifference curve. Accordingly, the intertemporal budget line for parent consumption will shift outward so that it reaches the abscissa at the optimal level of overall parent consumption. On this budget line, point Y indicates the new intertemporal distribution of parent consumption. To summarize: points E and X characterize the household's choice when there are no children and when only real investment is feasible, and points 2 and Y characterize the choice when an investment in human capital is also possible. As is indicated in the figure with the two arrows along the abscissa, parents now simultaneously invest the amount GL in real capital, S_K, and LE in human capital, S_H. The possibility of splitting savings between the two kinds of assets increases the utility $U(C_P, C_C)$ of the family and possibly even the egoistic part of parent utility, $V(C_{P1}, C_{P2})$.

It is sometimes argued that pensions cannot be a motive for having children when there is a well functioning capital market because (real capital) savings are available as a means

of receiving a resource transfer at retirement age. The model shows the limitations of this argument. While the capital market offers a given rate of return $R-1$ on foregone first-period consumption, a human capital investment offers an endogenous rate of return, $R \cdot f'(S_H) - 1$, which is generally higher and which will only equal it at the margin. The existence of high inframarginal returns on a human capital investment makes children an attractive investment for parents, and this would be so even if they did not have an altruistic concern for their children.

Of course it may be doubted that the inframarginal return on human capital is really higher than the rate of return on capital, in particular when the considerable fixed costs of child raising is taken into account. Possibly, the human capital production curve in Fig. 1 does not start at E but further to the left such that high inframarginal returns do not necessarily imply that the average rate of return on human capital investment will exceed the market rate of interest. However, empirically the matter is very clear, and therefore the fixed costs are neglected in the model. From 1961 to 1997, the average real rate of return on US government bonds was about 2.7%. This was far less than the average real rate of return on human capital investment, which various studies have placed in the range of 12–26%[5]. Obviously the ability to invest in human capital has an enormous wealth effect on the family's intertemporal budget constraint which generates a private pension motive for investing in human capital even if there is a well developed capital market. The following proposition summarizes these findings.

Proposition 1. *With enforceable transfers and in the absence of a public pension system, marginal investment in human capital will be as productive as an investment in the capital market. The existence of higher inframarginal returns on human capital implies that the family gains utility from having children and investing in their human capital.*

This result may seem puzzling when comparing it with the well known result of Aaron (1966) according to which the rate of return of a PAYGO system, be it public or private, equals the growth rate of the aggregate volume of intergenerational transfers which, in a dynamically efficient economy, falls short of the rate of return on capital. Note, however, that the Aaron return derives from comparing the payment flows from the working generation to the old generation in two consecutive periods of time rather than from comparing a person's labor income with the cost of his education. To calculate Aaron's return in the present model, it would be necessary to compare the pensions that parents pay to grandparents with the pensions parents themselves receive from their children. This return would indeed be below the market rate of interest if the family's income grows at the average growth rate of the economy. As shown in Sinn (2000) the interest disadvantage is not a sign of inefficiency but just an outcome of an intergenerational zero-sum game with regard to the transfers from children to parents. All generations in an ongoing

[5] In a recent detailed study, the OECD (1998) estimates the returns on human capital to lie between 12.6% for university education and 26.3% for upper secondary education in the US and finds similar values for all OECD members. In a more conservative estimation, McMahon (1991) finds that, for males and females in the US, the real rate of return to education ranges from 12% for high school education to 12–14% for college level education.

intergenerational transfer system pay an implicit tax to share the burden of servicing the implicit pension debt inherited from earlier generations. The interest disadvantage that results from this implicit tax is fully compatible with the interest advantage of human capital investment. To say it pointedly: the Aaron return measures the award for being kind to one's predecessors, the return on a human capital investment the award for being kind to one's descendants.

3. The pay-as-you-go system as fertility insurance

A household which is infertile, or for other reasons unable to raise children, will not be able to realize the utility gain that results from child consumption and human capital investment. Such a household would benefit from the introduction of a public PAYGO system, because this system would make it possible to draw on the earnings capacity of other people's children. A PAYGO system pools some of the earnings capacity of children among the old generation, and if the absence of such a capacity is bad luck rather than voluntary choice, risk averse agents may perceive this system as a useful fertility insurance.

In many traditional societies where social insurance systems have not been established, children are seen as an important safeguard against poverty in old age, and in the western world things were not very different before the social security systems were developed[6]. Without social security, biological infertility or a missed opportunity to find a partner with whom it would be possible to have children is perceived as a major economic misfortune. The public provision of the PAYGO pension system may be able to provide the desired insurance against this misfortune.

Note that, under the constitutional laws of western societies, such insurance could not be provided by private markets since this would imply that unmarried people can sign contracts which force their subsequent children, when adult, to make payments to childless members of the old generation. Contracts which imply such payments could only be made by the children themselves, but when these children are old enough to do that, it is known which families could not have children and therefore no voluntary payments will occur. A mutually beneficial insurance contract is only conceivable before the children are born, but then it is excluded by the constitution. Only a government imposed insurance is possible, and the PAYGO system can be seen as such an insurance.

The PAYGO system may, however, not only have favorable implications. Most insurance systems encounter moral hazard effects and the PAYGO system may not be an exception. The particular moral hazard effect that can be analyzed by using the model set up in the previous section is a reduction in human capital investment in the sense of reducing the quantity of children and/or the quality of their education.

The PAYGO system changes the household's budget constraints (1) and (2) to:

$$C_P = E - S_H + T + B \tag{7}$$

and

$$C_C = f(S_H)(1-\tau) - T \tag{8}$$

[6] See Neher (1971), Willis (1980) and Nugent (1985).

where B is the pension benefit and τ is the contribution rate. Eqs. (7) and (8) refer to both the fertile and the infertile household. An infertile household faces the additional constraint

$$C_C = S_H = T = 0 \quad \text{(infertile household)}.$$

Let π be the probability that the household is fertile and assume that fertility is a stochastically independent event across all households[7]. Then the government budget constraint is:

$$\pi \tau f(S_H) = B. \tag{9}$$

The household decides about its human capital investment after it knows which type it is. The infertile household takes E, B and hence, C_P as given. It optimizes its intertemporal consumption choice according to (4) and receives a utility

$$U(0, C_P) \text{ where } C_P = E + B.$$

The fertile household also takes E and B as given, but it can manipulate C_P via its choice of human capital investment. It maximizes $U(C_C, C_P)$ s.t. (7) and (8), and it also optimizes its intertemporal consumption choice according to (4). A necessary condition for the fertile household's optimum is:

$$f'(S_H)(1-\tau) = \frac{U_2}{U_1} = 1 \tag{10}$$

which implies that:

$$\frac{\mathrm{d}S_H}{\mathrm{d}\tau} = \frac{1}{f''(S_H)\cdot(1-\tau)^2} < 0. \tag{11}$$

Comparing Eqs. (10) and (6) shows that it will still be true that the household allocates consumption between parents and children so as to equate the marginal rate of substitution of child for parent consumption to one. However, the social security tax drives a wedge between the marginal product of human capital and this marginal rate of substitution. As Eq. (11) reveals, this wedge results in a decline in human capital investment. This is a moral hazard effect of the PAYGO system which has been studied by various authors in alternative frameworks[8].

Proposition 2. *While a PAYGO system may serve as fertility insurance, it brings with it a moral hazard effect in terms of reducing the optimal investment in human capital.*

To interpret this proposition properly note that the function $f(S_H)$ is meant to capture such matters as the marriage decision, the decision to have children, and the decision to invest in the education of a given number of children. The PAYGO system can be expected to discourage each one of these decisions.

[7] The paper abstracts from any uncertainty in the income earned by a child, given that it was born. A useful analysis of that type of uncertainty can be found in Rosati (1996).

[8] See Nugent (1985), Cigno (1991, 1993), Felderer (1992), Cigno and Rosati (1996), Rosati (1996), Werding (1997, 1998) or Becker and Barro (1988).

The nature of the moral hazard effect is illustrated in Fig. 2. Points 1 and 2 characterize the solution without the PAYGO system as known from Fig. 1. Taxing the return to human capital shifts the net-of-tax production line down to the position $f(S_H)(1-\tau)$, and the optimal production point on this curve is $1'''$ which corresponds to point $1'$ on the pre-tax production line $f(S_H)$. Point $1'$ is to the right of point 1 because, for any given S_H, the net-of-tax production curve has a lower (absolute) slope than the pre-tax production curve and because the slope of the former must be equal to one in the optimum. This demonstrates the moral hazard effect in terms of underinvesting in human capital as given by (11).

The fertile household's social security tax burden, $\tau f(S_H)$, is given by the distance $1'\,1'''$, and its pension, B, equals the distance $1''\,1'''$. Because of (11) the ratio of the distances $1''\;1'''$ and $1'\,1'''$ is π, the probability of being fertile and the share of fertile households in the population. Starting from point $1''$ the household can move to the south east along a redistribution line by transferring resources between the generations. The optimal consumption point is $2''$ where the slope of the indifference curve equals the slope of the redistribution line.

Of course, the moral hazard effect occurs only with fertile people. Infertile people also receive the pension, but they can only move from point 3 towards point $3''$ on the abscissa.

Note that the moral hazard effect does not depend on the assumption that the taxed households do not get a full rebate in terms of pensions. Since the size of the pension a household receives does not depend on the actions it chooses, the pension is a lump sum rebate. The size of this rebate influences the optimal consumption pattern, but not the optimal investment in human capital. Consider for a moment the extreme case where all

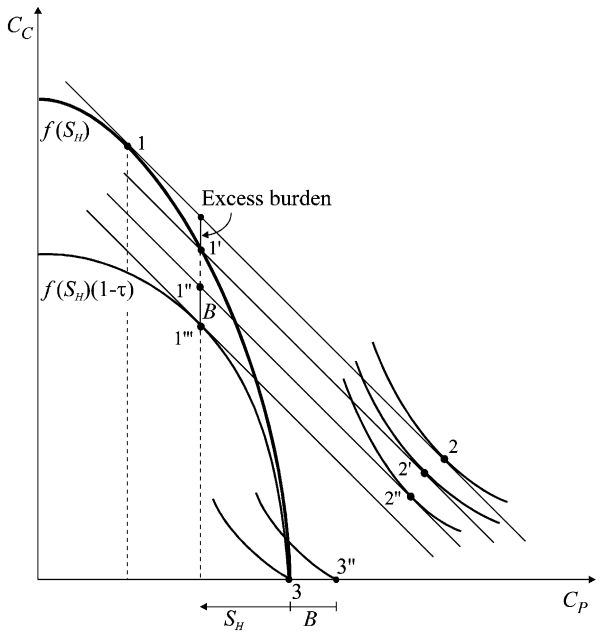

Fig. 2. The moral hazard effect of the PAYGO system.

households are fertile, $\pi = 1$, but the government nevertheless imposes the PAYGO system. In this case the lump sum rebate B would equal the social security tax $\tau f(S_H)$ and thus the family can move along the redistribution line that leads through $1'$. It will choose point $2'$ rather than $2''$. However, in either case, $1'$ gives the optimal pre-tax return on the human capital investment in terms of the wage income earned by the children.

The case of a full lump sum rebate is useful because it indicates the excess burden of the PAYGO system. Obviously the horizontal or vertical inward shift of the redistribution line from position 2 to $2'$ or 1 to $1'$ measures the excess burden in terms of second period consumption.

The reduction in marriage frequencies, birth rates and/or education efforts may be the most important distortions the PAYGO system causes, and these distortions could be the main explanation for the pension crises that western societies will face in the years to come. Hard empirical evidence for this effect is difficult to find since the reproduction behavior of people alters slowly. It may take generations for habits to change. Nevertheless, the literature has produced a growing body of evidence that confirms the existence of such an effect[9].

To assess the magnitude of the fiscal externality that results from charging descendants, some thought must be given as to how the model contribution rate relates to the contribution rate in existing PAYGO systems. This relationship is not trivial. Given the contribution rate, there is a big fiscal externality in flat pension systems such as that of the US and a smaller one in systems with individual accounts and a rough proportionality between pensions and contributions like in Germany. Even in the German case, however, the externality can be enormous. If a household decides to raise an additional child it will establish a new dynasty of descendants. If all members of this dynasty will reproduce at the average rate and earn an average income, 100% of the PAYGO contributions of this child are a fiscal externality that benefits other dynasties, and under actual conditions applying in Germany this is a sum of about € 90.000 in present value terms calculated for the time from child birth[10]. Seen this way, the social security hypothesis means that paying a mother € 90.000 at the time of child birth, so as to compensate for the moral hazard effect of the pension system, will increase the measured fertility rate. This does not seem an implausible proposition.

The example of Germany is also interesting because it was in this country that Bismarck introduced the first large-scale public pension system, and this system has developed here further than in most other countries. In the nineteenth century, Germany's population growth was the third highest in Europe. Now this country has one of the lowest birth rates of all OECD countries. Ten Germans have, on average, less than seven children throughout their lives, and a fatal crisis in the public pension system is in sight. In Germany, generations of households have learned that life in old age can be pleasant and economically sound even without children. The idea of marrying and having children in order to ensure satisfactory consumption in old age had been common before Bismarck's reforms. A century later, this idea has largely vanished, and a growing

[9] Cf. Caldwell (1982), Swindler (1986), Jensen (1990), and Cigno and Rosati (1996).
[10] See Sinn (2001).

number of people prefer to stay single or, at best form a 'dink family'—with double income and no kids[11].

The existence of an excess burden in terms of reduced human capital investment does not necessarily imply that it is unwise to impose a PAYGO system. The redistribution between fertile and infertile families which this system implies may still result in a net increase of expected utility from an ex ante perspective, that is, before it is known whether the household will be able to have children or not. In fact, it is possible to show that if people are risk averse in the sense that they prefer the kind of redistribution provided by a PAYGO system in the absence of moral hazard, they will like at least some of this redistribution even if there is moral hazard.

Before a household knows whether or not it will be fertile, its expected utility is:

$$\mathrm{E}U(C_C, C_P) = \pi \max U(C_C, C_P)\,|_{(7),(8)} + (1-\pi)U(0, E+B)$$

To see how expected utility is affected by a balanced budget increase in the pension level differentiate this expression with respect to B:

$$\frac{\mathrm{dE}U}{\mathrm{d}B} = \pi\left(U_1^C \frac{\mathrm{d}C_C}{\mathrm{d}B} + U_2^C \frac{\mathrm{d}C_P}{\mathrm{d}B}\right) + (1-\pi)U_2^{NC}. \tag{12}$$

Here the subscripts of the U terms indicate the derivatives with regard to the first and second arguments, C_C and C_P, and the superscripts C and NC indicate whether these derivatives are to be taken in the child or no-child situation. Using (10), Eq. (12) becomes:

$$\frac{\mathrm{dE}U}{\mathrm{d}B} = \pi U_2^C \cdot \left(\frac{\mathrm{d}C_C}{\mathrm{d}B} + \frac{\mathrm{d}C_P}{\mathrm{d}B}\right) + (1-\pi)U_2^{NC}. \tag{13}$$

A balanced budget increase in B will necessarily increase the contribution rate τ. This will reduce the fertile family's consumption possibilities and induce the moral hazard effect in terms of reduced human capital investment. It follows from (7) and (8) that, for such a family,

$$\frac{\mathrm{d}C_C}{\mathrm{d}B} + \frac{\mathrm{d}C_P}{\mathrm{d}B} = [f'(S_H)(1-\tau) - 1]\frac{\mathrm{d}S_H}{\mathrm{d}B} + 1 - f(S_H)\frac{\mathrm{d}\tau}{\mathrm{d}B}. \tag{14}$$

Because of (10), the first term on the right hand side is zero, and Eq. (14) reduces to:

$$\frac{\mathrm{d}C_C}{\mathrm{d}B} + \frac{\mathrm{d}C_P}{\mathrm{d}B} = 1 - f(S_H)\frac{\mathrm{d}\tau}{\mathrm{d}B}, \tag{15}$$

where $\mathrm{d}\tau/\mathrm{d}B$ follows from (9) and (10). Calculating $\mathrm{d}\tau/\mathrm{d}B$ at $\tau = 0$ gives:

$$\left.\frac{\mathrm{d}\tau}{\mathrm{d}B}\right|_{\tau=0} = \frac{1}{\pi f(S_H)}. \tag{16}$$

Inserting (16) into (15), and (15) into (13), yields, after a few arrangements,

$$\frac{\mathrm{dE}U}{\mathrm{d}B} = (1-\pi)\left[U_2^{NC} - U_2^C\right].$$

[11] Hard empirical evidence of the negative implication of the German pension system on fertility can be found in Cigno et al. (2000).

This expression shows that a moderate PAYGO system with low contribution rates will increase expected utility if, and only if, $U_2^{NC} > U_2^C$, i.e., if the marginal utility of consumption is higher for dynasties with bad luck than for those with good luck. Since U was assumed to be strictly concave, and since fertility increases utility (cf. Fig. 2), this is a plausible though not necessary case.

Note, however, that $U_2^{NC} > U_2^C$ is a necessary condition for an increase of expected utility in the absence of a moral hazard effect. Suppose we transfer the aggregate lump sum amount $\mathrm{d}Q$ from families with children to those without children, keeping individual behavior unchanged. Then the amount paid by a single household with children is $\mathrm{d}Q/(\pi N)$ and the amount received by an unlucky household without children is $\mathrm{d}Q/[(1-\pi)N]$ where N is the size of the population. Expected utility changes by:

$$\left[\frac{\mathrm{d}Q}{1-\pi}(1-\pi)U_2^{NC} - \frac{\mathrm{d}Q}{\pi}\pi U_2^C\right]\frac{1}{N},$$

an expression which obviously is greater than zero if, and only if, $U_2^{NC} > U_2^C$.

Proposition 3. *If people are risk averse in the sense that a lump sum redistribution from lucky (fertile) to unlucky (infertile) dynasties would increase expected utility, a moderate PAYGO system will increase expected utility even though it generates a moral hazard effect in terms of reducing investment in human capital.*

The benefit from insurance is a first-order effect on expected utility, and the disadvantage of moral hazard is a second-order effect. With small amounts of insurance the first-order effect dominates the second-order effect. Thus a moderately designed PAYGO system will be beneficial even though it discourages marriage, reduces the number of children born in a family, and lowers the family's investment in the education of their children.

4. The pay-as-you-go system as an enforcement device

The old age pension systems were introduced in order to improve the miserable conditions of the old who did not receive enough transfers from the working generation. One reason why an old person may not have received enough transfers was the lack of children. Another reason was that the existing children may not have looked after their parents. The assumption of ungrateful children seems to fit well into the evolutionary explanation of human preferences and, as was explained in the introduction (cf. also Footnote 1), it was the historical reason for the industrialized countries introducing the pension system in the nineteenth century. Genetic evolution has been able to bring about forward looking altruism from parents to children, but not the other way round. The old saying that "a father can provide for seven children but that seven children cannot provide for a father" reflects this trait of human preferences. The PAYGO system can be seen as a compensating enforcement device that makes it impossible for children to free ride and negate the intergenerational contract which was obeyed by the traditional family but lost its force when industrialization loosened the family ties.

The analysis of the enforcement problem begins by considering first the situation without a PAYGO system. In the presence of one-sided altruism and loose family ties, the allocation described in Section 2 and Fig. 1 with points 2 and Y will not be available. Children will not make the transfer T to their parents, and parents who know this will not be willing to make a human capital investment S_H large enough to reach the production point 1. Although parents have a concern for the consumption of their children, they will not neglect their own consumption. Knowing that their children will not let them share in the return on their human capital investment, parents will have to respect the fact that they cannot, in general, separate the decision about how much to invest in human capital from the intergenerational consumption decision. In Fig. 3a parents would choose the production point characterized by Z rather than the one characterized by 1. At Z, the production curve is steeper than at 1, indicating that the rate of return to human capital investment is above the market rate of interest, $Rf(S_H) - 1 > R - 1$, and that investment in human capital is lower than in the case where the family contract can be enforced.

The separation between consumption and investment would only be possible if parents wished to give or bequeath real, as well as human, capital to their children. This case is illustrated in Fig. 3b at point 2. Obviously, with an operative bequest motive the optimal investment in human capital remains to be characterized by the condition that $f'(S_H) = 1$.

Proposition 4. *Suppose parents exhibit one-sided altruism for their children and cannot force children to pay their pensions. Then those parents who wish to bequeath real capital to their children will invest more in human capital than those who would have preferred their children to pay them a pension. With the latter type, the rate of return to human capital investment exceeds the rate of return to real investment, and this indicates underinvestment in human capital.*

To overcome the underinvestment in human capital it would be necessary to settle a binding contract between parents and children before birth and education, which is not

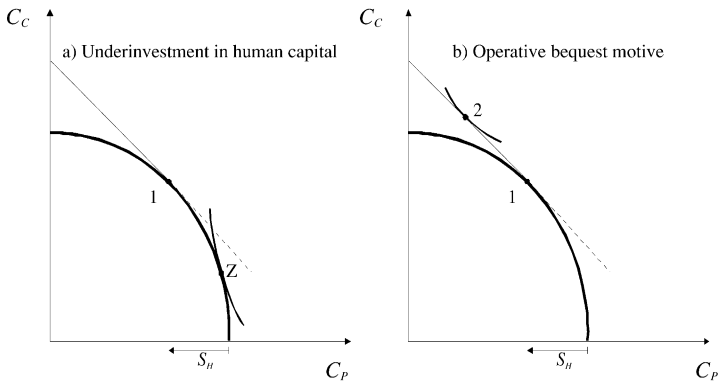

Fig. 3. One sided altruism, bequests and the investment in human capital.

feasible. An alternative is to oblige children to pay their own parents a pension. In fact, most societies have customs and laws that imply such an obligation. Obviously, with an extensive obligation which gives the parents at least the resources necessary to reach point 2 in Fig. 1, a first best solution is attainable. If children have to pay their parents more than the parents want, a voluntary bequest would allow the fine tuning which is necessary to reach an optimal allocation of consumption as seen from the parents' perspectives. However, the necessary implementation of such customs and laws may be difficult. Parents will hardly sue their children if they do not pay enough. The legal system is well suited to *inter*family disputes but not so much to *intra*family disputes.

A PAYGO system that requires people to pay pensions to their parents via the government budget is the alternative since the state can easily monitor and enforce the contributions. The problem is, however, the moral hazard effect with regard to human capital investment which was discussed above. Will a commitment via a PAYGO system be able to reinstall the proper incentives for human capital investment and to increase welfare even though the contributions are pooled and distributed among the parents irrespective of their own investment in human capital?

To analyze this problem let us abstract from the risk of being infertile and assume that parents would like to receive transfers from their children such that $f'(S_H) > 1$ in the absence of a commitment device, as illustrated in Fig. 3a. The family's budget constraints are, like (7) and (8),

$$C_P = E - S_H + T + B \tag{17}$$

and

$$C_C = f(S_H)(1-\tau) - T \tag{18}$$

where, however, one-sided altruism and the lack of a private enforcement mechanism implies that:

$$T \leq 0. \tag{19}$$

The government budget constraint is:

$$\tau f(S_H) = B. \tag{20}$$

The Lagrangean for parents who want to maximize $U(C_C, C_P)$ s.t. (17)–(19) is:

$$\begin{aligned} \mathrm{L} = U(C_C, C_P) &+ \lambda_1 \cdot [f(S_H)(1-\tau) - T - C_C] \\ &+ \lambda_2 \cdot (E + T + B - S_H - C_P) + \mu \cdot (-T) \end{aligned}$$

where the λ's are Lagrangean multipliers and μ is a Kuhn–Tucker multiplier. As before, the parents optimize their intertemporal consumption pattern according to (4), using the capital

market to establish an optimal combination of C_{P1} and C_{P2}. The necessary conditions for an optimum include:

$$U_1 = \lambda_1,$$

$$U_2 = \lambda_2,$$

$$\mu = \lambda_2 - \lambda_1,$$

$$\lambda_2 = \lambda_1 f'(S_H)(1-\tau),$$

$$\mu \cdot (-T) = 0.$$

They obviously imply that:

$$\frac{U_2}{U_1} = f'(S_H)(1-\tau) \left\{ \begin{matrix} > \\ = \end{matrix} \right\} 1 \quad \text{if} \quad T \leq 0 \text{ is a} \left\{ \begin{matrix} \text{strictly binding} \\ \text{non} - \text{binding} \end{matrix} \right\} \text{constraint.} \qquad (21)$$

Expression (21) shows that, as in the previous section, the marginal rate of substitution of child for parent consumption equals the net-of-tax marginal product of human capital. However, both of these values equal one if, and only if, the pension is so generous that parents wish to return some of it to their children ($T < 0$). If the pension is so low that parents would like to receive additional transfers from their own children, the marginal rate of substitution and the net-of-tax marginal product exceed unity. If the net-of-tax marginal product equals one and the contribution rate is positive, there is the moral hazard effect analyzed in the last section. If the net-of-tax marginal product exceeds one there is, in addition, the underinvestment motive resulting from the lack of enforcement. Thus, whatever regime applies, there is an underinvestment in human capital.

Proposition 5. *The PAYGO system is unable to mimic the private enforcement rules of the traditional family with regard to the incentives for an investment in human capital that these rules imply. The pooling of the contributions will result in an underinvestment in human capital, regardless of whether the contributions are large enough to allow for an operative bequest motive or not.*

As is well known, there are many similarities between a PAYGO system and public debt. In fact, the creation and redemption of a public debt can be seen as a transfer payment from the young to the old just like the one brought about by the PAYGO system. Thus Proposition 5 also dims the hope once expressed by Drazen (1978, p. 514) that government debt might help people specialize in the investment of human capital and reinstall the first best efficiency condition for such an investment. For such a result to occur it would have been necessary to assume either that people coordinate their individual fertility decisions or that the taxes could be tailored to each individual family so that a redistribution between child-rich and child-poor families can be avoided. When the individual pays a labor income tax of the normal kind, a distortion in the human capital formation is bound to result.

Despite this outcome, it may still be true that a PAYGO system, or public debt for that matter, brings about a welfare increase. After all, this system is an enforcement device that

does allow for a resource transfer in the desired direction. To analyze the relative strengths of the positive and negative welfare effects resulting from the resource transfer and the moral hazard effect, suppose that the government tries to increase utility by designing a reform of the PAYGO system subject to (17)–(19), (21) and its budget constraint (20). The government will have to calculate the marginal utility increase from a balanced budget increase of the tax rate,

$$\frac{\mathrm{d}U(C_C, C_P)}{\mathrm{d}\tau} = U_1 \frac{\mathrm{d}C_C}{\mathrm{d}\tau} + U_2 \frac{\mathrm{d}C_P}{\mathrm{d}\tau},$$

which, because of (21), can also be written in the form:

$$\frac{\mathrm{d}U(C_C, C_P)}{\mathrm{dH}} = \left[\frac{\mathrm{d}C_C}{\mathrm{d}\tau} + f'(S_H)(1-\tau)\frac{\mathrm{d}C_P}{\mathrm{d}\tau}\right] U_1 \tag{22}$$

Differentiating (17) and (18) with respect to τ, where the moral hazard effect on S_H is taken into account, gives[12]

$$\frac{\mathrm{d}C_P}{\mathrm{d}\tau} = -\frac{\mathrm{d}S_H}{\mathrm{d}\tau} + \frac{\mathrm{d}T}{\mathrm{d}\tau} + \frac{\mathrm{d}B}{\mathrm{d}\tau}$$

and

$$\frac{\mathrm{d}C_C}{\mathrm{d}\tau} = f'(S_H)(1-\tau)\frac{\mathrm{d}S_H}{\mathrm{d}\tau} - f(S_H) - \frac{\mathrm{d}T}{\mathrm{d}\tau}.$$

Inserting these equations into (22), rearranging terms and abbreviating the notation one gets:

$$\frac{\mathrm{d}U}{\mathrm{d}\tau} = \left\{ [\, f' \cdot (1-\tau) - 1] \frac{\mathrm{d}T}{\mathrm{dH}} + f' \cdot (1-\tau)\frac{\mathrm{d}B}{\mathrm{d}\tau} - f \right\} U_1. \tag{23}$$

The first term in the curved bracket is zero since (21) reveals that either $f' \cdot (1-\tau) - 1 = 0$ or $T = \mathrm{d}T/\mathrm{d}\tau = 0$. A differentiation of the government budget constraint (20) gives:

$$\frac{\mathrm{d}B}{\mathrm{d}\tau} = f + \tau f' \frac{\mathrm{d}S_H}{\mathrm{d}\tau}.$$

Hence Eq. (23) becomes:

$$\frac{\mathrm{d}U}{\mathrm{d}\tau} = \left\{ f' \cdot (1-\tau)\left[f + \tau f' \frac{\mathrm{d}S_H}{\mathrm{d}\tau} \right] - f \right\} U_1. \tag{24}$$

There are a few observations about this equation which are worth noting.

[12] As C_P indicates both aggregate parent consumption in in the two periods as well as the egoistic part of utility, the current analysis incorporates an endogenous reaction of the parents' savings decision to a change in the PAYGO contribution rate τ.

The most important observation follows from an evaluation of (24) at $\tau = 0$. For low tax rates $f' \cdot (1 - \tau)$ approximates the marginal productivity of human capital at point Z in Fig. 3 which was assumed to be strictly greater than one since parents prefer to receive transfers from their children. This implies that (24) becomes:

$$\left.\frac{dU}{d\tau}\right|_{\tau=0} = (f' - 1)f \cdot U_1 > 0.$$

Thus, a moderately sized PAYGO system will always increase welfare even though it generates a moral hazard effect in terms of reducing the investment in human capital. As in the previous section, the utility loss from moral hazard is a second-order effect that is unable to counteract the direct utility gain from the installment of a pension system as such. The difference is only that there the direct utility gain resulted from insurance against infertility while here it results from a resource transfer towards the old that the ungrateful children would not have voluntarily carried out.

Fig. 4 illustrates this result. Taxation shifts the net-of-tax production curve downward and results in a tax and pension level equal to B. If the investment decision does not change, parents can now realize point Z'' rather than Z, and obviously a higher indifference curve is

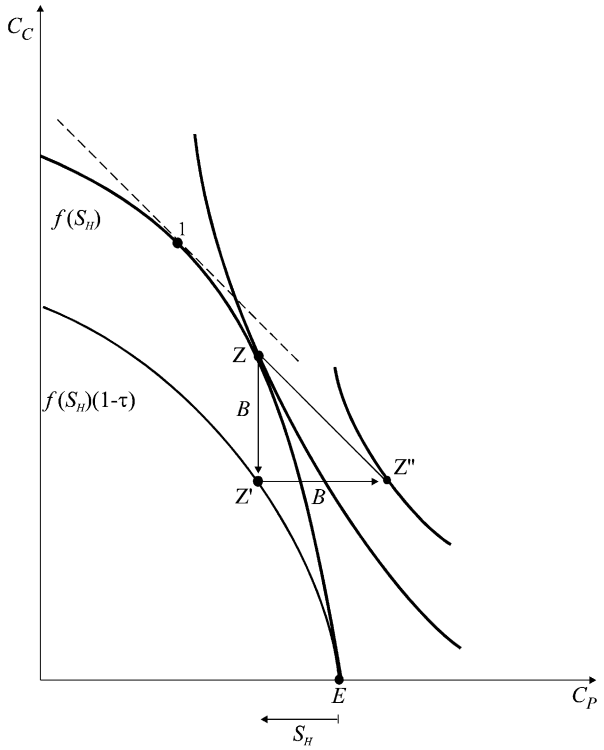

Fig. 4. Welfare gains from a moderate PAYGO system.

attainable. Note that the line ZZ'' has a slope of -1 while the slope of the indifference curve at Z is smaller than -1. This ensures that Z'' lies outside the production possibility set.

Without the enforcement of transfers, parents would also have been able to increase their own consumption by simply choosing a lower human capital investment, but, given the high marginal product of human capital investment, this would have been much more costly in terms of their descendants' consumption and would therefore not have been done. Thus, a deeper reason for the welfare gain resulting from the redistribution enforced by the PAYGO system can be seen in the fact that this system offers parents a cheaper way to ensure a sufficient old age consumption than a decision to have fewer children and to give them an inferior education.

In Fig. 4 it has been assumed that the slope of the indifference curve at Z'' is the same as that of the net-of-tax production curve at point Z'. It is known from (21) that, under these circumstances, parents' optimal investment does not change, but of course this is only a special case of the model set up above. In general, the two slopes will not be equal, and the optimal amount of human capital investment will therefore change. The welfare effect resulting from this change is the second-order effect which was shown to be too small to dominate the first-order effect illustrated in the figure.

Whether S_H will rise or fall after the introduction of a PAYGO system depends on the relative strength of two countervailing effects. One is the decline of the net-of-tax marginal product of human capital with any given level of S_H. This in itself generates the moral hazard effect discussed in the previous section; i.e., a decline in S_H. The other effect results from the forced redistribution in favor of the parents which is likely to make parents more willing to invest in human capital in the sense of reducing the marginal rate of substitution of child for parent consumption. Unless more constraints are imposed on the possible technologies and preferences it is impossible to say which of these effects will dominate.

Another observation, which is readily available from Eq. (24), refers to the case of an interior solution to the intergenerational transfer problem where parents bequeath resources to their children in addition to paying for their education. From (21) it is known that, in the case of an interior solution, $f'(S_H)\cdot(1-\tau)=1$ which implies that, as already stated in (11),

$$\left.\frac{\mathrm{d}S_H}{\mathrm{d}\tau}\right|_{T<0}=\frac{1}{f''\cdot(1-\tau)^2}<0.$$

Obviously it then follows from (24) that:

$$\left.\frac{\mathrm{d}U}{\mathrm{d}\tau}\right|_{T<0}=\frac{\tau f'}{f''\cdot(1-\tau)^2}\cdot U_1<0,$$

i.e., that a marginal increase in the contribution rate lowers welfare. This implies that it can never be optimal to choose a contribution rate high enough to induce parents to return some of their pensions to their children. Bequests are a clear sign that the PAYGO system is overdrawn and creates an unnecessarily large moral hazard effect.

Fig. 5 illustrates this case. The contribution rate is sufficiently large to make it possible for parents to reach point D which yields more pensions, B, than they would like to have. The parents return some of the pensions to their children $(T < 0)$ thus moving to the point of tangency $2'$. Given that there is an interior solution to the intergenerational transfer problem, the investment decision is separated from the consumption decision and human capital investment is determined such as to make the net-of-tax marginal product of human capital equal to one.

Point $2'$ characterizes an overshooting because a reduction of the contribution rate would shift point $1'$ to the north west along the production curve. The budget line cutting through this point would shift outward towards the dotted line through points 1 and 2, making it possible to reach a higher utility level as long as the point of tangency $2'$ remains to the left of point D. Clearly, therefore, in a second-best optimum points $2'$ and D have to coincide so as to make it unnecessary for the parents to return some of their pension to their offspring.

In general, the set of allocations the government can attain through the choice of the contribution rate is given by a curve like the white one connecting points Z, $2'$ and the origin of the production curve (where $C_P = E$). Point $2'$ is just one of the feasible points lying in the inefficient range, and point Z'' from Fig. 4 would be another one, located on the efficient downward sloping part of the white line. The next proposition summarizes the information gathered on the optimal tax problem involved.

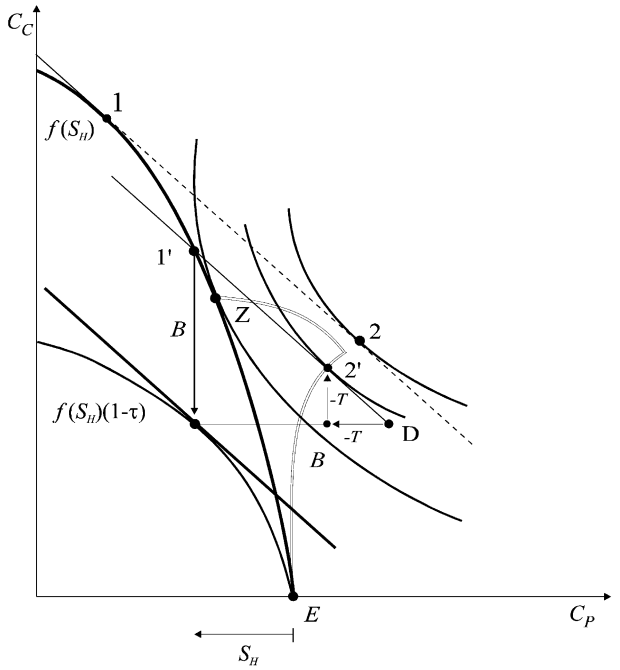

Fig. 5. Overshooting the optimum.

Proposition 6. *If parents care for their children but not vice versa, the PAYGO system can serve as an enforcement device that helps the economy overcome some of the disadvantages resulting from the impossibility of making binding pension contracts between parents and children. Despite a moral hazard effect with regard to human capital investment, a moderately designed PAYGO system will increase social welfare. However, a PAYGO system which is so generous that parents return some of their pensions to their children cannot be optimal. Welfare would increase by cutting the social security tax and the pension level.*

5. Concluding remarks

This paper has presented a basically favorable view of the allocation function of a PAYGO pension system. Despite the fact that the PAYGO system induces a moral hazard effect in terms of reducing the individual incentives for an investment in human capital, it may bring about welfare improvements. A moderately sized PAYGO system may serve as 'fertility insurance', protecting risk averse households against the risk of being infertile or not finding a partner for marriage and reproduction. A moderately sized PAYGO system may also improve welfare because it enforces a resource transfer from ungrateful children to parents which otherwise could only have been achieved in a much more costly way by cutting the amount of human capital investment.

None of these effects requires the absence of a capital market as might be suspected. In fact, the parent household always makes use of this market, optimizing the time path of its own consumption by an appropriate financial investment strategy. The reason why the household nevertheless prefers a substantial amount of human capital investment is the high inframarginal return to such investment which exceeds the constant return the capital market can offer.

The results should be a warning to those who find the theoretical case for the abolition of the PAYGO system clear enough to make corresponding policy recommendations. There are more problems than the labor/leisure distortion and the seemingly poor rate of return offered by a PAYGO system, and even these problems may not provide valid arguments in favor of a transition to a funded system if it is impossible to disregard existing pension claims[13].

On the other hand, the present paper also shows that only a moderate PAYGO system can be defended, since the adverse effects on human capital investment decisions create second-order welfare losses that counteract the first-order gains from the insurance and enforcement effects. If there is one-sided altruism from parents to children and if parents cannot force their children to pay them a pension, it is definitely wrong to implement a scale of the PAYGO system generous enough to induce parents to bequeath resources to their children. If bequests occur, the system is overdrawn and needs to be curtailed at least to the point where the voluntary bequests vanish.

[13] See Fenge (1995) and Sinn (2000).

Unfortunately, even in an optimally designed PAYGO system there will always be an underinvestment in human capital. This remains a somewhat disturbing conclusion of the analysis of this paper, emphasizing the need to discuss family and education policies complementing the analysis in this paper.

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References

Aaron, H., 1966. The social insurance paradox. Canadian Journal of Economics and Political Science 32, 374371.

Becker, G.S., 1976. Altruism, egoism, and genetic fitness: economics and sociobiology. Journal of Economic Literature 14, 817–826.

Becker, G.S., Barro, R.J., 1988. A reformulation of the economic theory of fertility. Quarterly Journal of Economics 103, 1–25.

Blackorby, C., Donaldson, D., 1984. Social criteria for evaluating population change. Journal of Public Economics 25, 13–33.

Caldwell, J.C., 1982. Theory of Fertility Decline. Academic Press, New York.

Cigno, A., 1991. The Economics of the Family. Clarendon Press, Oxford.

Cigno, A., 1993. Intergenerational transfers without altruism. European Journal of Political Economy 9, 505–518.

Cigno, A., Rosati, F.C., 1996. Jointly determined saving and fertility behaviour: theory, and estimates for Germany, Italy, UK and USA. European Economic Review 40, 1561–1589.

Cigno, A., Casolaro, L., Rosati, F.C., 2000. The role of social security in household decisions: VAR estimates of saving an fertilty behaviour in Germany. CESifo Working Paper 394.

Drazen, A., 1978. Government debt, human capital, and bequests in a life-cycle model. Journal of Political Economy 86, 505–516.

Enders, W., Lapan, H., 1982. Social security taxation and intergenerational risk sharing. International Economic Review 23, 647–658.

Feldstein, M., 1990. Imperfect annuity markets, unintended bequests, and the optimal age structure of social security benefits. Journal of Public Economics 41, 31–43.

Felderer, B., 1992. Does a public pension system reduce saving rates and birth rates? Journal of Institutional and Theoretical Economics 148, 314–325.

Fenge, R., 1995. Pareto-efficiency of the pay-as-you-go pension system with intergenerational fairness. Finanzarchiv 52, 357–363.

Gordon, R., Varian, H., 1988. Intergenerational risk sharing. Journal of Public Economics 37, 185–202.

Hassler, J., Lindbeck, A., 1997. Intergenerational Risk Sharing, Stability and Optimality of Alternative Pension Systems. Mimeo, Institute for International Economic Studies, University of Stockholm.

Jensen, E.R., 1990. An econometric analysis of the old-age security motive for childbearing. International Economic Review 31, 953–968.

Lindbeck, A., Weibull, J., 1988. Altruism and time consistency: the economics of fait accompli. Journal of Political Economy 96, 1165–1181.

McMahon, W.-W., 1991. Relative returns to human and physical capital in the US and efficient investment strategies. Economics of Education Review 10, 283–296.

Neher, D.A., 1971. Peasants, procreations and pensions. American Economic Review 61, 380–389.

Nerlove, M., Razin, A., Sadka, E., 1987. Household and Economy. Welfare Economics of Endogenous Fertility. Academic Press, Boston, Orlando.

Nugent, J., 1985. The old-age security motive for fertility. Population and Development Review 11, 75–97.

OECD, 1998. Human Capital Investment. An International Comparison. Paris.

Razin, A., Ben-Zion, U., 1975. An intergenerational model of population growth. American Economic Review 65, 923–933.

Razin, A., Sadka, E., 1995. Population Economics. MIT Press, Cambridge, MA.

Rosati, F.C., 1996. Social security in a non-altruistic model with uncertainty and endogenous fertility. Journal of Public Economics 60, 283–294.

Sinn, H.-W., 2000. Pension reform and demographic crisis. Why a funded system is needed and why it is not needed. International Tax and Public Finance 7, 389–410.

Sinn, H.-W., 2001. The value of children and immigrants in a pay-as-you-go pension system: a proposal for a transition to a funded system. Ifo Studien 47, 77–94.

Smith, A., 1982. Intergenerational transfers as social insurance. Journal of Public Economics 19, 97–106.

Stein, P., no year. Fürst Bismarcks Reden, Vol. 8. Steuerreform und Sozialpolitik 1810-1882, Reclaim, Leipzig.

Swindler, S., 1986. The old-age security motive for having children and the effect of social security on completed family size. Quarterly Review of Economics and Business 26, 14–34.

Townley, P.C.G., Boadway, R., 1988. Social security and the failure of annuity markets. Journal of Public Economics 35, 75–96.

Werding, M., 1997. Pay-as-you-go Pension Schemes and Endogenous Fertility. Mimeograph, University of Passau.

Werding, M., 1998. Zur Rekonstruktion des Generationenvertrages. Ökonomische Zusammenhänge zwischen Kindererziehung, sozialer Alterssicherung und Familienlastenausgleich. Mohr-Siebeck: Tübingen.

Willis, R.J., 1980. The old-age security hypothesis and population growth. In: Burch, T. (Ed.), Demographic Behavior: Interdisciplinary Perspectives on Decision Making. Westview Press, Boulder.