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THE PAY-AS-YOU-GO PENSION SYSTEM AS A FERTILITY INSURANCE AND ENFORCEMENT DEVICE

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ABSTRACT

It is argued that a PAYGO system may have useful allocative functions in that it serves as an insurance against not having children and as an enforcement device for 'rotten kid' who are unwilling to pay their parents a pension. It is true that the system has amoral hazard effect in terms of reducing the investment in human capital, but, if it is run on a sufficiently small scale, this effect will not strong enough to prevent 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.

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1. Introduction

The Pay-as-you-go pension (PAYGO) system has come under heavy attack since it has proved unable to provide satisfactory pensions in a time of declining population growth. Many authors, including Homburg (1990), Feldstein (1995, 1996), Fenge (1996), and Kotlikoff/Smetters/ Walliser (1997), have concentrated on the labour-leisure distortion resulting from the social security tax, and the dispute about whether this distortion can be avoided with a transition to a funded system has not yet ended. Others, notably Nugent (1985), Becker and Barro (1988), or Cigno (1991, 1993) have pointed to the adverse implications of the social security system on individual fertility decisions.

However, it is too early for a verdict on the PAYGO system as this system may bring about favorable allocation effects as well as negative ones. 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/Lapan 1982, Gordon/Varian 1988, Hassler and Lindbeck 1997). This paper studies two further potentially favorable effects which do not seem to have received any particular attention in the literature.

The first is insurance against not having children. If every household was able to have children, they could receive their pension 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 a well functioning capital market is not available and fertility choices are exogenous. Whether it will be able to retain its useful role when both of these assumptions are relaxed remains to be seen.

The second potentially favorable allocation effect of the PAYGO system is based on the fact that this system may serve as an enforcement device for ungrateful children, or "rotten kids", to use Becker's (1974, 1976) language. If inter-generational altruism is one sided, from parents to children but not vice versa, parents may underinvest in human capital since they are

afraid of not getting back enough of the fruits of their investment. A system that imposes the obligation on children to make pension payments to their own parents may reinstall the proper incentives for 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. It is not clear whether such a collective enforcement system can generate welfare improvements.

Section 2 of this paper will present a simple two period model that will serve as a basis for studying the two effects. Section 3 will study 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 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 capital, the other is saving in the form of human capital 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. In the present analysis R is fixed for technological reasons or since a small open economy is assumed. Saving in human capital is S_H in terms of second period goods and S_H / R in terms of first period goods. The labor income which the children earn in the second period is an increasing and strictly concave function of human capital investment, $f(S_H)$. It is assumed that $f'(S_H) > 1$ for some range $S_H < S_H^*, S_H^* > 0$, to ensure that the inframarginal return on human capital investment exceeds the return on investment in the capital market. This paper does not analyze the choice between the quantity and quality of children. It is assumed that $f(S_H)$ is the outcome of an optimal choice with regard to these two variables and that only the aggregate second-period consumption C_C of the children enters the parents' utility

function. 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. Similarly, C_{P1}, the parents' first-period consumption, can be seen as an indicator of an optimally structured commodity bundle consumed by parents and potential grandparents in the first period. Let C_{P2} be the parents' second period consumption and let T be a transfer from the children to their parents in the second period. Let E be the family's first period endowment, i.e. the sum of its material wealth, labor income and possibly the net income received from a pre-existing pension system, again expressed in terms of second period goods.

The family's intertemporal budget constraints are

(1) $$C_P = E - S_H + T$$

and

(2) $$C_C = f(S_H) - T$$

where

(3) $$C_P = RC_{P1} + C_{P2}$$

is aggregate parent consumption in terms of second period prices. Equation (1) says that aggregate parent consumption equals the excess of parent income over human capital investment plus transfers received from children, and equation (2) shows that (second period) child consumption equals the difference between wage income and these transfers.

Parents care for themselves and for their children. Parent utility is given by a strictly concave nested function of the type $U\left[C_C, V(C_{P1}, C_{P2})\right]$ where V is a linear homogeneous, strictly quasi concave sub-function reflecting the egoistic part of utility. Throughout, the paper bases welfare judgments only on altruistic parent utility, bypassing the difficult conceptional problems arising from other assumptions.[1] A rationale for not including child preferences in a more direct way is that, in the model, collective decisions in the form of introducing a

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

PAYGO system are taken before the children are born. Even if there are plausible axioms that legitimate a more direct 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 can also enforce transfers from their children to themselves if they so wish.[2] Section 4 will study the implications of giving up this assumption.

Solving the problem

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

gives an indirect utility function $V^*(C_P,R)$ where V^* is strictly proportional to C_P. Given R, we may set $C_P \equiv V^*(C_P,R)$ without a loss of generality. Thus the remaining optimization problem is

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

Problem (4) gives 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) gives

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

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

[2]Without harm, it may also be assumed until section 4 that children share the preferences of parents.

defined in terms of second-period goods, this implies that the marginal rate of return to human capital equals the marginal return to real capital.

Figure 1: Optimal investment in human and real capital

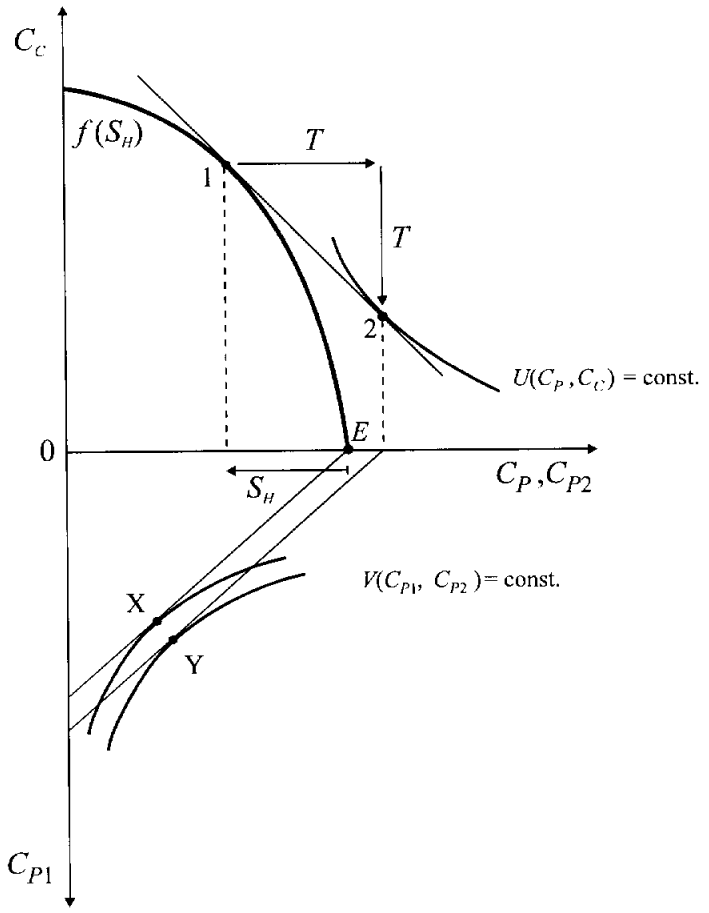


Figure 1 illustrates the nature of the two stage optimization problem solved by the parent household. The upper part of the diagram shows the household's transformation curve between parent and child resources and an indifference curve with regard to parent and child consumption assuming that parent consumption is optimally distributed between the first and second periods. The optimal time structure of parent consumption is determined in the lower quadrant where the straight lines indicate the transformation possibilities given by the capital market and the indifference curves represent the parents' 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, C_{P1} and C_{P2}.

The parents could realize $C_P = C_{P2} = E$, $C_C = C_{P1} = 0$, by not having children and consuming all of their endowment E in the second period, but there are significantly better strategies for them. One strategy would be giving up some second period consumption in order to afford first period consumption; doing this they could thus reach points E and X. 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 (point 1) and then to arrange a transfer T from their children to their own pockets so as to reach point 2. The intertemporal budget line for their own consumption will then shift and they will be able to realize points 2 and Y, which are strictly better than E and X. (Note that this would also be true if the household had preferences that imply a position of point Y that is closer to the origin than point X.) 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.

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 (real) capital market. The existence of higher inframarginal returns to human capital implies that parents derive utility from investing in the human capital of their children.*

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 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 a 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 modern

societies things were not very different before the social security systems were developed.[3] 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 misfortune. The public provision of the PAYGO pension system is 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 too late for these contracts to be perceived as insurance.

The PAYGO system may 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 analysed 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

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

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

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

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

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

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

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

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

The fertile household maximizes $U(C_C, C_I)$ s.t. (7) and (8). The necessary condition for this household's optimum is

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

which implies that

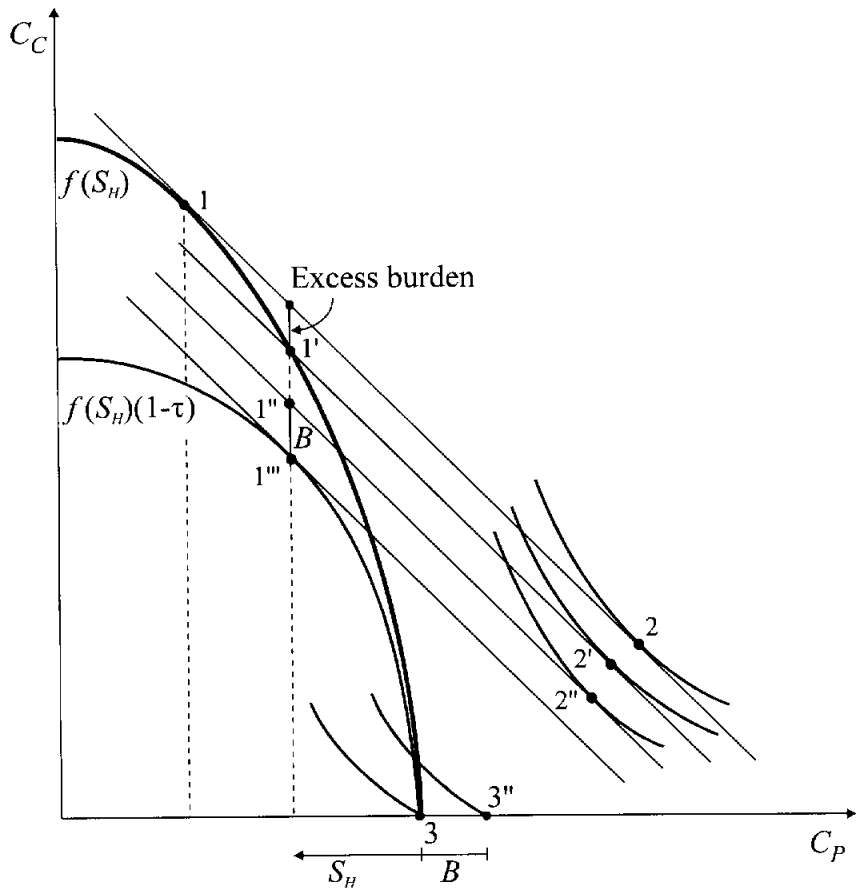
(11) $$\frac{dS_H}{d\tau} = \frac{1}{f''(S_H)\cdot(1-\tau)^2} < 0 .$$

Comparing equation (10) with (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 which, as equation (11) reveals, results in a decline in human capital investment. This is the moral hazard effect of the PAYGO system which, as mentioned in the introduction, has been studied by various authors in alternative frameworks.

Proposition 2: *While a PAYGO system may serve as a fertility insurance, it brings with it a moral hazard effect in terms of reducing the optimal investment in human capital (quantity and/or quality of children).*

The nature of the moral hazard effect is illustrated in figure 2. Points 1 and 2 characterize the solution without the PAYGO system as known from figure 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 curve $f(S_H)$. Point 1' is to the right of point 1 because, for any given S_H, the net-of-tax production line has a lower (absolute) slope than the pre-tax production line and because the slope of the former must be equal to one in the optimum. This establishes the existence of moral hazard effect in terms of underinvesting in human capital.

Figure 2: The moral hazard effect of the PAYGO system



The 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 having children. Starting from point 1'' the household can move to the south east along the budget line with slope - 1 that leads through this point by transferring resources between the generations. The optimal consumption point is 2'' where the indifference curve slope equals the slope of the budget line.

Of course, the moral hazard effect occurs only with fertile families. Infertile families 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 families do not get a full rebate in terms of pensions. Since the size of the pension a family receives does not depend on the actions this family chooses, it is a lump sum rebate. The size of this rebate influences the optimal consumption pattern, but not the optimal investment in human capital. If π =1, the lump sum rebate equals the social security tax $\tau f(S_H)$ and thus the family can move along the budget line that leads through 1'. It will choose point 2' rather than 2''. However, in either case, 1' indicates the optimal pre-tax return to the human capital investment in terms of the wage income received 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 budget line from position 2 to 2' or 1 to 1' measures the excess burden in terms of second period consumption.

The reduction in birth rates and/or education efforts may be the most important distortion the PAYGO system causes, and this distortion 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.[4]

The example of Germany is particularly interesting in this context, because it was in this country that Bismarck introduced the first large-scale public pension system and this

[4]Cf. Caldwell (1982), Swindler (1986), Jensen (1990), and Cigno and Rosati (1996).

system has developed here further than in most other countries. A century ago, Germany's population growth was the highest in Europe. Now this country is facing one of the lowest birth rates in the world. 10 Germans have, on average, less than 7 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 having children in order to ensure satisfactory consumption in old age had been common before Bismarck's reforms. A hundred years later, this idea has more or less vanished, and the attraction of the "dink family" has largely supplanted that of the traditional family.

The existence of an excess burden in terms of reduced fertility rates 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 sufficiently risk averse to prefer the kind of redistribution enacted by a PAYGO system in the absence of moral hazard, then 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

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

To see how expected utility is affected by an increase in the pension level differentiate this expression with regard to B:

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

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

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

It follows from (7) and (8) that

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

Because of (10) equation (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

$$\frac{\mathrm{d}\tau}{\mathrm{d}B} = \frac{1}{\pi f(S_H)} \,. \tag{16}$$

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

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

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. figure 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 lump sum amount $\mathrm{d}Z$ from dynasties with children to those without children, thus fixing individual behaviour. Then

the amount paid by a single household with children is dZ/π and the amount received by an unlucky household with children is $dZ/(1-\pi)$. Expected utility changes by

$$\frac{dZ}{1-\pi}(1-\pi)U_2^{NC} - \frac{dZ}{\pi}\pi U_2^{C},$$

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

Proposition 3: *If 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 the investment in human capital (number and/or quality of children)*

The proposition is a variant of a basic theorem on moral hazard first derived by Shavell (1979). 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.

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 is implicitly made in OLG models that disregard voluntary intergenerational transfers of the type analyzed by Barro (1974), Drazen (1978), and others, and it seems to fit well into the evolutionary explanation of human preferences. 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 nourish seven children but that seven children cannot nourish a father seems to reflect this very well.

Within the traditional family there may have been sufficiently strong enforcement mechanisms to make sure that children would nevertheless provide support for their old

parents[5]. However, the loosening of family ties that characterizes modern societies 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.

This development had been a matter of public concern in Germany at the time when the social security system was introduced. In the basic 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 "peculium". A peculium is a small amount of money that a Roman master left to the control of his slaves or that he allowed his slaves to save for the purpose of buying their liberty towards the end of their working life. Bismarck's 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 family. 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 old generation, one which would not have come about through voluntary private actions.

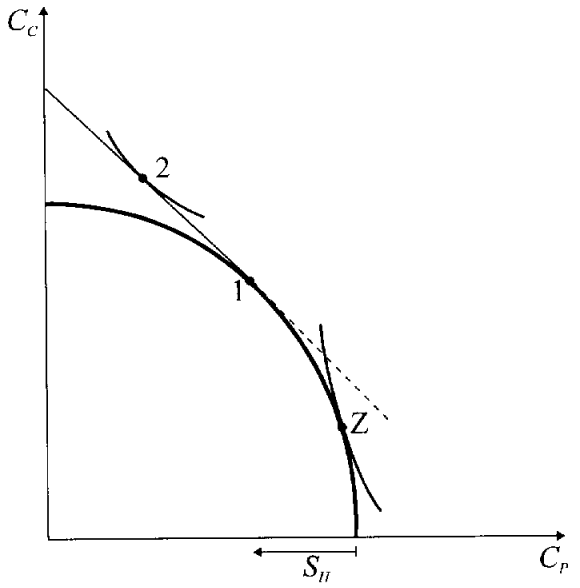
The analysis of the enforcement problem begins by considering first the situation without a PAYGO system.

In the presence of one-sided altruism and loose family ties the allocation described in section 2 and figure 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 participate in the return to their human capital

[5]Alternatively, this family can be seen as investing in the manipulation of their children's preferences so as to ensure the payment of a pension. See Stark (1995).

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 figure 3 parents would chose the production point characterized by point Z rather than the one characterized by point 1.

Figure 3: One sided altruism, bequests and the investment in human capital



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 figure 3 with 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 a 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, which is not feasible. An alternative is 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 figure 1, a first best solution is attainable. If children have to pay more to their parents 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, individual obligations are difficult to implement since parents will hardly be likely to sue their children if they do not pay enough. The law 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 through the government budget may be an 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. The dynasty's budget constraints are, like (7) and (8),

(17) $$C_P = E - S_H + T + B$$

and

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

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

(19) $$T \leq 0.$$

The government budget constraint is

(20) $$\tau f(S_H) = B.$$

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

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

where the λ's are Lagrangean multipliers and μ is a Kuhn-Tucker multiplier. In addition to (17)–(19), the necessary conditions for an optimum are

$$\begin{aligned} U_1 &= \lambda_1, \\ U_2 &= \lambda_2, \\ \mu &= \lambda_2 - \lambda_1, \\ \lambda_2 &= \lambda_1 f'(S_H)(1-\tau), \\ \mu \cdot (-T) &= 0. \end{aligned}$$

They obviously imply that

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

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. Obviously the investment decision is distorted by both the social security tax and the insufficiency of the PAYGO system as an enforcement device. Whatever regime applies, as long as the contribution rate is positve, the marginal product of a human capital investment remains above unity and this implies that, even at the margin, human capital is more productive than real capital. This leads to the following conclusion.

Proposition 5: *The PAYGO system is unable to mimick 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, might be able to bring 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 this problem suppose that there is a government that tries to increase utility by designing a reform of the PAYGO system subject to (17)–(19), (21) and its budget constraint (20). This

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

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

It follows from (17) and (18) that

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

and

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

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

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

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 equation (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.

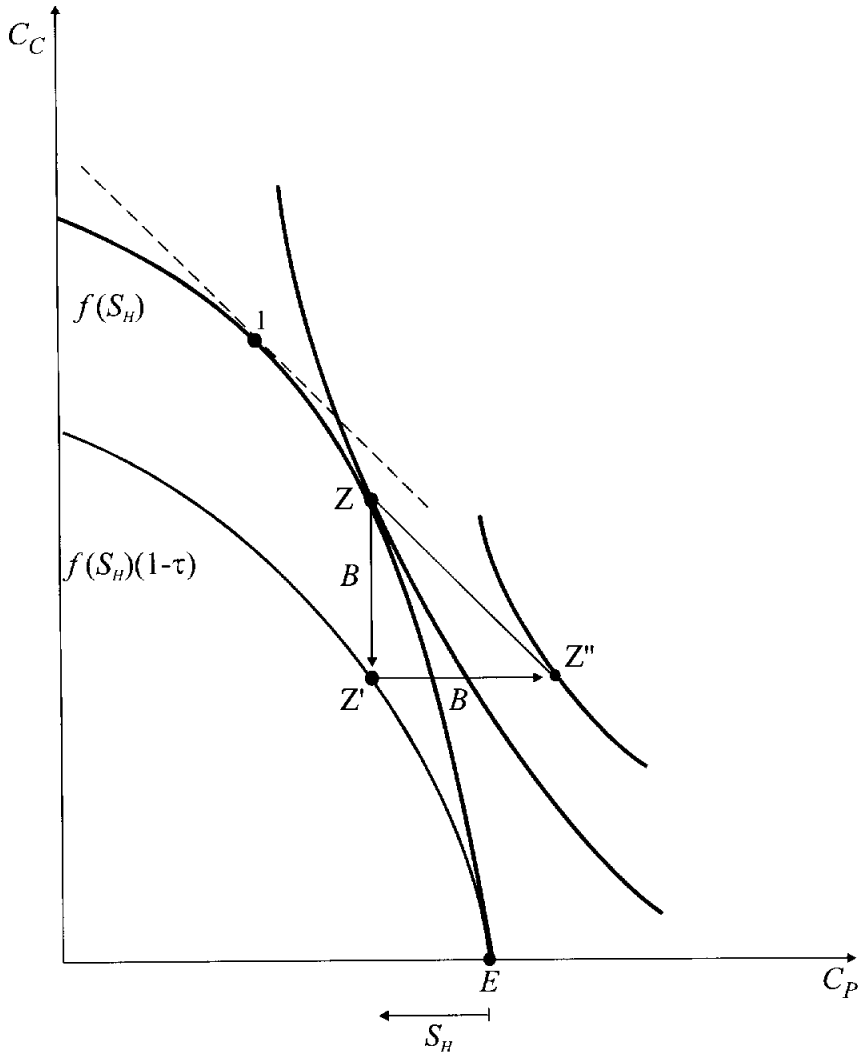
The most important observation follows from an evaluation of (24) at $\tau = 0$. For small tax rates $f' \cdot (1 - \tau)$ approximates the marginal productivity of human capital at point Z in figure 3 which was assumed to be strictly greater than one since parents prefer to receive transfers from their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

Figure 4 illustrates this result. Taxation shifts the net-of-tax production line 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 attainable. Note that the line Z Z" 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.

Figure 4: Welfare gains from a moderate PAYGO system



In the figure it has been assumed that the indifference curve slope 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. In general, this will not be true. The two slopes will not be equal, and the optimal amount of human capital investment will therefore change. However, the welfare effect resulting from this change is a second order effect which cannot dominate the first order effect illustrated in the figure.

Whether S_H will rise or fall 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 favour 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 equation (24) refers to the case of an interior solution to the parents' decision problem. 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 this implies that (24) becomes

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

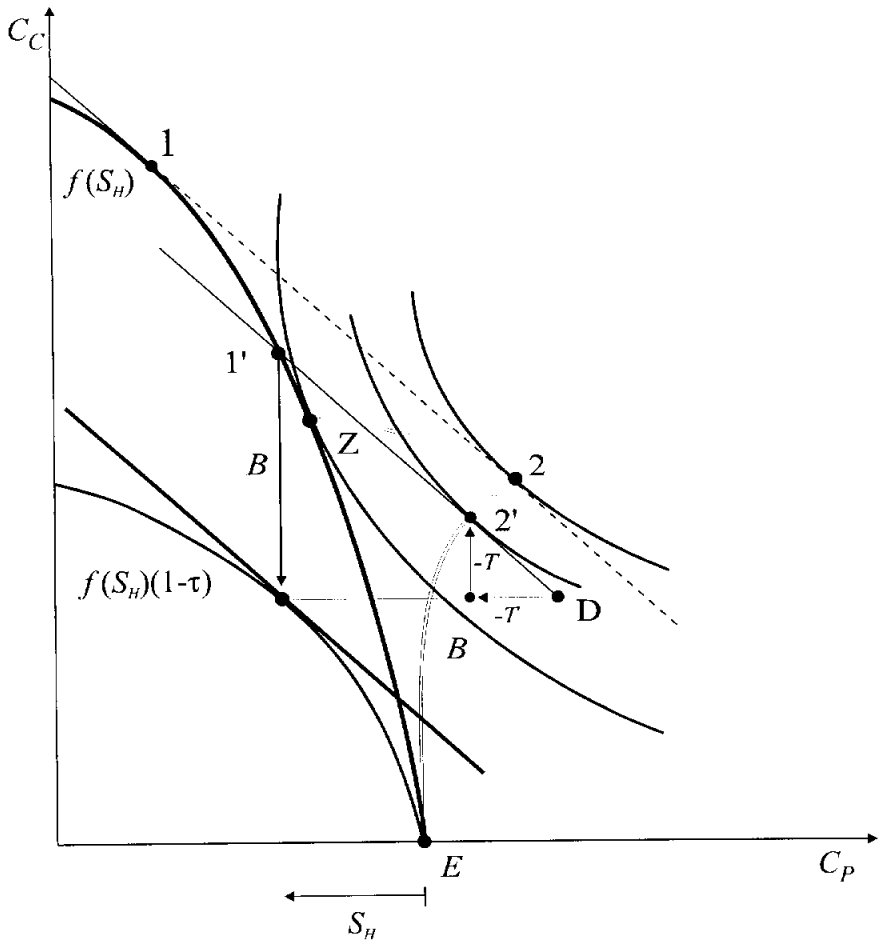
Thus, it can never be optimal to choose a tax rate high enough to induce parents to return some of their pensions to their children. This would overshoot the optimum and create an unnecessarily large moral hazard effect.

Figure 5 illustrates the overshooting case. The tax rate is sufficiently large to make it possible for parents to reach point D which brings 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 tax rate would shift point 1' to the north west along the production curve. The budget line that leads 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 had to coincide so as to make it unnecessary for the parents to return some of their pension to their offspring.

Figure 5: Overshooting the optimum



In general, the set of allocations the government can attain through the choice of the tax 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, and point Z'' from figure 4 is another one closer to the laissez faire solution. The next proposition summarizes the information gathered on the optimal tax problem involved.

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 given a basically favourable 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 the human capital of children, it may bring about welfare improvements. A moderately sized PAYGO system may serve as a "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 intramarginal 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 effects than the labor leisure distortion that are worth the concern of policy makers, and even this distortion may not provide strong arguments in favour of a transition to a funded system if it is impossible to disregard existing pension claims.[6]

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[6]See Sinn (1997).

On the other hand, the present paper makes it clear that only a moderate PAYGO system can be defended, since the adverse effects on individual fertility decisions create second-order welfare losses that counteract the first-order gains from the insurance and enforcement effects. If there is a 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.

References

Barro, Robert J. (1974): "Are Government Bonds Net Wealth?" *Journal of Political Economy* 82, 1095-1117.

Becker, G. S. (1974): "A Theory of Social Interaction," *Journal of Political Economy* 82, 1063-1093.

---(1976): "Altruism, Egoism, and Genetic Fitness: Economics and Sociobiology," *Journal of Economic Literature* 14, 817-826.

Becker, G. S., and R. J. Barro (1988): "A Reformulation of the Economic Theory of Fertility," *Quarterly Journal of Economics* 103, 1-25.

Blackorby, C., and D. Donaldson (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.

---(1993) "Intergenerational Transfers without Altruism," *European Journal of Political Economy* 9, 505-518.

Cigno, A., and F. C. Rosati (1996): "Jointly Determined Saving and Fertility Behaviour: Theory , and Estimates for Germany, Italy, UK and USA," *European Economic Review* 40, 1561-1589.

Drazen, A. (1978): "Government Debt, Human Capital, and Bequests in a Life-Cycle Model," *Journal of Political Economy* 86, 505-516.

Enders, W., and H. Lapan (1982): "Social Security Taxation and Intergeneratinal 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.

---(1995): "Would Privatizing Social Security Raise Economic Welfare?" *NBER Working Paper* No. 5281.

---(1996): "The Missing Piece in Policy Analysis: Social Security Reform," *American Economic Review* 86, Papers & Proceedings, 1-14.

Fenge, R. (1995): "Pareto-Efficiency of the Pay-as-you-go Pension System with Intergenerational Fairness," *Finanzarchiv* 52, 357-363.

Gordon, R., and H. Varian (1988): "Intergenerational Risk Sharing," *Journal of Public Economics* 37, 185-202.

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

Homburg, S. (1990): "The Efficiency of Unfunded Pension Schemes," *Journal of Institutional and Theoretical Economics* 146, 640-647.

Jensen, E. R. (1990): "An Econometric Analysis of the Old-Age Security Motive for Childbearing," *International Economic Review* 31, 1990.

Kotlikoff, L., K. Smetters, and J. Walliser (1997): "The Impact of Transiting to Privatized Social Security," in: H. Siebert, ed., *Redesigning Social Security*, Proceedings of the 1997 Kiel Week Conference, Kiel Institute of World Economics: Kiel, forthcoming.

Lindbeck, A., and J. Weibull (1988): "Altruism and Time Consistency: The Economics of Fait Accompli," *Journal of Political Economy* 96, 1165-1181.

Neher, D.A. (1971): "Peasants, Procreations and Pensions," *American Economic Review* 61, 380-389.

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

Nugent, J. (1985): "The Old-Age Security Motive for Fertility," *Population and Development Review* 11, 75-97.

Razin, A., and U. Ben-Zion (1975): "An Intergenerational Model of Population Growth," *American Economic Review* 65, 923-933.

Razin, A., and E. Sadka (1995), *Population Economics*, MIT Press: Cambridge, Mass.

Shavell, S. (1979): "On Moral Hazard and Insurance," *Quarterly Journal of Economics* 93, 541-562.

Sinn, H.-W. (1997): "The Value of Children and Immigrants in a Pay-As-You-Go Pension System: A Proposal for a Partial Transition to a Funded System," *NBER Working Paper* No. 6229.

Smith, A. (1982): "Intergenerational Transfers as Social Insurance," *Journal of Public Economics* 19, 97-106.

Stark, O. (1995): *Altruism and Beyond*, Cambridge University Press: Cambridge, UK.

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., and R. Boadway (1988): "Social Security and the Failure of Annuity Markets," *Journal of Public Economics* 35, 75-96.

Willis, R.J. (1980): "The Old-Age Security Hypothesis and Population Growth," in: T. Burch, ed., *Demographic Behavior: Interdisciplinary Perspectives on Decision Making*, Westview Press: Boulder.

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