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On social security financial crisis

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Abstract. We indicate that financial crisis in social security programs might be endogenous because social security affects fertility and human capital's decisions and thus, the aggregate growth rate of the economy. These effects lead to an endogenous erosion of the financial basis of the PAYG social security program so that, as a consequence, the PAYG system is not sustainable and it requires continuous increases in the social security tax rate.

JEL classification: H55, J1

Key words: Pay-as-you-go social security, demographic transition, financial crisis

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1. Introduction

Most social security systems established by governments in the past were financed by payroll taxes on a pay-as-you-go basis (PAYG). However, those systems have faced large financial problems due to the change in the age distribution and in life expectancy which have increased the fraction of population receiving benefits through time. More retirees, fewer workers, and longer life expectancy are a combination that requires increments in payroll taxation to avoid the bankruptcy of the system.

The financial crises of PAYG social security systems is a topic of significant economic research. Economic research has focused on determining the best solution to the financial crisis -Breyer (2001), Feldstein and Samwick (2000). Rather than focusing on how to solve the PAYG financial crisis, this

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paper focuses in its determinants and transmission channels. This is a topic which has not yet been analyzed in the literature so far.

The main idea of the paper is that the social security financial crisis, at least a part of it, is endogenous to the system. The paper explains PAYG financial crises by extending previous results concerning the relation between social security, fertility and growth – see Becker et al. (1990), Cigno (1992, 1995), Ehrlich and Zhong (1998), Nishimura and Zhang (1992), Veall (1986), Zhang (1995), Zhang and Zhang (1995,1999) and Wigger (1999). The novelty of the paper is that we argue that the interactions between the family and the government lead to an endogenous erosion of the financial basis of the PAYG social security program so that, as a consequence, the PAYG system is not sustainable and it requires continuous increases in the social security tax rate.

In fact, common sense would indicate that as long as a demographic transition occurs, a funding crisis in the PAYG system might occur. In this paper we indicate that one of the causes of the funding crisis is a feedback effect from the social security to the demographic structure and the labor market. Our hypothesis is that the demographic transition becomes, to some extent, endogenous to the social security system and that whenever the social security system taxes labor income, labor supply will be negatively affected by the social security system. Those effects shrink the tax base. In this scenario, the government must increase the contribution rate to be able of paying the promised benefits. This increase in the contribution rate produces further decreases in the fertility rate and amplifies the initial impacts. This is a circle, produced by the interaction between the family and the government, that finally produces the social security financial crisis and account for the unsustainability of the system.

We focus on a small open economy facing factor prices and we follow the literature on social security, fertility and endogenous growth. In our analysis, we endogenize the contribution rate while we keep constant the replacement rate. We do so because, this assumption seems to be in line with current practice in most pensions systems in the western world.

2. The environment

We will suppose that in this economy people live for three periods of time. In the first of them, people are born and receive education from their parents while, in the second and third periods, they obtain utility from consumption flows. We will assume that the utility function is separable through time, and has the CRRA form, e.g. $u(c) = \frac{c^{1-\sigma}}{1-\sigma}$, with parameter $\sigma > 0$. Each individual has a discount factor $\beta < 1$.

Parents are altruistic as they care about the utility of their children. Following Becker et al. (1990) we will assume that parents discount their children's utility by the factor $\alpha(n_t)^{-\epsilon}$, where n_t is the number of children parents choose to bear, and $\alpha > 0$ and $1 > \epsilon > 0$ are constant parameters. To assure concavity, we assume as in Becker et al. (1990) $\sigma - \epsilon > 0$.

Education determines the level of human capital, H_t, used during the second period of life (young adult). At this moment, the young adult obtains income from two sources: (1) inheritance from parents, b_t, and (2) labor income, that depends on her human capital and on the time devoted to the labor market. We will suppose that the agent has a unit of time that must be distributed between labor supply and time dedicated to raising children. Thus, the agent must decide how many children to raise and the amount of time dedicated to each one of them, e_t. It follows that labor income is $w_t H_t(1 - n_t e_t)(1 - \tau_t)$, where w_t is the wage rate per unit of human capital and τ_t is the tax rate levied by the government to collect revenues. Total income is distributed between consumption c_t^y and saving, s_t, for the third and last period of life.

During the last period of life (old adult), the individual obtains income from the return of her savings, $(1 + r_{t+1})s_t$, as well as a transfer from the publicly funded social security, which is a proportion Φ of the individual's contribution during her second period of life. The parameter Φ is constant through time. Income is used as consumption, c_{t+1}^o, and as inheritances for children, $n_t b_{t+1}$. The human capital evolves according to the functional form $H_{t+1} = Ae_t H_t$, where H_{t+1} is the son's human capital stock and H_t the parent's. Finally, we will assume $e_t > \widetilde{e}, \forall t$ to assure that max $\{n_t\}$ is bounded. This scheme is transformed in the following recursive problem:

$$V_t(b_t, H_t) = max \quad u(c_t^y) + \beta u(c_{t+1}^o) + \beta \alpha n_t^{1-\epsilon} V_{t+1}(b_{t+1}, H_{t+1}) \tag{1}$$

$s.t.$

$$b_t + w_t H_t(1 - n_t e_t)(1 - \tau_t) - s_t \tag{2}$$

$$c_{t+1}^0 = (1 + r_{t+1})s_t + \Phi w_t H_t(1 - n_t e_t)\tau_t - n_t b_{t+1} \tag{3}$$

$$H_{t+1} = Ae_t H_t \tag{4}$$

where $V_t(b_t, H_t)$ is an young individual's value function at t. Before characterizing the problem, we will indicate certain restrictions that we will impose in the parameters of the problem. In the first place, we will restrict the tax rate, τ_t to lie in the interval $[0, 1], \forall t$. Secondly, we will assume that the rate of return of the social security system, Φ, is smaller than the one of the financial system, e.g., $1 + r_{t+1} > \Phi$. Although this might be seen as an arbitrary assumption, the evidence provided by Song (2000) indicates that, in general, the rate of return of the PAYG social security systems throughout the world is smaller than the one obtained from the financial system and even in some cases is negative. Thirdly, we will assume that our economy is a small economy facing stationary factor prices, e.g. $w_t = w, r_t = r, \ \forall t$. Finally, it is important to notice that given the time restriction, it follows that $0 < n_t e_t < 1, \ \forall t$.

To simplify the notation, let $\widetilde{\tau}_t = \tau_t(1 - \frac{\phi}{1+r_{t+1}})$ be the implicit tax rate of the social security system, where $0 < \widetilde{\tau}_t < 1$. This implicit tax rate is already established in the literature – Homburg (1997), Sinn (2000) - and has a clear economic interpretation: individuals have to pay an implicit tax with their pensions, if the rate of return of the social security system is smaller than the market rate of interest. Using this notation plus the savings' optimality condition,[1] the first order conditions with respect to b_{t+1}, e_t, n_t, plus the envelope conditions on human capital and bequests, can be written as in:

$$n_t \beta u_c(c_{t+1}^o) = \beta \alpha n_t^{1-\epsilon} \frac{\partial V_{t+1}}{\partial b_{t+1}} \tag{5}$$

$$w_t H_t n_t [u_c(c_t^y)(1-\tilde{\tau}_t)] = A\beta\alpha n_t^{1-\epsilon} \frac{\partial V_{t+1}}{\partial H_{t+1}} H_t \tag{6}$$

$$w_t H_t e_t [u_c(c_t^y)(1-\tilde{\tau}_t)] = \beta\alpha(1-\epsilon) n_t^{-\epsilon} V_{t+1} \tag{7}$$

$$\frac{\partial V}{\partial H_t} = w_t(1-n_t e_t)[u_c(c_t^y)(1-\tilde{\tau}_t)] \tag{8}$$

$$\frac{\partial V}{\partial b_t} = u_c(c_t^y) \tag{9}$$

Equations (5), (6) and (7) equate marginal cost with marginal benefit. The left hand side of (5) is the marginal cost of bequests (utility cost of decreasing old age consumption) while the right hand side is the marginal benefit, which depends on the marginal increase in children's discounted utility. Equations (6) and (7) have similar structure. In fact, the marginal cost of human capital investment per child and the marginal cost of bearing and additional child depends on the opportunity cost of time, $w_t H_t(1-\tilde{\tau}_t)$, which includes the effect of social security payroll tax, τ_t, and the replacement rate, Φ, through $\tilde{\tau}_t$. The marginal benefit of human capital accumulation corresponds to the discounted marginal impact on utility per child (weighted by the number of children), while the marginal benefit of an additional child depends on total utility per child, weighted by the impact on the discount factor as we increase the number of children. Finally, Eq. (8) and (9) are the envelope conditions concerning human capital and bequests at time t -both depends on the value of larger resources.

Note that Eqs. (5)–(6) and (8)–(9) determine the following condition:

$$\underbrace{A(1-n_{t+1}e_{t+1})\frac{w_{t+1}}{w_t}\frac{1-\widetilde{\tau_{t+1}}}{1-\tilde{\tau}_t}}_{R_H} = \underbrace{1+r_{t+1}}_{R_k} \tag{10}$$

where R_H, R_k are the rates of return of human capital and the financial sector, respectively. Note that the numerator of R_H is the return of investing one unit of time in producing human capital. The return depends on the parameter A (the productivity of the human capital technology) and the son's labor supply decision. The denominator is the opportunity cost of dedicating a unit of time to human capital accumulation. The intuition of (10) is that, at the margin, the return of the two forms of inheritances (human capital and bequests) must be equal.

An additional condition is obtained from the bequests' first order and envelope conditions:

$$\frac{u_c(c_t^y)}{u_c(c_{t+1}^y)} = (\frac{c_{t+1}^y}{c_t^y})^\sigma = (Ae_t)^\sigma = \beta\alpha(1+r_{t+1})n_t^{-\epsilon} \tag{11}$$

The equality uses the the property of a stable growth path, e.g., $\frac{c_{t+1}^y}{c_t^y} = Ae_t$. This equation indicates that the growth rate of consumption across generations depends on a traditional Euler equation, where the discount factor is a function of the number of children, n_t.

Equations (11) and (12) determine a set of two implicit functions[2] as in $n_t = n_t(\tau_t, \tau_{t-1}), e_t = e_t(\tau_t, \tau_{t-1})$. An interesting property is obtained when we characterize the effect of an increase in the current tax rate. An increase in the current tax rate is similar to a fall in the after tax-wage rate and therefore is associated with an income and a substitution effect. The income effect occurs because the rate of return of the social security system is smaller than the rate of return of the financial system and therefore, the present value of an increase in the tax rate is negative. The substitution effect is associated with the increase in the opportunity cost of labor supply. As we will see below, the income effect is larger than the substitution effect and, as a consequence, total time spent on children decreases which will produce an impact on the fertility rate and time spent per child.

The next set of equations illustrates the effects of the increase in the current tax rate:

$$\frac{\partial n_t}{\partial \tau_t}\frac{\tau_t}{n_t} = -\frac{\sigma}{\sigma - \epsilon}\frac{(1 - n_t e_t)}{n_t e_t}\frac{\tilde{\tau}_t}{1 - \tilde{\tau}_t} \tag{12}$$

$$\frac{\partial e_t}{\partial \tau_t}\frac{\tau_t}{e_t} = -\frac{\epsilon}{\sigma}\left[\frac{\partial n_t}{\partial \tau_t}\frac{\tau_t}{n_t}\right] > 0 \tag{13}$$

$$\frac{\partial n_t e_t}{\partial \tau_t}\frac{\tau_t}{n_t e_t} = \frac{\sigma - \epsilon}{\sigma}\left[\frac{\partial n_t}{\partial \tau_t}\frac{\tau_t}{n_t}\right] < 0 \tag{14}$$

The results show that the fertility rate falls whereas the time dedicated to each son increases. Moreover the effect on fertility is greater, which produces the negative effect on total time dedicated to raising children. The intuition of the result is that the utility function on per capita consumption is more concave than the discount function (which depends on the rate of fertility). Hence, we try to diminish the variations in consumption (labor income), granting greater variation to the fertility rate.

Similarly, the effects of an increase in the lagged tax rate are:

$$\frac{\partial n_t}{\partial \tau_{t-1}}\frac{\tau_{t-1}}{n_t} = \frac{\sigma}{\sigma - \epsilon}\frac{(1 - n_t e_t)}{n_t e_t}\frac{\widetilde{\tau_{t-1}}}{1 - \widetilde{\tau_{t-1}}} > 0 \tag{15}$$

$$\frac{\partial e_t}{\partial \tau_{t-1}}\frac{\tau_{t-1}}{e_t} = -\frac{\epsilon}{\sigma}\left[\frac{\partial n_t}{\partial \tau_{t-1}}\frac{\tau_{t-1}}{n_t}\right] < 0 \tag{16}$$

$$\frac{\partial n_t e_t}{\partial \tau_{t-1}}\frac{\tau_{t-1}}{n_t e_t} = \frac{\sigma - \epsilon}{\sigma}\left[\frac{\partial n_t}{\partial \tau_{t-1}}\frac{\tau_{t-1}}{n_t}\right] > 0 \tag{17}$$

The results in this case are exactly the converse compared to the previous case. Firstly, for any value of σ and ϵ, the time dedicated to work diminishes, whereas the amount of time dedicated to raising children increases. The intuition is that the increase in the lagged tax rate was related to an increase in the tax rate faced by the parents of the current young adult generation, who reacted to this tax by increasing the time dedicated to their work, and diminished their total time dedicated to their children. In order to compensate to the present generation, these parents dedicated larger time per child or left greater inheritances per capita. This is the reason why the resources of the present generation, at the per capita level increased. This positive per capita income effect stimulates each current young adult, who provides less work and spends more time (altogether) in her children. This is done by increasing the fertility rate while smoothly diminishing the time spent in each child.

3. The endogenous social security crisis

The previous section showed that the fiscal variables could affect the family' decisions, and particularly the fertility decisions. This section extends these results by allowing the interaction of the family' decisions with the reactions of the government. We will argue that this interaction might produce a financial crisis in the PAYG social security system.

In our context, the government looks for keeping its promised benefits while maintaining the system working through time. We will suppose a balanced fiscal budget. This is a simplification that does not modify the analysis because debt emission, if it exists, must be financed in the future. The following definition explains what we will understand as a social security financial crisis:

Definition. *A PAYG social security financial crisis will be understood as a situation in which the government increases the social security tax rate in order to obtain sufficient revenue to pay social security benefits that have been promised.*

In the definition we assume that to palliate any financing problem, the government must adequate its tax policy. Nevertheless, it must be indicated that alternatively the government could modify its expenditure policy (through Φ) or could modify the age of retirement of individuals to obtain larger revenues and to diminish its expenses. In our case, we centered the analysis in the tax policy because we considered that whatever is the alternative, the problem does not change: there is a financial crisis on the social security system. The instrument chosen to face this financial crisis is the payroll tax rate.

Next, we will explain how the interaction between the family and the government produces the financial problem. The government must satisfy the following budget constraint:

$$\tau_{t+1} n_t w_{t+1}(1 - n_{t+1}e_{t+1})H_{t+1} = \Phi\tau_t w_t(1 - n_t e_t)H_t \tag{18}$$

The right hand side is total expenditure per old adult at t + 1, which depends on her past contribution to the system, while the left hand side is total revenue collection from current young adults. This equation can be written as in:

$$\tau_{t+1} = \frac{\Phi}{n_t A e_t} \frac{w_t(1 - n_t e_t)}{w_{t+1}(1 - n_{t+1}e_{t+1})} \tau_t \tag{19}$$

At first sight, this equation indicates that the tax rate is not constant. In fact, the tax rate would be constant through time only when the rate of return of the social security system is equal to the aggregate growth rate of the economy ($n_t A e_t$) and the per capita labor supply does not vary. The fulfillment of those conditions will happen only by chance. Therefore the stability of the system becomes fragile.

Further, the variables that affect the fragility of the social security system are determined by the family that reacts to the government policy, as indicated by the implicit functions of the previous section. To make explicit those effects, and as a matter of notation, let us define the elasticity of time spent raising children in t + 1 with respect to the lagged and the current tax rate and the elasticity of time spent on raising children at t with respect to the current tax rate as in:

$$\Theta^{n_{t+1}e_{t+1}}_{\tau_t} = \frac{\partial n_{t+1}e_{t+1}}{\partial \tau_t}\frac{\tau_t}{n_{t+1}e_{t+1}} > 0$$

$$\Theta^{n_{t+1}e_{t+1}}_{\tau_{t+1}} = \frac{\partial n_{t+1}e_{t+1}}{\partial \tau_{t+1}}\frac{\tau_{t+1}}{n_{t+1}e_{t+1}} < 0$$

$$\Theta^{n_t e_t}_{\tau_t} = \frac{\partial n_t e_t}{\partial \tau_t}\frac{\tau_t}{n_t e_t} < 0$$

where the signs of the elasticities follow from Eqs. (14) and (17). Using this notation, from Eq. (19) we obtain that an exogenous increase in the social security tax rate impacts the future tax rate as in:

$$\frac{\partial \tau_{t+1}}{\partial \tau_t}\frac{\tau_t}{\tau_{t+1}} = \frac{1 + \Theta^{n_{t+1}e_{t+1}}_{\tau_t}\frac{n_{t+1}e_{t+1}}{1-n_{t+1}e_{t+1}} - \Theta^{n_t e_t}_{\tau_t}\frac{1}{1-n_t e_t}}{1 - \Theta^{n_{t+1}e_{t+1}}_{\tau_{t+1}}\frac{n_{t+1}e_{t+1}}{1-n_{t+1}e_{t+1}}} \tag{20}$$

This equation indicates that the increase on the current tax rate, τ_t, produces an increase in the future tax rate, τ_{t+1}, due to the following three effects that appear on the numerator: (1) an increase in τ_t produces a proportional increase in contributions and thus in future benefits to be paid, for a given level labor supply and the fertility rate, (2) the increase of current taxes is related to a fall in the future labor supply (children will work less, as seen in the previous section, as indicated by $\Theta^{n_{t+1}e_{t+1}}_{\tau_t}$) and (3) current labor supply increases, which also increases future benefits to be paid -this effect is represented by $\Theta^{n_t e_t}_{\tau_t}$. All these effects are related to greater future benefits to be paid, and thus, require larger tax rates in the future. There is a fourth effect that goes in the opposite sense (the term on the denominator). This is related to the fact that an increase in the future tax rate causes an increase in the future labor supply, which allows to lessen the effect of τ_t on τ_{t+1}.

Note that the family's reactions to the system are directly related to a fall in the aggregate growth rate of the economy. The mechanism is the following. The increase in the tax rate produces an increase in the current labor supply, which diminishes time spent on children, $n_t e_t$, and directly impacts the aggregate growth rate of the economy as this last one is a linear function of $n_t e_t$, e.g., $n_t \frac{H_{t+1}}{H_t} = n_t A e_t$. This takes place through a demographic transition. As the aggregate growth rate is reduced, we will next show that it is not possible to collect the necessary funds to pay promised benefits and a larger future tax rate is required. In fact, after some steps of algebra [3] and replacing Eq (10) on (20), we obtain:

$$\frac{\partial \tau_{t+1}}{\partial \tau_t}\frac{\tau_t}{\tau_{t+1}} = \left[\frac{1 + r_{t+1}}{A}\right]\left[\frac{1}{(1 - n_{t+1}e_{t+1})}\right]\left[1 + \frac{\widetilde{\tau}_t}{n_t e_t}\right] > 0 \tag{21}$$

Since the three terms on the right hand side of (21) are positive. This expression indicates that an increase in the current social security tax rate requires further increases in the future tax rates to keep the system in balance. The three terms are related to the effects stated in (20). In fact, $[1 + \frac{\tau_t}{n_t e_t}]$ indicates that a larger current tax rate is associated to a larger future tax rate due to (1) the direct impact on future benefits to be paid, holding constant labor supply and to (2) the impact on current labor supply, which requires a further increase in future benefits to be paid. The term $[\frac{1}{(1-n_{t+1}e_{t+1})}]$ is related to the impact on future labor supply while $[\frac{1+r_{t+1}}{A}]$ is the ratio between the capital market rate of return and the productivity of human capital technology.

Note that when $0 < \frac{\partial \tau_{t+1}}{\partial \tau_t} \frac{\tau_t}{\tau_{t+1}} < 1, \forall t$, an increase in the current tax rate will produce a further increase in the future tax rate, but it should finally converge to some steady state value. However when $1 \leq \frac{\partial \tau_{t+1}}{\partial \tau_t} \frac{\tau_t}{\tau_{t+1}}, \forall t$, the behavior of the tax rate is explosive: an initial increase on the social security tax rate requires larger future increases. A sufficient, but not necessary condition, for the tax rate being explosive is $A \leq (1 + r_{t+1})$, since $[1 + \frac{\widetilde{\tau_t}}{n_t e_t}] > 1$ and $[\frac{1}{(1 - n_{t+1} e_{t+1})}] > 1$, $\forall t$. This is a quite intuitive condition. In fact, the return of contributions to the PAYG system depends on the increase on human capital of future generations, which will pay for pensions of current generations. The ratio $\frac{1+r_{t+1}}{A}$ compares the rate of return from the capital market with the rate of return of a unit of time invested on human capital accumulation and thus when $A \leq (1 + r_{t+1})$, the human capital technology is not able to provide enough funds to pay future pensions, even if the family does not react to the system. On the other hand, the other two terms of (21) indicate that the family reacts to the system by varying fertility and labor supply decisions. All those effects lessen the financial stability of the PAYG system and require increases in the future tax rate proportionally higher than the current increase in tax rate.

It is fair to notice that even if $A > (1 + r_{t+1})$, the behavior of the contribution rate might also be explosive, at least for some periods of time. In this case, even when the human capital technology is highly productive, the government might not be able to collect enough revenue in the future due to the family's responses to the social security system.

4. Conclusion

Financial crises are current and common phenomena of the PAYG social security system around the world. This paper adds to the current debate about the future of PAYG social security systems; our maintained hypothesis is that the financial crises of those systems are endogenous. The result relies on an endogenous demographic transition and a negative effect over labor supply that produce an upward trend in the social security tax rates over time. The relationships between the tax rate and the demographic transition and labor supply create an explosive vicious circle in the PAYG system with the consequence that the PAYG system becomes unsustainable.

Endnotes

[1] The savings' first order condition is $u_c(c_t^y) = \beta(1 + r_{t+1}) u_c(c_{t+1}^o)$.

[2] The implicit functions depend directly on $\widetilde{\tau}_t$ and, $\widetilde{\tau_{t-1}}$ plus others parameters, such as β, A, r_{t+1}, etc.. Here we use the property that $\widetilde{\tau}_t$ is a function of τ_t and Φ. In the implicit functions, we omitted the set of parameters that are constant through time such as Φ.

[3] Note that $\Theta_{\tau_t}^{n_t e_t} \frac{1}{1-n_t e_t} = -\frac{\widetilde{\tau_t}}{1-\widetilde{\tau_t}} \frac{1}{n_t e_t}, \Theta_{\tau_t}^{n_{t+1} e_{t+1}} \frac{n_{t+1} e_{t+1}}{1-n_{t+1} e_{t+1}} = \frac{\widetilde{\tau_t}}{1-\widetilde{\tau_t}}, 1 - \Theta_{\tau_{t+1}}^{n_{t+1} e_{t+1}} \frac{n_{t+1} e_{t+1}}{1-n_{t+1} e_{t+1}} = \frac{1}{1-\widetilde{\tau_{t+1}}}$.

References

Becker GS, Murphy K, Tamura R (1990) Human Capital, Fertility and Economic Growth. *Journal of Political Economy* 98(5):S12–S37

Breyer F (2001) Why Funding is not a Solution to the Social Security Crisis. Discussion Paper DIW Berlin 254, Berlin

Cigno A (1992) Children and Pensions. *Journal of Population Economics* 5(3):175–183

Cigno A (1995) Public Pensions with Endogenous Fertility: Comment on Nishimura and Zhang. *Journal of Public Economics* 57(1):169–173

Ehrlich I, Zhong J (1998) Social Security and the Real Economy: An Inquiry into Some Neglected Issues. *American Economic Review* 88(2):151–157

Feldstein M, Samwick A (1999) Maintaining Social Security Benefits and Tax Rates through Personal Retirement Accounts: An Update Based on the 1998 Social Security Trustees Report. National Bureau of Economic Research Working Paper 6540, Cambridge

Homburg S (1997) Old Age Pension Systems: A Theoretical Evaluation. In: H. Giersch (ed.) *Reforming the Welfare State*. Springer, Berlin Heidelberg New York, 233–246

Nishimura K, Zhang J (1992) Pay-As-You-Go Pensions with Endogenous Fertility. *Journal of Public Economics* 48(2):239–258

Sinn HW (2000) Why a Funded Pension System is Useful and Why it is not Useful. *International Tax and Public Finance* 7(4):389–410

Song CH (2000) *The Nature of Social Security and its Impact on Family*. PhD dissertation The University of Chicago, Chicago

Veall MR (1986) Public Pensions as Optimal Social Insurance Contracts. *Journal of Public Economics* 31(2):237–251

Wigger B (1999) Pay-as-you-go Public Pensions in a Model of Endogenous Growth and Fertility. *Journal of Population Economics* 12(4):625–640

Zhang J (1995) Social Security and Endogenous Growth. *Journal of Public Economics* 58(2):185–213

Zhang J, Zhang J (1995) The Effects of Social Security on Population and Output Growth. *Southern Economic Journal* 62(2):440–450

Zhang J, Zhang J (1998) Social Security, Intergenerational Transfers, and Endogenous Growth. *Canadian Journal of Economics* 31(5):1225–1241