SOCIAL SECURITY, DEMOGRAPHIC TRENDS, AND ECONOMIC GROWTH: THEORY AND EVIDENCE FROM THE INTERNATIONAL EXPERIENCE

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ABSTRACT

The worldwide problem with pay-as-you-go (PAYG) social security systems isn't just financial. This study indicates that these systems may have exerted adverse effects on key demographic factors, private savings, and long-term growth rates. Through a comprehensive endogenous-growth model where human capital is the engine of growth, family choices affect human capital formation, and family formation itself is a choice variable, we show that social security taxes and benefits can create adverse incentive effects on family formation and subsequent household choices, and that these effects cannot be fully neutralized by counteracting intergenerational transfers within families. We implement the model using calibrated simulations as well as panel data from 57 countries over 32 years (1960-92). We find that PAYG tax measures account for a sizeable part of the downward trends in family formation and fertility worldwide, and for a slowdown in the rates of savings and economic growth, especially in OECD countries.

Introduction

Social security has become a subject of intense policy concern because of its financial vulnerability. This paper focuses on a related, but no less important issue: social security's impact on demographic trends and economic growth. Data from 57 countries show, for example, that the average annual marriage net of divorce rate per 1000 people age 15 and over fell from 9.72 in 1960 to 6.40 in 1990, and that average total fertility rate fell from 3.82 in 1965 to 2.07 in 1989. In the U.S., the net marriage rate fell from 9.17 in 1960 to 6.39 in 1990, and the fertility rate fell from 2.9 in 1965 to 2.0 in 1989. These dramatic changes have been influences by trends in underlying economic and social factors operating in all countries. Our theoretical and empirical analyses indicate that the defined-benefits, pay-as-you-go (PAYG) social security systems operating in most countries have independently contributed to these trends.

To start from the end: we study a panel of 57 countries over the period 1960-1992. Controlling for a host of other contributing factors we find that the ratio of social security's pension benefits to GDP, which approximates the system's equilibrium tax rate (PEN), has adverse effects on: a. the rate of marriage net of divorce – decreasing marriage and increasing divorce; b. the total fertility rate; c. the private savings rate; and d. schooling attainment measures and per-capita GDP growth rates. These effects are especially large for family formation and fertility, and in OECD countries; they are not duplicated when PEN is replaced by a benefits measure that includes other welfare programs; and they are generally not observed in countries where social security is a **provident fund**, rather than a defined-benefits, PAYG system.

The insights we offer to rationalize these effects are based on a model of endogenous growth where human capital is the engine of growth, family choices affect fertility, investment in children's education, and savings, and family formation itself is a choice variable. Theoretically, we focus on the way the scale of the PAYG system, as indicated by the level of taxes and defined benefits, affects family decisions. In this regard, our paper generalizes the theoretical formulation in Becker and Barro [BB] (1988), which does not allow for human capital formation and endogenous growth, and in Ehrlich and Lui [EL] (1998), which does not model family formation as a separate choice variable and is based on a narrower specification of altruism.

The possible effects of PAYG systems on fertility especially, but savings and human capital formation as well, were analyzed in several previous studies, which reach varying conclusions depending on whether all three variables are examined in a dynamic context,[1] and on the way the parent's utility from children is specified.[2] All implicitly reach a common conclusion, however, which is a central proposition in EL (1998): exogenous increases in PAYG taxes must affect adversely **at least one** of these three choice variables. We go beyond all previous studies by considering, in addition, the consequences for net family formation.[3] This formulation allows for a more complete measurement of tax effects on **all** household choices, and it uncovers different **welfare** implications for single and married households.

We base our central propositions on a closed-economy OLG model of altruistic parents, which produces unequivocal adverse effects of social security taxes on family formation and fertility. By expanding this model to recognize private alternatives to public social security – household savings and old-age transfers from children to parents – we show that social security may also affect adversely aggregate savings and human capital formation. These results remain valid even if we reformulate the model in a dynastic setting, which allows for intergenerational transfers going from children to old parents or vice versa (bequest), or allow for an open-economy setting. We test the model's implications using both calibrated simulations and regression analyses based on the international panel data mentioned above. Although our theoretical model treats social security taxes and benefits as exogenous policy variables, empirically we allow for their possible endogeneity as well.

Our extended model suggests that exogenous increases in PAYG social security tax rates can be expected to impact adversely net family formation and at least one of the family's subsequent choices: fertility, savings, and educational investments. Our emphasis on the role of family formation in framing subsequent household choices produces additional insights: a. The net effect of social security taxes on the total fertility rate owes to their separate effects on family formation and on fertility decisions within families (given that most children are born within married households); b. Their impact on savings can vary significantly across "married" and "single" households; c. They have different welfare implications for married and single agents. Our model also suggests that higher social taxes crowd out intergenerational transfers going from children to old parents – the traditional family security system.

While both our calibrated simulations and regression analyses estimate relatively larger adverse tax effects on family formation and total fertility rate, they also confirm the existence of adverse effects on long-term growth rates and savings, which have been disputed issues in the literature (see footnote 1). Both analyses also indicate that these effects are larger where taxes and benefits levels are relatively high, and in advanced, relative to developing economies.

The basic source of these effects is an externality inherent in the PAYG system. The old-age benefits are **"defined"**: they are fixed at the individual level, largely independently of one's own contributions, and certainly independently of one's children's contributions, or whether one has any children. Therefore, individuals have little incentive to take such contributions into account in making fertility, investment, or savings decisions, and the incentive to form a family is affected by the implicit subsidy defined benefits provide to single (childless) households.

I. The Model

We consider a closed economy with competitive product and labor markets and workers of homogeneous capacity and fixed labor supplies.[4] Workers differ, however, in some idiosyncratic attributes that affect their matching prospects, which is why in equilibrium not all form families. We also limit search for a potential partner to a single period at the start of adulthood, by the end of which each worker winds up either "married" or "single". "Search", consisting of efforts to find and bond with a match, raises the **probability** of marriage, p, which we assume for convenience to be a **prerequisite** for having children. We assume that family formation decisions and all subsequent lifetime choices are based on rational expectations.

The engine of growth in this economy is human capital, and its accumulation is based on a production technology linking parents' human capital and investment in children's education with the human capital formed in the latter (as in Becker et al., 1990 and EL, 1991, 1998):

(1) $H_{t+1} = A(\overline{H} + H_t)h_t^{\mu}$.

In equation (1), $\overline{H}$ denotes raw labor, h_t ($\in [0,1]$) is the fraction of the production capacity parents invest in the human capital ("quality") of each child, H_{t+1}, and A captures technological or environmental factors enhancing effective intergenerational transmission of knowledge. For computational convenience, but without loss of generality, we henceforth set $\mu = 1$.

Our analysis builds on the overlapping-generations (OLG) framework in EL (1991), since this facilitates handling the family-formation choice. We recognize three overlapping generations: dependent children, working young adults, and retired old adults. We first analyze the interaction between social security and household choices in a benchmark case where the choice variables are marriage and the quantity and quality of children, and parents are motivated strictly by altruism. We then extend the model to allow for savings and old-age support from children as **private alternatives** to public social security. We also reformulate the model in a dynastic setting where the direction of intergenerational transfers (old-age support v. bequest) is determined endogenously.

The objective of the working young adult is to maximize expected lifetime utility function:

(2) $W(t) = U(C_0(t)) + p_t V_m^*(t) + (1-p_t)V_s^*(t)$,

where p_t denotes the probability of a successful marriage, and $V_m^*(t)$ and $V_s^*(t)$ denote the maximized expected lifetime utilities if the person winds up married or single, respectively. The term $U(C_0(t))$ in equation (2) denotes the utility of consumption during the single search-for-a-mate period when the young adult is already in full possession of the earning capacity $(\overline{H}+H_t)$ generated by parents. Search concludes in that period. Hence

(3) $C_0(t) = (\overline{H}+H_t)(1-\lambda(p_t))$,

where $\lambda(p)$ is the fraction of production capacity spent on search. The probability of a successful marriage, $p = p(\lambda)$, is a continuously increasing and concave function of λ, with $p(1) \leq 1$. Its inverse function $\lambda(p)$ is thus increasing and convex, with $\lambda(0)=0$.[5] The utility operator in each period is $U(C) = [1/(1-\sigma)][C^{1-\sigma}-1]$, with $0<\sigma\leq 1$.

1. The optimization problem

Optimization involves a two-step procedure. In the first, one maximizes the expected lifetime utilities, $V_m^*(t)$ and $V_s^*(t)$, conditional on being either a successfully married parent, or single and childless. In the second, the marriage decision is resolved.

A. ***If married***, the young adult thus maximizes the expected utility associated with parenthood:

(4) $V_m^*(t) = \max\, [1/(1-\sigma)][C_{m1}(t)^{1-\sigma}-1]+\delta\pi_2[1/(1-\sigma)]\{[C_{m2}(t+1)^{1-\sigma}-1]+[C_{m3}(t+1)^{1-\sigma}-1]\}$, where

(5) $C_{m1}(t) = (\overline{H}+H_t)(1-vn_t-h_t n_t-\theta)$,

(6) $C_{m2}(t+1) = S_{t+1}$, and

(7) $C_{m3}(t+1) = B(\pi_1 n_t)^{\beta}(\overline{H}+H_{t+1})^{\alpha}$, with $\beta > \alpha = 1$.

In equation (5), $C_{m1}(t)$ and n_t represent the consumption and number of children of a young parent (treated as a continuous variable), while v and h_t denote the unit monetary cost of raising and educating each child (but see fn. 4) as fractions of earnings capacity, $(\overline{H}+H_t)$, with the competitive wage rate normalized as 1. The policy variable θ is the PAYG system's tax rate on earnings, π_1 and π_2 denote probabilities of survival from childhood to adulthood and from adulthood to old age, and δ is a discount factor. In the benchmark model, social security is the only means of providing old-age insurance. The consumption of a parent at old age, $C_{m2}(t+1)$ in equation (6), thus equals the equilibrium social security benefit, S_{t+1}, in equation (11) below.

In equation (7), the term $C_{m3}(t+1)=B(\pi_1 n_t)^{\beta}(\overline{H}+H_{t+1})^{\alpha}$, with $\alpha = 1$, defines the "altruism function" in the context of our OLG framework, whereby parents derive utility vicariously from the potential income and expected number of surviving offspring, $\pi_1 n_t$ (we later allow for children's non-survival as well). This specification is analogous to that of altruism in dynastic models. To ensure interior solutions in both fertility and educational investment, it is necessary that $\boldsymbol{\beta>\alpha=1}$, otherwise quality would dominate quantity of children in a growth-equilibrium steady state because quantity always has a higher marginal cost than quality if educational investments apply to all children. To ensure the concavity of equation (4), we must further restrict $\beta(1-\sigma)<1$.

B. *If single*, the young adult maximizes a strictly "selfish" expected utility function:

(8) $V_s^*(t) = \max\,[1/(1-\sigma)][C_{s1}(t)^{1-\sigma}-1] + \delta\pi_2[1/(1-\sigma)]\{[C_{s2}(t+1)^{1-\sigma}-1]+[C_{s3}(t+1)^{1-\sigma}-1]\}$, where

(9) $C_{s1}(t) = (\overline{H}+H_t)(1-\theta)$,

(10) $C_{s2}(t+1) = S_{t+1}$,

and $C_{s3}(t+1)$ is zero for singles.

We assume that PAYG social security is a strictly defined-benefits system: all adults, regardless of marital status, pay the same taxes and enjoy the same defined benefits. In the benchmark model, therefore, $C_s(t+1)=C_m(t+1)$. Since only children born to married agents contribute to social security, the balanced-budget defined benefits per recipient are given by:

(11) $S_{t+1} = p_t(\pi_1/\pi_2)n_t\theta(\overline{H}+H_{t+1})$.

2. The family formation decision, subsequent choices, and equilibrium outcomes

By the economic approach to marriage (see Becker 1993), being married "pays" relative to staying single, i.e., $V_m^*(t) > V_s^*(t)$, because of parental rewards from children – marriage's unique product. Given the solutions for $V_m^*(t)$ and $V_s^*(t)$, the optimal probability of marriage, p_t, is determined by maximizing equation (2) with respect to p_t. The first order condition is:

(12) $\Delta(t) \equiv [V_m^*(t) - V_s^*(t)] - \phi(p_t)\,(\overline{H} + H_t)^{1-\sigma} = 0.$[6]

The marginal benefit of p_t is the utility differential from being married rather than single, and $\phi(p_t) \equiv [1-\lambda(p_t)]^{-\sigma}\lambda'(p_t)$ is its marginal cost per unit of production capacity. Optimal p_t is positive and unique, as $\phi(0)=0$ and $\phi(p)$ is rising with p. Since young adults in the economy have identical search costs and matching odds, the marriage market clears probabilistically: the value of p, which equates equation (2) across all young adults ex-ante, is equal to the ex-post fraction of married adults. Optimal p also depends, however, on the equilibrium values of fertility and human capital investments, which are dictated by married households.

For married agents, the values of n_t and h_t that maximize (4) are found from

(13) $[C_{m2}(t+1)/C_{m1}(t)]^{\sigma} \geq \delta(\pi_1)^{\beta}\pi_2 B\beta(n_t)^{\beta-1}(\overline{H} + H_{t+1})[C_{m2}(t+1)/C_{m3}(t+1)]^{\sigma}/[(\overline{H} + H_t)\,(v+h_t)] \equiv \delta R_{mn},$

(14) $[C_{m2}(t+1)/C_{m1}(t)]^{\sigma} \geq \delta A(\pi_1)^{\beta}\pi_2 B(n_t)^{\beta-1}[C_{m2}(t+1)/C_{m3}(t+1)]^{\sigma} \equiv \delta R_{mh}.$

In equations (13) and (14), the LHS terms denote the marginal rate of substitution in consumption between adulthood and old age, and R_{mi}, i = n, h, denote the monetary equivalents of expected rates of psychic returns on investments in the quantity and quality of children. Optimal p_t, h_t and n_t must satisfy simultaneously equations (12), (13), and (14). In these equations, however, social security benefits are taken as exogenous. **Equilibrium** solutions at the aggregate, or representative-agent level, must also incorporate the feedback effects of the micro-level solutions for p_t, h_t and n_t on the equilibrium level of benefits, as governed by equation (11). These are derived below.

Note, first, that the equilibrium solutions for our control variables determine the economy's "development" prospects, which are dictated by the marginal rate of human capital formation. Two stable regimes can be shown to exist in the benchmark model: a. a stagnant steady state where $h^*=0$, so there is no human capital formation or economic growth (a Malthusian trap); b. a growth equilibrium regime where Ah_t^* sufficiently exceeds 1, which converges on a steady state of perpetual growth. Whether the economy is stuck in the first, or can take off to the second steady state, is dictated by growth-enhancing parameters – in the benchmark case, essentially A, B, β, and v. Since our empirical data relate to developing economies exhibiting persistent growth, we focus henceforth on interior solutions for all our control variables.[7] In this case the benchmark model yields a closed-form equilibrium solution for h_t, based on equations (13) and (14):

(15) $h_t = v/(\beta-1) - \overline{H}/[A(\beta-1)(\overline{H}+H_t)]$.

In a steady state of growth, the equilibrium rate of investment in human capital thus becomes $h_t=h^*=\nu/(\beta-1)$. Two propositions follow:

Proposition 1. Absent savings or intergenerational transfers, an exogenous increase in the social security tax rate, θ, will lower the equilibrium quantity of children in a stable growth regime, n_t, while leaving unchanged their quality, h_t.

Proof. In equation (15) equilibrium h_t is independent of θ all along its dynamic path. By equations (13) and (15), we thus have:

(16) $(dn_t/d\theta) = 1/\{-(v+h_t) - \Psi[1-\beta(1-\sigma)]\, n_t^{[1-\beta(1-\sigma)-\sigma]/\sigma}/\sigma\}<0$,

where $\Psi = (\delta\pi_2\beta)^{-1/\sigma}(v+h_t)^{1/\sigma}[B(\pi_1)^{\beta}(\overline{H}+H_{t+1})/(\overline{H}+H_t)]^{1-1/\sigma} > 0$. Since stability conditions require that $\beta(1-\sigma)<1$ and $\sigma>0$, equation (16) must be negative. Indeed, in the log utility case, $n_t= n^*= \delta\pi_2\beta(\beta-1)(1-\theta)\, A(\overline{H}+H_t) / (1+\delta\pi_2\beta) /[\beta v A(\overline{H}+H_t) - \overline{H}]$, confirming the proposition.

Proposition 2. Absent savings or intergenerational transfers, an increase in the social security tax rate, θ, will lower the equilibrium probability of marriage, p_t.

Proof. Differentiating equation (12) totally with respect to θ and p_t, we obtain

(17) $(dp_t/d\theta) = [-C_{m1}(t)^{-\sigma} + C_{s1}(t)^{-\sigma} + (dn_t/d\theta)\Omega]/\phi'(p_t)$,

where $\Omega \equiv \partial V_m^* / \partial\theta = -C_{m1}(t)^{-\sigma}(v+h_t) + \delta\pi_2 C_{m3}(t+1)^{-\sigma}B\beta(\pi_1)^{\beta}(n_t)^{\beta-1}(\overline{H}+H_{t+1})/(\overline{H}+H_t) = 0$ by the envelope theorem. Since $\phi'(p_t)>0$, and the consumption level of parents raising children is lower than that of singles ($C_{m1}(t) < C_{s1}(t)$), the sign of $dp_t/d\theta$ is negative.

These propositions imply that any increase in the social security tax lowers the entire dynamic **paths** of fertility and family formation, not just the latter's steady-state values. The underlying reason is that individual parents cannot internalize the impact of **aggregate** marriages and educational attainments of all children on equilibrium defined benefits per recipient, since one's defined benefits do not depend on the number (n) or quality (h) of one's own children, or whether one has any children. In contrast, the tax is levied in proportion to household earnings, and thus is a greater **burden** on families raising and educating more children. This externality lowers the marginal benefits from children or from forming a family rather than staying single.

More specifically, an increase in the tax rate initially lowers one's consumption at young age, thus raising the marginal rate of substitution in consumption relative to the rate of (psychic) return on children. Since from an **individual** parent's perspective "defined" benefits (S_{t+1}) are independent of one's own n or h, these must be lowered so that the psychic return on children rises as well (see eq. 13, 14). But since h_t is invariant to tax changes in the benchmark model, the adjustment falls strictly on n: fertility must decline. The reason why an exogenous rise in the tax rate affects family formation is similar: An increase in the tax lowers young-age consumption for both parents and singles. Since benefits are uniform and parents also bear the cost of children, the higher tax rate reduces the welfare gain from marriage, $V_m^*(t) - V_s^*(t)$, in equation (12). This externality lowers the marginal benefits from forming a family rather than staying single.

Proposition 1 and especially the implication that h_t is unresponsive to tax changes stem from specifying altruism in equation (7) as a function of the expected number of surviving children. If **uncertainty** in the survival of children were formally recognized, **all** choice variables would become vulnerable to adverse tax effects (see Appendix A.1). This is also the case when we allow for any one of the model's extensions below.

3. Introducing savings opportunities and family-based old-age insurance

We now extend the benchmark model to allow for both savings opportunities and an informal family-security system in which old parents partly rely on adult children for old-age support and care. We pursue these extensions, as well as a related extension allowing for bequest in section 4, to determine whether the existence of either one of these "private" alternatives to social security can **neutralize** the tax effect on family formation or fertility, as in section 2. In this context, however, we also explore specific repercussions for savings and intergenerational transfers.

For simplicity, we introduce opportunities to save for old age consumption via a home-production function, or a highly segmented capital market, $F_j=D(\overline{H}+H_t)^{1-\kappa}[(\overline{H}+H_t)s_j]^{\kappa}$ $(0<\kappa<1)$, where s_j denotes the savings rate for married or single agents (j=m,n): Old agents use their production capacity to convert accumulated savings, $K_{jt} \equiv (\overline{H}+H_t)s_j$, which fully depreciate within one generation, to old-age consumption. This simple specification enables us to avoid modeling a distinct capital market, while capturing the idea that the equilibrium rate of return from physical capital in a closed economy is subject to diminishing returns.

The incentive to form an implicit family-security system arises from the investment parents make in their children's human capital (see equation 1). If this investment is productive, there is a mutual benefit for parents and children to reach a sharing arrangement based on implicit contracts.

EL (1991) specify sufficient conditions by which such contracts can be time-consistent, and show that the optimal parental share is proportional to the human capital stock parents help produce.[8] To simplify the insurance system, we assume that all siblings, single or married, form an extended-family insurance pool in which intergenerational transfers are actuarially fair and default-free.[9] This assumption is relaxed in Appendix A.1.

The consumption flows at adulthood and old age in this extended model become:

(5′) $C_{m1}(t) = (\overline{H} + H_t)(1 - vn_t - h_t n_t - s_{mt} - \theta) - \pi_2 w_t H_t$, and

(6′) $C_{m2}(t+1) = \pi_1 n_t w_{t+1} H_{t+1} + D(\overline{H} + H_t)^{1-\kappa}[(\overline{H} + H_t)s_{mt}]^{\kappa} + S_{t+1}$, for married agents; and

(9′) $C_{s1}(t) = (\overline{H} + H_t)(1 - s_{st} - \theta) - \pi_2 w_t H_t$, and

(10′) $C_{s2}(t+1) = D(\overline{H} + H_t)^{1-\kappa}[(\overline{H} + H_t)s_{st}]^{\kappa} + S_{t+1}$, for single agents,

where w is the optimal sharing rule and $\pi_2 w_t H_t$ is the actuarially fair rate of transfer of benefits to old parents. In equation (6′) old age consumption by a surviving parent, $C_{m2}(t+1)$, now combines transfers from surviving children, income from savings, and social security benefits, S_{t+1}. Single agents contribute to their parents' old-age support, but receive no old-age support themselves since they have no children. They do secure, however, additional old-age income via savings.

The first order optimization conditions for married agents become

(13′) $[C_{m2}(t+1)/C_{m1}(t)]^{\sigma} \geq \delta A \pi_1 \pi_2 w_{t+1}[1 + \beta N_t^*(\overline{H} + H_{t+1})/H_{t+1}]/[1 + (v/h_t)] \equiv \delta R_{mn}$,

(14′) $[C_{m2}(t+1)/C_{m1}(t)]^{\sigma} \geq \delta A \pi_1 \pi_2 w_{t+1}(1 + \alpha N_t^*) \equiv \delta R_{mh}$,

(18) $[C_{m2}(t+1)/C_{m1}(t)]^{\sigma} \geq \delta \pi_2 D\kappa / s_{mt}^{1-\kappa} \equiv \delta R_{ms}$,

and the optimal parental support rate, w_{t+1},is determined so as to satisfy

(19) $dW(t+1)/dw_{t+1} = [\partial W(t+1)/\partial H_{t+1}]\,[\partial H_{t+1}/\partial w_{t+1}] + \partial W(t+1)/\partial w_{t+1} = 0$.

In equations (13′) and (14′), $N_t^* \equiv C_{m2}{}^{\sigma} C_{m3}{}^{1-\sigma}/[\pi_1 w_{t+1} n_t(\overline{H} + H_{t+1})]$ is the ratio of psychic to material rewards. The rates of return to children's quantity (n) and quality (h) thus include both an old-age insurance benefit, and a purely altruistic reward. Also, investment in children does not rule out savings, given that the latter is initially productive, i.e., that $R_{ms}(s_m=0) > R_{mn} = R_{mh}$. Equation (19) sets a positive compensation rate for parents, w*, which maximizes equation (2) for each child. A formal analysis of this choice is outlined in **Appendix A.2**. Note that in this extended model with w*>0, all control variables can have interior solutions in all stable steady states, including the low-income, stagnant equilibrium state which no longer requires zero investments in human capital.

For single agents, the optimal savings condition is symmetrical to that of married ones:

(20) $[C_{s2}(t+1)/C_{s1}(t)]^{\sigma} \geq \delta\pi_2 D\kappa/s_{st}^{1-\kappa} \equiv \delta R_{ss}$.

Equilibrium solutions require that equations (13′), (14′) and (18)-(20) be satisfied along with social security's balanced-budget constraint (11). These equations form a set of non-linear, second-order simultaneous difference equations. Since no closed-form solutions exist, the equilibrium values of the model's control variables p, n, s, h, and w must be derived through simulations. **Table I** presents calibrated simulations of the effects of once-and-for-all changes in the tax rate θ on these variables in a steady state of persistent growth, using US data. The calibration procedure is outlined in **Appendix A.3**.

Some comparative dynamic results can be proved analytically if w is **given exogenously**.

Proposition 3: The optimal rate of savings for old-age consumption is lower for young parents than for single adults, or $s_{st} > s_{mt}$. Proof: see **Appendix A.4**.

The rationale is simple. At zero human capital investment in children (h=0), and regardless of optimal n, the rate of return to parents from investment in h, R_{mh} in equation (14′), must exceed the rate of return on savings they could obtain if they chose to save the same amount as singles, R_{ss} in equation (19), otherwise it would not pay to invest. Parents must thus have lower optimal savings and higher consumption at old age, relative to singles ($C_{m2}>C_{s2}$).

Proposition 4*:* An increase in the social security tax rate (θ) that raises the equilibrium defined-benefits per recipient would depress the share of married households (p), as long as young parents' consumption is lower than singles' (C_{m1}<C_{s1}). Proof: See **Appendix A.5**.

The rational here is the same as in the case of proposition 2, but the existence of savings and old age support as means of enhancing future utility complicates an analytical proof. Given that parenting costs lower parents' consumption relative to that of singles, C_{m1}<C_{s1}, as our simulations show, an increase in θ also lowers the utility of consumption for parents relative to singles. As long as a higher θ raises the equilibrium social security benefits per recipient S_{t+1}, this raises the utility of consumption for old single agents relative to married ones, as $C_{m2} > C_{s2}$ by proposition 3. The defined-benefits system thus provides a subsidy to single recipients because they share in the larger social security pie produced by offspring of married ones without having to bear the latter's parenting costs. Both effects lower the gain from family formation. Note, however, that in some PAYG systems, like the US, non-contributing spouses may independently benefit from pension rights vested in contributing workers through a legal entitlement, which our homogeneous-worker model cannot recognize. In such cases, the net effect of a higher θ on family formation would depend on the relative strength of these opposing effects.

Proposition 5: An increase in the social security tax rate (θ) that raises the equilibrium defined benefits per recipient, cannot increase all of the three family-choice variables, s_m, n, and h; **at least one** of these must decline, and possibly all three. This proposition implies that a higher θ **necessarily lowers the savings rate for single agents**, s_s. Proof: See **Appendix A.6**.

As in Proposition 1's case, the rationale is that higher PAYG taxes and benefits raise the marginal rate of substitution in consumption (MRS) relative to the rates of return from children's quantity and quality, and savings (equations 13′, 14′, 18). Consequently, at least one of these variables must be downsized in equilibrium, and this applies **unambiguously** to savings - the only choice variable - in the case of singles.[10] This adjustment also leads to an increase in the equilibrium rates of return on savings for singles (R_{ss}) and married agents (R_{mn}=R_{mh}=R_{ms}), as our simulations invariably show. In this extended framework, unlike the benchmark model, human capital investment is no longer independent of the social security tax rate, and this is the case even if we add just savings as an alternative private means of securing old age needs.

Given the optimal old-age support rate, w, savings and human capital investments can be shown to be **"complements"**, in the sense that an increase in θ would affect both s_m and h in the same direction. In contrast, fertility and human capital investments are **"substitutes"**: a higher θ or v would move n and h in opposite directions. Indeed, if a rise in θ causes a significant decline in fertility, human capital formation and savings may even **rise** as a result. However, **Appendix A.6** shows that it is impossible that all three family choice variables would rise. Our calibrated simulations in Table I invariably show that all three, as well as family formation (p), in fact **fall** as a result of a higher θ, and the percentage decline is larger the higher is the tax rate itself. Also, a higher θ has a larger adverse effect on the savings rate of **singles** relative to parents.

Other comparative Dynamics

The impact of higher social security taxes on old-age support. One can expect direct competition between a compulsory social insurance system and a voluntary family-security system. Indeed, our calibrated simulations confirm this prediction: the optimal value of w* **falls** consistently with a higher θ at the growth equilibrium steady state. By these results, social security has contributed to the **crowding out** of intergenerational transfers within families, but has not eliminated them, consistent with recent stylized facts.[11]

Comparative dynamics over the development phase: A once-and-for-all upward shock in the technology of producing human capital, A, or a decreases in the cost of raising a child, v, can produce a takeoff from a stagnant to growth equilibrium through a “development phase” linking the two. Over this phase family formation (p) and fertility (n), or the product of the two, **pn** – an index of “total fertility rate” – generally trend downward, while the rate of human capital investment trends upward. This is seen in unreported simulations charting the transitional paths of these variables over the development phase from an early stage of the transition (t=1) toward the growth equilibrium steady state ($t=\infty$). The simulations in part B of Table 1 show the effects of an exogenous rise in θ at these two stages. We find that a higher θ actually exerts **larger** adverse effects on all our control variables at the **more advanced** stage of development.

The impact of changes in survival probabilities: An increase in the survival probabilities from childhood to adulthood (π_1) and from adulthood to old age (π_2) raises both the altruistic and material benefits to parents from own and children’s survival, and thus family formation, p. Their effect on other control variables is more ambiguous: higher π_1 and π_2 increase desired spending on kids, but not necessarily on both quantity and quality. A higher π_2 increases the odds of living through old age, thus the need for savings and intergenerational transfers (w), while a higher π_1 raises the total return on children, and can thus lower s_m and w. These implications are confirmed in separate simulations, which we do not report in Table I to save space.

4. The Model in a Dynastic setting

Do our basic propositions hold also in a dynastic framework? To allow for intergenerational transfers mandated by a PAYG system we continue to recognize two periods, young and old, in the lifecycle of a dynasty head, but we abstract from family-formation (letting p=1) and focus on the growth-equilibrium steady state. The value function can then be stated in its usual recursive form:

(4a) $V_t(H_t) = \max\, [1/(1-\sigma)][C_1(t)^{1-\sigma}-1] + \delta\pi_2[1/(1-\sigma)][C_2(t+1)^{1-\sigma}-1] + \delta\pi_2(\pi_1 n_t)^{\beta(1-\sigma)}V_{t+1}(H_{t+1})$,

where $C_1(t) = (1-vn_t - h_t n_t - s_t - \theta - \pi_2 w)H_t$, $C_2(t+1) = \pi_1 n_t w H_{t+1} + DH_t^{1-\kappa}(H_t s_t)^{\kappa} + S_{t+1,}$

$H_{t+1} = AH_th_t$, and $S_{t+1} = (\pi_1/\pi_2)n_t\theta H_{t+1}$.

The value function $V_t(H_t)$ in equation (4a), unlike that in (4), incorporates the offspring's utility, rather than full income, into the dynasty head's utility, and thus the utilities of all future generations as well. In a growth steady state, however, $V_t(H_t)$, depends on the single state variable, H_t, since "raw" human capital $\overline{H}$ vanishes in relative importance as H_t grows without bound. To simplify the analysis we also take the old-age support rate, w, as given.

Using the optimality conditions (see **Appendix 7**) we can show that the steady state values of h and s have an explicit relation: $h = [v/(\beta-1)][D\kappa s^{\kappa-1}/(D\kappa s^{\kappa-1} - \pi_1 wA)]$, which implies that they move in tandem as a result of a shock in θ, as is the case in our OLG model. Moreover, our simulations in Table II indicate that a higher social security tax, θ, has **adverse effects** on all family-based choices, essentially because of the same externality operating in the OLG setting. At least one of the family's choice variables must fall, and by the simulations, all three do.

Moreover, these effects hold if we assume that the dynasty head also controls the pooled incomes of the overlapping generations within the family. In this case, where the dynasty head determines the optimal values of s_t, n_t, and h_t as well as consumption allocation across co-existing generations, the **direction** of optimal intergenerational transfers is determined endogenously. Here too, our simulations show adverse effects of θ on all the control variables (see table II part iii). This underscores the fact that the impact of θ cannot be neutralized by Ricardian Equivalence adjustments, even in the presence of bequest.

5. The model in a small open economy

In this section we set the interest rate on savings at an internationally fixed level, r and explore the impact of social security in this small, open-economy setting, assuming first that parents are motivated just by altruism (w=0).[12] The first-order optimization conditions become

(13a) $[C_{m3}(t+1)/C_{m1}(t)]^{\sigma} \geq \delta\pi_2 B\pi_1^{\beta} \beta n_t^{\beta-1} (\overline{H} + H_{t+1})/(\overline{H} + H_t)/(v+h_t)$,

(14a) $[C_{m3}(t+1)/C_{m1}(t)]^{\sigma} \geq \delta\pi_2 B\pi_1^{\beta} \beta n_t^{\beta-1} A$,

(18a) $[C_{m2}(t+1)/C_{m1}(t)]^{\sigma} \geq \delta\pi_2(1+r)$,

(20a) $[C_{s2}(t+1)/C_{s1}(t)]^{\sigma} \geq \delta\pi_2(1+r)$.

A notable difference between this model and our general closed-economy model is that the inter-temporal MRS in consumption is equal for **both** parents and singles. As in our benchmark case where w=0, the optimal value of human capital investment is the same as that in equation (15), so h is independent of the tax rate, θ. As in Proposition 3, however, singles have a higher rate of savings for old-age consumption than parents, and Propositions 4 and 5 hold here as well: a higher tax rate, θ, necessarily lowers savings by singles and cannot increase both fertility and savings in married households. Moreover, a higher θ cannot reduce savings alone: either p or n must be affected as well (see Table III for the simulation results of this model).

If we further allow for intergenerational transfers via a family-security system, with an **endogenously** determined rate of transfer, w, propositions 4 and 5 still hold, albeit with a caveat: since the rate of return on savings $R_s \equiv \pi_2(1+r)$ is a constant, we can show that in married families either savings or intergenerational transfers would be used to secure old-age consumption. The chosen instrument depends on the relative magnitudes of R_s vs R_h and R_n.

6. Welfare Implications

While the preceding versions of our general model have similar implications about the impact of exogenous changes in social security tax rates and benefits, they do have different welfare implications. In the **dynastic** framework of section 4, a rise in θ unambiguously **lowers** the dynasty head's welfare, $V_t(H_t)$, since any expansion of mandated intergenerational transfers cannot improve on the optimal transfers chosen by the dynasty head. In all our OLG models, in contrast, higher social security taxes may in principle **increase** the parent's utility, V_m*, since intergenerational transfers are not set at their Pareto-optimal level (see **Appendix A.2**). Moreover, there is an intriguing distinction in this regard between married and single agents: higher social security taxes give an added advantage to singles at the expense of parents because of the implicit subsidy they provide to single (childless) households. In our simulations, the parents' utility level, V_m*, always falls with a rise in θ while the single household's utility level, V_s*, can actually **rise** with θ when specific parameter values are used in the simulations.

II. Empirical Implementation

We test these propositions against international panel data via a **reduced-form** specification of our model in which the dependent variables are the model's endogenous variables, and the basic regressors measure its basic parameters, including the social security tax rate, θ. Although θ is an exogenous variable in our model, we allow for its possible endogeneity in our regressions analysis. For variable construction, sources, and sample statistics, see Appendix A.8.

1. The Sample and Variable Construction

Our social security data are taken from *The Cost of Social Security*, published by the International Labour Office (ILO). The data are available in 57 countries over 33 years, 1960-1992, but in some countries not for all years. We measure our theoretical social security tax rate, θ, by the "pension" portion of social security benefits relative to GDP (PEN). Under a balanced budget, expected benefits per recipient equal $\pi_2 S_{t+1} = p_t \pi_1 n_t \theta_{t+1}(\overline{H} + H_{t+1})$ (see equation 11), while expected earnings per worker equals $Q_{t+1} = p_t \pi_1 n_t(\overline{H} + H_{t+1})$. It follows that $\pi_2 S_{t+1}/Q_{t+1} = \theta_{t+1} \equiv \text{PEN}$. In a balanced-budget setup, PEN consistently measures the tax rate applying to the overlapping generations of workers. In short-run situations, however, it is possible that PEN will be subject to dynamic adjustments towards its equilibrium value. In section IV.5 we allow for such possibility.

We use the population's annual marriage net of divorce rate (NETMARRY) as a proxy for our family formation variable (p),[13] and the official total fertility rate (TFR) as a proxy for average population fertility. Summers and Heston's (1992) investment rate (I) is used to impute a proxy for the private savings rate using national income account identities (see section III.3).

To approximate our theoretical per-capita rate of investment in human capital, **h**, or, equivalently, the marginal rate of human capital formation **Ah** (see equation 1) we use measures of intermediate and the long-term per-capita GDP growth rate, since by our model, the latter converge on (1+g)=Ah in a steady state. To corroborate our results, we also construct a direct measure of per-capita investment in human capital based on three variants of schooling data: average schooling years in the population (SCHYR), average enrollment rate in secondary schools (SEC), and students' performance scores in international knowledge tests (SCORE) (see section IV.1).

Our basic explanatory variables include PEN, measures of the survival probabilities to adulthood and old age (Pi1 and Pi2), and the GDP share of government spending (G) separating our social security tax from overall taxation. In all regressions we also include measures of the economic status of women, since our model does not distinguish between male and female agents, but mothers' employment opportunities may have special relevance for family choices. Since our sample includes a combination of developing and advanced economies, we also control for an economy's development stage by including initial GDP per-capita (GDPN) or schooling level (SCHYR) as **endogenous** regressors. To test specific theoretical predictions we also separate our full sample into OECD and non-OECD and distinguish provident-fund and non-provident-fund countries. Our data sources are presented in Appendix A.8.

2. Model Specification

Our basic regression specification is a linear model with country-specific fixed-effects:

(21) $L\bar{y}_{t,t+4} = \alpha_0 + \alpha_1 LPEN_t + \alpha_2 LPi1_t + \alpha_3 LPi2_t + \alpha_4 LG_t + u_t$,

where $\overline{y}_{t,t+4}$ measures the average value of each of our four endogenous variables, including per-capita income growth ($GDPN_{t+4}/GDPN_t$), over a **5-year lead period**, from t to t+4; L denotes natural logs; and α_0 is a vector of country-specific dummy variables. The other regressors (X) are measures of the model's basic parameters in period t.

The basic idea is to treat the mean realized values of the model's endogenous variables over periods of intermediate length as samples of their equilibrium values along the growth-equilibrium development path, and to test the effects of initial changes in our measure of θ, PEN, on these values (see Barro and Lee, 2003). Although in equation (21), PEN_t is entered as a predetermined variable, we also run regressions treating it as endogenous using a 2SLS procedure (see below). We rely on two sample specifications to estimate equation (21): In variant (21.a) the sample we use includes "rolling" 5-year periods, where $\overline{y}_{t,t+4}$ and the X_t are computed over consecutive beginning periods (t, t+1, etc). In variant (21.b) $\overline{y}_{t,t+4}$ and X_t are computed for non-overlapping 5-year periods. Clearly, the sample size associated with (21.b) becomes much smaller. We also examined 3 and 7 lead-year specifications, which yielded similar qualitative results to those reported in tables 1-4.

As explained above, we introduce $GDPN_t$, or $SCHYR_t$, treated as endogenous variables, to account for the economy's stage of transition to a steady state of growth, which yield very similar results, except that SCHYR restricts the sample size by approximately 600 observations, so GDPN is used in most regressions.[14] In our **intermediate income-growth** regressions based on equation (21), however (and by necessity in equation 22 below where $GDPN_t$ is a dependent variable), we use instead the schooling measure (SCHYR), to avoid a "regression fallacy bias" (see Friedman 1992). The family-formation regressions include also the absolute deviation of the female population share from 50 percent (DSEX). Other regressors added in variants of equation (21) are female labor force participation rate (FLFP) and ratio of female to male schooling (FSCH). In the savings regression we also introduce money supply (M2) and inflation rate (INFLA) (see section III.3). The country-dummies in equation (21) control for missing country-specific **institutional** factors, including differences in variable counts,[15] or the initial values of physical capital. This fixed-effects specification captures **within-country** variations in our regressors (X).

We add a special regression specification, (24) below, as an alternative to equation (21), to account for the **long-term** growth rate of per-capita income or schooling attainments, (1+g) = Ah, which serve as proxies for our theoretical growth rate of human capital per capita. In a steady state:

(22) $GDPN_t = (GDPN_0) \exp[g(X_t)t] \exp(u_t)$, and by the logic of equation (18)

(23) $g(X_t) = \beta_1 + \beta_2 LPEN_t + \beta_3 LPi1_t + \beta_4 LPi2_t + \beta_5 LG_t$.

Taking the log of (22), the growth rate equation (23) can then be estimated from:

(24) $LGDPN_t = \beta_0 + \beta_1 t + \beta_2 t \cdot LPEN_t + \beta_3 t \cdot LPi1_t + \beta_4 t \cdot LPi2_t + \beta_5 t \cdot LG_t + u_t$,

where β_0 is a vector of country-specific dummy variables. The growth rate g over the entire sample period in these **long-term growth regressions** is thus the sum of the coefficients of the time trend (t) and the interaction terms associated with it. The **interaction terms** (tX), in turn, capture both between- and within-country variations in the explanatory variables (X), and may thus improve our ability to estimate the long-term effects of these variables, including PEN, on the growth rate. In another version of equation (24) - (24a) - we add the interaction terms of t and our country dummies ($t\beta_0$) to allow for heterogeneous growth rates across countries, making (24a) analogous to (21).

To account for the possible endogeneity of PEN, we employ a 2SLS estimation procedure. Hausman's tests reject the exogeneity of PEN_t in regressions explaining marriage, divorce, net marriage, investment rate, and income growth rate. Indeed, in countries with relatively high values of these variables, the PAYG system can more easily **balance** high "defined benefits" set by politicians. Also, observed $GDPN_t$ and $SCHYR_t$ are inherently endogenous variables in our model.

Instrumental variables used consistently in our first-stage regressions (apart from the exogenous variables entering equation 21) are: the age of the social security program since initiation (MATURE), its squared value (MATURESQ), the population share of age groups 0-14 (AGE) and 65 and over (POP65), the population share of females (SEX), the economy's inflation rate (INFLA), net export (NX), money supply (M2), and GDP share of public education expenditures (PUBED). The first five variables capture the impact of the systems' maturity, or past and prospective buildups of surpluses in the social security budgets, and the impact of retiree interest groups relative to younger age cohorts (following the logic of Boadway and Wildasin, 1989, Mulligan and Sala-i-Martin, 1999, and Boldrin and Rustichini's 2000 political-economy models of "demand" for PAYG social security) on the political willingness to raise social security taxes and benefits. INFLA, NX, M2 and PUBED are used to capture the long-term impacts of monetary, trade, and public educational policies on the macro economy. We use PUBED also as an instrument for predicting PEN because, as argued by Rojas (2004), public educational subsidies may lower the cost of human capital investment and thus raise the quality of children at the expense of quantity. This can change the age structure of the population and require an increase in the social security tax rate. Basmann's test indicates that these variables can indeed serve as instrumental variables in the first-stage regressions, and they are also found to have inconsistent and insignificant effects if added as regressors in the structural model.

As part of our sensitivity analysis, we introduce PEN in both linear and logarithmic forms. A Box-Cox analysis of optimal transformation generally favors using a linear transformation of PEN in equation (21), but a logarithmic one in the growth regressions based on both equations (21) and (24). It also favors a log transformation for all other variables in both equations (21) and (24). Although we report only the results from the optimal transformations, those based on the alternative transformations of PEN yield similar elasticity estimates.

III. Empirical Findings

1. Family Formation Regressions

In **Table 1**, the dependent variables are the annual rates of marriage, divorce, and net marriage in the population age 15 and over, averaged over a 5-year lead period. The basic regression specification is (21), with all variables entered in logs except PEN. Models (columns) 1 and 2 present OLS estimates of (21.a), augmented by the deviation of the female/male ratio from 50% (DSEX.). In model 2 we add female labor force participation rate (FLFP) and female-male ratio of schooling years (FSCH). In model 3, we treat PEN and LGDPN as endogenous via 2SLS (the instrumental variables are listed in the legend). In models 4, 5 and 6, we re-estimate models 1, 2 and 3, based on non-overlapping periods. A complete analysis of the determinants of PEN is beyond the scope of this paper. Our **first-stage** regressions indicate, however, that political support for a PAYG system is greater in countries with aging populations, more qualifying male workers, and more mature systems. That our OLS estimates of PEN effects are lower than corresponding 2SLS estimates is consistent with the endogeneity argument, since political pressure to raise PEN is likely to be greater in countries where family formation, savings, and productivity growth are higher. The first-stage LGDPN regressions also indicate that higher inflation rates affect LGDPN adversely.

The measured PEN effects are significant and consistent with our predictions: while a higher PEN **reduces** marriage, it **raises** divorce. Indeed, PEN has an even more pronounced effect in **all** NETMARRY regressions, despite the latter's limitations as a measure of family formation (see fn. 13), and distinct from the generally negative impacts of the government's tax or spending rate, G, or the average income level, GDPN. This is also despite the fact that a non-working spouse may have an incentive to marry and stay married, at least over a prescribed number of years, especially when legally entitled to collect pension benefits vested with the working spouse (see section I.3).

The analysis in section I.3 and our simulations suggest that higher survival probabilities, π_1 or π_2 increase the benefits from family formation. Table 1 supports these predictions.[16] It also shows that the more imbalanced is the female-male population ratio, the lower is the marriage rate. Consistent with Becker's theory of marriage, lower female labor force participation and higher (more similar) female, relative to male, schooling also increases net family formation.

2. Fertility Regressions

In **Table 2**, the dependent variable, TFR, stands for the average number of children born to all females aged 15-49, averaged over a 5-year lead period. Theoretically, TFR represents, therefore, the product of the fertility rate per parent, n, and the share of parental households in the population, p. Since p is approximated by the flow variable NETMARRY, however, TFR can be expected to be a monotonically increasing, but not necessarily proportional, function of n and NETMARRY. Models 1-6 are analogous to those of NETMARRY with the exception that in models 1A-3 and 5-6 we add LNETMARRY (treated as endogenous in models 3 and 6), along with LFLFP and LFSCH. Hausman's test rejects the exogeneity of GDPN and NETMARRY, but not of PEN.

In all of Table 2's models, PEN has a negative and significant effect on TFR. By including the net marriage rate as an additional regressor, we attempt to isolate the **partial** effect of PEN on fertility within families (n) conditional on our proxy for p, which is what we analyzed theoretically. In model 1A the partial effect of PEN on TFR in elasticity terms is -.051, while that of NETMARRY is .2314. The unconditional elasticity of TFR with respect to PEN in model 1A can thus be imputed as -0.051+ 0.2314*(-0.379) = -0.138, where -0.379 is the estimated elasticity of NETMARRY with respect to PEN in Table 1. This estimate is very close to the estimated elasticity in model 1, -0.113. A very similar finding applies to our corresponding 2SLS estimates. Tables 1 and 2 are thus seen to exhibit remarkably consistent results.

Consistent with our analysis in section I.3, Pi1 significantly lowers fertility, while Pi2 generally raises it. GDPN has a negative and significant effect on fertility, reflecting our predicted dynamic pattern of TFR over the demographic transition, and PEN's negative effect on fertility is shown to be distinct from that of G. The negative effect of female labor force participation reflects the impact of higher labor market opportunities on the shadow price of the quantity of children, but it is interesting to note that higher relative educational attainments by females increase desired fertility. Conceivably, the more similar are the educational attainments of married couples, the greater is their demand for public goods within marriage, including children.

3. Savings Regressions

As an empirical measure of the individual savings rate, s, we use the share of investment in GDP (I). The national-income-accounts identity links this measure with the savings rate SAV (a proxy for s) as follows: SAV = I+DEFICIT+NX, where DEFICIT is the fraction of the government deficit in GDP and NX is the fraction of net exports in GDP. In models 1-6 and 1A of Table 3 we utilize this identity to run **unrestricted** regressions by entering DEFICIT and NX as additional regressors. The regressions are analogous to those in Table 2, except that regressors in models 2 and 5 include, apart from FLFP and FSCH, money supply (M2) and the inflation rate (INFLA), as these variables can exert independent effects on yields in capital markets (from which our theoretical model abstracts for simplicity). The dependent variable is the natural log of I (LI), but regressions run with I in natural form yield similar elasticity estimates of equal statistical significance. In models 7 and 8 we run alternative **restricted** specifications of model 1 using overlapping and non-overlapping 5-year periods. Here the natural log of SAV (LSAV) serves as dependent variable, where SAV is computed as I+DEFICIT+NX. Since the data used for DEFICIT and NX come from different sources, the restricted regressions have lower explanatory power, but the qualitative results for PEN and other regressors are consistent across comparable restricted and unrestricted specifications.

In all regressions SAV is imputed as the ratio of savings to aggregate income. It thus approximates the **weighted average** of savings rates by married and single adults [$ps_m + (1-p)s_s$] weighted by their respective population shares. Theoretically, the effect of PEN on SAV therefore incorporates both compositional and behavioral effects. An increase in PEN may reduce s_m and especially s_s by proposition 5. It also reduces the marriage probability, however, which is expected to raise the average savings rate by proposition 3. The effect of PEN on SAV may thus be ambiguous if it also reflects the reduction in the net marriage rate, p. To account for this ambiguity, we present the regressions for SAV with and without NETMARRY as a regressor. In models 2A and 5A we also report the estimated effect of an interaction term of NETMARRY and PEN in order to allow for possible different marginal effects of the social security tax rate on savings by parents and single agents, as implied by proposition 5 and our calibrated simulations.

Table 3 shows that PEN exerts an adverse effect on the savings rate, consistent with our simulations in Table I. Similar qualitative findings are reported in Feldstein (1997), using US time series data, and Samwick (2000) using cross-section data from 94 countries averaged over 1991-94.

Inconsistent with proposition 3, however, the effect of NETMARRY is positive in most regressions. A basic reason is that our **empirical** savings measure includes not just savings for own old-age needs, which is sole purpose of savings we model theoretically, but also savings to finance children's higher education or bequest, which our model treats as part of the cost of children, and which is thus larger in **married** households. The direction of the impact of PEN or the interaction term of PEN and NETMARRY should not be affected by this broader savings measure, however, as these regressors are expected to affect the savings for old age component of total savings. Indeed, while PEN reduces the imputed savings rate, the coefficient of PEN*NETMARRY is positive and significant, implying that a higher PEN has a greater adverse effect on savings by singles, consistent with our calibrated simulations. Also consistent with our theoretical simulations, a higher Pi1 decreases the savings rate in married households and a higher Pi2 increase the savings rate in all households. None of the added regressors entering model 2 is found to have statistically significant effects on the imputed savings. We report these results essentially as sensitivity tests.

4. Per Capita GDP Growth Regressions

In **Table 4** we report our "growth" regression results. In part A, we implement equation (21), where the dependent variable is the intermediate growth rate $GDPN_{t+4}/GDPN_t$. In part B, we implement equation (24), where the dependent variable is $LGDPN_t$, the **long-term** growth rate over the 30-year sample period is measured partly by the time trend coefficient, and the impact of basic parameters on growth is indicated by interaction terms' effects (T*X).[17]

The regression models in part A are analogous to those in the earlier tables except that SCHYR is included instead of GDPN due to a regression fallacy bias noted by Friedman (1992): countries with higher than expected per-capita income at an initial period are likely to regress towards the means in later years, exerting a downward bias especially in the intermediate-growth regressions of part A. Indeed, if we add LGDPN as a regressor, this variable becomes dominant, rendering all other regressors insignificant. We mitigate the potential bias by using average schooling years to account for the development stage, which is imperative in our long-term growth regressions of part B, where LGDPN is also the dependent variable. Consistent with our main prediction, LPEN exhibits a significant **adverse** effect on the long-term income growth rate in **all** regressions, contrary to the reported positive effects of PEN in Zhang and Zhang (2004).[18]

Note that in model 1 of both parts A and B, the interaction terms of the time trend and country dummies allow for only within-country variability in all regressors, and hence for **heterogeneous** growth rates across countries. In part B, however, the interaction terms capture both within- and between- country variations. For comparability we therefore run model 1B in part A. Models 3 and 6 feature 2SLS estimates accounting for the endogeneity of LPEN, LSCHYR, and LNETMARRY, as indicated by Hausman's test. We should also point out that GDPN is shown to have a unit root in part B. We therefore conducted a panel cointegration test, based on Pedroni (1999), which showed that GDPN and our regressors are **cointegrated**. The estimated regression coefficients are thus statistically unbiased.

The introduction of LNETMARRY as an added regressor in both parts A and B has a special significance. Although our theoretical analysis abstracted from ascribing to family formation any direct effect on human capital formation, such an effect can be established through a straightforward extension of our model, since our theoretical "probability of marriage" is also a proxy for the average duration of **stable** marriages; the latter enhances the opportunity of married households to invest in children. In Model 3 of part B, we estimate the importance of family formation (p) by introducing NETMARRY as an additional endogenous regressor.

The survival probability Pi2 generally exhibits a positive effect on the GDPN growth rate when these effects are also statistically significant, while Pi1 has no robust effect. One reason is that Pi1, computed as the survival probability from age 0 to age 24, does not account effectively for the age at which young adults enter the labor force and contribute to production in different countries. In contrast, in constructing Pi2, we were able to correct for the age at which old-age "dependency" begins in different countries according to their social security laws (see Appendix A.8).

Government spending as a share of GDP, G, generally shows an adverse effect on growth, consistent with the findings in Ehrlich and Lui (1999). The independent effect of PEN cannot be ascribed, therefore, to higher government spending or a higher general tax rate. In Table 4, female labor force participation is generally found to enhance the growth rate, while female relative schooling is found to have the opposite effect, although these effects are not consistent.

IV. Corroborations and Additional Sensitivity Tests

1. Human Capital Regressions. In section III, we used measures of long-term per-capita income growth to test our model's implication about the long-term human capital growth rate, Ah. In part (1) of Table A, we attempt to construct more direct measures of human capital formation based on schooling attainments proxies, using the basic regression specifications of Table 4. In Table A, we report only the estimated regression coefficients for our focus variable, PEN.

In the first three columns implementing equation (21.a), the dependent variables are the growth rates over a 5-year lead period of three schooling measures: average schooling years in the population (SCHYR), secondary school enrollment rates (SEC), and our international test scores measure (SCORE). The first two are essentially quantity rather than quality measures of schooling, and they do not fully reflect parental inputs into children's education. The serious limitations of "schooling" measures as proxies for human capital formation notwithstanding, these measures appear to better approximate the **stock** of human capital per worker, rather than investment flows, even in the case of SEC, which may be partly a stock measure because it is the average enrollment rates of 6 cohorts. In the following three columns implementing equation (24), the effect of PEN on the long-term growth rate is estimated via the interaction term T*LPEN, as in Table 4.

Consistent with our main prediction, LPEN or T*LPEN exhibit a pronounced and significant **adverse** effect on the long-term growth rates of our human capital proxies. Taken together with the results of Table 4, the "human capital formation" regressions of Table A lend support not just to our results concerning the adverse "growth effects" of social security taxes, but also to our underlying theoretical analysis, whereby human capital serves as the engine of growth.

2. PAYG v. Provident-Fund Systems. An important corroborative test of our model is the comparative effect of PEN in countries where social security operates as a **defined-contributions "provident fund"**, rather than a PAYG, defined-benefits system. In provident-fund countries, PEN represents essentially a compulsory retirement-savings rate rather than a tax. It may alter voluntary private savings only to the extent that the former exceeds the latter. But even in this case, there will be little change in private savings if individuals can borrow against their provident-fund savings. Some provident funds even permit using individual balances to finance health, education, and housing needs, which allows the rate of savings to adjust to its privately desired level. We thus expect PEN to exert little impact on family choices in provident-fund, relative to PAYG, countries.

Our sample includes just three countries where social security is a government-managed provident fund (Fiji, Malaysia and Singapore). Applying Chow's test for the equality of the regression coefficients in this subset relative to our non-provident-fund subset, we reject the hypothesis of equal PEN coefficients in all regressions.[19] Moreover, PEN has statistically **insignificant** effects on all our endogenous variables when we run separate regressions for the provident-funds countries (see part 2 of Table A), and when these countries are excluded from the total sample, PEN's impact becomes slightly larger than in tables 1-4. In contrast, we find virtually no changes in the estimated regression coefficients when we exclude from the full sample countries with 0 PEN (i.e., no social security) over our sample period (Hong Kong, Korea, and Venezuela).

3. OECD v. Non-OECD Countries. Our theoretical simulations in part B of Table I indicate that the negative elasticities of p, n, and s with respect to θ are higher in magnitude at an advanced, relative to an early, phase of development. To control for large gaps in development levels, we have separated our sample to OECD and non-OECD countries. Consistent with our simulations, the elasticities of each of the endogenous variables with respect to PEN are found to be significantly larger in magnitude in the OECD, relative to the non-OECD set (see part 3 of Table A). This can also be partly an outcome of the fact that the tax rate levels (PEN) are higher in the OECD countries – our simulations in Table I indicate that the adverse effects of θ are larger in this case. Note that for countries at an initial transition to a growth regime, the growth of per-capita GDP, (1+g), is not an efficient measure of the growth-equilibrium value of Ah. This may explain why the PEN effect on growth is much less pronounced in the non-OECD set.

4. Time Trend and Autocorrelation. Since our demographic variables exhibit clear downward trends in most countries, in part (4) of Table A, we also report regression estimates of model 1 with time trend entered arbitrarily as an additional regressor. Cochran-Orcutt tests indicate the presence of serial correlation of the first order in the family formation and fertility regressions, but not in the savings and growth regressions. We thus show estimates of model 1 in part (5) of Table A after correcting for serial correlation in the former two regressions. However, an AR(1) correction may not be the appropriate one to use in these 5-year lead regressions, and for this reason we do not rerun Tables 1 and 2 in their entirety with this correction. The qualitative effects of PEN and other regressors are not affected by these tests.

5. Other Sensitivity Tests. Our tax measure PEN, measures the ratio of "pension" benefits to GDP. **Total** benefits, as reported by the ILO, include also welfare payments for unemployed, employment injury payments, and maternity benefits, which are **not** expected to exert the same negative intergenerational externality we predict for the theoretical PAYG tax rate, θ (see fn. 10). Maternity benefits may actually increase the incentive to bear children. To test this implication, we have replaced PEN by NETBEN, defined as the ratio to GDP of total social security benefits minus pension benefits. The estimated effects of NETBEN are found to be weaker and less pronounced than those in tables 1-4 in general. We also find that the effects of PEN on our dependent variables are robust when we include PEN as well as NETBEN (not reported to save space).

In Tables 1-4 we have treated PEN_t (or $LPEN_t$) as a "balanced-budget" measure of our theoretical tax variable, θ_t. To test the sensitivity of our results to possible deviations of the observed PEN_t from its fully funded value PEN*, we insert PEN_t and PEN_{t-1} as regressors in a modified version of equation (21.1) - equation (21.1a) - representing a dynamic partial adjustment process:

(25) $PEN_t - PEN_{t-1} = \varpi(\theta_t - PEN_{t-1})$, which implies that $\theta_t = PEN^* = \eta PEN_t + (1-\eta)PEN_{t-1}$, with $\eta=(1/\varpi)>0$. Note that while the coefficients η and α_1 cannot be identified separately if we use either OLS or a non-linear maximum likelihood estimation method to estimate equation (21.1a), the **sum** of the estimated coefficients of PEN_t and PEN_{t-1} adds up by equation (25) to the behavioral effect of θ_t we seek to estimate (α_1). In all cases, this effect is found to be negative and statistically significant, and its magnitude is found to be close to the estimated effect of PEN in tables 1-4.[20]

V. Conclusion and Some Policy Implications

By formulating a comprehensive model of family formation and family choices, we are able to derive a set of discriminating implications concerning social security's impact on demographic variables and the real economy. This enables us to reexamine and partly reconcile some conflicting theoretical inferences and empirical findings in earlier studies. Taken together, our empirical results in Tables 1-4 are consistent with corresponding simulations of both the OLG and dynastic versions of our model.[21] They are also corroborated by Table A and related tests.

Our regression results suggest the existence of non-trivial effects of PEN on key demographic and economic variables in countries subject to PAYG, defined-benefits systems. **Table B** projects the quantitative importance of such effects using two scenarios: (a) a single percentage point reduction in PEN; (b) a reduction in the mean level of PEN over 1960-1991 to its level in 1960. The projections are illustrated for the "world" set, based on the non-provident-fund sample regressions, and for the U.S., based on our OECD-set regressions in table A.

For the U.S., for example, we project that had the average PEN remained constant at its 1960 level of .0459, instead of the average level of .0666 over the sample period, the net marriage rate would have increased by 12.7%, and the total fertility rate would have increased by 6.5% over the sample period.[22] Also, the average savings rate would have risen by 2.1%, and the mean annual growth rate of per-capita GDP would have increased from 1.81% to 1.96%, implying that per-capita GDP would have been higher by 3.1 percent in 1991. Comparable projections apply to the "world" set if its average PEN remained at its 1960 level of .0322 instead of .056.

Our projections are consistent with Feldstein's (1997) assessment that elimination of social security taxes in the U.S. would raise the private savings level by 60%. Based on the regression models for savings and income-growth using the OECD data in Table A (with PEN entered as a linear regressor in both models) we project that if PEN were reduced to 0 from its mean level of 0.0666 over 1960-1991, the private U.S. savings level would have risen by 46% in 1991.

The projections in Table B also indicate the potential benefits from a partial shift from the current PAYG system to a mandated savings system of personal retirement accounts (PRA), based on defined contributions. Our projected effects of a percentage point tax reduction may apply to such a shift, provided that the mandated savings do not exceed the optimal savings rate desired by individuals, or that individuals could efficiently borrow against their PRA balances.

Our study suggests that expanding social security tax rates and defined benefits over the last 60 years under the PAYG system, has independently contributed to the weakening of the financial viability of this system through unintended consequences on fertility and productivity growth. A shift in the direction of fully funded, defined-contributions system could improve not just the **economy**, but also the **financial viability** of a newly structured social security system.

Quite apart from these policy implications, our simulations suggest that the expanding scale of social security has also contributed to the diminished importance of intergenerational transfers from children to old parents – the traditional family security system. Needless to say, our work is not exhaustive. For example, we have not fleshed out our model's implications on trends in labor force participation and life expectancy, and we have addressed only partially net welfare implications. We leave the study of these issues for future work.

Appendix

A.1 A simple, but sufficiently general way to allow for uncertainty of children's survival in the benchmark model, or in the extended model of section I.3, is to assume that benefits to parents are subject to two 'states of the world': either no children survive, so parents lose all old-age benefits from their investments in children (a default state), or at least one child survives and assumes the obligations of all siblings towards their parents (a non-default state). The prospect of old-age consumption for parents becomes $\{D(\overline{H}+H_t)^{1-\kappa}[(\overline{H}+H_t)s_{mt}]^{\kappa} + S_{t+1}\}$ with probability $(1-\pi_1)^n$, and $\{[\pi_1 n_t w_{t+1} H_{t+1}]/[1-(1-\pi_1)^n] + D(\overline{H}+H_t)^{1-\kappa}[(\overline{H}+H_t)s_{mt}]^{\kappa} + S_{t+1}\}$ with probability $1-(1-\pi_1)^n$. The altruism function, specified for the event that at least one child survives becomes: $B\{(\pi_1 n_t)/[1-(1-\pi_1)^n]\}^{\beta} H_{t+1}{}^{\alpha}\}$. The basic change in behavioral implications is that parental investment in children, h, is no longer independent of θ. Thus all control variables: n, h, and s_m may now fall if θ rises. Indeed, our simulations of this case, which we do not report to save space, are consistent with the calibrated simulations of the deterministic case in Table I.

A.2 Optimal investments in children and savings in equations (13′), (14′) and (18) are conditional on the compensation parents expect to receive from each child, w_{t+1}, assuming that implicit family contracts are fully honored (see fn 9). We follow EL (1991) in analyzing the choice of w_{t+1} as a **principal-agent** problem, since parents and (unborn) children cannot negotiate a Pareto-optimal bargaining solution for n. Accordingly, parents (acting as agents) select values of w_{t+1} that maximize equation (2) for children. The resulting Stackelberg-equilibrium solution is inferred from:

(19) $dW(t+1)/dw_{t+1} = [\partial W(t+1)/\partial H_{t+1}]\,[\partial H_{t+1}/\partial w_{t+1}] + \partial W(t+1)/\partial w_{t+1} = 0.$

The optimal compensation rate, w^*, which we simulate in Table I after expanding equation (19), equates the marginal cost and benefit to grown-up children from rewarding their parents for the earning capacity they helped create, subject to the "reaction function" {h, w} governing the parents' investment decision ($\partial h_t/\partial w_{t+1}$).

A.3 We calibrate the model's basic parameters using actual U.S. data and some consensus estimates in the literature. Each of the model's "periods" is assumed to last 25 years. Survival probabilities of the U.S. population from ages zero to 25 and from 50 to 75 are then calculated from various issues of the *United Nations Demographic Yearbook*, and set to be 0.9663 and 0.5823, respectively. The average US social security tax rate over our sample period is 6.66%. Consistent with many studies, we set the inter-temporal elasticity of substitution to be 2, so

σ=0.5, and the time preference parameter to be 1.5%, so $\delta = (1/1.015)^{25}$. Allowing for general theoretical restrictions, we set the altruism function parameters β and B as 1.1 and 1, and the savings and marriage search production parameters as $\kappa = 0.65$ and $\varepsilon = 5$. The remaining parameters, A, v, D and L, are **solved** from the growth equilibrium steady state conditions of our extended model, using U.S. data on average per capita GDP growth rate (1.81%), average national savings rate (18.72%), average total fertility rate (2.166), and average share of households with married couples (64.90%) over our sample period (for sources see Appendix A.8, and the US *Current Population Survey* for the average share of married households). The average national savings and fertility rates are proxies for $[ps_m+(1\text{-}p)s_s]$ and np, respectively.

A.4 Suppose $s_{mt} \geq s_{st}$. Then $C_{m1} < C_{s1}$ if parents also invest in children. From (18) and (20) we know that $R_{ss} \geq R_{ms}$ in this case, and thus $(C_{s2}/C_{s1}) \geq (C_{m2}/C_{m1})$ as well, which also implies that $C_{m2} \leq C_{s2}$. But if parents save more than single adults, they also benefit directly from children at old age, and thus $C_{m2} > C_{s2}$, which is a contradiction.

A.5 To facilitate an analytical proof we take the compensation rate w to be a given constant. Totally differentiating $\Delta(t)$ in equation (12) with respect to θ and dividing it by $(\overline{H}+H_t)^{1-\sigma}$, we obtain the following growth-equilibrium steady state:

$\Delta_\theta \equiv \Delta_\theta(t)/(\overline{H}+H_t)^{1-\sigma} = -(c_{m1}{}^{-\sigma} - c_{s1}{}^{-\sigma}) + p\delta\pi_1 n(c_{m2}{}^{-\sigma} - c_{s2}{}^{-\sigma})\, Ah\, [1 - E_{n\theta} - E_{h\theta}]$,

where $c_{m1} = 1- vn- hn- s_m- \pi_2 w- \theta$, $c_{m2} = [\pi_1 nw+ p(\pi_1/\pi_2)]Ah + Ds_m{}^{\kappa}$, $c_{s1} = 1- s_s- \pi_2 w- \theta$, $c_{s2} = p(\pi_1/\pi_2)n\theta Ah + Ds_s{}^{\kappa}$, $E_{n\theta} = -d\ln(n)/d\ln(\theta)$, and $E_{h\theta} = -d\ln(h)/d\ln(\theta)$. Since $c_{m2} > c_{s2}$ by the logic of proposition 3 and $\Delta_p \equiv \Delta_p(t)/(\overline{H}+H_t)^{1-\sigma}$ is negative by the second order optimality condition, $dp/d\theta = -\Delta_\theta/\Delta_p < 0$ provided that $c_{s1} \geq c_{m1}$ (which is always the case if spending on raising children is sufficiently large) and the sum of the elasticities of h* and n* with respect to θ, $E_{n\theta} + E_{h\theta}$, is less than one. Our simulation analysis indicates that the sum of these elasticities is indeed less than unity for a wide range of variations in the model's underlying parameters.

A.6 If the absolute elasticity of family formation, p, with respect to the social security tax rate is lower than one, the increase in the tax rate will raise the social security benefits per adult, and hence the consumption ratio, (C_2/C_1), for both a married adult and a single adult. Appendix B in EL (1998) proves for the case where β>1, which is uniformly assumed in this paper to ensure interior solutions in both n and h over the entire dynamic equilibrium path, that the higher θ

lowers at least one of the parent's three choice variables satisfying equations (13′), (14′) and (18). For a single adult, the increase in θ will necessarily lower the saving rate by equation (20).

A.7 The optimality conditions for interior values of the control variables s_t, n_t, and h_t are now:

$0 = -C_1(t)^{-\sigma}H_t + \delta\pi_2\ DH_t\kappa s_t^{\kappa-1}\ C_2(t+1)^{-\sigma}$,

$0 = -C_1(t)^{-\sigma}(v+h_t)H_t + \delta\pi_1\pi_2 wH_{t+1}C_2(t+1)^{-\sigma} + \delta\pi_2(\pi_1 n_t)^{\beta(1-\sigma)}\beta(1-\sigma)V_{t+1}(H_{t+1})/n_t$,

$0 = -C_1(t)^{-\sigma}(n_t/A) + \delta\pi_1\pi_2\ n_t wC_2(t+1)^{-\sigma} + \delta\pi_2(\pi_1 n_t)^{\beta(1-\sigma)}V_{t+1}'(H_{t+1})$,

where, by the envelope theorem, the derivative of V_{t+1} with respect to the state variable H_{t+1} is:

$V_{t+1}'(H_{t+1}) = C_1(t+1)^{-\sigma}\ (1-vn_{t+1}-s_{t+1}-\theta-\pi_2 w)+\delta\pi_2\ Ds_{t+1}^{\kappa}\ C_2(t+2)^{-\sigma}$,

and from the functional form of equation (4a) we also know that $V_{t+1}'(H_{t+1})=(1-\sigma)V_{t+1}/H_{t+1}$.

By combining these optimality conditions we can derive the explicit solution for h n the text.

If the dynasty head in period t also controls the pooled incomes of the overlapping generations of earners in period t+1, the consumption allocation decisions are first determined to maximize the corresponding joint utilities as seen by the dynasty head:

$[1/(1-\sigma)][C_2(t+1)^{1-\sigma}-1] + (\pi_1 n_t)^{\beta(1-\sigma)}\ [1/(1-\sigma)][C_1(t+1)^{1-\sigma}-1]$, subject to the budget constraint: $\pi_2 C_2(t+1) + \pi_1 n_t C_1(t+1) = \pi_2 S_{t+1} + \pi_2 DH_t s_t^{\kappa} + \pi_1 n_t(1-vn_{t+1}-h_{t+1}n_{t+1}-s_{t+1}-\theta)H_{t+1}$. The first-order optimality conditions for consumption are:

$[C_1(t+1)/C_2(t+1)]^{\sigma} = (\pi_1 n_t)^{\beta(1-\sigma)-1}\ \pi_2$. Plugging this optimal solution for each period beyond t into dynasty head's expected utility in period t, the relevant value function in period t becomes:

$$
\begin{aligned}
V_t(H_t) = {} & \max\ [1/(1-\sigma)][C_1(t)^{1-\sigma}-1] \\
& + \delta\pi_2\{[1/(1-\sigma)][C_2(t+1)^{1-\sigma}-1] + (\pi_1 n_t)^{\beta(1-\sigma)}\ [1/(1-\sigma)][C_1(t+1)^{1-\sigma}-1]\} + \ldots, \\
= {} & \max\ [1/(1-\sigma)][C_1(t)^{1-\sigma}-1] + \delta\pi_2\ \Omega_a(n_t)V_{t+1}(H_{t+1}),
\end{aligned}
$$

where $\Omega(n_t) \equiv [(\pi_1 n_t)^{[1-\beta(1-\sigma)](1-\sigma)/\sigma}\ \pi_2^{(\sigma-1)/\sigma} + (\pi_1 n_t)^{\beta(1-\sigma)}]$. The optimality conditions for interior values of the control variables s_t, n_t, and h_t, used in our simulations in part (iii) of Table II are:

$0 = -C_1(t)^{-\sigma}\ \pi_1 n_{t-1}\ H_t/\Phi(n_{t-1}) + \delta\pi_2^2\ \Omega(n_t)\ C_1(t+1)^{-\sigma}\ DH_t\kappa s_t^{\kappa-1}\ /\Phi(n_t)$,

$0 = -C_1(t)^{-\sigma}\ \pi_1 n_{t-1}(v+h_t)H_t/\Phi(n_{t-1}) + \delta\pi_2[\partial\Omega(n_t)/\partial n_t]V_{t+1}(H_{t+1})$,

$0 = -C_1(t)^{-\sigma}\ \pi_1 n_{t-1}\ n_t/[A\ \Phi(n_{t-1})] + \delta\pi_2\ \Omega(n_t)\ V_{t+1}'(H_{t+1})$,

where, by the envelope theorem, $V_{t+1}'(H_{t+1}) = C_1(t+1)^{-\sigma}\pi_1 n_t(1-vn_{t+1}-s_{t+1}-\theta)/\Phi(n_t)$,

$\Phi(n_t) \equiv [(\pi_1 n_t)^{[1-\beta(1-\sigma)]/\sigma}\ \pi_2^{(\sigma-1)/\sigma} + (\pi_1 n_t)]$, and $V_{t+1}'(H_{t+1})=(1-\sigma)V_{t+1}/H_{t+1}$,. The direction of intergenerational transfers can be determined, in principle, by comparing the consumption flows for each of the overlapping generations relative to their assigned share of the family income.

A.8 Variables used, sources, and mean values over the sample period 1960-1992.

Variable	Description	Mean [Std. Dev.]
PEN ("Pension")	Old-age, survivor, and disability-insurance portion of social security benefits as a share of GDP (ILO)	0.056 [.040]
NETMARRY	Current marriage net of divorce rate (UN)	8.35 [2.82]
MARRY	Marriage rate: the annual number of marriages per 1000 population age 15 and over (UN)	10.06 [2.53]
DIVORCE	Divorce rate: the annual number of divorces per 1000 population age 15 and over (UN)	1.69 [1.19]
TFR	Total fertility rate: number of children born to an average woman over her reproductive years (UN)	2.81 [1.28]
I	GDP shares of capital investment (Summers-Heston)	23.71 [7.47]
DEFICIT	Share of the government deficit in GDP (IMF)	2.94 [4.25]
NX	current account surplus (IMF)	-5.54 [117.0]
SCHYR	Average schooling years in the population 25 years and over (Barro-Lee)	6.22 [2.46]
SEC	Students enrolled in secondary schools as a share of official secondary school-age children (UNESCO)	0.60 [0.23]
SCORE	Students' performance scores in international knowledge tests[1] (ETS)	268.5 [51.6]
GDPN	Real per-capita income (Summers-Heston)	6753 [3911]
G	GDP shares of government spending (Summers-Heston)	14.69 [5.98]
Pi1	Survival probability of the population from ages zero to twenty four (UN)	0.95 [0.04]
Pi2	Survival probability from the official qualifying age for pension benefits through the following fifteen years[2] (UN)	0.64 [0.12]
DSEX	Deviation of females' population share from 50 percent in absolute value (WB)	0.93 [1.50]
FLFP	Female labor force participation rate (WB)	38.34 [12.9]
FSCH	Ratio of average schooling years for females to that for males (Barro-Lee)	0.85 [0.16]
M2	Aggregate money supply (WB)	0.69 [11.71]
MATURE	Number of years elapsing from the year when the pension benefits program started (SSA)	39.34 [24.1]
POP65	Population share of the age group 65 and up (UN)	0.09 [3.97]
AGE	Population share of the age group 0-14 (UN)	0.29 [0.09]
SEX	Population share of the female (UN)	0.51 [0.02]
INFLA	Annual inflation rate (Summers-Heston)	5.03 [3.01]
PUBED	Share of public education expenditures in GDP (UNESCO)	4.60 [1.57]

1. The Educational Testing Service (ETS) of the International Association for the Evaluation of Educational Achievement (IEA) has conducted cross-country evaluations of educational achievement in science over the past four decades. These tests reveal the **relative** achievements of students in different countries in a given year, but they are not comparable over time, since they are not adjusted for changes in the tests' degree of difficulty. To make such adjustments, we calibrate the international test scores using data about the achievements of US students in standardized science tests from 1970 on, as reported by the National Assessment of Educational Progress (NAEP) of the U.S. Department of Education. Specifically, the ETS scores in a given year are multiplied by the ratio of the U.S. NAEP score to the U.S. **relative** international test score in the same year, to account for a common cohort effect in all countries. The U.S. can serve as an anchor because it has participated in all the international tests.

2. Typically, the official qualifying age for pension benefits is 55 or 60 in developing countries, and 60 or 65 in developed countries.

3. Data sources:

(ILO) International Labor Office, *The Cost of Social Security*, and *Year Book of Labour Statistics*, Geneva, various issues.

(UN) United Nations, *Demographic Yearbook*, various issues.

(WB) World Bank, *World Development Indicators*, 1998.

(IMF) International Monetary Fund, *International Financial Statistics*, various issues.

(Barro-Lee) "International Comparisons of Educational Attainment," *Journal of Monetary Economics*, 32, 1993.

(UNESCO) United Nations Educational, Scientific and Cultural Organization, *Statistical Yearbook*, various issues.

(ETS) Educational Testing Service, *A World of Differences*, 1989.

(SSA) Social Security Administration, *Social Security Programs Throughout the World*, 1995, 97, 99.

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ENDNOTES

[1] For example, Rosati (1996) concludes that social security affects fertility adversely but raises savings, using a static model where fertility and savings are the only alternatives. Wigger (1999) reaches a similar conclusion in an endogenous-growth model where only fertility and growth are considered as alternatives. Docquier and Paddison (2003) show adverse effects on both saving and growth, but treat fertility as exogenous. EL (1998) and Ehrlich and Zhong (1998) examine growth effects along with fertility and savings and conclude that all may be adversely affected. Zhang and Zhang (2004), who also consider all three choice variables, conclude that adverse effects apply only to fertility, but they base their analysis on a non-standard utility function whereby parental utility is strongly separable in the quantity and quality of children, which produces a strong degree of substitutability between the two, and positive growth effects. Their specification is inconsistent, however, with that of BB (1988), Becker et al. (1990) and EL (1998) where utility from children is a multiplicative function of their number. For recent reviews of the longer-held debate on social security's effect on savings see Seater (1993), and Feldstein (1997).

[2] For example, if parents are motivated just by old-age transfers from children, as in the benchmark case of EL (1998), social security does not affect fertility. In Boldrin, De Nardi and Jones (2004), a similar motive reduces just fertility and savings; however they do not consider human capital investments. Cigno and Rosati (1996) consider a static model with forward or backward altruism to investigate the social security effect on fertility and savings. If altruism is the only motive for parents, and no private alternatives to social security exist, we show that only fertility and family formation, but not human capital formation, are adversely affected (see proposition 1).

[3] To our knowledge, no previous study has dealt directly with the effect of social security on family formation. However, Baker, Hanna and Kantarevic (2004) study the effect of Canadian system reform in 1987, which allowed surviving spouses of deceased workers to keep their survivor benefits upon remarriage. They show that this has substantially raised the remarriage rate. Dickert-Conlin and Meghea (2004) study the effect of a reform in the US system in 1977, which shortened the minimum marriage duration for divorcees entitling them to claim auxiliary benefits based on their ex-spouse's record from 20 years to just 10 years. They find that the divorce rate at the ninth year of marriage decreased following the reform. Both results are consistent with our model's basic predictions.

[4] The propositions in this paper concerning the "real" effects of social security can be shown to hold even if labor supply were elastic and all production costs were time, rather than goods, intensive. See EL (1998, Appendix C).

[5] Institutional, legal, and religious constraints also determine the cost of "search" for a durable marriage. Empirically, we account for these via fixed-effects regression models.

[6] The equilibrium value of p is also an index of family stability, and as such it may serve as an efficiency parameter affecting the transmission of knowledge from parents to kids, or $A= A(p)$ with $A'(p)>0$ in equation (1). Since our basic results hold independently of this effect, we eschew a formal specification of A(p) in (12).

[7] Interior equilibrium solutions require that $B>0$, $1=\alpha<\beta<[1/(1-\sigma)]$, and $w>0$. These restrictions apply in the extended model of section I.3 as well. In the benchmark model, β needs to be further restricted: In a growth equilibrium, where $Ah>1$, $\beta<\alpha+\alpha vA$, whereas under the stable stagnant equilibrium, where $h^*=0$, $\beta>\alpha vA$.

[8] We specify the efficient compensation rate w as a fraction of the offspring's return on human capital, rather than earnings, since this way both children and parents always share the costs and benefits from human capital accumulation. While for simplicity we take here all intergenerational transfers to be monetary costs and ignore leisure, our basic propositions would not be affected if all transfers involved time costs (see EL 1998 appendix C).

[9] A key condition for compliance with implicit intergenerational contracts is that young parents expect their own children to treat them the same way they treat their old parents. Compliance may also hold for childless single adults because of effective parental mentoring or sanctions imposed by siblings. And since all siblings are members of the extended family's insurance pool, the compliance conditions spelled out in EL (1991) would apply to singles as well if they are at least **minor** participants in the intergenerational transfers taking place within married siblings' families.

[10] This "intergenerational tax effect" does not apply necessarily to payroll taxes, as these do not necessarily alter the inter-temporal rate of substitution in consumption relative to the rates of return from children or savings.

[11] The 1999 "MetLife Juggling Act Study", conducted by the National Center for Women and Aging at Brandeis University, shows that 25 percent of all U.S. households provide care for an elderly person and that care-giving costs individuals upwards of $659,000 over their lifetimes in lost wages, social security benefits, and pension contributions.

[12] The consumption flows at adulthood and old age become: $C_{m1}(t) = (\overline{H} + H_t)(1-vn_t - h_t n_t - s_{mt} - \theta)$ and $C_{m2}(t+1)=(1+r)(\overline{H} + H_t)s_{mt}+S_{t+1}$, for married agents; $C_{s1}(t)=(\overline{H} + H_t)(1-s_{st} - \theta)$ and $C_{s2}(t+1)=(1+r)(\overline{H} + H_t)s_{mt}+ S_{t+1}$, for single agents, where r is the interest rate.

[13] The theoretically relevant measure of p is the share of parental households among all households, for which no accurate data exist. A proxy for it would be the share of legally married households in the population. However, this variable, if available, is typically reported in population censuses conducted every 5 or 10 years. Changes in the "flow" variable, NETMARRY, can still capture the change in the "stock" variable, p_t in a steady state, albeit imperfectly, because marriage and divorce occur at different points over the life-cycle.

[14] Current GDPN includes both transitory and cyclical deviations from its equilibrium value along the dynamic growth path. If such deviations were a function of current GDPN, this would also justify the latter's inclusion as a regressor. We have also experimented with regression methods controlling for cyclical changes in GDPN over the sample periods, but these did not affect our results.

[15] For example, the marriage or divorce rate statistics depend on the way cohabitation is counted.

[16] It is arguable that population longevity is also an endogenous variable affecting, as well as being affected by, PEN. However, Hausman's tests reject the endogeneity of Pi1 and Pi2 in all the regressions reported in Tables 1-4.

[17] While in this set of regressions, Box-Cox tests imply that LPEN, thus T*LPEN should be entered in logarithmic, rather than natural terms, a linear transformation of PEN yielded similar results. In some countries, the reported "pension" benefits are zero over the entire sample period or over some parts of it (Columbia, El Salvador, Guatemala, Hong Kong, Honduras, Jordan, Korea, Thailand, Tunisia, Venezuela). In the log transformations of PEN here and in Table A, we replace 0 by 0.00001, a value substantially below the smallest value of PEN in our full sample.

[18] Zhang and Zhang (2004), using our definition of the social security tax rate, PEN (they quote both EZ (1998) and an earlier version of this paper), report a positive effect of PEN on intermediate income growth rates. The reason is that they use **initial GDP** as a regressor. As our experiment above indicates, we can obtain similar results when using initial LGDPN as a regressor in the 5-year-lead growth regressions, because of a regression fallacy bias.

[19] For our four endogenous variables, we used our original set of regressors plus their interaction terms with a dummy variable distinguishing the provident-fund countries. F-tests were performed on the OLS regression results.

[20] We have also tried an alternative specification of the adjustment process whereby $\theta_t = \eta_1 PEN_t + \eta_2 PEN_{t-1} + (1-\eta_1-\eta_2)PEN_{t-2}$, which again produced similar estimates of the effect of PEN* relative to the estimated effects of PEN in tables 1-4. Running this specification or equation (21.1a) via 2SLS resulted in the same inferences.

[21] Curiously, our theoretical model's simulations in part A of Table I, calibrated on US data, show projected effects of a 1 percentage point social security tax reduction that are of the same order of magnitude as the empirical estimates reported in Table B. These two sets of estimates are not quite comparable, however, because the estimated coefficients used in Table B are derived from regressions relating to OECD states, rather than strictly to the US, and the simulated projection in Table I is also conditional on a few free parameter values.

[22] The projected change in LTFR in the US is computed as –2.9549*(0.0459-0.0666) = .0493, where –2.9549 is the PEN coefficient in Table A for the OECD set. We then calculate the projected level of TFR as 2.17*exp(.0493) = 2.31, where 2.17 is the sample mean of TFR in the U.S. The projections for all other variables are similarly calculated. The projections are higher for the OECD countries: Using the OECD regression results in Table A, we project that if average PEN remained at its 1960 level of .044 instead of .076 over the sample period, NETMARRY, TFR, and average savings would have increased by 20.3%, 9.9%, and 4.1% from their mean levels, and that per capita GDP level in 1991 would have been 11.8 percent higher than its actual mean level of 6067.5.

Table I. Comparative Dynamics in the Extended Model:

Impact of Changes in the Social Security Tax Rate (θ)

A. Growth Steady State

	p	**n**	**p·n**	**h**	**Annual Growth**	s_m	s_s	**Average saving**	**w***	**$(V_m – V_s)$****
θ = 0.0666	0.6490#	3.3374	2.1660#	0.1461	1.810# (%)	0.1057	0.3378	0.1872#	0.2442	1.1812
	[-0.0133]	[-0.0453]	[-0.0586]	[-0.0378]		[-0.0233]	[-0.0834]	[-0.0492]	[-0.1175]	
θ = 0.0566	0.6504	3.3620	2.1867	0.1470	1.833	0.1061	0.3424	0.1887	0.2489	1.1926
θ = 0.0466	0.6518	3.3864	2.2073	0.1480	1.857	0.1066	0.3471	0.1903	0.2536	1.2039
	[-0.0089]	[-0.0296]	[-0.0385]	[-0.0168]		[-0.0156]	[-0.0572]	[-0.0370]	[-0.0749]	
θ = 0.0366	0.6532	3.4106	2.2278	0.1486	1.880	0.1070	0.3519	0.1920	0.2582	1.2153

B. Early and Advanced Phases of Growth †

	p		**n**		**h**		s_m		s_s	
	T = 1	**$T \to \infty$**	**T = 1**	**$T \to \infty$**	**T = 1**	**$T \to \infty$**	**T = 1**	**$T \to \infty$**	**T = 1**	**$T \to \infty$**
θ = **0.0666**	0.6552	0.6278	5.3289	3.4501	0.08928	0.14331	0.10478	0.09667	0.3401	0.3348
θ = **0.0566**	0.6566	0.6292	5.3576	3.4761	0.09001	0.14411	0.10527	0.10067	0.3448	0.3395

Note: Parameter values used are: $\sigma = 0.5$, $\delta = (1/1.015)^{25}$, $\pi_1 = 0.9663$, $\pi_2 = 0.5823$, v =0.0114, A=10.717, B = 1, $\beta = 1.1$, k = 0.65, D = 8.1849, $\overline{H} = 1$. The steady-state growth equilibria are independent of $\overline{H}$. The marriage search function is specified as $\lambda(p) = Lp^{\varepsilon}$, with, L = 1.2334, $\varepsilon = 5$. Average savings rate is $\mathbf{p \cdot s_m} + (1-\mathbf{p})\mathbf{s_s}$. The numbers in brackets denote the elasticity of each endogenous variable with respect to θ.

***** The expected compensation to an old parent by each child, $\pi_2 w$, is 58.23% of w if $\pi_2 = 0.5823$

****** The values for V_m and V_s are normalized by dividing equations (4) and (8) by ($\overline{H} + H_t$). The welfare gain from marriage is indicated by $(V_m - V_s)$.

These are the actual average values of the endogenous variables for the U.S. during 1960-90.

† To facilitate the simulations in part B, w is taken to be constant at the values reported in part A above: 0.2442 when θ = 0.0666, and 0.2489 when θ = 0.0566.

Table II. Comparative Dynamics in Dynastic Models:

Impact of Changes in the Social Security Tax Rate (θ)

Case	**n**	**h**	**s**	**V**
(i) w = 0				
θ = 0.0666	3.2180	0.1908	0.0797	9.5652
θ = 0.0566	3.2704	0.1908	0.0816	9.7543
(ii) w (exog) = 0.01				
θ = 0.0666	3.1921	0.1919	0.0773	9.5537
θ = 0.0566	3.2443	0.1920	0.0790	9.7425
(iii)† Income pooling				
θ = 0.0666	2.8723	0.04571	0.8342	0.3330
θ = 0.0566	2.8697	0.04572	0.8443	0.3336

Note: These dynastic models abstract from the family formation decision and take all agents to be "married". In model (i) and (ii), w is assumed to be exogenous. Parameter values used are: $\sigma = 0.7$, $\delta = (1/1.015)^{25}$, $\pi_1 = 0.9663$, $\pi_2 = 0.5823$, v =0.0114, A=8, $\beta = 1.06$, k = 0.65, D = 8.1849.

† In case (iii), we set A=30, v =0.001, k = 0.95, D = 5.

Table III. Comparative Dynamics in the Small Open Economy Model:

Impact of Changes in the Social Security Tax Rate (θ) (w = 0)

Growth Steady State	**p**	**n**	**p·n**	**h**	**s_m**	**s_s**	**Average saving**	**(V_m–V_s)**
θ = 0.0666	0.6941	2.8830	2.0011	0.1145	0.2249	0.3824	0.2731	1.6717
θ = 0.0566	0.6943	2.8958	2.0106	0.1145	0.2319	0.3900	0.2802	1.6742

Note: Parameter values used are reported in Table I. The interest rate is set at r = 8%, which is comparable to the endogenously determined annual rates of return (R) in the extended model of section I.3 of the close economy with w=0.

Table 1. Family Formation Regressions: Net Marriage, Marriage, and Divorce

Fixed Effects Model

	LNETMARRY						LMARRY				LDIVORCE			
	Model 1 OLS	Model 2 OLS	Model 3 2SLS	Model 4 OLS Non-overlap	Model 5 OLS Non-overlap	Model 6 2SLS Non-overlap	Model 1 OLS	Model 2 OLS	Model 3 2SLS	Model 5 OLS Non-overlap	Model 1 OLS	Model 2 OLS	Model 3 2SLS	Model 5 OLS Non-overlap
PEN	-6.7686	-6.5193	-15.8717	-8.0439	-8.5330	-10.3618	-4.5399	-4.5002	-10.2068	-5.9332	5.5392	4.0250	7.4741	3.5647
	-17.46	-15.84	-13.32	-8.11	-7.27	-3.18	-17.72	-15.91	-13.95	-8.13	9.03	7.09	4.94	2.40
	[-0.379]	[-0.365]	[-0.889]	[-0.451]	[-0.478]	[-0.580]	[-0.254]	[-0.252]	[-0.572]	[-0.332]	[0.310]	[0.225]	[0.419]	[0.200]
LPi1	2.6131	3.4845	2.1396	1.0702	2.1687	-0.0559	0.7660	0.8010	0.2976	0.6746	3.0551	-0.3529	-2.2062	2.4271
	5.02	6.07	2.71	1.01	1.56	-0.03	3.00	2.98	0.88	1.24	3.71	-0.45	-2.20	1.38
LPi2	0.2533	0.2280	0.1743	0.3523	0.2980	0.2116	0.1812	0.1696	0.1180	0.2537	-0.0685	0.0361	0.1382	0.0136
	5.39	4.64	2.85	2.74	2.00	1.19	5.78	5.04	3.04	2.86	-0.92	0.53	1.78	0.07
LG	-0.1233	-0.1038	-0.1117	-0.0089	-0.0510	-0.2882	0.0231	-0.0003	0.0896	-0.0245	0.7309	0.4589	0.6437	0.3425
	-2.40	-1.75	-1.45	-0.07	-0.33	-1.42	0.66	-0.01	1.83	-0.26	9.00	5.60	6.57	1.78
LGDPN	-0.3671	-0.4011	0.0079	-0.1899	-0.2858	-0.2339	-0.0342	-0.0598	0.1912	-0.0249	0.7095	0.6735	0.9413	0.4952
	-9.63	-9.05	0.09	-2.24	-2.54	-1.01	-1.61	-2.41	3.97	-0.46	11.76	11.02	8.61	3.49
LDSEX	-0.0246	-0.0062	-0.0110	-0.0186	0.0082	-0.0353	-0.0098	-0.0073	-0.0017	0.0092	-0.0042	-0.0537	-0.0037	-0.0740
	-3.13	-0.72	-1.06	-0.95	0.29	-1.15	-1.83	-1.21	-0.26	0.53	-0.33	-4.53	-0.28	-2.05
LFLFP		-0.2703			-0.0595			-0.0663		0.1010		1.1587		1.1795
		-4.79			-0.42			-1.71		1.18		14.88		6.66
LFSCH		0.3730			0.1505			0.4004		0.3720		0.3003		0.2076
		2.55			0.45			5.63		2.72		1.49		0.49
Adj. R^2	0.6383	0.6778		0.6591	0.6739		0.4649	0.4939		0.5491	0.6291	0.7604		0.7877
N	751	638	663	168	144	111	871	754	642	172	751	638	532	144

Notes: All regressions employ a fixed-effects regression model, but the results for country-dummies are suppressed. Rows show the estimated β and β/S_β for each variable. The square-bracketed numbers for PEN convert the estimated coefficients into **elasticity** terms. In all regressions the dependent variables are averaged over a 5-year lead period. The 2SLS regressions account for the endogeneity of both PEN and LGDPN since Hausman's test rejects their exogeneity. Instrumental variables include, in addition to exogenous structural regressors, LAGE, MATURE, MATURESQ, LPOP65, LINFLA, NX, LM2, and LPUBED. Model 4, 5, and 6 repeat the specification of model 1, 2 and 3 using non-overlapping 5-year periods.

Table 2. Total Fertility Rate Regressions

Dependent Variable: LTFR — Fixed Effects Models

	Model 1 OLS	Model 1A OLS	Model 2 OLS	Model 3 2SLS	Model 4 OLS Non-overlap	Model 4A OLS Non-overlap	Model 5 OLS Non-overlap	Model 6 2SLS Non-overlap
PEN	-2.0145	-0.9088	-0.9822	-1.0791	-2.1421	-0.1974	0.1730	-0.3381
	-7.23	-2.92	-3.21	-3.73	-2.93	-0.21	0.18	-1.36
	[-0.113]	[-0.051]	[-0.055]	[-0.060]	[-0.120]	[-0.011]	[0.010]	[-0.019]
LPi1	-2.5384	-1.7980	-1.6433	-1.8005	-1.8617	-2.0497	-1.7652	-1.3164
	-7.14	-4.38	-4.12	-4.06	-2.41	-2.29	-1.91	-1.20
LPi2	0.1113	0.0440	0.0588	0.0499	0.0503	-0.0772	-0.0928	-0.0958
	3.47	1.39	1.91	1.51	0.58	-0.82	-0.96	-0.83
LG	-0.2010	-0.1822	-0.1233	-0.2051	-0.2053	-0.1990	-0.1621	-0.2462
	-5.00	-4.83	-2.97	-4.22	-2.31	-2.34	-1.52	-1.65
LGDPN	-0.4218	-0.3111	-0.2981	-0.3613	-0.4346	-0.2974	-0.2855	-0.4157
	-16.70	-10.35	-9.23	-8.57	-7.08	-3.88	-3.21	-3.59
LNETMARRY		0.2314	0.1681	0.2798		0.2773	0.2195	0.2752
		10.68	7.79	8.81		4.29	3.32	3.29
LFLFP			-0.2883				-0.3425	
			-7.46				-3.65	
LFSCH			0.5092				0.3648	
			5.59				1.75	
Adj. R-sq.	0.7321	0.7458	0.7908		0.7250	0.7332	0.7729	
N	642	563	520	427	155	135	122	97

Notes: See notes to Table 1. In Model 1A we include LNETMARRY as a regressor in addition to those in model 1. In all regressions the dependent variable is averaged over a 5-years lead period. The 2SLS regressions account for the endogeneity of both LGDPN and LNETMARRY since Hausman's test rejects the exogeneity of LGDPN and LNETMARRY, but not of LPEN. Instrumental variables include, in addition to exogenous structural regressors, LAGE, LSEX, MATURE, MATURESQ, LPOP65, LINFLA, NX, LM2, and LPUBED. Models 4, 4A, 5, and 6 repeat the specifications of models 1, 1A, 2 and 3 using non-overlapping 5-year periods.

Table 3. Savings Regressions

Fixed Effects Models

	LI										LSAV	
	Model 1 OLS	Model 1A OLS	Model 2 OLS	Model 2A OLS	Model 3 2SLS	Model 4 OLS Non-overlap	Model 4A OLS Non-overlap	Model 5 OLS Non-overlap	Model 5A OLS Non-overlap	Model 6 2SLS Non-overlap	Model 7 OLS	Model 8 OLS Non-overlap
PEN	-2.4082	-0.7761	-0.6340	-1.8257	-2.9755	-3.1577	-1.6013	-0.8616	-2.5400	-9.0584	-1.2353	-2.4189
	-8.74	-2.28	-1.98	-3.02	-2.78	-4.56	-1.70	-0.89	-1.38	-2.91	-2.74	-2.54
	[-0.135]	[-0.044]	[-0.036]	[-0.102]	[-0.167]	[-0.177]	[-0.090]	[-0.048]	[-0.142]	[-0.507]	[-0.069]	[-0.135]
LPi1	-0.9699	-1.5195	-0.6882	-0.6048	-2.6144	-0.9256	-1.6446	-1.8057	-1.6845	-2.8078	-2.9583	-2.1516
	-3.32	-3.30	-1.48	-1.30	-5.28	-1.54	-1.59	-1.59	-1.48	-2.35	-6.14	-2.57
LPi2	0.1619	0.0895	0.0619	0.0496	0.0373	0.2799	0.1865	0.1551	0.1370	0.1945	0.2134	0.2654
	4.53	2.29	1.62	1.29	0.93	2.74	1.53	1.28	1.12	1.52	3.62	1.86
LG	-0.0030	0.0288	0.0209	0.0401	0.0481	0.0198	0.0215	-0.0274	-0.0117	-0.1938	0.2869	0.2352
	-0.07	0.67	0.44	0.83	1.01	0.22	0.23	-0.18	-0.08	-1.27	4.23	1.92
DEFICIT	-0.0058	-0.0030	-0.0097	-0.0095	-0.0062	-0.0099	-0.0074	-0.0125	-0.0123	-0.0054		
	-2.81	-1.29	-3.84	-3.79	-2.48	-2.06	-1.35	-1.97	-1.94	-0.90		
NX	-0.0172	-0.0171	-0.0181	-0.0184	-0.0177	-0.0251	-0.0245	-0.0224	-0.0231	-0.0175		
	-9.88	-8.22	-8.83	-9.01	-8.19	-5.92	-4.55	-4.12	-4.22	-3.10		
LGDPN	0.1544	0.1058	0.1952	0.1847	0.4144	0.2646	0.2240	0.3253	0.2948	0.5319	0.3426	0.3793
	6.07	3.31	4.83	4.57	8.27	4.46	2.89	2.99	2.63	3.95	8.50	4.71
LNETMARRY		0.1705	0.1879	0.1018	0.2694		0.1471	0.1445	0.0192	-0.0634		
		6.98	7.24	2.25	4.97		2.15	1.82	0.14	-0.40		
LFLFP			0.0371	0.0435				-0.0524	-0.0357			
			0.85	1.00				-0.43	-0.29			
LFSCH			-0.1056	-0.1296				-0.3391	-0.3756			
			-0.83	-1.02				-1.09	-1.20			
LM2			-0.0235	-0.0251				-0.0235	-0.0229			
			-3.32	-3.54				-1.33	-1.30			
LINFLA			-0.0003	-0.0001				-0.0037	-0.0028			
			-0.03	-0.01				-0.19	-0.14			
NETMARRY*PEN				0.1727					0.2375			
				2.32					1.07			
Adj. R-sq.	0.2684	0.3452	0.4301	0.4367		0.3790	0.4058	0.5095	0.5182		0.1173	0.1854
N	784	631	508	508	507	173	137	110	110	109	782	173

Notes: See notes for Table 1. The 2SLS regressions account for the endogeneity of only LGDPN since Hausman's test rejects the exogeneity of LGDPN, but not of PEN or LNETMARRY. Instrumental variables include, in addition to exogenous structural regressors, LAGE, LSEX, MATURE, MATURESQ, LPOP65, LINFLA, NX, LM2, and LPUBED. Model 4, 4A, 5, 5A and 6 repeat the specification of model 1, 1A, 2, 2Aand 3 using non-overlapping 5-year periods. Models 7 and 8 are restricted regressions using as dependent variable LSAV where SAV = I+DEFICIT+NX, based on overlapping and non-overlapping 5-year periods, respectively.

Table 4. Per Capita GDP Growth Regressions

A. IINTERMEDIATE (5-yr-lead) GROWTH RATES (see eq. 21)

	Model 1 OLS	Model 1B OLS w/o FE	Model 2 OLS	Model 3 2SLS	Model 4 OLS Non-overlap	Model 5 OLS Non-overlap	Model 6 2SLS Non-overlap
Constant	-0.0278†	0.0443	0.0070†	0.0251†	0.0102†	-0.0877	0.1196†
		6.96					
LPEN	-0.0075	-0.0017	-0.0035	-0.0287	-0.0078	-0.0086	-0.0241
	-5.39	-3.88	-1.98	-3.87	-2.13	-1.75	-1.66
LPi1	-0.1662	0.0134	-0.0425	0.4166	-0.0837	-0.1733	0.1175
	-3.75	0.45	-0.60	4.28	-0.96	-1.21	0.64
LPi2	0.0380	0.0210	0.0214	0.0098	0.0482	0.0632	0.0629
	7.15	5.42	3.03	1.03	3.88	3.49	3.01
LG	0.0153	-0.0043	0.0244	0.0136	0.0032	0.0124	0.0033
	2.91	-2.06	3.17	1.52	0.29	0.69	0.19
LSCHYR			-0.0414	-0.0486		0.0007	-0.0445
			-4.47	-2.11		0.08	-1.02
LNETMARRY			0.0018	-0.0064		0.0007	-0.0287
			0.47	-1.69		0.08	-3.31
LFLFP			0.0074			0.0232	
			0.94			1.48	
LFSCH			0.0006			0.0753	
			0.03			2.14	
Adj. R-sq.	0.1699	0.0624	0.1706		0.1949	0.2446	
N	928	928	644	527	206	143	111

B. SAMPLE-PERIOD GROWTH RATE (see eq. 24)

	Model 1 OLS Hetero growth	Model 1B OLS	Model 2 OLS	Model 3A 2SLS	Model 3 2SLS
T	-0.0003††	0.0552	0.03142	0.0988	0.0438
		18.80	2.93	16.26	4.81
T*LPEN	-0.0021	-0.0020	-0.0010	-0.0017	-0.0017
	-7.09	-11.26	-3.74	-5.54	-5.08
T*Lpi1	-0.1138	0.0613	0.0340	0.0610	0.0287
	-8.82	3.51	1.21	2.31	0.92
T*Lpi2	-0.0013	0.0036	0.0041	0.0058	0.0045
	-1.36	2.63	2.32	2.89	2.40
T*LG	-0.0116	-0.0111	-0.0111	-0.0218	-0.0138
	-9.11	-11.08	-7.21	-13.46	-8.37
T*LSCHYR			-0.0016	-0.0057	0.0039
			-0.85	-2.99	1.71
T*LNETMARRY			0.0048		0.0063
			3.76		3.79
T*LFLFP			0.0049		
			2.63		
T*LFSCH			-0.0368		
			-9.53		
Adj. R-sq.	0.9411	0.7870	0.8264		
N	1333	1333	752	729	587

Notes: See notes to Table 1. The regressions in Part A implement regression specification (21), with the dependent variable measured as the average growth rate of GDPN over a 5-year lead ("Intermediate Growth") period. The results for country dummies are suppressed. Here estimated coefficients represent elasticity terms. Models 1 and 1B are regressions with and without fixed-effects. Models 3 and 6 account for the endogeneity of LPEN and LSCHYR, but not LNETMARRY, based on the Hausman's test results. Instrumental variables include, in addition to exogenous structural regressors, LSEX, LAGE, MATURE, MATURESQ, LPOP65, LINFLA, NX, LM2, and LPUBED. Models 4, 5, and 6 repeat the specifications of model 1, 2 and 3 based on non-overlapping 5-year periods. In Part B we implement the "long-term growth" regression specification of equation (24). In model 1, we enter both country-dummies and their interaction terms with T as additional regressors. Models 3A and 3 report 2SLS regression estimates accounting for the endogeneity of LPEN, LSCHYR and LNETMARRY since Hausman's test rejects their exogeneity. We use here the same set of instrumental variables used in model 3 of Part A. † = Coefficient representing the mean value of constant terms of all country dummies. †† = Coefficient representing the mean value of the interaction terms of T and all country dummies.

Table A. Additional Sensitivity Tests

(1) Human capital formation regressions

	SCHYRGTH	SECGTH	SCOREGTH		LSCHYR	LSEC	LSCORE
LPEN	-0.0014	-0.0020	0.0026	T*LPEN	-0.0007	-0.0024	-0.0020
	-3.79	-4.00	1.19		-4.40	-11.30	-4.84

(2) Provident funds v. PAYG systems

	LNETMARRY	LMARRY	LDIVORCE	LTFR	LI	5-YR GROWTH	LT GROWTH
[Provident Funds]							
PEN	-0.0826	-4.3476	-0.2276	0.7515	0.8148	-0.0043	-0.0041
	-0.12	-5.79	-0.25	1.27	1.13	-0.57	-2.22
[Non Provident Funds]							
PEN	-7.0481	-4.3791	5.8500	-2.3912	-1.9553	-0.0075	-0.0021
	-17.84	-16.91	9.30	-8.17	-6.86	-5.15	-12.56

(3) OECD v. Non-OECD countries

	LNETMARRY	LMARRY	LDIVORCE	LTFR	LI	5-YR GROWTH	LT GROWTH
[OECD]							
PEN	-5.7664	-3.1179	5.5751	-2.9549	-1.0299	-0.0099	-0.0040
	-12.72	-11.54	7.94	-8.82	-4.85	-4.51	-16.09
[Non OECD]							
PEN	-2.3173	-3.2162	0.2293	-0.0938	-0.0975	-0.0042	-0.0013
	-4.18	-6.29	0.17	-0.16	-0.12	-1.83	-4.58

(4) Entering a Time Trend as added regressor

	LNETMARRY	LMARRY	LDIVORCE	LTFR
PEN	-4.9445	-3.6422	4.0050	-0.6745
	-12.37	-13.38	6.00	-2.66

(5) Correcting for autocorrelation AR(1)

	LNETMARRY	LMARRY	LDIVORCE	LTFR
PEN	-1.8900	-0.9551	0.8998	-0.2814
	-6.69	-5.94	2.85	-2.31

Note: This table shows estimates based on model 1 (OLS) regressions in Tables 1-4. For the long-term growth regressions results in parts (2) and (3) we report the coefficient associated with T*LPEN and PEN is entered in log form. The AR(1) coefficients applied to the NETMARRY, LMARRY, LDIVORCE and LTFR regressions are 0.7991, 0.8308, 0.8728, and 0.8859, respectively.

Table B. Impact of Hypothetical Tax Reductions: Projections for the World and US Economies

	(1) Actual mean 1961-91	(2) Projected mean: Reducing the sample mean tax rate by one percentage point†	(3) Projected mean: Going back to the 1960 tax rate†
WORLD		From .056 to .046	From .056 to .0322
Net Marriage Rate	8.35	9.01	9.93
Total Fertility Rate	2.81	2.88	2.97
Private Saving Rate	25.94	26.45	27.18
Per Capita GDP Growth Rate	2.84 %	2.88%	2.96%
Per Capita GDP††	\$10,452	\$10,583	\$10,824
U.S.		From .0666 to .0566	From .0666 to .0459
Net Marriage Rate	8.11	8.59	9.14
Total Fertility Rate	2.17	2.24	2.31
Private Saving Rate	18.72	18.91	19.12
Per Capita GDP Growth Rate	1.81%	1.88%	1.96%
Per Capita GDP††	\$17,594	\$ 17,691	\$18,148

Note: Projections for the "world" are based on regression estimated for the non-provident-fund sample in model 1 (OLS) of the relevant endogenous variables in Table A. Projections for the U.S. are based on the regressions estimated for the non-provident-fund sample of OECD countries in model 1 (OLS) of Table A. The projections for the per-capital GDP growth rate and per-capita GDP are based on the long-term growth regression results using LGDP as dependent variable.

† Average tax rate approximated by PEN = Pension benefits/GDP.

†† This row shows the actual and predicted per capita GDP in 1991, rather than their mean values over 1961-91.