On the Impact of Extending the Coverage of Social Security in Developing Countries*

(Preliminary and Incomplete)

Chung Tran† and Juergen Jung
Indiana University - Bloomington

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Abstract

In this paper, we investigate the effects of extending the coverage of social security system to uninsured group on saving, labor supply, distribution of wealth and welfare in developing countries. We construct a two production sector and heterogeneous agent overlapping generations model with inter-vivos transfers and bequests. In contrast to the previous literature that analyzes issues surrounding social security system in developed countries, we find that an extension of social security via introducing of a state social assistance program improves welfare.

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†Corresponding author: Chung Tran, Department of Economics, Indiana University at Bloomington, IN 47405. *Email*: chtran@indiana.edu

1 Introduction

Although there is a substantial literature on social security, issues surrounding social security systems in the developing countries have not had enough attention, of which low coverage[1] of social security is the most prevailing issues. According to World Bank (WorldBank (1994)), as opposed to a coverage rate of close to 100% in most OECD, coverage rates are less than 10% in low income countries in Sub-Saharan Africa and South Asia and rarely exceed half of the work forces in the middle income countries in Latin America.

Not surprisingly, among different means of living in old age, public pensions are not the one that majority of elderly people could count. Personal savings are not the one neither because of under-developed financial markets, that fails to provide credible instruments to insure against income shocks over the age profile. Instead, the prevalent sources of supporting old-age people are family transfers and incomes from supplying labor service. The family transfer system, that parents support their children when young and become recipients of support from their children when old, is widely observed in developing countries (e.g. caring services, individuals co-residing with their aging parents, gifts, and remittances). Evidences that the elderly are relying heavily on the family support system are reported in Frankenberg and Karoly (1995), Knodel and Debavalya (1997), Frankenberg and Kuhn (2004) and Cox and Jimenez (2006). Left with no other sufficient sources of income, many elderly people have to work as long as they are physically capable, which is often referred to as "ceaseless toil" in the development literature. For example, more than 70% of healthy Indonesian men at the age of 70 are active in the labor force (McKee (2006)) and about 50% of Vietnamese elderly at the age of 70 participated in the labor force in 1998 (Tran (2007)).

As documented in the literature, the family transfer system is not a perfect mechanism to insure people during old age. First, family transfers alone fail to pool risk efficiently over different families. Second, since lack of enforcement mechanism, the family transfer system is vulnerable to economic and social changes, which lead to erosion of family ties as it has been the case in western societies[2]. Third, the family-based system to support old-age people will shrinks as developing countries step in ageing society, which will happen rapidly as projected by WHO.

The lack of an effective private mechanism to insure against risk at higher ages puts many elderly into poverty, which then raises a need for government intervention to guarantee basis consumption. In practice, the role of state programs to provide a social assistance to fight poverty and inequality has been stressed by international development organizations like the UNDP, the World Bank and the International Labor Organization (ILO) and by governments. The ILO, for instance, has recently been developing action plans geared towards implementing universal coverage of social protection programs (e.g. see ILO (2002)) . Some countries like Brazil and South Africa already started social assistance programs for old-age people.

The literature on social security in general does not support an expansion of social security systems. In models with altruism, Barro (1974) and Becker (1974) show that the interaction between public and private transfers can neutralize the effect of public

[1] Coverage here means the fraction of working population participating in contributory schemes, which then produce some pension during old age.

[2] See Thornton and Young-DeMarco (2001) for a study on the evolution of attitudes towards the family in the United States.

transfers and public debt (Ricardian equivalence). In pure life-cycle frameworks, Auerbach and Kotlikoff (1987) and Imrohoroglu, Imrohoroglu and Joines (1999) find that social security substantially decreases capital accumulation, which results in welfare losses. In an environment with uncertainty and two-sided altruistic agents, Fuster, Imrohoroglu and Imrohoroglu (2004) show that individuals would prefer to be born into an economy without social security mainly due to efficiency gains from removing distortions on labor supply.

Empirical evidences in favor of the hypothesis that public transfers crowd out private transfer have been found in some developing countries like Peru, the Philippines and South Africa (see Cox and Jimenez (1992), Cox and Jimenez (1995) and Jensen (2003)). Also, it is evident that public transfers discourage labor supply in developing countries. Filho (2004) found that the social pension program in Brazil has induced rural workers to retire earlier. McKee (2006) reports similar results when estimating the labor supply decision of elderly workers in Indonesia using a dynamic forward looking model.

Theories and empirical evidences together make social security reform of extending social security coverage in developing countries a controversial idea. To make an argument about the extension of social security it is essential to evaluate the impacts social security in the presence of a sizeable informal sector, incomplete and segmented markets, high income inequality, low coverage of social security programs and a large family supporting system. However, these are open questions in the literature on social security reform in developing countries.

This paper aims to model an old-age supporting system, including public and private transfers, to quantify the impacts of extending coverage of public social security on efficiency, inequality and welfare while taking into account the context of developing countries. Specific questions that we address are concerned with the impacts on family transfers, saving, labor market behavior and distribution of wealth. Furthermore, we investigate the welfare consequences and the impacts of alternative tax policies to finance the extension of social security.

We use an OLG framework to model a dual production economy populated with two-sided altruistic individuals. The production sector consists of two distinct sub-sectors, a formal and an informal sector. The two sectors differ with respect to technology and the quality of labor inputs. Overlapping generation individuals in a family form decision a unit called a household. Within a household resources are pooled and decisions are made jointly. Inter-generational links created by two-sided altruism group blood-related households in a family line called a household dynasty. Households in a family line face two uninsurable shocks, demographic and occupational shocks. The government manages a public social security system for formal sector workers in the benchmark economy. The government taxes consumption, labor income and capital income to balance its budget each period. We calibrate the model to match certain characteristics of developing countries. In our policy experiment we study the effects of extending the coverage rate of the social security system to include varying fractions of informal sector workers.

The paper is structured as follows. In the next section we set up the model and define equilibrium. Section 3 describes the calibration and section 4 contains the discussion of the policy reforms and results. We conclude in section 5.

2 Model

2.1 Environment

Production Sectors. The economy consists two distinct production sectors populated by low productivity firms call informal sector firms and by high productivity firms called formal sector firms, which together produce a common final consumption good. The production technology is Cobb-Douglas

$$Y_t^{se} = A^{se} \left(K_t^{se}\right)^{\alpha^{se}} \left(H_t^{se}\right)_t^{1-\alpha^{se}},$$

where $A^{se} > 0,\ \alpha^{se} \in (0,1)$ and $se = \{F, I\}$ which denotes formal and informal sectors. Capital K^{se} depreciates at rate δ^{se} each period and H^{se} is aggregate human capital. We impose $A_F > A_I$, so that the formal sector is more productive than the informal sector. The aggregate final consumption good is the sum of formal and informal sector production so that

$$Y_t = Y_t^F + Y_t^I.$$

Population and Living Arrangements. The population consisting $2J$ overlapping generation is normalized to 1 at any point in time. The population grows exogenously at rate n. The demographic structure of population is assume to be stationary so that the population share of cohorts are time-invariant. After detrending the growth of population, the population share μ_i is recursively defined as

$$\mu_j = \frac{sp_i}{(1+n)}\mu_{j-1}.$$

Individuals become economically active at age 20, and live for maximum $2J$ periods, which is equivalent to 60 years. The individuals face lifetime uncertainty and die for sure at age 80. The individual changes her status from a child to a parent when she is $J+1$ years old, at that age her parent die and her children become economically active. Thus, individuals overlap with their parents in the first J periods of their life and they overlap with their own children in the last J periods of their life. We call the economically active young agents in their first stage of life, that is from age $1, ..., J$ *children*. At age $J+1$ this agent becomes a *parent* until she dies.

Individuals are assumed to be two sided altruistic toward their ascendants and descendants. Parents are altruistic towards their children in the sense that parents value the utility of their children either when they are alive or die. Therefore, parents would transfer wealth to their children in term of inter-vivos transfers while they are alive, accidental bequests if parents die early before age of $2J$ and intended bequests at the end of their life. On the other hand, children are also altruistic towards their parents and can transfer wealth to ensure the well being of their parents. Hence, individuals derive utility not only from their own consumption and leisure but also from the well-being of their parents and children.[3]In uncertain environments, two-sided altruism generates a risk sharing mechanism across generations, which is called family insurance.

At each period, survival individuals in a family, who are economically active, form a

[3] A similar setup is used in Laitner (1992) and Fuster (1999).

decision unit called a household. Depending on demographic structures, households could be classified into one of three groups, group 1 consisting households of a parent and children who are all survived from the demographic shocks, group 2 consisting of households of a parent only and group 3 consisting households of children only. If a parent and children survive, they pool resources and solve a joint utility maximization problem, which is the simplest way to incorporate two-sided altruism[4]. If children are not survive, parents run households of their own and the family line stop when parents die. If parents die early, children take over and run a household of their own. At age $J+1$, children themselves become new parents and start a new household with their own children if they survive. They again pool their resources and jointly solve a new household optimization problem.

The household of group 1 last for J periods until the parents die at age $2J$. During J periods, a household from group 1 could change its state either to group 2 if children die or to group 3 if a parent dies. Meanwhile, the households of group 2 and 3 could not. The transition probability matrix that a household moves from one group to others is given by

$$\Omega\left(g_j, g_{j+1}\right) = \begin{bmatrix} sp^p_{J+j} sp^k_j & sp^p_{J+j}\left(1 - sp^k_j\right) & \left(1 - sp^p_{J+j}\right)\left(1 - sp^k_j\right) \\ 0 & sp^p_{J+j} & 0 \\ 0 & 0 & sp^k_j \end{bmatrix}$$

where $g_j = 1, 2$,and 3, sp^p_{J+j} and sp^k_j are survival probabilities of a parent and children, respectively.

Household preferences are the sum of preferences of parents and m children during the J periods in which they overlap. These expected preferences are expressed as

$$W_h = E\sum_{j=1}^{J}\beta^{j-1}\left\{\prod_{i=1}^{j} sp^k_{i,t}\, u\left(c^k_{j,t}, l^k_{j,t}\right) + m\prod_{i=J}^{J+j} sp^p_{i,t}\, u\left(c^p_{J+j,t} l^p_{J+j,t}\right)\right\}, \tag{1}$$

where superscripts p denotes parents and k denotes kids, j is the kid's age, t is time calendar, $J+j$ is the parent's age, β is the discount rate and the period consumption-leisure utility function is

$$u\left(c, l\right) = \frac{\left(c^{\gamma} l^{1-\gamma}\right)^{1-\sigma}}{1-\sigma}, \tag{2}$$

where c is period consumption, l is leisure, γ is the utility intensity of consumption and σ is the inverse of the intertemporal rate of substitution.

Skill Endowment and Job Assignment. When agents become economically active they are endowed either low or high skill. If individuals have high skill, they will work in the formal, otherwise they will work in the informal sector. Formal sector workers have higher income and participate in a pay-as-you-go social security program. Informal sector workers have lower income and no access to social security. Individuals are not allowed to choose their working sectors and they cannot move between sectors. However, their children have a chance to be endowed a different skill and so working sector[5]. The probability to be endowed a job in either the formal or informal sector depends on the current working

[4] If we assume that parents and children maximize different objective functions, a strategic game between parents and children will arise. Solving models that incorporate such games requires a more complicated solution technique. Nishiyama (2002) provides more details on this.

[5] Since skill and working sector are interchanged, we use either "sector" or "skill"to indicate both.

sector of her parents. That is, sector mobility is allowed across generations and follows a simple a two-state Markov process with the transition probability matrix given by[6]

$$\Pi\left(se^p, se^k\right) = \begin{bmatrix} \pi_{I,I} & \pi_{I,F} \\ \pi_{F,I} & \pi_{F,F} \end{bmatrix},$$

where $\pi_{se,se'}$ is the probability to get a job in sector se' conditioning on the parent's working sector se.

Household dynasties are heterogeneous in the composition of the respective working sectors of parents and children which results in four different household types, (F,F), (F,I), (I,F), and (I,I), where the first letter denotes the occupational sector of the parent and the second the occupational sector of the children.

Individuals are endowed with one unit of time each period which is allocated to leisure or work. An individual's effective labor supply each period is given by $h_j^i = e_j^i\left(1 - l_j^i\right)$, where h_j^i is the human capital (or effective labor) of individual i at age j, e_j^i is the efficiency unit and l_j^i denotes the amount of leisure consumed.

There is a minimum mandatory retirement age of J_w,equivalent to 65, for formal sector workers. Upon reaching this age they can draw benefits from pension schemes. Formal sector retirees are allowed to continue working in the informal sector when receiving pension or transfer payments. J_w is also eligible age for informal sector workers to participate in a social assistance program.

Household Dynasty. The sequence of households of parents, children, grandchildren and so on in a family line defines a household dynasty. Each individual of a generation in the dynasty participates in two consecutive decision making units (or households) one with their parents and one with their children. The expected utility of a dynasty as the household starts from generation 0 with a parent working in sector se_0^p and children working in sector se_1^k is given by[7]

$$\sum_{h=0}^{\infty} \Pi\left(se_h^p, se_{h+1}^k\right)\left[(\theta\beta)^{\frac{1}{J}}\right]^h W_h, \tag{3}$$

where h is the generation age in the household dynasty and θ is an altruistic parameter that connects the households. If parents die before age of $2J$, the survived children still live in a household without parent until the age of J and then start a new household with their children. If all children are dead, parents live alone until they die then the family line breaks down.

The model combines features of both, the OLG and the infinite horizon framework. Skill transmission and two-sided altruism generate a household dynasty, that essentially introduces the infinite horizon framework. On the other hand, each individual has a random

[6] Parents skills and occupation as well as parental networks will play an important role in deciding their children's chances to find work in the formal sector. These private networks are especially important in the context of developing countries and are a source of intergenerational dependence. Children of formal sector employees have typically better education than children of informal sector workers with low education and low income. Compare Marcouiller, de Castilla and Woodruff (1997) for evidence on the better education of formal sector workers in developing countries. Better education and existing private networks will make it easier to secure work in the formal sector.

[7] To save notation we drop time subscript t but we do not restrict our setup to steady state only.

finite lifetime overlapping with her parents and her children and the demographic shock breaks family line with certain probability, that introduce the life-cycle framework.

Government and Social Security. The government runs a social security system including a contributory public pension and a non-contributory social assistance program. The public pension program is not universal. Only workers in the formal sector who pay a social security tax when young are entitled to draw pensions when old. Meanwhile, informal sector workers who do not pay social security taxes when they are young are prohibited to collect pension benefits when old. Pension payments to the old pensioners are defined as a function of current wage rates in the formal sector w^F, average effective labor $\bar{h}^F$ over the working periods of the formal sector worker, and a replacement rate Ψ^F. The functional form is

$$Pen = \Psi^F w^F \bar{h}^F.$$

Government considers a proposal for social assistance program targeting to elderly workers in the informal sector, who are not covered by the public pension program. The individual lump-sump transfer/social pension is calculated based on the following formula

$$T = \Psi^I w^I \bar{h}^I,$$

where Ψ^I, w^I and $\bar{h}^I$ denote the replacement rate, the wage rate and the average effective labor in the informal sector, respectively.

Residual government expenditures are given as a fraction of final output

$$G = \Delta_G Y.$$

The government collects a social security tax, a labor income tax and a capital income tax and a consumption tax to finance pensions for formal sector retirees, lump-sum transfers to informal sector workers and general government consumption. The government budget constraint is assumed to be balanced each period.

2.2 Household Problem

Individual members of the household have different incomes depending on their working time, age-dependent labor productivity and which sector they work for. The income of economically active children y_j^k at age j are defined as

$$y_j^k = \begin{cases} \left(1-\tau_L^F-\tau_{SS}\right)\left(1-l_j^k\right)e_j^F w_j^F & \text{if } se^k = F, \\ \left(1-\tau_L^I\right)\left(1-l_j^k\right)e_j^I w_j^I & \text{if } se^k = I. \end{cases}$$

where, τ_L^F and τ_L^I denote the labor tax rates in the formal and informal sectors, respectively and τ_{SS} is is social security tax, which is paid by formal sector workers only. Since it is much easier to evade tax in the informal sector, labor income tax rate in the formal sector is assume to be higher than that in the informal sector, $\tau_L^F > \tau_L^I$.

The income of parent y^p_{J+j}, including wage income and pensions, is summarized as

$$y^p_{J+j} = \begin{cases} \left\{ \begin{array}{ll} \left(1-\tau^F_L-\tau_{SS}\right)\left(1-l^p_{J+j}\right)e^F_{J+j}w^F_j & \text{if } J+j \le J_w \\ \left(1-\tau^I_L\right)\left(1-l^p_{J+j}\right)e^I_{J+j}w^I_j + Pen^i_{J+j} & \text{if } J+j > J_w \end{array} \right| \text{if } se^p = F, \\ \left\{ \begin{array}{ll} \left(1-\tau^I_L\right)\left(1-l^p_{J+j}\right)e^I_{J+j}w^I_j & \text{if } J+j \le J_w \\ \left(1-\tau^I_L\right)\left(1-l^p_{J+j}\right)e^I_{J+j}w^I_j + T^i_{J+j} & \text{if } J+j > J_w \end{array} \right| \text{if } se^p = I, \end{cases}$$

$\left(1-\tau^F_L-\tau_{SS}\right)\left(1-l^p_{J+j}\right)e^F_{J+j}w^F_j$ is the net labor income if parents work in the formal sector. As long as parents working in the formal sector reach mandatory minimum retirement age, they have to retire and eligible to receive pensions Pen_{J+j}. Also, they could earn additional income if the formal sector retiring parents choose to work in the informal sector. Hence, the total income of a formal sector retiree is given by $\left(1-\tau^I_L\right)\left(1-l^p_{J+j}\right)e^I_{J+j}w^I_j + Pen_{J+j}$. If workers in the informal sector can work as long as they are alive and want to work. When they are older than the mandatory minimum retirement age, informal sector workers may receive an additional income from a social assistance program T_{J+j} so that the total income is $\left(1-\tau^I_L\right)\left(1-l^p_{J+j}\right)e^I_{J+j}w^I_j + T_{J+j}$.

Individuals are endowned 1 unit of time each period so that leisure of parent and children lies in the following range $0 < l^p_j, l^k_j \le 1$. When $l = 1$, individuals choose not to work and use up all time endowment for leisure.

The household budget constraint is given by

$$\begin{aligned} (1+\tau_C)\left(\xi^k_j c^k_j + \xi^p_j c^p_{J+j}\right) + a_{j+1} &= Ra_j + \xi^p_j y^p_j + \xi^k_j y^k_{J+j}, \\ j &= 1, ...J, \end{aligned} \tag{4}$$

where ξ^k_j is an index function which takes the value $m = (1+n)^J$ if the children are alive and 0 otherwise, while ξ^p_j is an index function which takes the value 1 if parent is alive and 0, otherwise, a_j is the household asset at age j. It is assumed that the household faces a borrowing constraint so that $a_j \ge 0$.The household saving at the last period is intended bequest, which become the initial asset of the next household in the family line, $a'_1 = a_{J+1}$.

Let $V_j\left(a_j, \Phi_j\right)$ be the indirect utility of a household at age j given state variables a_j and $\Phi_j = \left\{se^p, se^k, \xi^p_j, \xi^k_j\right\}$, including occupational composition and demographic structure of the household. A household in a dynasty starts with some initial assets in form of bequests received from the previous household and then choose consumption, leisure and saving to maximize its indirect utility given its state variables each period. At last period, the household, if children are till alive, maximizes not only its utility but also the expected utilities of the next households so it leaves bequests to the next household in the dynasty. The household problem can be defined recursively in term of Bellman equation as

$$V_j\left(a_j, \Phi_j\right) = \underset{\left\{c^k_j, l^k_j, c^p_{J+j}, l^p_{J+j}, a_{j+1}\right\}}{max} \left\{\xi^k u\left(c^k_j, l^k_j\right) + \xi^p u\left(c^p_{J+j} l^p_{J+j}\right) + \beta E V_{j+1}\left(a_{j+1}, \Phi_{j+1}\right)\right\} \tag{5}$$

subject to (4), and expected value function EV_{j+1} is defined as

$$EV_{j+1}(a_{j+1},\Phi_{j+1}) = \begin{cases} \sum_{g=1}^{3} \Omega(g_j, g_{j+1}) V_{j+1}(a_{j+1},\Phi_{j+1}) & \text{for } j = 1,..,J-1, \\ \sum_{se^{k\prime}\in\{F,I\}} \pi\left(se^{p\prime}, se^{k\prime}\right) \sum_{g=1}^{3} \Omega(g_J, g_1) V_1(a_1,\Phi_1) & \text{for } j = J. \end{cases}$$

Note that households in the family line face shocks to their demographic structure each period, which assumed to be a function of age, working sector and current demographic structure, and a shock to occupational composition every J period when a new generation comes in and new households are formed.

2.3 Firm Problem

Firms choose to rent physical capital and human capital to maximize profits. Thus, the firm's problem is

$$\max_{(H_t^{se},K_t^{se})} \left\{ A^{se} (K^{se})^{\alpha^{se}} (H^{se})^{1-\alpha^{se}} - w^{se} H^{se} - q^{se} K^{se} \right\},$$

given factor prices w^{se} and q^{se}, where $se = \{I, F\}$.

2.4 Recursive Competitive Equilibrium

Definition 1 *Given realizations of initial assets, occupational composition* $\left\{se^p, se^k\right\}$, *exogenous sector transition probabilities* Π, *survival probabilities, and government policies* $\left\{\tau_C, \tau_L^I, \tau_L^F, \tau_{ss}, \tau_K, \Delta_G, \Psi^I, \Psi^F\right\}$, *a stationary recursive competitive equilibrium is a collection of value functions* $\{V_j(a_j,\Phi_j)\}_{j=1}^{J}$ *with* $\Phi_j = \left\{se^p, se^k, \xi^p, \xi^k\right\}$, *household decision rules* $\left\{c_{J+j}^p, l_{J+j}^p, c_j^k, l_j^k, a_{j+1}\right\}_{j=1}^{J}$, *a collection of sequences of time variant distributions* $\left\{\mu_j(a_j,\Phi_j)\right\}_{j=1}^{J}$, *sequences of aggregate stocks of physical capital and human capital* $\{K^{se}, H^{se}\}$ *and sequences of prices* $\{w^{se}, q^{se}, R\}$ *where* $se = \{F, I\}$ *such that*

(*i*) *household decision rules* $\left\{c_{J+j}^p, l_{J+j}^p, c_j^k, l_j^k, a_{j+1}\right\}_{j=1}^{J}$ *solve the household maximization problem* (5),

(*ii*) *firms solve the profit maximization problem so that factor prices are determined by*

$$\begin{aligned} w^F &= \left(1-\alpha^F\right) A^F \left(\frac{K^F}{H^F}\right)^{\alpha^F}, \\ w^I &= \left(1-\alpha^I\right) A^I \left(\frac{K^I}{H^I}\right)^{\alpha^I}, \\ q^F &= \alpha^F A^F \left(\frac{K^F}{H^F}\right)^{\alpha^F-1}, \\ q^I &= \alpha^I A^I \left(\frac{K^I}{H^I}\right)^{\alpha^I-1}, \end{aligned}$$

and the after-tax interest rate is determined by

$$R = \left(1-\tau_K\right) q^F + 1 - \delta^F = \left(1-\tau_K\right) q^I + 1 - \delta^I,$$

(*iii*) *aggregate stocks are given by*

$$\begin{aligned} S &= \sum_{j,a,se^p,se^k,\xi^p,\xi^k} \mu_j\left(a_j,\Phi_j\right) a_j\left(a_j,\Phi_j\right), \\ C &= \sum_{j,a,se^p,se^k,\xi^p,\xi^k} \mu_j\left(a_j,\Phi_j\right) c_j\left(a_j,\Phi_j\right), \\ H^I &= \sum_{j,a,se^p,se^k,\xi^p,\xi^k} \mu_j\left(a_j,\Phi_j\right)\left(1-l_j\right) e_j^I, \\ H^F &= \sum_{j,a,se^p,se^k,\xi^p,\xi^k} \mu_j\left(a_j,\Phi_j\right)\left(1-l_j\right) e_j^F, \end{aligned}$$

(*iv*) *commodity markets clear*

$$C + S + \Delta_G \sum_{se\in\{I,F\}} Y^{se} = \sum_{se\in\{I,F\}} Y^{se} + \sum_{se\in\{I,F\}} \left(1-\delta^{se}\right) K^{se},$$

(*v*) *and the government budget constraint holds*

$$\begin{aligned}
&\Delta_G Y + \overbrace{\sum_{j=J_w+1}^{J} \sum_{a,se^p=F,\xi^p,\xi^k} \mu_j\left(a_j,\Phi_j\right) Pen}^{pension\ payment} + \overbrace{\sum_{j=J_w+1}^{J} \sum_{a,se^p=I,\xi^p,\xi^k} \mu_j\left(a_j,\Phi_j\right) T}^{transfer\ payment} \\
= &\sum_{j,a,\xi^p,\xi^k} \sum_{se=\{I,F\}} \mu_j^i\left(a_j,\Phi_j\right) w^{se}\left(1-l_j\right) e_j^{se} \tau_L^{se} + \sum_{j,a,\xi^p,\xi^k} \mu_j^i\left(a_j,\Phi_j\right) w^F\left(1-l_j\right) e_j^F \tau_{SS} \\
&+ \sum_{j,a,se^p,se^k,\xi^p,\xi^k} \mu_j\left(a_j,\Phi_j\right) a_j\left(a_j,\Phi_j\right) \tau_K + \sum_{j,a,se^p,se^k,\xi^p,\xi^k} \mu_j\left(a_j,\Phi_j\right) c_j\left(a_j,\Phi_j\right) \tau_C + \\
&\overbrace{\sum_{j,a,se^p,se^k,\xi^p=\xi^k=0} \left[1-\mu_j\left(a_j,\Phi_j\right)\right] a_j\left(a_j,\Phi_j\right)}^{accidental\ bequests}.
\end{aligned}$$

(*vi*) *and the time invariant distribution satisfies*

$$\begin{aligned}
\mu_1\left(a_1,\Phi_1\right) &= \sum_{se^{p\prime=k}=\{I,F\}} \sum_{a,\xi^{p\prime},\xi^{k\prime}} \Pi\left(se^{p\prime}, se^{k\prime}\right) \Omega\left(g_1,g_J\right) \mu_J\left(a_J,\Phi_J\right), \\
\mu_{j+1}\left(a_{j+1},\Phi_{j+1}\right) &= \sum_{a,\xi^p,\xi^k} \Omega\left(g_j,g_{j+1}\right) \mu_j\left(a_j,\Phi_j\right), \quad for\ j=1,...,J-1.
\end{aligned}$$

3 Calibration

We use parameters reported in table 1 to calibrate the benchmark economy to match data from developing countries. Model outcomes and data comparisons are reported in table 2. In the following we will discuss the parameter selection. Solutions to the model as well as algorithms are available upon request from the authors.

3.1 Life-Time Income Profile

In the benchmark model we abstract from population growth so that each parent has one child. Survival probabilities are taken out from the world life table. We adjust annual rates to 5 year period rates in our model.

To our knowledge, there is no overall estimate of the income-age profile for developing countries, but there are estimates for some specific countries. We base the shape of the income-age profile on Ferreira (2005) who provides an estimate of the wage-age profile wh_j, where

$$h_j = \exp(-.2314 + .0529j - .0093j^2),$$

and $j = 1, 2, ...55$. We use Ferreira's estimates for our formal sector wage-age profile and scale it to a 12 period model. We see that after formal sector workers retire their income remains stable due to pension income.

The informal sector income-age profile is lower than the one in the formal sector reflecting the lower productivity of informal sector workers. Marcouiller, de Castilla and Woodruff (1997) estimates the ratio of years of education of informal versus formal sector workers in Mexico, El Salvador and Peru to be between 0.5 and .83.

Based on these observations we construct the wage-age profile of informal sector workers so that we match estimates of the average income ratio between formal and informal sector workers. Marcouiller, de Castilla and Woodruff (1997) estimate average income ratios between $30\% - 80\%$ for Mexico, El Salvador and Peru. Gindling and Terrell (2004) estimate average income ratios between 50% and 70% for Costa Rica. In our model the average income ratio between informal and formal sector worker is around 50%. We report the income-age profiles of informal and formal sector workers in figure 1.

Informal sector income drops off earlier than the formal sector income, reflecting the stronger adverse effect of age on the income of informal sector workers. We justify this assumption by pointing out that a large share of informal sector workers is composed of rural field workers whose manual work is strongly affected by their age. Since informal sector workers are also not eligible to receive pension payments, their income is steadily declining with age.

3.2 The Size of the Informal Sector and Sector Mobility

The size of the informal sector in terms of employment and relative size of GDP varies across countries. According to a World Bank report (World Bank 2004) the informal sector employs between 20% and to 80% of non-agricultural employment in developing countries and contributes between 25% and 40% of annual output in developing countries in Asia and Africa. Schneider (2005) reports the size of the shadow economy in a range from 10% to 90% of GDP. Friedman et al. (2000) report estimates of informal sector sizes for 69 countries. Their estimates for developing countries range from 20% to 65% of GDP. In our calibration we choose the share of informal sector employment at 30% and that of informal sector's output of GDP at about 19%. The Markov transition probabilities that result in these shares are $\begin{bmatrix} 0.44 & 0.56 \\ 0.24 & 0.76 \end{bmatrix}$. In a second case we choose a larger share of informal sector workers. Picking a Markov switching matrix of $\begin{bmatrix} 0.8 & 0.2 \\ 0.2 & 0.8 \end{bmatrix}$ results in 50% of the labor force working in the informal sector and an informal sector size of 30% of GDP.

3.3 Preference and Altruism

Empirical estimates of the parameter of intertemporal elasticity of substitution, σ, vary from 1 to 10. Most calibration studies pick $\sigma = 2, 3$ or 4. We choose $\sigma = 2$ for our benchmark economy.

In the current version of the paper agents supply labor inelastically so that we set the parameter measuring the share of consumption in the preferences $\gamma = 1$. Agents do not value leisure. We will relax this assumption in later versions of the model.

The discount factor β and the altruistic factor θ are free parameters. One may calibrates either β or θ or both to match the capital-output ratio. Fuster, Imrohoroglu and Imrohoroglu (2003) choose $\theta = 1$ and calibrate annual $\beta = 0.988$. Nishiyama (2002) calibrates both β and θ. We set $\theta = 1$ and adjust β to pin down the capital-output ratio.

3.4 Technology

In standard one sector models the income share of capital, α, is chosen in the range between 0.3 and 0.36. Estimates of α for developing countries tend to be higher. Ferreira and do Nascimento (2005) use $\alpha = 0.4$ to match the Brazilian economy. We are not aware of an estimate relating the capital shares of formal to the informal sector. Often, the informal sector is documented as a labor-intensive sector so that the income share of capital is likely to be smaller. We therefore calibrate the benchmark economy income shares of capital in the informal and formal sectors with $\alpha^I = .2$ and $\alpha^F = 0.36$.

The depreciation rate is 6% annually for both sectors.

To the best of our knowledge there is no estimate of levels of total factor productivity for the informal and formal sector. However, we feel comfortable applying the restriction $A^I < A^F$ so that the formal sector is more efficient. We then normalize A^F to 1 and pick A^I to restrict the share of informal sector output in GDP to about 20%.

We will conduct sensitivity analysis in a later version of the paper.

3.5 Government and social security

Residual government consumption is 20% of GDP. The government runs a social security program for retirees of the formal sector. The social security trust fund is not independent from the government budget. The social security tax applies to labor income of formal sector employees and is set to 10%. The replacement rate for pension payments, Ψ^F, is 40% of the average labor income of the active work life. In the benchmark economy there is no social assistance available to the elderly in the informal sector so that $\Psi^I = 0$.

The government taxes labor income of informal and formal sector workers. However, the labor income tax rate in the informal sector τ_L^I is rather small at 5%, whereas the labor tax in the formal sector is $\tau_L^F = 15\%$. Consumption tax is 6% and matches consumption tax revenue reported in Bird and Gendron (2006). In addition, the government taxes capital income. In the benchmark model, capital tax is endogenous to clear the government budget constraint.

4 Policy Experiments

We start the benchmark economy without a social assistance program for informal sector workers. We then assume that the government starts a social assistance program that is available to all informal sector workers. The generosity of the social assistance program is reflected in the magnitude of the replacement rate Ψ^I. To finance the program the government can use either capital income tax or labor income tax or consumption tax. We study the effect of varying degrees of generosity of the social assistance program and the different tax instruments to finance it. We then report changes in aggregate variables, wealth distributions, family transfers and welfare.

4.1 Capital Tax

We phase in a social assistance program for informal sector workers who are 65 and older by increasing the replacement rate parameter Ψ^I gradually. We consider two cases that differ in their respective sizes of the informal sector. In case one, 25% of the labor force

is employed in the informal sector, whereas in case two 50% of the labor force works in the informal sector. Capital tax is adjusted to clear the government budget constraint each period. The steady state results are reported in tables 3, 4, 5 and 6. We normalize the results of the benchmark to 100 and use them as a base to express the corresponding results of all alternative policies.

Inter-vivos transfers and bequests. Family transfers play both credit and insurance roles. The former lessens the borrowing constraint so that individuals are able to consume more when young. The later insures consumptions of parents and children against and income shocks. As seen in figure 2, children in households type I-I and I-F borrow from parents in early time of their careers, when children's incomes are low, and repay/ transfer back to their parents. Children in households type F-I and F-F, whose incomes are relatively lower in household, always receive transfers from their parents.

The effects of public transfers on inter-vivo transfers from parents to their children are different across household types. Parents in household type I-I and type I-F, who directly receive social pensions, transfer more to their children in the middle ages and receive less in old age. Parents in household type F-I, who do not directly receive social but their children will, transfer less to their children. These indicate that inter-vivos (private) transfers are partially crowded out by public transfers.

Capital accumulation and outputs. A rise in social assistance decreases steady state output as we report in column 3 of table 4. Increasing the generosity of social assistance from $\Psi^I = 0$ to $\Psi^I = 0.5$ decreases output in economy 1 (2) by around 2.7% (5.6%). Capital tax rate rise substantially from 19.3% (20.5%) to 23% (29%) to clear government budget. The decrease in output in economy 2 with the larger informal sector are more pronounced.

The negative effect on long-run output comes from the fall in steady state savings, around 7% and 17% for economy 1 and 2, respectively. As documented in the literature, extending social security discourages people to save. First, increases in capital income tax rate reduce return on savings, which also disincentive people save. Second, the social security program redistributes income from young population, who have high propensity to save, to the elderly population, who have lower propensity to save. In this setup, the drops in capital accumulation are lessened because the decrease in savings due to life cycle reasons is compensated by bequest motive.

Distribution of wealth. Wealth concentration measures like the Gini coefficient and the Lorenz curves depicted in figure **??** indicate that the introduction of the social assistance program increases wealth inequality. Introducing the program by increasing from $\Psi^I = 0$ to $\Psi^I = 0.5$ increases the Gini coefficient by 5.5% for the economy in case one. The Gini coefficient also increases by 3%. The changes are non-monotone as replacement rates rise. Gini coefficient reaches the trough when $\Psi^I = 0.4$ and then drops.

Bequest motive plays a role in making distribution of wealth more inequality. Heterogeneous households react differently to redistribution policy. Young formal sector workers, who are not recipients of social pension, receive more bequests from their parents as a protection against high tax in future. As a consequence, this leads to more concentration of wealth in the formal sector or rich households.

Welfare. The welfare effects across household groups and types are reported in table 5. Social assistance program has welfare effects not only recipient households but also non-recipient households. Due to the heterogeneity of households the welfare effects are varying across household characteristics and over policy range. The welfare of households

whose parents in the parent-children households G1:I-I and G1: I-F and in the single parent household G2:I is increased by 17%, 3% and 17% respectively when increasing replacement rate from $\Psi^I = 0$ to $\Psi^I = 0.5$. In addition, the welfare of households G1: F-I whose parents do not receive social pension but their children will improve too, around 1.8%. Surprisingly, other households who do not receive social pension directly could also have some welfare gain depending on the generosity of social pensions.

The dynamic general equilibrium effects might generate welfare gains are for non-recipients of social pension. The altruistic households value the expected utility of next households in the family line. If the future households are better off, so are the current households. So, the positive effects on the welfare of non-recipient households could come from improving the expected utility of their offsprings. On the other hand, the negative welfare effects are in play due to high tax. When the former dominates the later, the welfare gains of non-recipients could be observed. As government increases the replacement rate, the later seems to be dominant so that the welfare declines for non-recipient households meanwhile the reverse results holds for recipient households.

Overall, in contrary to the previous literature on social security, extending social security coverage has positive effects on welfare even though steady state capital accumulation and long-run income drop. This "surprising" result indicates that additional welfare gains of the recipient households is dominant over the losses of the rest.

4.2 Labor Tax

In this section we allow the government to adjust taxes on labor income of formal sector workers to finance the social assistance program for informal sector retirees. In theory, the government can also tax labor income of informal sector workers. However, due to the high costs associated with collecting the tax from informal sector workers we assume that the government does not use this option. That is more like a progressive income tax program, to redistribute income from the rich to the poor. The results of this policy experiment are reported in tables 8, 9, 10 and 12.

Capital accumulation and output. Introducing the social assistance program again lowers steady state savings and income. However, in comparison to the previous policy experiment, these changes are relatively small, less than 1% decrease in output and 3% decrease in savings in the economy with 25% of the labor force employed in the informal sector. The effects are slightly larger for the case with 50% of the labor force working in the informal sector.

Welfare. Similar to the previous experiment, welfare effects are heterogeneous across households and range of policy choices. The households receiving social pensions either currently or in future have welfare gains meanwhile the other households have welfare losses. Again, contrary to the previous social security literature as more general, average welfare increases monotonically as the replacement rate Ψ^I rises from 0 to 0.5.

Distribution of wealth.Introduction of social pension program has opposite effects on wealth inequality. In the small informal sector economy, the Gini coefficient is higher when social assistance program exists. However, in the large informal sector economy, the Gini coefficient of wealth concentration decreases as increasing degree of generosity of the social pension program.

Our results might changes when we relax assumption of inelastic labor supply, which limits the distortionary effects of increases in labor taxes.

4.3 Consumption Tax

In the final policy experiment, the government is allowed to use consumption tax to finance expenditures from social assistance program. The results are reported in tables from 13 to 15.

Capital accumulation and output. The effect of introducing consumption tax-financing social pension program on saving and output is minimized. As reported in table 14, aggregate capital and output in economy 1 (2) just drop by 1.2% (2.3%) and .6% (.8%), respectively when increasing the replacement rate to 0.5.

Welfare. Similarly, the households receiving social pensions are winners. Overall welfare is higher if government introduces social assistance program.

Distribution of wealth. Overall, as Gini coefficient is higher when extending social assistance program, the wealth inequality is worse off. The changes in Gini coefficient are non-monotone over policy range.

5 Conclusion

In this paper, we construct a two sector model populated by altruistic households who face uninsurable shocks, demographic and occupational shocks. We investigate the implications of social security reform to include elderly workers in the informal sector for savings, labor supply, wealth distribution and welfare and the implication of different financing schemes.

Our study is different from previous studies by incorporating novel characteristics of developing countries such as segmentations of production sectors and labor markets. In addition, we take into account the roles of family transfers in providing credit and insurance. On contradiction to literature on social security reform in developed countries, we find that the introduction of a public social assistance program has positive effects not only on the welfare of recipients of social assistance but also on average welfare. Also, we find that distribution of wealth becomes more inequality and that the magnitude of distortion of financing instruments influences the effects of the social assistance program.

Our findings imply that taking into account the context of developing countries would result in new insights for social security reform. Our findings also result in some policy implications for introducing a non-contributory pension program to uninsured and poor elderly in developing countries. First, it provides a justification for extending the coverage of social security. Second, it indicates that direct transfers via social assistance program may not be an effective way to achieve a more equality society. Third, it suggests that consumption tax should be used as financing instrument. Fourth, the size of uncovered group and the generosity of public transfers are crucial for welfare effects.

Our current model does not allow for labor elasticity, which is important when studying how an extension of social security and its financing instruments would distorts labor markets. Also, what would happen in transition is missing, so it is impossible to say anything about the short-run implications of the reform. We leave these issues for future research.

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6 Appendix

Parameters			Observation/Comment/Source
Preferences			
		$\beta = .97$	to match $\frac{K}{Y}$ and R
	Inverse of intertemporal elasticity of substitution	$\sigma = 2$	Issler and Piqueira (2000) Soriano and Nakane (2003)
	Altruism parameter	$\theta = 1$	to match $\frac{K}{Y}$ and R
	Consumption share in preferences	$\gamma = 1$	
Technology			
		$A^I = 1$, $A^F = 1.1$,	to match $\frac{Y^I}{Y^F}$
		$\alpha^I = 0.20$, $\alpha^F = 0.36$,	Ferreira and do Nascimento (2005) report 0.4 for Brazil
		$\delta^I = 1 - 0.95^{\frac{60}{2J}}$, $\delta^F = 1 - 0.95^{\frac{60}{2J}}$,	to match $\frac{K}{Y}$ and R
Demography			
	Maximum lifetime	$2J = 12$	equivalent to 60 years
	Working periods	$J_w = 9$	equivalent to 45 year
	Retirement periods	$J_r = 3$	equivalent to 15 year
	Household lifetime	$J = 6$	
	Population growth	$n = 0$	
Case 1:	Sector Transitions	$\pi_{I,I} = .44$, $\pi_{F,F} = 0.76$	to match 25% of employment in the informal labor market
Case 2:	Sector Transitions	$\pi_{I,I} = 0.8$, $\pi_{F,F} = 0.8$	to match 50% of employment in the informal labor market
Government			
	Labor income taxes	$\tau_L^I = 0.05$, $\tau_L^F = 0.15$,	
	Capital tax	τ_K	endogenous
	Social security tax	$\tau_{SS} = 0.1$	
	Consumption tax	$\tau^C = 0.06$	to match consumption tax revenue reported in Bird and Gendron (2006)
	Replacement rates	$\Psi^I = 0$, $\Psi^F = .4$	
	Government consumption	$\Delta_G = 0.20$	

Table 1: Preference and Policy Parameters

	Variables: $\Psi^I = 0$	Case 1 (Case 2)	Observation/Comment/Source
$\frac{K}{Y}$	Capital output ratio	3.23 (3.07)	Bresser-Pereira (1990) and Souza-Sobrinho (2004) report 3
R	Interest rate	4.1% (4.1%)	
	Size of government sector	25% of GDP	Herwig et al. (2006) report 35% of GDP.
$\frac{Y^I}{Y}$	Informal sector size (in % of GDP)	19.5% (39%)	Schneider (2005) and Friedman et al. (2000) report estimates ranging from 15% to 65%
$\frac{w^I H^I}{w^F H^F}$	Average income ratio informal to formal sector	53% (53%)	Marcouiller, de Castilla and Woodruff (1997) and Gindling and Terrell (2004) report estimates between $30\% - 80\%$.
	Labor tax revenue (in % of GDP)	8.7% (7.8%)	
	Consumption tax revenue (in % of GDP)	6% (3.5%)	to match consumption tax revenue reported in Bird and Gendron (2006)
	Social security tax revenue (in % of GDP)	5.4% (4.4%)	
	Capital tax revenue (in % of GDP)	3% (3.5%)	

Table 2: Model Outcomes that Match Data

	Ψ^I	Gini	Y^I/Y	y^I/y^F	K^I/Y^I	K^F/Y^F	K/Y	R	τ_K
	0.00	0.36	0.19	0.52	2.08	3.75	3.43	1.03	0.19
	0.10	0.36	0.19	0.52	2.06	3.71	3.39	1.03	0.20
Case 1:	0.20	0.37	0.19	0.53	2.04	3.67	3.35	1.03	0.21
I:25%	0.30	0.38	0.19	0.53	2.02	3.63	3.32	1.03	0.21
F:75%	0.40	0.38	0.19	0.53	1.98	3.57	3.26	1.03	0.22
	0.50	0.39	0.19	0.53	1.98	3.56	3.25	1.03	0.23
	0.00	0.44	0.31	0.52	2.07	3.73	3.21	1.03	0.20
	0.10	0.46	0.31	0.53	2.01	3.63	3.12	1.03	0.22
Case 2:	0.20	0.46	0.31	0.53	1.98	3.56	3.06	1.03	0.24
I:50%	0.30	0.47	0.32	0.54	1.92	3.46	2.98	1.03	0.26
F:50%	0.40	0.47	0.32	0.54	1.87	3.36	2.88	1.03	0.28
	0.50	0.46	0.32	0.55	1.82	3.27	2.80	1.03	0.29

Table 3: Aggregate Variables with Endogenous Capital Income Tax.

	Ψ^I	Gini	Y	K	Y^I	K^I	Y^F	K^F	w^I	w^F
	0.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
	0.10	101.01	99.46	98.37	99.73	98.67	99.40	98.33	99.73	99.40
Case 1:	0.20	103.71	98.94	96.81	99.47	97.38	98.81	96.74	99.47	98.81
I:25%	0.30	104.60	98.45	95.38	99.23	96.20	98.27	95.27	99.23	98.27
F:75%	0.40	106.74	97.51	92.62	98.75	93.92	97.21	92.45	98.75	97.21
	0.50	107.33	97.39	92.28	98.69	93.63	97.08	92.10	98.69	97.08
	0.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
	0.10	104.80	98.70	95.87	99.30	96.55	98.43	95.71	99.30	98.43
Case 2:	0.20	105.48	97.80	93.08	98.81	94.19	97.34	92.80	98.81	97.34
I:50%	0.30	106.90	96.60	89.44	98.16	91.12	95.90	89.02	98.16	95.90
F:50%	0.40	106.82	95.23	85.41	97.41	87.68	94.26	84.85	97.41	94.26
	0.50	104.34	94.06	82.05	96.75	84.79	92.84	81.36	96.75	92.84

Table 4: Percentage Changes in Aggregate Variables with Endogenous Capital Income Tax.

	Ψ^I	G1:I,I	G1:I,F	G1:F,I	G1:F,F	G2:I	G2:F	G3:I	G3:F	Average
	0.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
	0.10	102.15	101.23	101.17	100.50	105.74	101.71	101.21	100.99	101.03
Case 1:	0.20	102.17	100.64	100.37	99.29	106.02	99.57	99.26	99.15	100.21
I:25%	0.30	103.78	101.50	101.06	99.41	110.20	100.38	99.81	99.53	100.82
F:75%	0.40	103.62	100.62	99.82	97.66	110.69	97.60	97.63	97.18	99.57
	0.50	105.06	101.52	100.36	97.78	114.11	97.94	97.87	97.36	100.13
Measure		0.13	0.17	0.17	0.53	0.00	0.00	0.00	0.01	
	0.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
	0.10	100.20	98.95	98.60	97.83	101.90	96.69	97.67	97.26	99.17
Case 2:	0.20	102.79	100.30	100.15	98.31	109.37	99.11	99.18	98.58	100.88
I:50%	0.30	103.47	99.84	99.17	96.51	112.38	96.67	97.95	96.53	100.50
F:50%	0.40	103.84	99.04	97.37	93.87	114.91	92.54	96.34	93.40	99.59
	0.50	105.32	99.37	97.03	92.56	119.46	91.37	96.50	92.34	99.91
Measure		0.40	0.10	0.10	0.40	0.00	0.00	0.00	0.00	

Table 5: Welfare of Household Age 1 with Endogenous Capital Income Tax.

	Ψ^I	I,I	I,F	F,I	F,F	I	F	Average
	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0.10	-0.03	0.10	0.20	0.71	0.00	0.00	0.99
Case 1:	0.20	-0.07	0.06	0.22	0.99	0.00	0.00	1.20
I:25%	0.30	-0.10	0.01	0.24	1.24	0.00	0.00	1.38
F:75%	0.40	-0.13	-0.02	0.26	1.46	0.00	0.00	1.56
	0.50	-0.16	-0.03	0.28	1.73	0.00	0.01	1.82
Type measure		0.13	0.17	0.17	0.53	0.00	0.01	
	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0.10	-0.14	0.10	0.16	0.93	0.00	0.00	1.06
Case 2:	0.20	-0.27	0.09	0.21	1.43	0.00	0.00	1.46
I:50%	0.30	-0.38	0.09	0.25	1.89	0.00	0.01	1.87
F:50%	0.40	-0.48	0.10	0.31	2.37	0.00	0.01	2.31
	0.50	-0.55	0.11	0.36	2.81	0.00	0.01	2.75
Type measure		0.40	0.10	0.10	0.40	0.00	0.00	

Table 6: Compensating Income to Households Age 1 with Endogenous Capital Income Tax.

	Ψ^I	G1:I,I	G1:I,F	G1:F,I	G1:F,F	Average
	0.00	100.00	100.00	100.00	100.00	100.00
	0.10	111.15	155.34	102.42	111.28	106.09
Case 1:	0.20	97.01	132.06	93.64	101.92	96.57
I:25%	0.30	104.24	171.39	93.42	107.87	99.15
F:75%	0.40	95.02	146.62	84.22	97.47	89.73
	0.50	101.45	168.47	82.03	99.14	89.69
	0.00	100.00	100.00	100.00	100.00	100.00
	0.10	84.34	76.19	90.14	87.33	89.42
Case 2:	0.20	105.57	166.41	94.48	108.21	99.10
I:50%	0.30	100.30	154.76	86.95	100.44	92.22
F:50%	0.40	94.41	114.87	76.20	84.79	81.41
	0.50	107.31	139.76	72.49	85.49	80.59

Table 7: Bequests to Next Households with Endogenous Capital Income Tax.

	Ψ^I	Gini	Y^I/Y	y^I/y^F	K^I/Y^I	K^F/Y^F	K/Y	R	τ_{L2}
	0.00	0.35	0.19	0.52	2.09	3.75	3.43	1.03	0.15
	0.10	0.35	0.19	0.52	2.08	3.74	3.42	1.03	0.15
Case 1:	0.20	0.36	0.19	0.52	2.07	3.72	3.40	1.03	0.16
I:25%	0.30	0.36	0.19	0.52	2.07	3.73	3.41	1.03	0.16
F:75%	0.40	0.36	0.19	0.52	2.07	3.72	3.40	1.03	0.17
	0.50	0.36	0.19	0.52	2.06	3.71	3.39	1.03	0.17
	0.00	0.41	0.31	0.52	2.08	3.74	3.23	1.03	0.15
	0.10	0.42	0.31	0.52	2.07	3.72	3.21	1.03	0.16
Case 2:	0.20	0.43	0.31	0.52	2.05	3.70	3.19	1.03	0.17
I:50%	0.30	0.42	0.31	0.52	2.05	3.69	3.18	1.03	0.19
F:50%	0.40	0.41	0.31	0.53	2.05	3.68	3.17	1.03	0.20
	0.50	0.39	0.31	0.53	2.04	3.67	3.16	1.03	0.21

Table 8: Aggregate Effects with Endogenous Labor Income Tax.

	Ψ^I	Gini	Y	K	Y^I	K^I	Y^F	K^F	w^I	w^F
	0.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
	0.10	101.55	99.86	99.58	99.93	99.66	99.85	99.57	99.93	99.85
Case 1:	0.20	102.27	99.58	98.74	99.79	98.97	99.53	98.71	99.79	99.53
I:25%	0.30	104.10	99.61	98.81	99.80	99.02	99.56	98.78	99.80	99.56
F:75%	0.40	103.64	99.53	98.59	99.77	98.84	99.48	98.55	99.77	99.48
	0.50	102.94	99.43	98.28	99.72	98.59	99.36	98.24	99.72	99.36
	0.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
	0.10	103.50	99.75	99.19	99.86	99.33	99.70	99.16	99.86	99.70
Case 2:	0.20	104.07	99.41	98.12	99.68	98.43	99.29	98.04	99.68	99.29
I:50%	0.30	103.02	99.36	97.95	99.66	98.29	99.23	97.86	99.66	99.23
F:50%	0.40	99.76	99.23	97.55	99.59	97.95	99.07	97.45	99.59	99.07
	0.50	96.44	99.10	97.13	99.52	97.60	98.91	97.01	99.52	98.91

Table 9: Percentage Changes in Aggregate Variables with Endogenous Labor Income Tax.

	Ψ^I	G1:I,I	G1:I,F	G1:F,I	G1:F,F	G2:I	G2:F	G3:I	G3:F	Average
	0.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
	0.10	101.40	100.29	100.37	99.67	104.08	100.06	99.98	99.63	100.19
Case 1:	0.20	103.86	101.72	101.68	100.20	110.44	102.02	101.60	100.76	101.36
I:25%	0.30	104.31	101.34	101.07	98.98	111.73	100.09	100.11	98.95	100.67
F:75%	0.40	105.61	101.79	101.32	98.56	115.05	100.01	100.14	98.54	100.82
	0.50	107.12	102.48	101.79	98.35	118.68	100.36	100.55	98.48	101.18
Measure		0.13	0.17	0.17	0.53	0.00	0.00	0.00	0.01	
	0.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
	0.10	102.06	100.17	100.42	98.99	106.47	99.76	100.16	99.05	100.75
Case 2:	0.20	104.70	101.05	101.48	98.60	113.77	100.89	101.59	99.19	102.11
I:50%	0.30	106.08	100.76	100.81	96.61	117.72	98.49	101.15	96.80	102.06
F:50%	0.40	107.97	101.08	100.78	95.20	122.73	97.46	101.76	95.46	102.57
	0.50	109.86	101.46	100.81	93.83	127.22	96.56	102.37	94.20	103.10
Measure		0.40	0.10	0.10	0.40	0.00	0.00	0.00	0.00	

Table 10: Welfare of Household Age 1 with Endogenous Labor Income Tax.

	Ψ^I	I,I	I,F	F,I	F,F	I	F	Average
	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	0.100	-0.038	0.111	0.193	0.789	0.000	0.001	1.057
Case 1:	0.200	-0.079	0.067	0.199	1.095	0.000	0.003	1.286
I:25%	0.300	-0.115	0.027	0.205	1.378	0.000	0.004	1.500
F:75%	0.400	-0.151	0.004	0.220	1.746	0.000	0.007	1.826
	0.500	-0.179	-0.018	0.219	1.918	0.000	0.008	1.948
Type measure		0.131	0.166	0.166	0.526	0.003	0.006	
	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	0.100	-0.179	0.116	0.144	1.075	0.000	0.003	1.159
Case 2:	0.200	-0.344	0.129	0.167	1.648	0.000	0.006	1.606
I:50%	0.300	-0.486	0.150	0.192	2.195	0.000	0.009	2.061
F:50%	0.400	-0.605	0.173	0.217	2.709	0.000	0.013	2.506
	0.500	-0.703	0.198	0.242	3.249	0.001	0.016	3.002
Type measure		0.396	0.099	0.099	0.396	0.004	0.004	

Table 11: Compensating Wealth to Households Age 1 with Endogenous Labor Income Tax.

	Ψ^I	I,I	I,F	F,I	F,F	Average
	0.00	100.00	100.00	100.00	100.00	100.00
	0.10	100.60	122.61	97.82	102.45	100.60
Case 1:	0.20	116.78	185.24	101.33	115.38	116.78
I:25%	0.30	109.14	165.52	93.56	106.98	109.14
F:75%	0.40	113.52	198.19	90.80	107.45	113.52
	0.50	122.29	239.66	89.46	110.31	122.29
	0.00	100.00	100.00	100.00	100.00	100.00
	0.10	105.39	145.50	97.97	106.28	105.39
Case 2:	0.20	125.12	236.52	99.76	121.60	125.12
I:50%	0.30	124.99	216.73	91.98	112.66	124.99
F:50%	0.40	136.58	284.90	87.74	112.00	136.58
	0.50	150.61	357.16	83.99	112.33	150.61

Table 12: Bequests to Next Households with Endogenous Labor Income Tax.

	Ψ^I	Gini	Y^I/Y	y^I/y^F	K^I/Y^I	K^F/Y^F	K/Y	R	τ_C
	0.00	0.35	0.19	0.52	2.09	3.75	3.43	1.03	0.06
	0.10	0.35	0.19	0.52	2.08	3.75	3.43	1.03	0.06
Case 1:	0.20	0.36	0.19	0.52	2.08	3.74	3.42	1.03	0.06
I:25%	0.30	0.37	0.19	0.52	2.07	3.73	3.41	1.03	0.07
F:75%	0.40	0.37	0.19	0.52	2.07	3.73	3.41	1.03	0.07
	0.50	0.37	0.19	0.52	2.07	3.72	3.41	1.03	0.07
	0.00	0.41	0.31	0.52	2.08	3.74	3.23	1.03	0.06
	0.10	0.43	0.31	0.52	2.07	3.73	3.22	1.03	0.06
Case 2:	0.20	0.44	0.31	0.52	2.06	3.71	3.20	1.03	0.07
I:50%	0.30	0.44	0.31	0.52	2.06	3.71	3.20	1.03	0.07
F:50%	0.40	0.43	0.31	0.52	2.06	3.71	3.20	1.03	0.08
	0.50	0.43	0.31	0.52	2.06	3.70	3.19	1.03	0.08

Table 13: Aggregate Effects with Endogenous Consumption Income Tax.

	Ψ^I	Gini	Y	K	Y^I	K^I	Y^F	K^F	w^I	w^F
	0.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
	0.10	101.95	99.89	99.67	99.95	99.73	99.88	99.66	99.95	99.88
Case 1:	0.20	103.91	99.80	99.39	99.90	99.50	99.77	99.37	99.90	99.77
I:25%	0.30	105.73	99.73	99.17	99.86	99.32	99.69	99.15	99.86	99.69
F:75%	0.40	105.74	99.65	98.94	99.83	99.13	99.61	98.92	99.83	99.61
	0.50	105.80	99.59	98.77	99.80	98.99	99.55	98.75	99.80	99.55
	0.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
	0.10	104.62	99.83	99.46	99.91	99.55	99.80	99.44	99.91	99.80
Case 2:	0.20	106.49	99.57	98.62	99.77	98.85	99.48	98.56	99.77	99.48
I:50%	0.30	107.33	99.63	98.83	99.80	99.02	99.56	98.78	99.80	99.56
F:50%	0.40	105.98	99.56	98.59	99.76	98.83	99.47	98.53	99.76	99.47
	0.50	104.39	99.51	98.44	99.74	98.69	99.41	98.37	99.74	99.41

Table 14: Changes in Aggregate Variables with Endogenous Consumption Income Tax.

	Ψ^I	G1:I,I	G1:I,F	G1:F,I	G1:F,F	G2:I	G2:F	G3:I	G3:F	Average
	0.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
	0.10	101.22	100.46	100.45	99.99	103.64	100.33	99.89	99.99	100.37
Case 1:	0.20	102.45	101.06	100.82	99.92	107.01	100.46	99.72	99.88	100.71
I:25%	0.30	103.58	101.61	101.09	99.78	110.05	100.42	99.46	99.67	100.98
F:75%	0.40	104.89	102.35	101.58	99.84	113.50	100.91	99.67	99.86	101.45
	0.50	106.11	103.04	101.96	99.82	116.62	101.17	99.74	99.91	101.84
Measure		0.13	0.17	0.17	0.53	0.00	0.00	0.00	0.01	
	0.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
	0.10	101.63	100.72	100.58	99.91	105.63	100.52	99.74	100.07	100.90
Case 2:	0.20	103.86	102.01	101.76	100.33	112.14	102.21	100.69	101.03	102.36
I:50%	0.30	104.67	102.24	101.15	99.36	115.05	100.44	99.54	99.69	102.42
F:50%	0.40	106.27	103.15	101.43	99.11	119.80	100.45	99.90	99.63	103.24
	0.50	107.78	104.00	101.60	98.78	123.90	100.25	100.12	99.44	103.97
Measure		0.40	0.10	0.10	0.40	0.00	0.00	0.00	0.00	

Table 15: Welfare of Household Age 1 with Endogenous Consumption Income Tax.

	Ψ^I	I,I	I,F	F,I	F,F	Average
	0.00	100.00	100.00	100.00	100.00	100.00
	0.10	99.07	121.12	98.07	103.24	99.07
Case 1:	0.20	100.08	136.12	95.72	105.54	100.08
I:25%	0.30	101.64	147.96	92.93	106.82	101.64
F:75%	0.40	106.50	184.62	91.34	109.86	106.50
	0.50	111.99	213.86	89.31	111.79	111.99
	0.00	100.00	100.00	100.00	100.00	100.00
	0.10	103.02	140.35	99.17	107.72	103.02
Case 2:	0.20	119.06	218.80	101.82	124.05	119.06
I:50%	0.30	113.55	180.89	94.47	114.57	113.55
F:50%	0.40	123.64	232.79	92.09	117.33	123.64
	0.50	134.06	277.59	89.16	118.43	134.06

Table 16: Bequests to Next Households with Endogenous Consumption Income Tax.

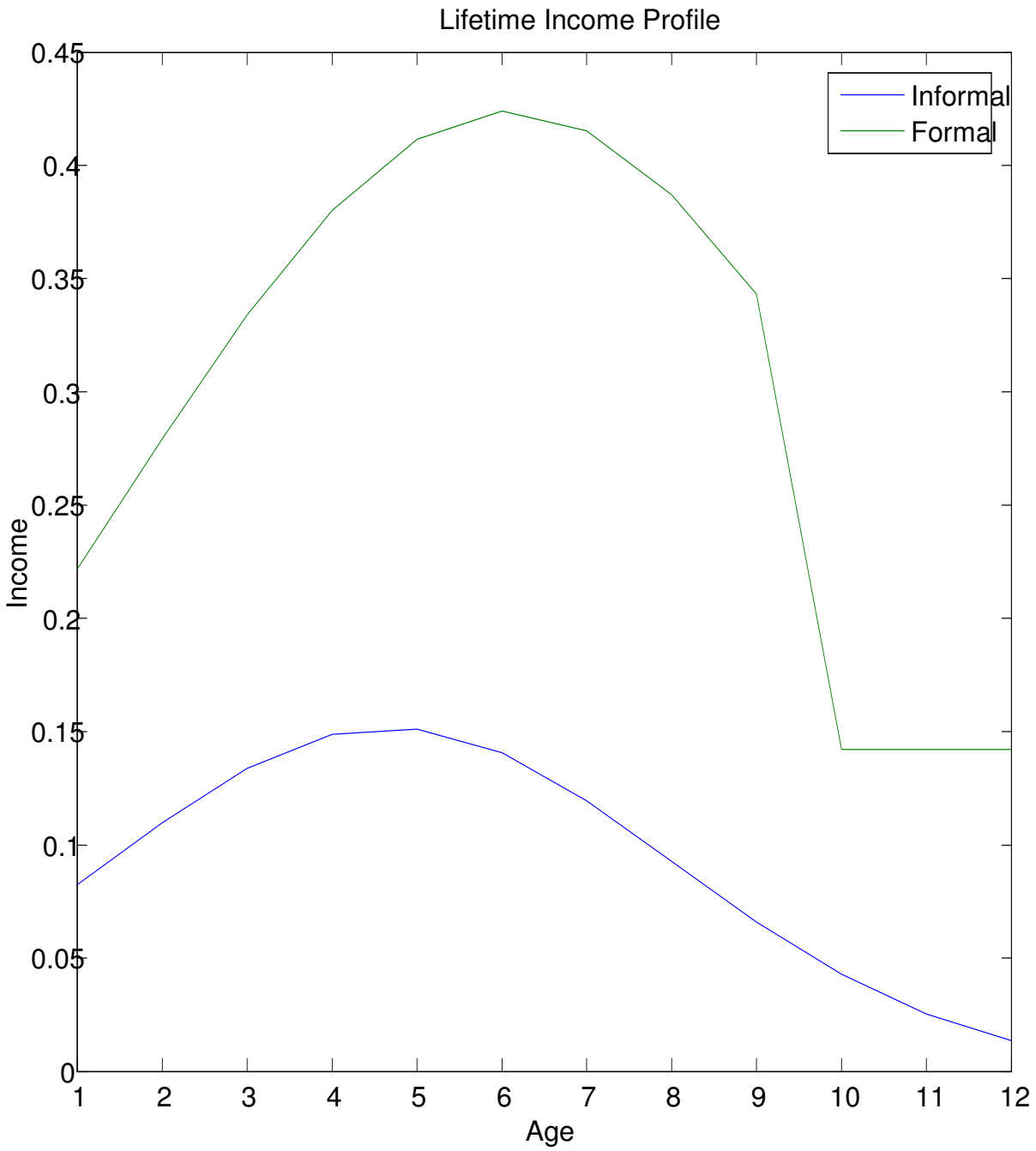

Figure 1: Income Profile

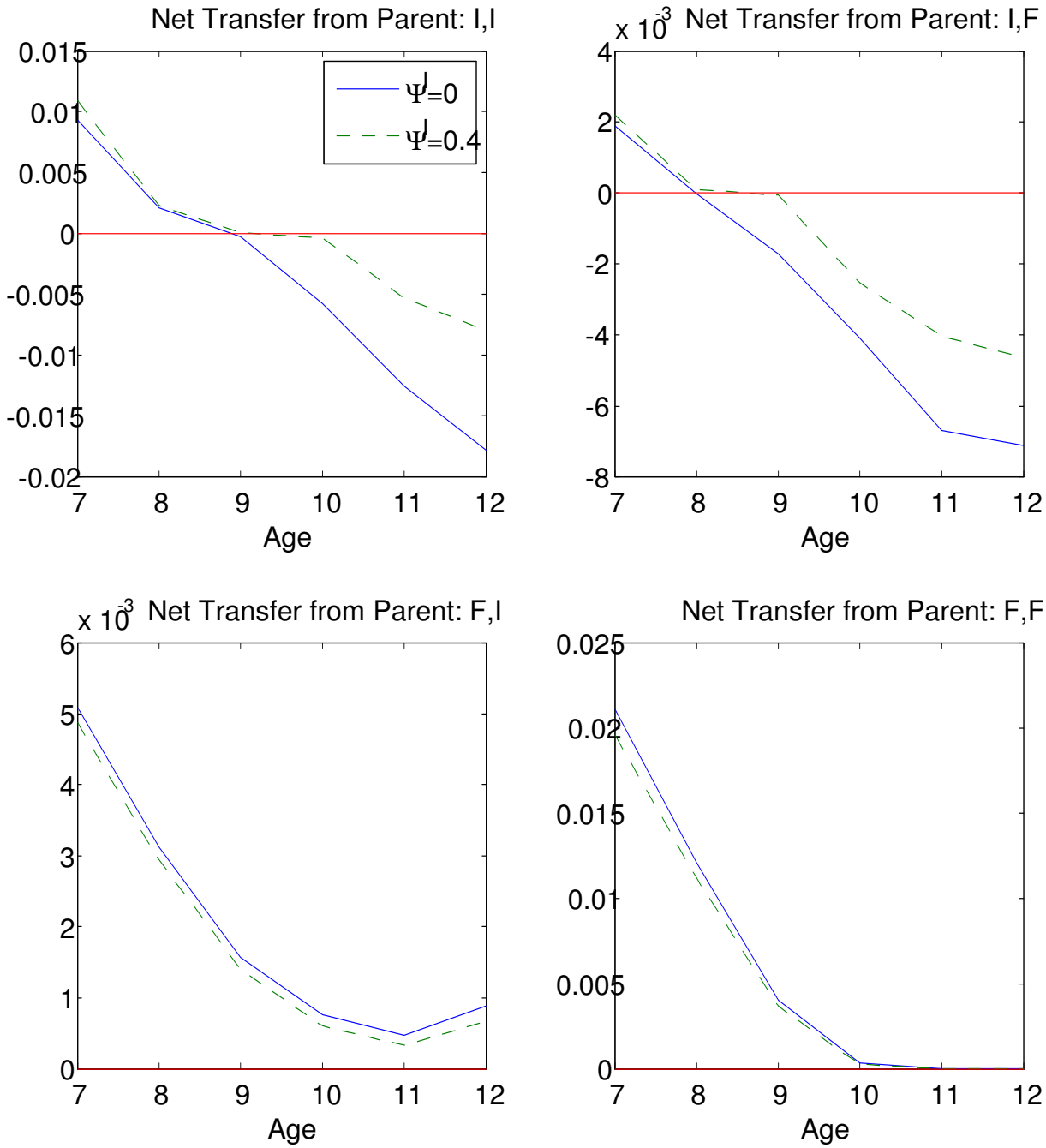

Figure 2: Aggregate Net Intra Family Transfers with/without Social Assistance-Captial Income Tax