The Extension of Social Security Coverage in Developing Countries

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Abstract

A shortage of risk sharing mechanisms against income and longevity risk is an important issue in developing countries. In this paper we investigate the dynamic effects of introducing a social assistance program to elderly informal sector workers in developing countries using a stochastic dynamic general equilibrium model featured with salient characteristics of a developing country. We find that the extension of such “retirement benefits” in environments with lacking formal risk-sharing mechanisms results in welfare increases and relatively minor efficiency losses. Our results suggest that welfare gains attributed to the insurance and redistribution function of the social assistance program dominate welfare losses from distortionary effects of pension payments.

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1 Introduction

Developing countries are confronted with a shortage of formal risk-sharing mechanisms against income and longevity risks. According to Palacios and PALLares-Mirallets (2000) the coverage rates of social security systems are less than 10 percent in low-income countries in Sub-Saharan Africa and South Asia and rarely exceed 50 percent in middle-income countries in Latin America.\(^1\) Instead, the family transfer system – briefly summarized as parents supporting their young children and becoming recipients of support from their children when old – is know as the most important source of income for the elderly. The importance of the family transfer system in developing countries is well documented in the literature (see e.g. World-Bank (1994), Frankenberg and Karoly (1995), Knodel and Debalava (1997), Frankenberg and Kuhn (2004), and Cox and Jimenez (2006)).

Although the family transfer system has the advantage of eliminating moral hazard and adverse selection that are associated with standard insurance programs, the family transfer system fails to provide full insurance against income and mortality risks. A major weakness of the family transfer system is that it fails to pool risk efficiently across different families. In addition, the family transfer system has also been weakened due to rapid changes in the social and economic environment in developing countries.\(^2\) On the other hand, financial markets are underdeveloped and do not provide viable insurance instruments for individuals not covered by social security. Consequently, being left without sufficient income many elderly are forced to rely on their own means and to work until very high ages. Evidence of very high rates of labor force participation of the elderly has been found in China (Benjamin, Brand and Fan (2003)), Indonesia (McKee (2006)), and Vietnam (Tran (2008)).

Since formal market arrangements fail to be adequate mechanisms to allocate risk efficiently across households and generations in developing countries, it naturally gives a further rise for the social insurance role of the governments. Recently, many international development organizations and governments have been picking up on this idea and argue that social insurance a.k.a social assistance programs are very effective policy instruments to fight poverty among the elderly (e.g. see ILO (2002)). In reality, several developing countries including Brazil, India, and South Africa have started social assistance and pension programs for the uncovered elderly; and, currently, an increasing number of developing countries consider instituting similar programs.\(^3\)

In the context of developing countries a social assistance program plays two important roles. First, it is an intergenerational redistribution mechanism to redistribute income to the poor elderly in the informal sector, and, second, it is an important source of insurance against income and longevity risks, which allows people to smooth consumption over the life cycle. This

\(^1\) We define coverage as the fraction of the working population participating in a contributory social security program. This program then pays pensions to retired participating workers.

\(^2\) It is not unreasonable to assume that the erosion of family ties that has been observed in western societies can also advance to less developed countries. For a study on the evolution of attitudes towards the family in the United States compare Thornton and Young-DeMarco (2001).

\(^3\) See Palacios and Sluchynsky (2006) for an overview of social pension programs in developing countries.
subsequently it provides avenues for efficient risk sharing across households and generations, which potentially is welfare increasing. On other hand, however, an extension of a social insurance system comes with cost as it introduces economic distortions on individuals’ savings and labor incentives as well as on allocation of resource within the economy, which potentially leads to welfare loss. In sum, one of the major benefits of social security is that, which is welfare increasing. On the other hand, a social assistance program distorts savings and labor decisions, which results in welfare losses. The final conclusion on welfare outcomes depends on which effect is a dominant force.

In this paper we conduct a dynamic general equilibrium analysis of extending social security coverage in a developing country. In particular, we focus on quantifying the effects from introducing a social assistance program into the informal sector in a dynamic general equilibrium model of a developing country. We are particularly interested in the effects of this program on family transfers, bequests, savings, labor supply, the wealth distribution, and welfare and the implications of alternative tax financing schemes. Our general equilibrium analysis is motivated by several reasons. First, an extension of social assistance program for older informal sector workers in developing countries \(i\) has impacts on a significant part of the population, \(ii\) fundamentally affects the consumption, savings and labor market behavior of households, which influence operations of labor and capital markets, and \(iii\) makes up a non-trivial share of the government budget which requires substantial amount of government revenue. It is therefore necessary to have an analytical framework, using a state of the art dynamic general equilibrium framework, to capture all dimensions of these effects. In addition, there are some defining features of developing countries (e.g. a sizeable informal sector, incomplete financial markets, segmented labor markets, high income inequality, low coverage rates of public social security, and a large family transfer system) which are important in determining the aggregate and welfare effects of a social insurance program. We believe that important new insights can be gained in evaluating such programs with a dynamic general equilibrium model that incorporates such features.

To that end, we construct a two-sector overlapping generations economy with two-sided altruistic agents, competitive firms and a government with full commitment technology. The setup of the household sector is similar to Laitner (1992) and Fuster (1999). Parents and children form a decision unit called a household in which resources are pooled and decisions are made jointly. A sequence of households in a family line form a household dynasty. A household dynasty is linked together via skill (or ability) transmission from parents to children, a bequest motive, and children deriving utility from caring for their parents. Households face demographic and occupational shocks which are partially insurable. Deviating from previous studies we allow for endogenous retirement and model the labor market behavior of the elderly. Besides, we introduce two production sectors, a formal and an informal sector. The two production sectors differ with respect to technology and the quality of labor inputs. In addition, the social security system is only available to formal sector workers. The social security system is financed by the government via taxes on consumption, labor income, and capital income. In order to
derive quantitative results, we calibrate the model to match certain characteristics of Brazil, a
country with a large informal sector. We then study the effects of social assistance programs
of various sizes.

Our quantitative results suggest that extending retirement benefits to informal sector work-
ers results in a welfare increase with relatively minor efficiency losses in terms of output. Our
model predicts that the public social pension program crowds out capital stock and aggregate
labor supply. We also find that the introduction of a social assistance program with a 50 percent
replacement rate decreases output by up to 3.25 percent and labor supply by up to 2.5 percent.
The magnitude of the crowding-out effects depends substantially on the tax that is used to
finance the expansion. In addition, the social assistance program allows the very old (> 75)
in the informal sector to retire from the labor force. Moreover, the model has an interesting
implication for welfare. In our calibrated economy, it turns out that the positive insurance-
and redistribution effects of the social assistance program outweigh the negative crowding-out
effects, so that we find welfare gains for recipients of social assistance benefits. This result is
in contrast to findings in previous studies with models calibrated to the U.S. economy and can
be explained as follows:

In our model individuals face two types of risk, an uninsurable survival risk and uncertainty
about their skill or ability level which in turn determines whether the individual has access to
formal sector work. Social assistance provides insurance against both types of risk. Notice that
family transfers can also play this role but fail to pool risk over different families. Frictions in
both labor markets and production sectors expose informal sector workers (poor and low ability)
to even more risk so that the insurance role of the social assistance programs is even stronger.
In addition, the social assistance program makes retirement affordable for the “ceaseless toil”
elderly whose marginal utility of leisure is extremely high, which contributes to the welfare
gain. On the other hand, the social assistance program creates relatively small distortions since
it targets only the relatively small group of older informal sector workers. The social assistance
program can therefore be kept small in size. Besides, the crowding-out effect on saving is
mitigated as intended bequests are operative. Consequently, the social assistance program only
causes very small efficiency losses and is therefore able to generate welfare gains. In this sense
our findings are a direct result of modelling the main features of a developing economy in a
macro model, and are therefore unprecedented.

Understanding the impacts of the introduction/or expansion of a social assistance program
in developing countries is important for academics and policymakers. There are growing number
of empirical and microeconomic studies in development economics evaluating the impacts of
public transfer programs. So far that literature has mainly focused on empirical issues using
mostly microeconomic (partial equilibrium) models (e.g. see Cox and Jimenez (1992), Cox
and Jimenez (1995), Jensen (2003), Filho (2004), McKee (2006) and Tran (2008)). However,
the literature falls short in providing a thorough dynamic general equilibrium analysis of the
effects of extending such social insurance programs. To our knowledge, there is only one study
by Corsetti (1994) investigating the potentially important general equilibrium effects caused
by the introduction or expansion of social security in developing countries. More specifically, in this paper Cosertti develops a deterministic neoclassical growth model with the endogenous size of the informal sector to study the growth effects of social security. Differently, we develop a stochastic dynamic general equilibrium model with two production sectors and heterogeneous agents. We concentrate on analyzing the social insurance role of a social security program. The novel features of our model allows us to study the redistributional effects of a social security program as well as the potential welfare gains resulting from a more efficient risk-sharing mechanism.

Note that accounting for general equilibrium adjustments is a crucial aspect of our paper. Recently, Acemoglu (2010) argues general equilibrium and political economy is important for the external validity of econometric estimates when extrapolating the policy implications from these specific empirical exercises. This also points out that policy analysis in development economics should extend its analysis to account for such general equilibrium and political economy effects. Our work contributes to advancing general equilibrium analysis of public policy in the developing countries.

There is a large body of related literature analyzing the effects of social security systems. Since the seminal contribution by Diamond (1965) the adverse effects of unfunded social security have been well documented in life cycle models (e.g. Auerbach and Kotlikoff (1987), Hubbard and Judd (1987), Imrohoroglu, Imrohoroglu and Jones (1995), Imrohoroglu, Imrohoroglu and Joines (1999)). The effects of social security have also been analyzed in models with altruism (see e.g. Barro (1974), Fuster (1999), Fuster, Imrohoroglu and Imrohoroglu (2003), Fuster, Imrohoroglu and Imrohoroglu (2007)). This literature focuses on developed countries and, in general, does not support the expansion of social security systems because the adverse effects on capital accumulation and labor supply tend to dominate the insurance role so that the introduction of social security usually leads to welfare losses. Our analysis is complementary to that literature as we focus on the welfare effects of social security in a developing countries rather than a developed country. In addition, we incorporate some salient features of features of a developing country including formulation of the informal sector. We therefore could factor in the distortive effects of introducing a social insurance program on allocation of production factors across informal and formal sectors.

The paper is structured as follows. In the next section we set up the model and define equilibrium. Section 3 describes the calibration. Section 4 contains the discussion of policy reforms and results. Section 5 is devoted to sensitivity analysis. We conclude in section 6. The Appendix contains all tables and figures. The Technical Appendix presents the solution method, the solution algorithm, the construction of efficiency profiles, and the tables from the sensitivity analysis.\footnote{For an excellent literature survey of the literature on unfunded social security see Imrohoroglu, Imrohoroglu and Jones (1999).}

\footnote{The Technical Appendix is available on the authors' website at: http://site.google.com/site/chungqtran/research/sscApp.pdf}
2 Model

2.1 Production Sector

The economy consists of two distinct production sectors. Sector one, the informal sector, is populated by low productivity firms. Sector two, the formal sector, is populated by high productivity firms. The production technologies are Cobb-Douglas in both sectors

\[ Y_{t}^{se} = A^{se} (K^{se})^{\alpha^{se}} (H^{se})^{1-\alpha^{se}}, \]

where \( A^{se} > 0, \alpha^{se} \in (0, 1) \) and \( se = \{ F, I \} \), and where \( F \) denotes the formal sector and \( I \) denotes the informal sector. Sector specific capital \( K^{se} \) depreciates at rate \( \delta^{se} \) each period. We denote human capital in sector \( se \) as \( H^{se} \). Each sector is assumed to use a specific type of labor input. These restrictions result in a higher labor compensation for workers in the formal sector relatively to ones in the informal sector. Physical capital, however, is allowed to move freely across sectors.\(^6\)

Both informal and formal sectors produce a common final consumption good. The aggregate final consumption good is the sum of formal and informal sector production so that

\[ Y_t = Y_t^F + Y_t^I. \]

The economy is assumed to grow exogenously at a constant rate \( g \).

2.2 Demographics

Every period a new generation of individuals becomes economically active. Individuals face age and sector specific mortality \( sp_j(se) \) and live at most \( 2J \) periods. We assume that the survival probability depends on an individual’s working sector \( se \) to captures the effect of working conditions on longevity. The population grows exogenously at rate \( n \). The demographic structure of the population is assumed to be stationary so that the population share of the age cohorts is time invariant. The population consists of \( 2J \) overlapping generations and is normalized to 1 at any point in time. After detrending with the population growth rate, the population share of generation \( j \) in sector \( se \) is recursively defined as

\[ \mu_j(se) = \frac{sp_j(se)}{(1+n)\mu_{j-1}(se)}, \]

\(^6\)We abstract from any friction in the financial markets which could result in tighter borrowing constraints for informal sector firms.
where $j = 1, \ldots, 2J$ and $\sum_{se=\{F,I\}}^{2J} \mu_j(se) = 1$. Similarly, the cohort size of agents dying each period (conditional on survival up to the previous period) can be defined recursively as

$$v_{j,t}(se) = \frac{1 - s p_j(se)}{(1 + n)} \mu_{j-1}(se).$$

### 2.3 Altruism, Living Arrangements, and Household Dynasty

Individuals are assumed to be altruistic towards their children and their parents (two-sided altruism). Parents are altruistic towards their children valuing the utility of their children. Therefore, parents transfer wealth to their children while they are alive (intervivos transfers). Additional transfers are made via accidental bequests if parents die before age $2J$ and intended bequests which they leave when reaching age $2J$. On other hand, children are also altruistic towards their parents and 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 children and parents.

We model two stages in the living arrangement of individual. In the first stage agents are *children* and in the second stage they become *parents*. That is, individuals are children from period 1 to $J$ and become parents when they are $J + 1$ periods old. At that age their parents have died and their own children become economically active. Thus, individuals overlap with their parents in the first $J$ periods and they overlap with their own children in the last $J$ periods of their life.

In each period the surviving and economically active members of a family form a decision unit called *household*. The sequence of households of parents, children, grandchildren etc. 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. If parents and children survive, they pool resources and solve a joint utility maximization problem.\(^7\) If children do not survive, parents run households of their own and the family line stops after parents have died. If parents die early, children take over and become a child-only household. At age $J + 1$, children themselves become new parents and start a new household with their own children. They again pool their resources and jointly solve a new household optimization problem.

In this environment, family transfers due to two-sided altruism generate a risk sharing mechanism across generations within family lines. These private transfers act imperfectly substitutes for arrangements in insurance and credit markets. The transfers flowing from high to low income members in a household and from rich to poor households in a household dynasty play the role of a partial insurance arrangement against income and longevity risks.\(^7\)

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\(^7\)This is the simplest way to incorporate two-sided altruism. 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.
In addition, the practice that transfers agents borrowed from middle-age parents are paid back when parents are old, helps lessen liquidity constraints and allow agents to smooth consumption over the life-cycle.

2.4 Skill Inheritance and Job Matching

When agents become economically active they are endowed with a specific type of skill $\theta$, which is either low $\theta^L$ or high $\theta^H$. Individuals cannot change their skill type during their lifetime. In addition, individuals aged $j$ are endowed with efficiency unit $e_j^i(\theta)$ and one unit of time in each period. The efficiency unit depends on an agent’s age and ability type $e_j^i(\theta)$ where $\theta = \{\theta^L, \theta^H\}$. Individuals allocate their time to leisure $l_j^i(\theta)$ and work $1 - l_j^i(\theta)$. The effective labor supply, or human capital $h_j^i(\theta)$, is defined by $h_j^i(\theta) = e_j^i(\theta) \left(1 - l_j^i(\theta)\right)$.

A matching technology in the background assigns agents to jobs according to their skills. If individuals have high skill, they are assigned a job in the formal sector, otherwise they work in the informal sector. Since individuals are not able to change their skill type, workers are also not able to change their employment sector. Low skill workers are restricted to work in the informal sector only. High skill workers are restricted to work in the formal sector for the first $J_w$ periods of their lives. After that they can retire from the formal sector and work in the informal sector. Note that there is no restriction on how long individuals can stay in the labor force. Retirement age is endogenously chosen by individuals.

Skill inheritance is assumed to follow a simple two-state Markov process across generations. The probability to be endowed with a certain type of skill (and corresponding job in either the formal or informal sector) depends on the current skill/working sector of the parents.

Sector mobility across generations follows a transition probability matrix

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

where $\pi_{se,se'}$ is the probability to get a job in sector $se'$ conditional on the parents’ working in sector $se$. This creates four types of households $(F,F), (F,I), (I,F),$ and $(I,I)$. The first letter denotes the occupational sector of the parent and the second denotes the letter denotes the occupational sector of their children. A household in a family line cannot change its skill composition, while the next household in a family line can because newborn children can inherited different skill endowments than their parents and therefore work in a different sector as well.

Skill inheritance and intended bequest motives generate inter-generational links, that essentially transform the finitely-lived agent model into an infinite horizon model. On the other hand, since skill and working sector are interchangeable in our setup, we use either “sector” or “skill” from now on. Our assumptions on skill endowment and job matching introduce permanent shocks to the individuals’ human capital. Such risk cannot be diversified via market arrangements but can be partially insured under certain family arrangements.

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8 Since skill and working sector are interchangeable in our setup, we use either “sector” or “skill” from now on.
9 Our assumptions on skill endowment and job matching introduce permanent shocks to the individuals’ human capital. Such risk cannot be diversified via market arrangements but can be partially insured under certain family arrangements.
hand, each individual has a random finite lifetime overlapping with her parents and her children. The demographic shock, which could break family lines with a certain probability, introduces the life-cycle framework. Hence, our model combines features of both the life-cycle and the infinite horizon framework.

### 2.5 Household Composition

Depending on their demographic structure, households are classified into one of three groups. Group 1 households are made up of parents and children, group 2 households are parent-only households, and group 3 households consist of children only. Since individuals face mortality shocks, the demographic structure of a household can change every period.

Let $g_j$ denote the demographic state of a household at age $j$ so that $g_j = \{1, 2, 3\}$. Let $\Omega(g_j, g_{j+1})$ be transition probabilities between the demographic states of households aged $j$ to age $j + 1$. These probabilities are products of the corresponding survival probabilities of parents and children within a household. A household of group 1 where both parents and children are alive can become a household of group 2 if all children die, which happens with probability $\Omega(g_j = 1, g_{j+1} = 2) = sp^p_{j+1} \left(1 - sp^k_j\right)$. Similarly, a household of group 1 can become a household of group 3 if parents die, that is the transition probability is $\Omega(g_j = 1, g_{j+1} = 3) = \left(1 - sp^p_{j+1}\right) sp^k_j$.

The parent-only and child-only households of group 2 and 3 cannot change their type to group 1 but they can remain in group 2 and 3 if they survive to the next period. The transition probability matrix that describes these movements between groups is given by

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

where and $sp^p_{j+1}$ and $sp^k_j$ are survival probabilities of parents and children, respectively.

### 2.6 Government and Fiscal Policy

The government runs a social security system including a contributory public pension program 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 from collecting pension benefits. 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 $\Psi^F$. The functional form is

$$Pen = \Psi^F w^F \bar{h}^F.$$
In our policy experiment we allow the government to introduce a social assistance program targeted to elderly workers in the informal sector, who are not covered by the public pension program. The individual social assistance is calculated as

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

where \( \Psi^I, w^I \) and \( \bar{h}^I \) denote the replacement rate, the wage rate and average effective labor in the informal sector, respectively. The replacement rate \( \Psi^I \) is a measure of the generosity of the social assistance program. The social assistance program plays two important roles. First, it is an important source of insurance against income and longevity risks. Second, it is an instrument to redistribute income to the poor elderly in the informal sector.\(^{10}\) Since it is evident that social security systems in developing countries are not self-financed and governments usually have to finance deficits in the social security system, we assume that in our model social security is not independent of the government budget.\(^{11}\)

Government debt is assumed to be a constant fraction of final output

\[ B = \Delta_B Y, \]

and residual government expenditure is given as a fraction of final output

\[ G = \Delta_G Y. \]

The government collects a social security tax \( \tau_{SS} \), a labor income tax \( \tau_L \), a capital income tax \( \tau_K \), and a consumption tax \( \tau_C \) to finance pensions of formal sector retirees, lump-sum transfers to informal sector workers, debt service, and general government consumption.

### 2.7 Household Problem

#### 2.7.1 Household Budget

Individual members of the household have different incomes depending on their time spent at work, their age-dependent labor productivity and their employment sector. The income of economically active children at age \( j \) is defined as

\[
y^k_j = \begin{cases} 
(1 - \tau_L^F - \tau_{SS}) \left(1 - l^k_j\right) e_j^F w^F_j & \text{if } se^k = F, \\
\left(1 - l^k_j\right) e_j^I w^I_j & \text{if } se^k = I,
\end{cases}
\]

\(^{10}\)In our set up, we abstract from transitory shocks like labor productivity shocks or health shocks and the skill inheritance process generates permanent income shocks to households in a dynasty. In this sense we understate the importance of the insurance function and the redistribution function of the social assistance program.

\(^{11}\)For a description of financing social security in developing countries see Puffert (1988) and Ginnelen (2003), for example.
where \( \tau_L^F \) and \( \tau_L^I \) denote the labor tax rates in the formal and informal sectors, respectively and \( \tau_{SS} \) is the social security tax which is paid by formal sector workers only. Expression \((1 - t^k)\) denotes labor supply, \( e_j^{se} \) is the age-dependent efficiency unit of an individual in sector \( se \), and \( h_j^p = (1 - t^k_j) e_j^{se} \) is the effective labor or human capital of the child. Pretax labor earnings income at age \( j \) is given by \((1 - t^k_j) e_j^{se} w_j^{se}\).

The income of parents \( y_{j+j}^p \), including wage income and pensions, is summarized as

\[
y_{j+j}^p = \begin{cases} 
(1 - \tau_L^F - \tau_{SS}) (1 - t^p_j) e_j^{F} w_j^{F} & \text{if } j + j \leq J_w \\
(1 - t^p_j) e_j^{F} w_j^{F} + Pen_{J+j} & \text{if } j + j > J_w 
\end{cases}
\]

where \((1 - \tau_L^F - \tau_{SS}) (1 - t^p_j) e_j^{F} w_j^{F}\) is the after tax labor income if parents work in the formal sector. When parents who work in the formal sector reach their mandatory retirement age, they have to retire and become eligible to receive pensions \( Pen_{J+j} \). After retirement they can choose to work in the informal sector. Hence, the labor and pension income of a formal sector retiree is given by \((1 - t^p_j) e_j^{I} w_j^{I} + Pen_{J+j} \). If formal sector retirees choose not to participate in the labor market, that is \((1 - t^p_j) = 0\), then the labor income is zero. Informal sector workers can work as long as they are alive. Our policy experiment assumes that when informal sector workers are older than the mandatory minimum retirement age, they receive additional income from a social assistance program \( T_{J+j} \) so that their total income becomes \((1 - t^p_j) e_j^{I} w_j^{I} + T_{J+j}\).

Let \( \xi_j^k \) denote an index function that is equal to \( m = (1 + n)^J \) if children are alive and 0 otherwise and \( \xi_j^p \) denote an index function equal to 1 if parents are alive and 0 otherwise. Let \( a_j \) denote the household’s asset holding at beginning of age \( j \) and \( a_{j+1} \) is the asset holding in next period. Let \( g \) denote the exogenous economic growth rate, which is the same for both sectors. Let \( V_j (a_j, \Phi_j) \) be the value function of a household at age \( j \) given state variables \( a_j \) and \( \Phi_j = \{ se^p, se^k, \xi_j^p, \xi_j^k \} \), where \( se^p \) is the working sector of the parent, \( se^k \) is the working sector of the children, \( \xi_j^p \) is the indicator of whether parents are alive, and \( \xi_j^k \) is the indicator of whether children are alive.

The household income is the sum of all household members’ incomes and savings. The growth-adjusted household budget constraint is given by

\[
(1 + \tau_c) \left( \xi_j^k e_j^k + \xi_j^p e_j^p \right) + (1 + g) a_{j+1} = Ra_j + \xi_j^p y_j^p + \xi_j^k y_{j+j}^k, \text{ for } j = 1, ..., J. \tag{1}
\]

\( ^{12} \) We assume that all children of a family either survive or die.
We restrict leisure of parents and children to be between $0 < l^p_j, l^k_j \leq 1$. When $l = 1$, individuals choose not to work. In addition, we assume that households face a borrowing constraint so that $a_j \geq 0$.

### 2.7.2 Dynamic Programming Formulation

A household within a dynasty starts with some initial assets in the form of bequests received from the previous household and then chooses sequences of consumption, leisure and sequence of savings to maximize its value function each period. Note that during the last period a household whose children are alive maximizes not only its utility from consumption and leisure of its current household members but also the expected utilities of the next households. The household has therefore an incentive to leave bequests to the next household in the dynasty.

The household problem can be defined recursively in terms of a Bellman equation as

$$V_j(a_j, \Phi_j) = \max_{\{c^k_j, l^k_j, c^p_j, l^p_j, a_{j+1}\}} \left\{ \xi^k u \left( c^k_j, l^k_j \right) + \xi^p u \left( c^p_j, l^p_j \right) + \beta EV_{j+1}(a_{j+1}, \Phi_{j+1}) \right\}$$

subject to (1). The expected value function $EV_{j+1}$ is defined as

$$EV_{j+1}(a_{j+1}, \Phi_{j+1}) = \begin{cases} \sum_{g=1}^{3} \Omega(g_j, g_{j+1}) V_{j+1}(a_{j+1}, \Phi_{j+1}) & \text{for } j = 1, \ldots, J - 1, \\ \sum_{se^{b'} \in \{F,I\}} \Pi \left( se^{b'}, se^{b''} \right) \sum_{g=1}^{3} \Omega(g_j, g_1) \theta mV_1(a_1, \Phi_1) & \text{for } j = J. \end{cases}$$

Households face shocks to their demographic structure in each period as expressed by the Markov switching matrix $\Omega(g_j, g_{j+1})$. Every $J$ period when the new household is formed a shock to the occupational composition/skill is realized via the Markov switching matrix $\Pi \left( se^{b'}, se^{b''} \right)$. This shock only affects the newborn generation and determines the type of household that this generation will form with their parents. The degree of altruism is controlled by parameter $\theta$. When the altruism parameter is $\theta = 0$, the current household does not care about the utility of the next households in a family and the model becomes a pure life-cycle model. When $\theta > 0$, the current household does care about its offsprings so it leaves intended bequests. The number of children is expressed by parameter $m$.\(^{14}\)

### 2.8 Firm Problem

Firms in both sectors choose to rent physical capital and human capital to produce output. Given sectorial factor prices $w^{se}$ and $q^{se}$, where $se = \{I, F\}$, the firm’s profit maximization

\(^{13}\)We follow Fuster, Imrohoroglu and Imrohoroglu (2005) who use a similar formulation for the value function.

\(^{14}\)The last period savings serve as the intended bequests, which is divided equally among the number of children $a'_1 = \frac{a_{J+1}}{m}$. So, these intended bequests are the initial asset of the next households in the family line.
The problem becomes

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

# 2.9 Recursive Competitive Equilibrium

### Definition 1
Given realizations of initial assets, occupational composition \( \{se_p, se_k\} \), exogenous sector transition probabilities \( \Pi \), survival probabilities, and government policies \( \{\tau_C, \tau_L, \tau_s, \tau_K, \Delta_G, \Delta_B, Pen, T\} \), a stationary recursive competitive equilibrium is a collection of value functions \( \{V_j(j,a_j,\Phi_j)\} \) with \( \Phi_j = \{se_p, se_k, \xi^p, \xi^k\} \), household decision rules \( \{c^p_{j+1}, l^p_{j+1}, c^k_j, l^k_j, a_{j+1}\} \), a collection of sequences of time invariant distributions \( \{\mu_j(a_j, \Phi_j)\} \), sequences of aggregate stocks of physical capital and human capital \( \{K^{se}, H^{se}\} \), and sequences of prices \( \{w^{se}, q^{se}, R\} \) with \( se = \{F,I\} \) such that

(i) household decision rules \( \{c^p_{j+1}, l^p_{j+1}, c^k_j, l^k_j, a_{j+1}\} \) solve the household maximization problem (2),

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

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

and the after-tax interest rate is determined by

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

(iii) aggregate stocks of wealth, physical capital, saving, consumption, and human capital are
given by

\[ A = \sum_{j, s_{ep}, s_{ek}, \xi_k} \int_a \mu_j (a_j, \Phi_j) a_j (a_j, \Phi_j) + \int_a v_j (a_j, \Phi_j) a_j (a_j, \Phi_j), \]

\[ K = A - B, \]

\[ S = \sum_{j, s_{ep}, s_{ek}, \xi_k} \int_a \mu_j (a_j, \Phi_j) a_{j+1} (a_j, \Phi_j), \]

\[ C = \sum_{j, s_{ep}, s_{ek}, \xi_k} \int_a \mu_j (a_j, \Phi_j) c_j (a_j, \Phi_j), \]

\[ H^I = \sum_{j, s_{ep}, s_{ek}, \xi_k} \int_a \mu_j (a_j, \Phi_j) (1 - l_j) e_j^I, \]

\[ H^F = \sum_{j, s_{ep}, s_{ek}, \xi_k} \int_a \mu_j (a_j, \Phi_j) (1 - l_j) e_j^F, \]

(iv) commodity markets clear

\[ C + (1 + g) S + \Delta_G Y = Y + \sum_{se \in \{I, F\}} (1 - \delta^{se}) K^{se}, \]

(v) the government budget constraint holds

\[ \Delta_B Y + \Delta_G Y + \sum_{j=J_w+1} J_{se_{ep}} \sum_{se_{ek}, \xi_k} \int_a \mu_j (a_j, \Phi_j) \text{Pen}_j + \int_a \mu_j (a_j, \Phi_j) T_j \]

\[ = \sum_{j, \xi_k, \xi_k} \sum_{se \in \{I, F\}} \int_a \mu_j^I (a_j, \Phi_j) w^{se} (1 - l_j) e_j^{se} \tau_L + \sum_{j, a, \xi_k, \xi_k} \int_a \mu_j^I (a_j, \Phi_j) W^F (1 - l_j) e_j^F \tau_{SS} + \]

\[ \sum_{j, s_{ep}, s_{ek}, \xi_k, \xi_k} \int_a \mu_j (a_j, \Phi_j) a_j (a_j, \Phi_j) \tau_K + \sum_{j, s_{ep}, s_{ek}, \xi_k, \xi_k} \int_a \mu_j (a_j, \Phi_j) c_j (a_j, \Phi_j) \tau_C + \]

\[ \sum_{j, s_{ep}, s_{ek}, \xi_k, \xi_k} \int_a v_j a_j (a_j, \Phi_j) + (1 + n) (1 + g) \Delta_B Y, \]
(vi) and the time invariant distribution satisfies

$$
\mu_1(a_1, \Phi_1) = \sum_{se^{u=1} = \{I,F\}} \sum_{se_k} \int_a \Pi \left( se^{v'}, se^{v''} \right) \Omega \left( g_1, g_j \right) \mu_j \left( a_j, \Phi_j \right), \\
\mu_{j+1}(a_{j+1}, \Phi_{j+1}) = \sum_{se^{u=1}} \int_a \Omega \left( g_j, g_{j+1} \right) \mu_j \left( a_j, \Phi_j \right), \quad \text{for} \ j = 1, \ldots, J - 1.
$$

3 Calibration

Solutions to the model as well as algorithms are presented in a Technical Appendix.\(^{15}\) We use parameters reported in table 1 to calibrate the benchmark steady state economy to match data from Brazil in the late 1990s. We choose Brazil for two reasons: first, Brazil has been implementing a social assistance program for years; and second, Brazil is a middle income emerging economy with reasonably good availability of data. Model outcomes and data comparisons are reported in table 2. In the following we will discuss the parameter selection.

3.1 Production Technology

In standard one sector models the income share of capital \( \alpha \) is between 0.3 to 0.36. Estimates of \( \alpha \) 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 estimates relating the capital shares used in the formal and informal sectors separately. However, the informal sector is generally documented as a labor-intensive sector so that the income share of capital is smaller than in the formal sector. We therefore calibrate the income shares of capital in the informal and formal sectors as \( \alpha^I = 0.25 \) and \( \alpha^F = 0.4 \) in the benchmark economy. We then conduct sensitivity analysis on the capital income share of the informal sector. The depreciation rate is assumed to be 5\% annually for both sectors (e.g. Ferreira and do Nascimento (2005) and Feu (2004)).

To the best of our knowledge there is no estimate comparing the levels of total factor productivity (TFP) in the informal sector to TFP in the formal sector. Since it is widely documented that in developing countries "traditional" technology with lower productivity is commonly used in the informal sector while "modern" technology is used in the formal sector (see e.g. Dessy and Pallage (2003)) we feel comfortable applying the restriction \( A^I < A^F \). That is, the formal sector is more efficient. We then normalize \( A^F \) to 1 and calibrate \( A^I \) so that the share of informal sector output in GDP to be around 25\%, which is close to the estimated range for Brazil in Friedman et al. (2000) who report a lower bound of 29\%.

The annual growth rate in Brazil was around 8.6\% in the 1970s, dropped down to around 1.6\% in the 1980s, and then went up again to 2.65\% in the 1990s.\(^{16}\) In the model, we therefore choose an exogenous real annual growth rate \( g = 2.65\% \).

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\(^{15}\)The Technical Appendix is available on the authors’ website at: http://chungbeo.googlepage.com/research/sscApp.pdf

\(^{16}\)See the report on GDP, growth and employment at http://www.brazil.org.uk/economy/gdp.html
3.2 Demographics

We assume that individuals are born at age 20 and become immediately economically active. Since survival rates are relatively small after the age of 90, we assume that individuals die at age 90. To reduce the computational burden, we pick the model period to be 5 years. This restriction implies that individual lifetime is 14 periods, composed of 9 working periods (equivalent to 45 years) and 5 retirement periods (equivalent to 25 years). In other words, agents retire at age 65, which is close to Brazil’s average retirement age of 63 reported in Queiroz (2005). In the model we completely abstract from the link early retirement issues.\footnote{Generous pensions and early retirement are highly correlated in Brazil, especially in the public sector. See Glomm, Jung and Tran (2008) for more details on this issue.}

Survival probabilities are taken from the life tables published by World Health Organization.\footnote{Visit http://www.who.int/whosis/database/life/life_tables/life_tables_process.cfm?country=bra&language=en} We adjust annual rates to 5 year period rates in our model. We do not have separate survival probabilities for formal and informal sector workers in Brazil. As documented in the literature, the poor (informal sector workers) have lower survival probabilities than the rich (formal sector workers). We therefore adjust the life-table survival probabilities and lower the survival probabilities of informal sector workers by 2%. We increase the survival probabilities of formal sector workers by 0.5%.

In the model, we assume that population grows at a constant rate so that there is a stationary demographic structure. Population growth has slowed during the last 20 years in Brazil. According to Ferreira (2005) the average annual population growth rate over the last 20 years from 1980 to 2000 is 1.79%. We therefore pick a growth rate $n = 0.018$ resulting in $m = 1.5631$ children per individual in the model.

3.3 Preference

We assume additive preferences in consumption and leisure as

$$u(c_j, l_j) = \begin{cases} c_j^{1-\sigma} & \text{for } j = 1, ..., J \\ \frac{c_j^{1-\sigma}}{1-\sigma} + \kappa \log l_j & \text{for } j = J + 1, ..., 2J. \end{cases}$$

In our benchmark model, we restrict the utility of consumption to be of log form ($\sigma = 1$) in order to fulfil the condition for balanced growth as suggested in King, Plosser and Rebelo (2001).\footnote{Estimates of the parameter of intertemporal elasticity of substitution $\sigma$ for Brazil vary from 1 to 5 (see Issler and Piqueira (2000) and Soriano and Nakane (2003)). Fuster, Imrohoroglu and Imrohoroglu (2007) use $\sigma = 4$ in a similar model with altruism. In our sensitivity analysis, we choose $\sigma = \{2 \text{ and } 4\}$ while assuming inelastic labor supply $\kappa = 0$.} We do not know any estimate for the parameter governing the intertemporal elasticity of leisure $\psi$ in Brazil. Following previous studies, we choose the log utility function.

In a model for the U.S. economy Fuster, Imrohoroglu and Imrohoroglu (2003) assume inelastic labor. Fuster, Imrohoroglu and Imrohoroglu (2007) allow elastic labor but set retirement age exogenous. In this paper, since we are interested in modelling labor supply of the elderly in...
the developing countries, we assume that children supply labor inelastically. This assumption implies that the weight of leisure of young household members is \( \kappa = 0 \) for \( j = 1, \ldots, J \). We calibrate the exogenous labor supply of young agents to match average weekly working hours. On other hand, we assume parents supply elastic labor so working hours and retirement age are endogenously determined. We calibrate parameter \( \kappa \) for parents to match average labor supply of the elderly and average retirement age.

Discount factor \( \beta \) and altruism factor \( \theta \) are free parameters. One may calibrate either \( \beta \) or \( \theta \), or both to match the capital-output ratio. Fuster, Imrohoroglu and Imrohoroglu (2003) to choose \( \theta = 1 \) and calibrate \( \beta = 0.97 \) (annual discount factor) to match the capital-output ratio. Nishiyama (2002) calibrates both \( \beta \) and \( \theta \). We follow the first approach and fix \( \theta = 1 \). We then adjust \( \beta \) to match the capital-output ratio.

### 3.4 Sector Size and Mobility

It is evident that parents’ skills and occupation as well as parental networks will play an important role in determining their children’ probabilities to find work in the formal sector. These private networks are especially important in the context of developing countries and are a source of inter-generational dependence. Children of formal sector employees in developing countries have typically better education than children of informal sector workers (e.g. Marcouiller, de Castilla and Woodruff (1997)). Better education and existing private networks will make it easier to secure work in the formal sector. In other words, the probability to transition from the formal to the informal sector is smaller for children of formal sector parents. In our calibration, we use Markov transition probabilities of \( \pi_{I,I} = 0.8 \) and \( \pi_{F,F} = 0.8 \), which reflect the sector persistence and result in 50% of the labor force working in the informal sector. The size of the informal sector in terms of employment and relative size of GDP varies across countries. The size of formal sector employment coincide with the fraction of social security coverage in our model. According to Giambiagi and Mello (2006) the coverage of social security in Brazil is around 50% in 2005.

### 3.5 Life-Time Efficiency Unit and Labor Earnings Profile

Turra and Queiroz (2005) report labor incomes of household heads by age and level of education in Brazil. Ferreira, Lanjouw and Neri (2003) report the distribution of the labor force by educational levels. We combine their estimates to construct labor income profiles for informal and formal sector workers and the average labor income ratio between informal and formal sector workers. We assume that less educated people tend to work in the informal sector as reported in Telles (1992).

We calibrate the labor efficiency profile so that we match the labor earnings profiles as well as the average income ratio between informal and formal sector workers in Brazil. In our model the average labor income ratio between informal and formal sector workers is around 56%, which is in the range reported in Gindling and Terrell (2004) and Marcouiller, de Castilla
and Woodruff (1997). We graph the income-age profiles of informal and formal sector workers in figure 1.20

3.6 Government and Fiscal Policy

In Brazil, total tax revenue is about 30% of GDP in 1998, with social security tax revenue contributing almost 5% (see Ferreira (2005)). We calibrate tax rates to match this size of government.

In the model, the government taxes labor income of both informal and formal sector workers. The labor tax in the formal sector is $\tau^F_L = 15\%$. We assume that the labor income tax rate in the informal sector $\tau^I_L$ is rather small at 5%, which captures implicit financial contributions of informal sector workers to the government budget such as paying fees when using public infrastructure or land. According to Palacios and Pallares-Mirallets (2000), effective pension taxes are between 7% to 12% of total labor cost in developing countries. In our calibration, the social security tax applies to labor income of formal sector employees and is set to 11% to match the share of social security tax revenue in terms of GDP. The capital income tax rate is chosen at 25%. The proportional consumption tax rate is around 23% which is close to the one reported in Herwig et al. (2006). In the model, either consumption tax, formal sector labor income tax, or capital income tax adjust to balance the government budget every period.

In the benchmark economy there is no social assistance available to the elderly in the informal sector so that $\Psi^I = 0$. The government only runs a social security program for retirees in the formal sector. The social security trust fund is not independent from the government budget. As reported in Palacios and Pallares-Mirallets (2000), the average pension as a share of average wage ranges from 35% to 60%. Since Brazil has a very generous pension program, we choose the replacement rate for pension payments $\Psi^F$ to match social security payments as a fraction of GDP. Our hypothetical replacement rate $\Psi^F$ is 60% of the average labor income of pre-retirement employment and results in the social security program to be around 4.6% of GDP. Ferreira (2005) reports that social security spending made up 5.06% of GDP.

We assume that government borrows a fixed fraction of GDP each period. We calibrate the ratio of government debt to GDP to be 35% which is close to the average in the data between 1995 and 2000. Residual government consumption is 25% of GDP and matches the size of the government budget in the data. Government consumption plays no further role in the model.

4 Policy Experiments and Results

We start the benchmark economy without a social assistance program for informal sector workers. We then assume that the government introduces a social assistance program to all informal sector workers who are 65 and older. The generosity of the social assistance program

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20 The Technical Appendix contains the efficiency profiles that were used as a basis for the income profiles. The Technical Appendix is available on the authors' website at: http://chungbeo.googlepage.com/research/sscApp.pdf
is reflected in the magnitude of the replacement rate $\Psi^I$. In the benchmark economy the replacement rate equals zero, $\Psi^I = 0$.

Previous studies have concentrated on developed countries and usually use a payroll tax or a labor income tax to finance social security. In developing countries, however, financing social security is quite different (see e.g. Puffert (1988) and Ginneken (2003)). First, social security funds are usually not independent of the general government budget. In developing countries, many governments use surplus from social security funds to finance government budget deficits, meanwhile other governments have to finance social security programs when it is in deficit. Second, governments have very limited capacity to raise labor income taxes to finance an expansion of social security. In developing countries consumption taxes including tariffs are therefore a major source of government revenue.

In our policy experiments we assume that the government can finance the social assistance program using revenue from either consumption taxes, labor income taxes collected from formal sector workers, or capital income taxes to finance the expansion. We vary the generosity of the social assistance program and report changes in key aggregate variables, family transfers, and welfare in tables 3, 4 and 5.

4.1 Efficiency

Savings and capital accumulation. The distortions on savings from introducing the social pension program are reported in the third column of table 3. The extension of social security discourages people to save for two reasons. First, the social assistance program redistributes from the young (high propensity to save) to the poor elderly (low propensity to save). Second, taxes used to finance the program distort the savings behavior. This is especially true for capital taxes.

The crowding-out effects vary substantially between different financing instruments. Crowding out effects are the largest when capital income tax is used to finance the extension and the smallest when consumption taxes are used. When increasing the replacement rate from 0 to 0.5, capital stock drops by 0.8%, 2.1%, and 7.2% under consumption tax, labor income tax, and capital income tax financing schemes, respectively.

The crowding-out effect is relatively small in comparison to previous results in the literature on social security reform (e.g. see Auerbach and Kotlikoff (1987), Imrohoroglu, Imrohoroglu and Jones (1995), and Fuster, Imrohoroglu and Imrohoroglu (2003)) due to two reasons. First, the social assistance program is targeted to a subpart of the population so that its size is kept relatively small. This leads to smaller distortions in the economy. Second, as established in Fuster (1999), the bequest motive dampens the decrease in savings due to life cycle patterns.

Labor supply. The labor supply adjustments are reported in columns 4, 5 and 6 of table 3. The social assistance program generates different effects on average labor supply depending on skills and working sector. The average labor supply of informal sector workers drops by

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Note that we normalize the results of the benchmark economy to 100 which allows for easy comparison with the results of alternative policies.
more than 3% when increasing the replacement rate to 0.5. The intuition is straightforward. Without social assistance the elderly in the informal sector have to work longer (extensive margin) and harder (intensive margin) to support their consumption. After the reform they have additional income from government transfers to finance their consumption and therefore supply less labor. The top panel of figure 2 reports changes in the labor force participation rate of informal sector workers. We see that after the introduction of the social assistance program the participation rate of informal sector workers drops significantly. Before the social assistance program some informal sector workers stay in the labor force until age 90. The social assistance program ensures that no workers work beyond age 80. The bottom panel in figure 2 shows the change in labor supply of informal sector workers.

The average labor supply of formal sector workers also decreases slightly when the replacement rate is 0.5 and either consumption taxes or labor taxes adjust. Surprisingly, the labor supply of formal sector workers increases slightly when capital tax is used as a financing instrument and the social assistance program is relatively large ($\Psi > 0.6$). As the crowding-out effects are more pronounced under this financing scheme, formal sector workers decide to work longer to compensate for the income loss. Note that formal sector workers finance the extension without getting much direct benefit from it.

Overall, the aggregate labor stock declines by almost 2% when introducing a social assistance program with a 0.5 replacement rate.

Output. As a direct consequence of the crowding-out effects, which lower the stocks of physical capital and human capital, output is lower when introducing a social assistance program. This efficiency loss is relatively small but non-trivial. Specifically, for a 0.5 replacement rate the social assistance program reduces steady state output between 0.5% and 3% depending taxation used to finance the expansion. The efficiency loss is smallest when financed with (almost) non-distortionary sources as consumption taxation. The efficiency loss is maximized when financed with capital income taxation.

4.2 Intergenerational Transfers and Wealth Distribution

Bequests. We report the effect of public transfers on bequests by household types in table 4. We observe both crowding-out and crowding-in effects on intended bequests across household types. The effects are also non-monotone for certain types of households.

For households $G1 : I, I$ – whose parents and children are informal sector workers – bequests increase by 14% when the replacement rate is 0.5 and consumption tax is the financing instrument. The introduction of a social assistance program has a direct effect on the income of old parents. Holding other variables constant, the income of old parents increases and so does the overall income of the household. As a consequence, parents want to leave more bequests to their children (positive effect). On the other hand, the introduction of a social assistance program raises the future income of children because current “informal sector” children will become recipients of a social pension when they are old. This results in a disincentive for leaving bequests (negative effect), since the current parents’ account for these future gains of
their children when optimizing the bequest decision. Whenever the positive effect is dominant, current households will increase their bequests as can be seen in column 2 of table 4.

For households $G_1: I, F$ – whose parents are in the informal sector but whose children are in the formal sector – bequests increase. That is, the current household with older members (parent) receiving social assistance wants to increase bequests to offset the negative effect on younger members (children) who will not receive the additional social assistance but have to pay a higher price for consumption in the future (positive effect). On the other hand, since social assistance crowds out the labor supply of old parents, their labor earnings decline. Moreover, efficiency losses due to declines in aggregate capital stock and labor supply lower individual income which decreases bequests (negative effect). Our results show that average bequests are consistently larger under all tax regimes. This implies that the positive effects dominate.

For households $G_1: F, I$ – whose parents work in the formal sector but whose children work in the informal sector – bequests decrease for all three tax regimes. The current “formal sector” parents, who are suffering from the social assistance program, cut bequests to their “informal sector” children, who will then benefit from the program.

For households $G_1: F, F$ bequests change by a small amount ($1\%$) when a tax on consumption is the financing instrument. However, when labor and capital income taxes are used to finance the expansion, bequests start dropping as the social assistance program becomes more generous (up to $5\%$ for $\Psi^I = 0.5$).

At the aggregate level, bequests increase when the government finances the social assistance program with consumption taxes or labor taxes (crowding in effect). On the other hand bequests decrease when capital taxes finance the expansion. In other words, in this case public transfers crowd out aggregate bequests.

**Within family transfers.** Family transfers have a credit and an insurance function. The former lessens the borrowing constraint so that individuals are able to consume more when young. The later insures the consumption of parents and children against income shocks. As reported in the top panels of figure ??, households whose parents work in the informal sector $G_1: I, I$ and $G_1: I, F$ transfer money from children to parents. From the bottom panels we see that children in households where parents are formal sector workers ($G_1: F, I$ and $G_1: F, F$), borrow from their parents early in their careers because their income is low. They later transfer income back to their parents when the parents have become old.

The effects of the public insurance program (when capital taxes adjust) on intervivos transfers from parents to their children differ across household types. Household types $G_1: I, F$ and $G_1: F, I$ tend to increase transfers from children to parents, whereas households of type $G_1: I, I$ increase transfers to parents around age 70 and decrease transfers when parents are older than 75. This indicates that intervivos (private) transfers are only partially crowded out by public transfers.

**Wealth Inequality.** Perhaps surprisingly, the wealth inequality increases. The Gini coefficient becomes larger after increasing the replacement rate of the social assistance program. The changes in the Gini coefficient are monotone over the range of the policy parameter. We
identify two possible reasons. First, altruistic agents change the amount of bequests to compensate their parents or children who suffer from the new policy. Young formal sector workers who will not be recipients of social assistance receive more bequests from their parents as protection against high taxes in the future. Young informal sector workers who will receive social assistance tend to receive less bequests from their parent. Second, the effects of the social assistance program on labor supply are not identical across agents. The labor supply of informal sector workers drops much more than that of formal sector workers. Therefore, labor income of informal sector workers is much lower than that of formal sector workers. This also leads to higher concentration of wealth.

4.3 Welfare

We report welfare effects across household groups and types in table 5. Welfare is measured in terms of the value functions of newly established households. We normalize the welfare of every group in the benchmark to 100. Household welfare under alternative policy are also normalized with respect to the welfare result of the benchmark regime. This allows for easy comparison. In the row labeled CV, we present the amount of compensating consumption in percent of lifetime consumption of an average household. This is the consumption adjustment for a household in the new regime, so that this household becomes indifferent between living in the benchmark regime without the social assistance program and the new regime with the social assistance program for elderly informal sector workers. We report the compensating consumption values for a social assistance program with a 50% replacement rate. If the compensating consumption is negative then the household is better off with the social assistance program in place so that the household would prefer the new regime.

We identify the following opposing forces driving the welfare effects. On the negative side, the social assistance program distorts savings and labor supply, which results in efficiency loss and then welfare loss. The magnitude of these crowding out effects depends also on the financing instruments. On the positive side, the introduction of social assistance program provides an important instrument to insure against longevity and income shocks across households and generations. When individuals are risk averse the insurance function of the social assistance program increases welfare. In addition, the redistribution function of the tax-financing social assistance program improves the welfare of recipients. The distributional effects of the social assistance program depend on the progressiveness of its financing instrument. Finally, the social assistance program makes retirement affordable for the “ceaseless toil” elderly, whose marginal utility of leisure is very high. This effect is also welfare enhancing.

The welfare effects vary across household types and change significantly with increasing generosity of the social assistance program. Depending on the demographic structure and the working sector/skill composition, a household can experience welfare gains or losses.

The welfare on parent-child households $G_1 : I, I$ – who are recipients of social pensions – increases following an increase in the replacement rate from $\Psi^I = 0$ to $\Psi^I = 0.5$ (consumption tax case). The welfare effects are positive as compensating consumption is $-1.3\%$ for this
group. This household type in the new regime would have to be faced with a 1.3% reduction in all future consumption streams in order to be willing to live in the benchmark regime without the social assistance program. The welfare gain is even more pronounced when more progressive tax financing instruments (formal sector workers’ labor income tax or capital income tax) are used. The welfare effects are monotone over the range of policy parameter $\Psi_I$.

The welfare effects on parent-child households $G_1 : I, F$ – whose parents are recipients of social assistance – are not monotone. On one hand, cash transfers to parents in the informal sector increase household wealth, consumption and leisure (positive effect). On the other hand, higher taxes and distortionary effects on savings and labor supply lower household income, especially the income of children working in the formal sector (negative effect). Consequently, the dominant effect will determine the direction of the welfare change. For small transfer programs the negative effect dominates, so that welfare drops. As the social assistance program grows in size, welfare increases approximately to its original level. The effects depend again on the financing instruments in use. When formal sector workers’ labor income tax is used to finance the extension of social assistance the welfare effects are always negative. We see that this in the case when the government subsidizes parents working in the informal sector by taxing their children’s labor income in the formal sector.

The welfare effect on households $G_1 : F, I$ – whose formal sector parents do not receive a social pension and whose informal sector children do receive a pension when they are old – is negative. Inter-generational links via operative bequests spread the income effects over the generations in the dynasty. An additional increase in transfer income of the future household creates a positive effect on the current household’s welfare. However, the current household suffers from paying a higher tax. The welfare loss indicates that the negative effects are dominant.

For households $G_2 : I$ – “parents” working in the informal sector having no more children – the welfare effect is remarkably strong. They will have no family support nor will they receive public pension payments when old. They therefore rely on their own savings to support consumption when old. There is no other instrument to insure themselves against longevity risk. The introduction of a social assistance program, therefore, gives them a great opportunity to smooth their consumption. This type of households requires a 3.3% decline in consumption forever to agree to live in the economy without social assistance program.

Households $G_3 : I$ – children working in the informal sector without parents – experience welfare losses when consumption taxes and capital taxes are financing the expansion of the social assistance program. In the regime, in which formal sector workers’ labor income tax is an financing instrument, this type experiences a welfare gain, due to the fact that this type does not pay the increased labor tax.

For all other household types, $G_2 : F$ and $G_3 : F$ we report welfare losses. This is mainly due to the distortion of the social assistance program which in the end lowers household incomes. The introduction of a social assistance program does not result in any additional benefits to these agents. On the other hand, the program creates a number of distortions such as lower
wage rates, higher taxes, and higher consumption prices, which then lower income and welfare. For instance, households $G2:F$—parents in the formal sector without children—will not receive benefits from the public pension program but have to live in a less efficient economy with higher tax rates.

Hence, depending on the net effects of the opposing forces a household can experience welfare gains or losses. Overall, for low-income households welfare gains are dominant. The size of this welfare improvement depends on efficiency losses resulted from distortions of tax-financing instruments. Even when the most distortionary financing instrument (capital income tax) is used the introduction of the social assistance program still results in welfare gains for low income households. These results indicate that the insurance function and the redistribution function of the social assistance program dominate the distortionary effects in an environment where there is severe lack of adequate risk sharing mechanisms and high income inequality.

5 Sensitivity Analysis

In this section we conduct sensitivity analysis on parameters $\sigma$ and $\kappa$ in the utility function.\(^{22}\) First, we shut down the labor/leisure choice of the elderly by setting $\kappa = 0$ and keeping the parameter of risk aversion unchanged at $\sigma = 1$. In our policy experiments, welfare gains are still obtained for household types $G1: I, I$ and $G2: I$. Household type $G1: I, F$ still exhibits a non-monotonic pattern but the positive welfare effect already starts at low replacement rates.

Second, since the magnitude of the risk-sharing effect is sensitive to the parameter of risk-aversion, we consider two cases with more risk averse agents. That is, we set $\kappa = 0$ but increase the level of risk aversion to $\sigma = 2$ and $4$. In our policy experiments, welfare gains for all of these recipient households are magnified because the insurance function of the social assistance program becomes more important with increasing risk aversion.

Third, since the welfare effect varies with the preference for leisure of the elderly, we consider an economy in which the elderly value leisure more than in the benchmark economy, that is $\kappa = 2$. In this scenario, our results on the welfare effects become even more pronounced.

Fourth, we are interested in analyzing these effects in an economy with more income inequality. We calibrate efficiency profiles for formal and informal sector workers using a smaller ratio of informal to formal sector average lifetime income. The positive welfare effect for group $G1: I, F$—parents in the informal sector, children in the formal sector—becomes more pronounced. Therefore, group $G1: I, F$ experiences a welfare gain. In this case the insurance function and the redistribution function of the social assistance program dominate the negative effects from the distortions. This is true for all tax regimes. This also implies that for developing countries with a large income gap between formal and informal sector workers we are more likely to observe a positive welfare effect from a social assistance program.

Fifth, we are also concerned that the size of the informal sector or the coverage rate of

\(^{22}\)The tables for these experiments are available in the Technical Appendix on the authors’ website at: http://chungbeo.googlepage.com//Research/sscApp.pdf
social security may be important for the magnitude of the distortion of the effects caused by the social assistance program. To verify whether our results would be different in an economy with either a smaller or a larger informal sector, we calibrate the model to an economy with coverage rates of social security of 25% and 75%, respectively. Our results indicate that even though the magnitudes of the policy effects on aggregate variables are changing, the general result of the policy experiment does not change.

Sixth, in our benchmark model we assume that governments are capable to adjust their consumption and borrowing in the long run so that government consumption and debt are held constant as a fraction of GDP. To check if our results are robust to this assumption we consider a different assumption. We conduct the same set of policy experiments assuming revenue neutrality by keeping the level of government consumption and debt for the benchmark economy unchanged. Since the economy experiences more efficiency loss under this assumption the social assistance program introduces more distortions into the economy because the government has to increase taxes even more to collect enough revenue. We find that welfare effects for low income households ($G_1 : I, I$ and $G_2 : I$) are still positive. However, household $G_1 : I, F$ is no longer a beneficiary from the introduction of a social assistance program.

Finally, we conduct our analysis in an economy with alternative capital income shares in the informal sector: $\alpha^I = 0.2$ and $\alpha^I = 0.3$. We also run a smaller social assistance program targeting only to households where both, parents and children are informal sector workers. In all of these experiments our main result, that group $G_1 : I, I$, $G_1 : I, F$, and $G_2 : I$ experience welfare gains, still holds.

6 Conclusion

We study the effects of introducing a social assistance program for elderly informal sector workers in the context of developing countries. We concentrate on the effects on private transfers, savings, labor supply of elderly workers, the wealth distribution, and welfare. Unlike previous studies, our analysis incorporates the defining features of developing countries. First, we model frictions in the labor markets as well as in production technologies. These frictions result in permanent negative shocks to low skill informal sector workers. Second, we model the persistence of skill transmission across generations. Third, we explicitly model a double-standard social security system, a formal one operated by the government and covering only a part of the population and an informal based on intra-household transfers. Finally, we assume away any market instrument that would allow households to diversify risks across households and generations. Informal sector workers face a severe shortage of risk-sharing vehicles and rely exclusively on family insurance.

Similar to results in previous literature, our model predicts the crowding-out effects of social security. Introducing a moderately-sized social assistance program lowers output by up to 3.25% and labor supply by up to 2%. The magnitude of the effects depends on how the expansion is financed. In contrast to previous literature on social security reform in developed
countries (e.g. see Fuster, Imrohoroglu and Imrohoroglu (2003) and Fuster, Imrohoroglu and Imrohoroglu (2007)), our model predicts that the introduction of a social assistance program has positive effects on the welfare of recipients. The reasons are as follows: First, since social assistance programs target only a small part of the population and intergenerational transfers mitigate the crowding-out effects, efficiency losses are relatively small. Second, skill shocks in combination with the segmentation of the production sectors and labor markets are the main frictions that increase the importance of the insurance function of social assistance programs. Third, the tax-financed social assistance program has an important redistributive function since it is targeted to the elderly in the informal sector. Finally, welfare is increased by decreasing the labor supply of “ceaseless toil” elderly informal sector workers (older than 75), whose marginal utility of leisure is extremely high.

Our result emphasize that accounting for the characteristics of developing countries is crucial when studying social security reform in developing countries. Most importantly, our finding highlights the important role of public insurance in an environment - with a severe lack of private insurance instruments against demographic and lifetime income shocks. Yet, we find that the “positive” welfare effects resulting from the insurance function and the redistribution function of the social assistance program dominate the “negative” welfare effects resulting from efficiency losses. This is consistent with the argument that social safety nets could be valuable in low-income economies by Chetty and Looney (2006). Note that we completely assume away any transitory shock like labor productivity shock or health shock and the skill inheritance process is only source of income shocks to households. In this sense we underestimate the role of the insurance function and the redistribution function of the social assistance program. If we consider an environment incorporating transitory shocks like labor productivity shocks or health shocks the insurance and redistribution role of the social assistance program would be even more pronounced.

Our paper carries policy implications. It provides a justification for the introduction of social assistance programs in developing countries. In addition, it provides an estimate of the efficiency loss resulting from running a social assistance program. It also sheds some light on how to best finance the program.

Our analysis is limited in several dimensions. First, we limited our analysis to steady states. We are therefore not able to analyze the short-run implications of the introduction of the social assistance program. In addition, there are several interesting questions which can be studied within this framework, for example, endogenous sector choice, the relationship between fiscal policy and the size of the informal sector, allocation of skills across sectors, trade-offs between a social assistance program and other public programs such as education and health, the effects on private investment in education and human capital accumulation, and the effects of population aging in developing countries. We leave these issues for future research.
References


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URL: [http://ecen.com/eee43/eee43e/caprdX.htm](http://ecen.com/eee43/eee43e/caprdX.htm)


URL: [http://ideas.repec.org/p/rio/texdis/466.html](http://ideas.repec.org/p/rio/texdis/466.html)


McKee, Douglas. 2006. A Dynamic Model of Retirement in Indonesia PhD thesis UCLA.


### 7 Appendix

#### 7.1 Tables and Graphs

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Table 5: Welfare of Household Age 1 by Groups and Types
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Figure 2: Labor Force Participation Rate and Lifetime Labor Supply of Informal Sector Workers