Expanding Pension Coverage in Developing Countries: Incentive Scheme for Informal Workers

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Abstract

In this paper we develop a life cycle model to examine welfare and savings impact of a government sponsored matching contributions proposal on voluntary pension scheme for informal workers in developing countries. Our setup for the analysis consists of overlapping generations of 60-period lived heterogeneous individuals facing mortality risk and individual income risk emanating from employment and health status uncertainties. We find that introduction of matching contributions to informal workers improves old age consumption by redistributing consumption from period of relatively high and stable income but subject to overspending to old age where income is low and uncertain. In addition, targeted matching contributions to informal workers redistribute income from high income formal workers with lower propensity save to the low income but higher propensity to save informal sector workers. The redistribution however enhances savings of informal workers unlike redistribution for social pensions. Thus, we find that national saving could be increased when informal workers have access to matching contribution on voluntary pension scheme. In addition, we find that welfare and savings are highly responsive to benefit payment options: annuity payment, in particular, is found to generate higher savings and improve welfare due the provision of insurance against longevity, mortality premium and redistribution from savings subsidy. Increasing the magnitude of the level of matching influences contributions or savings for retirement.

Keywords: Pension schemes; old age poverty; informal workers; matching contributions.

JEL classification: H55; J26; O17

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1 Introduction

Despite various policies in broadening the pension coverage to ensure sustainable flow of income and reduce old age poverty, less has been achieved in many countries particularly low- and middle-income countries (Holzmann, Hinz, and Tuesta, 2015). The coverage of social security or pension system in developing countries are usually low with less than 20 percent in lower-middle income countries and rarely exceed 50 percent even in upper middle income countries (Palacios and Pallares-Mirallets, 2000). In low-income countries the coverage rate of pension scheme for working-age adults is often less than 10% (Social security, 2015). Therefore developing countries with large informality without universal pension system are faced with old age poverty. According to Kakwani and Subbarao (2005), households with old people are poor than the general population in some sub-Saharan African countries where there are no social pension.

Older people in developing countries with large informal sector without comprehensive pension policies rather financed old age consumption through labor income from active employment which are insecure due to bad health that come with old age and family support (Palacios and Rabalino, 2010). Comparing developed and developing economies, Kidd and Whitehouse (2009) finds that over 70% of men above age 60 work outside home in low income countries compared with around 20% in developed economies. This poses danger on many developing countries due to rising longevity risk associated with increasing life expectancy.\(^1\) Figure 1 indicates that even among lower middle income economies, old age employment differs depending on the coverage of pension system. Unlike advanced economies with pension system, remaining active in the labor market in many developing countries is no longer choice but for survival (Kidd and Whitehouse, 2009).

In recent times, many developing countries in responding to the persistent low coverage for formal sector pensions, and encouragement from international organizations\(^2\), have been exploring alternatives approaches of providing social security or stable income for informal sector workers who are usually plunged into poverty when they are old. One common approach is allowing informal workers and self employed to voluntary contribute to pension schemes when they are young in order to secure their future income and consumption when old and incapable of working (Palacios and Orszag, 2015). These schemes

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\(^1\)Longevity risk is essentially poverty or income insecurity resulting from partial or complete loss of ability to earn income through employment associated with ageing population.

\(^2\)See, for example, World Bank (1994) - ”Averting the Old Age Crisis”. Though the report emphasized increasing coverage for non-contributory pension to reduce old age poverty, the huge fiscal cost involved has led to the concentration on expansion of the coverage of contributory pension system.
Figure 1: Pension Beneficiaries and Employment rate of some selected Lower Middle Income Countries

are expected to provide income security for old people, reduce old age poverty and improve welfare in developing countries. Moreover, it is expected to increase national savings to facilitate capital accumulation for economic development. This is particularly important for developing countries with low saving rates. The important role of these forms of institutions in facilitation savings by low income households has been discussed (See, for example, Beverly and Sherraden, 1999). Savings rate in low-income and lower-middle income economies are relatively to support need growth and development. Figure 2 indicates that savings rates are low in low-income and lower-middle income compared with upper income countries where informality is relatively low. Thus, a policy that will enable the employees of informal sector to save for retirement will enhance capital accumulation and
spur development.

Despite these reforms, the pension scheme coverage for working adults is still low in many developing countries that have introduced voluntary pension scheme for informal workers (Holzmann, Hinz, and Tuesta, 2015). This has necessitated the introduction of financial incentives to induce pension participation and contributions for informal workers who do not adequately prepare old age due to binding liquidity constraints, myopic decision making or lack of foresight, and incomplete information. Matching contributions, one of financial incentives\(^3\), is increasingly being employed to increase the pension coverage

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\(^3\)Traditionally, granting of preferential tax treatment has been employed in advanced economies to encourage private voluntary retirement saving (Whitehouse, 2015). However, the large size of labor force that do not pay tax (either earning is below taxable income or work in informal sector which is dominant in developing
and contribution of workers in many countries and informal workers particularly in developing countries (Palacios and Robalino, 2009). For low and middle income countries with large informal employment who cannot be mandated to contribute to the traditional (formal) pension scheme, matching contribution could be a important approach of expanding pension coverage given its ability to overcome the inherent present consumption bias and liquidity constraints by providing an immediate and easily understandable incentives associated future benefits during retirement (Holzmann, Hinz, and Tuesta, 2015).

Matching contributions increase the net rate of return on retirement savings relative to ordinary savings (Hubbard and Skinner, 1996). By incentivizing pension savings, matching contribution may provide pension/resources for informal workers to ensure adequate old age consumption at a lower cost for government (relative to social pension) in the long-term (Helena et al, 2010).

Recommendations for including matching contributions in voluntary pensions scheme for informal sector has been proposed for developing countries with low pension coverage (Dorfman, 2015). These reforms therefore generate important questions regarding the effect on matching on informal sectors in developing countries where worker can continue to depend on old wage labor income (albeit insufficient) and the role of benefits payment options in these pension schemes. Yet the impact of matching rates and the appropriate form of benefit payment options have not been analyzed in the literature. Two main forms of benefits payment of these scheme are annuity and lump sum payments. However, the participation and contribution effect of each type of benefit payment options available have been ignored in the literature. Annuity payments and lump sum payments could have different impact on contribution and old age poverty reduction. Whiles annuity in the presence
countries) will cannot be incentivized by tax incentives.

*Takana and Murooka (2012) suggest that savings in developing countries are low due to their inability to resist temptation in an environment with limited access to retirement plans that serve as commitment device. Angeletos et al. (2001) and Laibson et al. (2003, 2007) through simulations of consumption-saving models find that present bias agents use illiquid asset to commit in order to accumulate savings.

*Several low- and middle-income countries, including Colombia, Mexico, and Peru; China; and India are implementing variant forms of matching contributions to facilitate pension coverage expansion. Legislation and proposals for other countries have also been made (for example, Peru).

*Agents contributions to the retirement account are matched by government to motivate agents to save and also serves as incentive to contribute towards retirement. The matching rate typically range from 25 percent to 100 percent and sometimes above 300 percent with some differences in modalities depending on the sponsor (government, employer or both).

*Typical options include lump sums, phased withdrawals, and mandated annuitization (Palacios and Orszag, 2015). A Phased withdrawal is similar to annuity payments but does not pool longevity risk hence no insurance component.
of agents’ present bias would reduce old age poverty, the increase in life time income resulting from annuity could reduce participation and contribution. Also, the lower survival probability during old age would make agents prefer a higher early consumption during old age to consumption smoothing. In effect, the old age labor market decision and saving incentives of these types of payments options of are very different. Understanding the effect of matching contributions and payment options for informal workers on household saving behavior and welfare in developing countries is crucial for optimal pension design for informal workers.

This paper quantitatively analyze these issues by employing a life cycle model of consumer behavior. We investigates the impact of matching contribution on participation and contribution for voluntary pension savings, national savings and welfare in developing countries with large informal sector where workers cannot be mandated to join social pension scheme. We build a dynamic partial equilibrium model economy populated by tempted agents with self control preferences to analyze welfare implications of retirement schemes for informal sector workers who do not have access to old age pension. The set setup consists of overlapping generations of 60-period lived individuals facing mortality risk and individual income risk in the absence of private credit markets, including markets for private annuities. Formal employment that offer old age pension is available for workers below the mandatory retirement age. Informal employment however, is available throughout their life time. Before mandatory retirement age, individuals face stochastic employment opportunities and supply labor inelastically when given opportunity either in formal or informal employment. They are unemployed and rely on past savings or government transfer when there is no opportunity to work. Savings to accumulate private asset holdings in the ordinary saving account are used to self-insure against future income uncertainties and while savings into retirement account are used to support old-age consumption.

2 Related Literature

This study contributes to two main strands of literatures on matching contributions and voluntary pension schemes. The first is the literature on calibrated of models that analyze response of retirement savings to savings incentives targeted to boost consumption after retirement with behavioral life cycle set up in partial equilibrium. The literature, that con-

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\[8\text{Self-control problems is view to largely account for under-saving for retirement (Madrian and Shea, 2001; Choi et al., 2003; Thaler and Benartzi, 2004). Madrian (2015) suggest the importance of incorporating behavioral and psychological frictions such present bias, and temptation that impede savings in economic model of savings.}

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centrates on advanced economies and United States in particular, have analyze implications of employer and government matching contributions in tax-favored Individual retirement accounts (IRAs). Closely related papers in this literature include Love (2007), Engen et al. (1994) and Laibson et al. (1998). Engen (1997) analyzed the effect of matching contributions on 401(k) plans and IRAs using a partial equilibrium life cycle model with income and mortality risks. The simulation results of their study indicates a short run substitution from liquid or conventional savings account to the IRAs but found a moderate increase in aggregate savings in the long run. Laibson et al. (1998) explicitly models savings impact for households with hyperbolic discount functions. They find that IRAs increase households savings and the impact is larger for hyperbolic households that benefits from commitments provided by IRAs. Love (1997) quantitatively characterized the impact of employer-matching and other features of 401(k) plans. The simulation results indicate that participation and contribution response to matching contributions are significant albeit for only middle age workers since young workers in their early working life facing rising life cycle income profile also face liquidity constraints.

Others including Fehr and Kindermann (2010b) and Imrohoroglu et al. (1998) have considered retirement savings in general equilibrium set up. Imrohoroglu et al. (1998) studied IRA in United in a general equilibrium framework and find that financial incentives provided by IRAs raises national savings rate and capital stock in a steady-state and that about 9 percent of IRA contributions are additional saving. Fehr and Kindermann (2010b) calibrated a general equilibrium model with sophisticated time inconsistence agents to Germany to examine the effect of moving from PAYG pension to voluntary personal retirement assets. They find that sophisticated hyperbolic consumers would voluntarily save optimally when committing accounts are available. They find that welfare losses of replacing pay-as-go- pension with IRA is less severe for hyperbolic consumers compared to rational consumers. IRAs are found to be more attractive for hyperbolic than for rational consumers, due to the commitment device provided by restricted withdrawal during active years of life. They find that assets are higher in response to IRAs availability in an economy populated by hyperbolic individuals.

A closely related study with regard to a developing country context is Palacios and Rabalino (2009). It is the only study that analyze effectiveness of matching contributions on pension savings using life-cycle behavioral model in a developing country context. The model assumed the absence of precautionary motive savings in order to concentrate on the response of workers to matching contributions. The study which simulated life cycle decisions indicates that matching contributions can substantially raise the density of contribu-
tions to a pension system. Their result suggest that the level of matching relative to earnings is an important determinant of take up rates and amount of contributions. Our paper builds a more realistic life cycle behavioral model including precautionary savings and availability of employment for old people in the informal sector. A related paper on provision of pension for informal sector workers in developing economies is Jung and Tran (2012) who considers welfare and savings impact of social pension for informal sector workers in dynamic general equilibrium set up. Giving the fiscal challenges in provision of universal old age pensions, many developing countries are not considering *ex post* transfer as discussed by Jung and Tran (2012) but rather *ex ante* incentives to participate in contributory scheme. Our study therefore considers welfare and savings implications of these policies.

The second strand of relevant literature is on empirical estimation analyzing effect of financial incentives (tax incentives and matching contributions) on retirement savings mostly in developed economies, and United States, in particular. In United States, the matching rates variations in employer-sponsored matching contribution has been used as natural experiment analyze its effect on individual savings. Most studies find some support for theoretical prediction of positive effect of matching on participation rates (see for example Dworak-Fisher, 2008; Mitchell, Utkus, and Yang 2007; Papke and Poterba 1995; and Huberman, Iyengar, and Jiang 2007). The empirical evidence on impact of employer matching rates on contributions, is however, less conclusive (see Marian, 2015 and Adams et al. 2015 for review on literature in United States). In Korea, matching contributions is found have had a moderate effect in increasing participation by farmers and fishermen who are entitled to the matching (Moon, 2015).

In developing countries, there is lack of literature on the evidence of matching effectiveness and implications on welfare due to data unavailability as programs are in their early stages of implementations. Early evidence from China and India indicates that matching contributions has the potential to increase participation and contribution to informal pension schemes in developing countries (Palacios and Sane, 2013). Given the lack of empirical evidence due to data unavailability, much can be learned from a well designed simulation exercise. We therefore use behavioral life cycle model to examine the effects of

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the proposed policies. For such an exercise to be able to provide a compelling results and policy evaluations, the model must reflect adequately the behavior of workers in developing countries than that of the simple model of Palacios and Rabalino (2009). The model in particular should represent saving-consumption choices and the key features of informal pension scheme in developing countries.

In our study, we consider how matching contributions will influence informal workers with low savings rate in a developing country context. Moreover, we also examine the influence of benefit payments methods including lump sum, partial and full annuity. This is particularly important since annuity payments, for example, could reduce over consumption and provide income security for old people who may suffer from temptations and through its insurance effect. Hubbard and Judd (1987) finds that annuitization of saving by providing longevity insurance increases welfare and reduces savings in a model with an uncertain lifespan. Thus, the study takes into consideration the implications of different payments options on participation and contribution and analyze their effect on savings and welfare of government sponsored matching contributions in developing economy with large informal workers that lack access to formal pension.

This study contributes to the existing literature on pension policies in developing countries with sizable informality. Very few studies consider pension expansion in developing countries. Jung and Tran (2012) considers pay-as-you-go (PAYG) or unfunded pension to informal workers focusing on risk sharing role of social pension. This study focuses on funded pension in the presence of self-control problems which may lead to old age poverty resulting from suboptimal savings. These issues were not considered by Jung and Tran (2012).

The study also extends the literature on impacts of financial incentives on pension participation by allowing for endogenous elderly labor supply, a key feature in developing countries. Love (2007) assumed exogenous retirement which increases the necessity of retirement savings. The differential impacts of lump sum and annuity payments options which have not been considered in the literature are also explored as part of instrument to encourage pension participation and for welfare improvement.

While some studies analyze the savings and welfare impacts of matching contributions, there is no study that determines the optimal matching contribution rate, at least in the context of developing economy. Love (2007) examines contributions and participation response of 401(k) plans to employer matching rates in United States. Fehr and Kindermann (2010a, 2010b) and Imrohoroglu et al. (1998) have considered savings effect of tax-favored retirement accounts in general equilibrium set up. This study is the first to determine the op-
timal matching contributions rate with annuitization of pension assets as benefits payment option in the context of a developing economy.

3 The model

We develop a model that is consistent with the literature on voluntary pension contribution (or retirement savings) with key feature in developing countries (i.e., the presence of large informal employment). The uncertainties in the model emanates from sector of employment and health shocks resulting to labor income uncertainties. There is also uncertainty regarding the length of life. Agents in the model economy are heterogeneous in terms of education status, age, sector and status of employment, young or old, health status, retirement status and asset holdings.

3.1 Demographics

The economy is populated by ex ante heterogeneous individuals in terms of education of age \(j = 1, 2, \ldots, J\). We assume that an individual enters the economy with a permanent education status \(e\), which can be low or high, \(e \in \{l, h\}\). Agents are categorized into young and old along the life cycle: young agents are those with age \(j < J^r\) (where \(J^r\) is the mandatory retirement age from formal work) and those with age \(j \geq J^r\) are described as old agents. An individual with age \(j\) survives to the next period \(j + 1\) with conditional probability \(\psi_j\). All agents live a maximum of \(J\) periods.

3.2 Social Security System and Government

There are two forms of mandatory social security that all formal sector employees contribute to: tier 1 basic pension which pays annuity to pensioners after retirement and tier 2 fully funded pension that pays lump sum upon retirement. All these forms of pension systems are contributory. Contribution rates for tier 1 pension system and tier pension are given by \(\tau_1\) and \(\tau_2\) respectively.

We introduce retirement saving (or pension) scheme to the informal workers. Informal workers make voluntary contributions to retirement account which will only be available at ‘mandatory retirement’ age through lump sum payment. We also consider a mandatory annuity at retirement age \(J^r\): in this case the government converts the value of assets in the retirement account into annuity payments for the rest of their life.
The government collects a consumption tax $\tau_C$ to finance lump-sum transfer $y_{min}$ as assistance for unemployed and disable old people who are unable to work to maintain a minimum consumption and matching contributions for informal workers who contribute to retirement account. The government budget clears in every period. Thus, consumption tax rate is set to ensure balance government budget.

$$\tau_c \sum_{i=1}^{N} \sum_{j=1}^{J} c_{i,j} = \sum_{j=1}^{J-1} P^j_u y_{min} + \sum_{j=J}^{J} \sum_{h} P^j_h y_{min}$$

(1)

where $P^j_u$ denotes the probability of being employed at age $j$. $P^j_h$ is the probability of receiving the negative health shock (disable) at age $j$.

### 3.3 Employment shocks and Labor Income

There are two sectors of employment where workers may work for wage income: formal and informal sectors. In the formal sector, workers are mandated to contribute to pension system in the active years of employment during their young period and receive pension or retirement benefits when they retired from formal work. Agents who do not gained employment in the high wage formal sector, work in the informal sector while awaiting opportunity to work in the formal sector. Informal workers do not contributes to the social security hence do not earn any pension right when engaged in the informal sector. The rest of agents are unemployed.

All young individuals with age $j < J^r$ work and supply labor inelastically when given opportunity to work in either formal or informal sector until age $J^r$. We assume endogenous retirement from informal employment for old people and as such agents can continue to work in the informal sector as long as they want and are capable.\(^\text{10}\)

Agents receive $w^m \eta^{m,e}_{j} l_j$ as wage income, where $w^m$ is the aggregate wage per labor efficiency unit in sector of employment $m$. $\eta^{m,e}_{j}$ represents deterministic age-dependent productivity at age $j$ for individual with education status $e$ and employment status $m$. $l_j$ is the amount of labor supply.

All individuals face employment and sector of employment uncertainties and consequently income. At the beginning of every period workers receive sector of employment shock that determines the sector of employment and unemployment status. The employment shock results from rationing of formal sector vacancies for informal workers and un-

\(^{10}\)This is very critical feature in developing countries and has important implications on savings. The opportunity for lifetime employment may reduce savings during young age of an individual by using old age labor supply to smooth consumption along the life cycle.
employed people. We assume that the probability of getting formal employment is a function of previous sector of employment, education status and age. Thus, the individual sector of employment state \( m \in \{1, 2, 3\} \) is assumed to follow a three-state first order Markov process. An agent with \( m = 1 \) is given the opportunity to work in formal sector and informal sector if \( m = 2 \). Unemployed agents state is given by \( m = 3 \). The age and education dependent transition probability distribution between the current employment state \( m \) and the next period’s sector of employment state \( m' \) is given by the \( 3 \times 3 \) matrix \( P_{m,e}(m', m) \).

### 3.4 Old age Health shocks

Agents with age \( j = J',...,J \) experience health shock at the beginning of every period. Agents that receive the negative health shock are unable to work to earn income.\(^{11}\) We assume that the probability of receiving negative health shock depends on age as older people are more likely to become disabled with permanent loss of earning potential. The age dependent health state of an agent is given by \( h \in \{0, 1\} \). An agent with \( h = 1 \) has good health and can work to earn income if desired while agent with \( h = 0 \) has a bad health status hence unable to work for the remaining period of his/her life.

### 3.5 Preferences

Young agents chooses consumption, voluntary pension contribution, and ordinary savings to maximize expected utility. Giving health shock realization, old agents of age \( j = J',...,J \) choose hours worked, consumption and savings to maximize expected utility. Agents chooses consumption, labor, and pension contributions to maximize expected lifetime utility which can be expressed as:

\[
E \left[ \sum_{j=1}^{J} \beta^{j-1} \left( \prod_{t=1}^{j-1} \psi_{t} \right) U(c_{j}, l_{j}, \hat{c}_{j}) \right], \quad \text{where} \; l_{j} = \bar{l} \; \text{if} \; j < J' \tag{2}
\]

where \( c_{j}, \hat{c}_{j}, \) and \( l_{j} \) represent an individual’s consumption, total cash on hand (wealth available for consumption) and labor supply at age \( j \), respectively. The preference structure assumes that agents in this economy have self-control problems. In every period of their life, agents face temptations for present gratification by consuming their entire wealth as argued in Gul and Pesendorfer (2004). Time inconsistency and self-control problems are usually faced by individuals when making dynamic decisions as high value (in terms of

\(^{11}\)We abstract from health care expenditure that may result from receiving negative health shock in order to concentrate on loss of income associated with disability and sickness.
satisfaction) is placed on immediate consumption relative to future consumption. The utility function of an agent with self-control preferences as described by Gul and Pesendorfer (2001) is stated as follows:

$$U(c, l, \hat{c}) = u(c, l) + v(c, l) - v(\hat{c}, l)$$  \hspace{1cm} (3)

where the functions $u(\cdot)$ and $v(\cdot)$ are von Neumann-Morgenstern utility functions that represent the momentary and "temptation" utilities respectively. Thus, $c$ represents the "commitment" consumption with $\hat{c}$ being the temptation consumption. The psychological cost or dis-utility (self-control cost) of exercising self control in choosing $c$ instead of the tempted consumption $\hat{c}$ is given by $v(c, l) - v(\hat{c}, l)$. Thus, individuals who yield to temptation and consume $\hat{c}$ (so that $c = \hat{c}$) do not incur any dis-utility since $v(c, l) - v(\hat{c}, l) = 0$.

### 3.5.1 Self-Control

Self-control problems and procrastination have been cited as among the major reasons for under-saving for retirement (see for example Madrian and Shea, 2001; Choi et al., 2003; Thaler and Benartzi, 2004). Tanaka and Murooka (2012) suggest that lack of access to retirement saving plans, such as Individual Retirement Accounts (IRA), 401(k) retirement savings plan, and social security in USA makes it difficult to resist temptation and save. Indeed, the preponderance of empirical evidence on the demand and use of commitment devices regarding savings suggests not only the existence but also the awareness of self-control problems. The commitment devices are therefore strategically used to alleviate the self-control that makes savings difficult. For example, in a randomized field experiment conducted by Dupas and Robinson (2013), an interest-free bank account with a withdrawal penalty were offered to participants. They find a high take-up rate of the interest-free bank account with commitment suggesting the use of saving commitment devices to reduce self-control problems. Ashraf et al. (2006), also through field experiment (together with Filipino

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12 In related literature time inconsistent preferences in the spirit of Liabson (1997) has been used. The main difference between self-control preferences and time-inconsistent preferences is that the former do not imply dynamic inconsistency. Preferences are perfectly consistent. Agents can perfectly commit to future actions and do not regret their past actions. Moreover, self-control preferences allow agents to exercise self-control, an option not existing in time-inconsistent preferences.

13 Clearly, agents that face consumption temptation may also face temptation to reduce hours supply (see also Bucciol, 2011). The temptation consumption, $\hat{c}$, is the total available wealth or cash on hand or the highest possible consumption that an individual could be tempted to consume for a given available resources in a given period. However, it is not important in our setup, since our main concern is getting policies to serve as commitment device and help to reduce self control cost of saving.
bank), suggest that time-inconsistent agents are more likely to take-up savings account with commitment features without any other advantage in terms of interest rates when compared with other savings products.

Rotating savings and credit associations (ROSCA)\textsuperscript{14} are one of the most common saving arrangements in many developing countries where there is lack of access to formal savings arrangements such as retirement account. Tanaka and Murooka (2012) reviewed literature on the use and contributions of ROSCA and found that ROSCA has been widely used by different countries and at different stages of development. They suggest high participation and contribution to ROSCA in different countries and its importance as a source of capital accumulation and acquisition of household durable goods. Among other advantages, ROSCA is primarily used by its participants as saving-commitment devices (Gugerty, 2007; Anderson and Baland, 2002). Basu (2011) shows that for hyperbolic discounters, ROSCA would work as an effective commitment device even in the absence of contractual obligations and punishment by appealing to them to willingly forego instant gratification.

All these studies suggest the existence and awareness of social control problems concerning savings and conceptions. ODonoghue and Rabin (2001) refer to these individuals who are aware of their self-control problems as sophisticated time-inconsistent who would use commitment devices to prevent the negative consequences of their behavior. Thus, we explicitly model temptation and self-control problems following Gul and Pesendorfer (2001).

3.6 Agents’ problem

In the beginning of every period, individual agent of education type $e$ receives the employment shock $m$ or health shock $h$. After realization of sector of employment or health shocks, individuals make decisions about consumption and savings to maximize the expected lifetime utility.

3.6.1 Young agents’ problem

In beginning of every period, young agents receive employment shock that determines their total labor income. They then make decisions on consumption, ordinary savings and retirement savings. At beginning of every period, the state of agents is given by education status

\textsuperscript{14}In a ROSCA, people make regular periodic contributions to a pool with one member receiving all the contributions in the pool of each meeting. In principle, an individual can accumulate personal savings equivalent to total contributions received in a pool for the same periods
(e), age (j), assets in ordinary account (a), asset in pension account (aR) and employment status (m). Thus, the state of agents is given by \( s = (e, j, a, aR, m) \).

Thus, given prices and tax rates, government matching contribution rate, a young individual of age \( j = 1, \ldots, J' - 1 \) solve the dynamic problem below:

\[
V(s) = \max_{c, a', q \in [0, \bar{q}]} \left\{ u(c, \bar{I}) + v(c, \bar{I}) - v(\bar{c}, \bar{I}) + \beta \psi_j \sum_{(m')} \mathcal{P}^{j | c}_{m'} (m' | m) V(s') \right\} \tag{4}
\]

subject to

\[
c + a' + q = (1 + r) a + W^y \tag{5}
\]

\[
W^y = \begin{cases} 
(1 - \tau_1 - \tau_2) w^F \eta^e_j \bar{I} & \text{if } m = 1 \\
w^N \eta^e_j & \text{if } m = 2 \\
y_{\min} & \text{if } m = 3 
\end{cases} \tag{6}
\]

\[
aR' = \begin{cases} 
(1 + r)aR + \tau_2 w^F \eta^e_j \bar{I} + q & \text{if } m = 1 \\
(1 + r)aR + q (1 + \tau_q) & \text{if } m = 2 \text{ or } m = 3 
\end{cases} \tag{7}
\]

\[
a' \geq 0; \ c \geq 0; \ 0 \leq q \leq \bar{q}. \tag{8}
\]

q is the amount of contribution an individual deposits into retirement or pension account. \( \tau_q \) is the matching contributions rate (or subsidy rate) offered by the government.

Equation 7 represents how pension account accumulates over time for both formal workers \((m = 1)\) and informal workers \((m = 2)\) and unemployed \((m = 3)\). \( W^y \) is disposable labor income or assistance to unemployed agents given by Equation 6 for both formal, informal workers and unemployed.

3.6.2 Old and Formal retired Agents’ problem

In the beginning of each period during retirement age, old and formal retired agents of age \( j = J', \ldots, J \) receive a permanent health shock that affect their earning potential. They then decide on labor hours if they are healthy as well as savings. The state of adult agents at beginning of every period is given by \( s = (e, j, a, m, h) \). Thus, the old agents solve the
following problem \(^1^5\)

\[
V(s) = \max_{c, a', l \in \{0, \bar{l}\}} \left\{ u(c, l) + v(c, l) - v(\hat{c}) + \beta \psi_j \sum_{(h')} p^j_h(h'|h) V(s') \right\}
\]  

(9)

\[
c + a' = w^N \eta_j \cdot l \cdot I_h + y_{min} \cdot (1 - I_h) + (1 + r) a + (1 + r) a^R \cdot I_j = J_r + ss^{m,e} + beq
\]

(10)

\[
da' \geq 0; \ c \geq 0; \ ss^{m,e} \geq 0. \ beq \geq 0;
\]

(11)

\(I_h = 1\) if the agent is healthy and can work and 0 otherwise. \(I_j = 1\) if \(j = J_r\) and 0 otherwise. \(ss^{m,e}\) is the pension for retired formal sector workers that depends on education status. Informal workers donot have pension \((ss^{m,e} = 0)\). \(beq\) is lump sum bequest transfer to the survival old people financed by accidental bequest resulting from assets left by deceased old people.\(^1^6\)

### 4 Data, Estimation and Calibration

This section describes our parameter selection and some Ghanaian data used. To estimate the employment, income, and health shocks in the benchmark model, we mainly use the recent Ghana Living Standard Survey (GLSS 6) data from the Ghana Statistical Service. The data are basically cross-sectional with retrospective information on current and past employment episodes. We use parameters that are discussed in this section and summarized in Table 1 to calibrate the benchmark economy to match data from Ghana. We calibrate our model under the assumption that the model period is one year.

#### 4.1 Demographics

The demographic parameters are chosen as follows: Individuals are assumed to be born at the real-time age of 21 and they can live a maximum of \(J = 60\) years, to the real-time age

\(^1^5\)We do not model family support explicitly though important for pension in developing countries. However, it has been documented that there is a decline in family arrangement of support for the elderly in Ghana (Aboderin, 2004; Ogwumike et al., 2005). It is against this background that the new pension system which is intended to cover the informal workers was introduced. But like in many developing countries with informal pension arrangements, the pension participation is still low in Ghana. At the same time, old people are poorer than the general population in countries without social pension (Kakwani and Subbarao, 2005). Thus, the study abstracts from material family support. In addition, we also conduct sensitivity analysis of income transfer to the disable and sick agents to explore how those changes could affect the results of the policy if we consider better family support system as higher income transfer.

\(^1^6\)Bequest is introduced in experiments but not in the baseline analysis.
of 80 and die for sure after age 80. For all ages under 80, the survival probabilities $\psi_j$ are taken from UN life tables.

The formal sector workers retire at model age $J^r = 40$ equivalent to mandatory retirement age of formal sector workers of 60. When informal pension is introduced model age $J^r = 40$ is also assumed to be the age of withdrawal.\footnote{As opposed to retirement age, Palacios and Orszag (2015) use 'age of withdrawal' to indicate that most participants in the informal pension schemes will not necessarily retire from working upon reaching this age.} The retired formal sector workers and informal sector workers can continue to work in the formal sector after $j = 40$ until they experience health shock that renders them invalid to work.

### 4.2 Preference

Following Jung and Tran (2012) we abstract from the choice labor hours during the youthful age $j < J^r$ in order to concentrate on old agents’ of age $j \geq J^r$ labor supply which is very common in developing countries due to the absence of universal pension system. The $u(c, l)$ function is characterized by a Constant Relative Risk Aversion (CRRA) utility function with consumption, $c_j$, and leisure, $1 - l_j$ as the arguments. The temptation utility function $v(.)$ is assumed to be equal to fraction, $\lambda$, of $u(.)$. Thus, the instantaneous utility from consumption and leisure as well as temptation utility are given as

$$u(c, l) = \left[ \frac{c^\phi \left(1 - l_j - \chi_j \cdot l_{wk}\right)^{1-\phi}}{1-\sigma} \right]^{1-\sigma}; \quad v(c, l) = \lambda u(c, l)$$

and therefore

$$U(c, l) = u(c, l) + \lambda u(c, l) - \lambda u(\hat{c}, l), \text{ where } l_j = l^T \text{ if } j < J^r$$

$$\hat{c} = (1 + r) a + W^y$$

for $j = 1, ..., J_r - 1$

$$\hat{w}^N \eta_j \cdot l \cdot l_{h} + y_{min} \cdot (1 - l_{h}) + (1 + r) a + (1 + r) a^R \cdot I_{j = J_r} + s^m \cdot e$$

for $j = J_r, ..., J$

The curvature parameter $\sigma$ measures the inter-temporal elasticity of substitution between present consumption and future consumption in different states and therefore affects retirement and precautionary savings. The parameter $\lambda$ determines the sensitivity of agents to temptation of present consumption. Parameter $\chi_j$ is age dependent utility cost of labor force participation that increases with age and measured in terms of lost leisure time (Kitao,2015). We assume that $\chi_j = 0$ for $j = 1, ..., J_r - 1$ and turns positive for age $j = J_r, ..., J$ so that only old people face labor force participation cost.
Since the retirement savings available for informal sectors in our benchmark model does not offer any advantage over ordinary savings which also serves as medium for precautionary savings, we assume that only tempted agents would contribute to retirement savings account. Thus, the self control and tempted agents value commitment through savings in illiquid asset. The degree of temptation parameter $\lambda$ is chosen to target the percentage of workers that voluntarily contribute to pension scheme in order to reduce self control cost of wealth accumulation or as a commitment device. In the data about 1.5% of agents contribute to retirement account.

The exogenous labor supply of young agents is normalized to 0.4. The endogenous labor hours of old people is then matched to the percentage labor supply of young workers. The data indicate that, on average, old people workings hours per week is 80% of young workers average work hours. The preference parameter measuring the weight of consumption relative to leisure $\phi$ for age $j = Jr, ..., J$ is set so that old people working hours on average is about 80% of that of working hours of the young workers.

To capture labor force participation and voluntary retirement from informal employment, we calibrate the age dependent utility cost of labor force participation $\chi_j$ so that the model old age employment rate for old people matches the steadily decline of employment rate in the data. Following Kitao (2015), the age-dependent utility cost follows a non-linear function of the form $\chi_j = \kappa_1 j^{\kappa_2}$. Figure 3 shows old age employment rate by age group.

The risk aversion parameter $\sigma$ is set at 0.70, which together with $\phi$ translate into relative risk aversion of 0.712 which is well within the commonly used parameter in numerical simulations analysis literature.

We choose discount factor $\beta$ to match the consumption profile of workers based on the

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18 Two studies have estimated the size of the degree of temptation with high standard deviation. DeJong and Ripoll(2007) estimated the degree of temptation parameter to be 0.073 while Huang et al.(2005) estimated it to be 0.206. We do not know any estimates from Ghana and any other developing country.


20 Given that major factors affecting household savings including employment uncertainties, sickness and disability, and mortality rates are well characterized in the model, we calibrate the temptation parameter to match the pension participation rate. It means that the temptation in the model will capture the residual of saving effect, which cannot be explained by control factors. The observed participation rate even though it is very low can only be identified by the temptation parameter. We find a very small level of the temptation parameter (0.013) to match the participation rate. Without the temptation parameter, we cannot capture the participation rate that is observed in the data. In essence our utility function is general form of the standard CRAA utility function as it becomes CRAA when the temptation parameter is set to zero.
household survey data. The model $R$ is the gross return on a riskless asset. We set $R$ to 1990-2010 average real return on 3-month Treasury bill of 1.045.

4.3 Employment shocks and labor income

The transition matrix of unemployment-informal-formal employment status is derived from the question on current employment and a retrospective question of past employment over the one-year period. Individuals are categorized into formal and informal employment using information on availability of pension or social security retirement income of the current employment to categorize individuals into formal and informal workers. Though the GLSS classifies individuals into formal and informal workers which is based on firms’ records keeping level, we believe availability of social security meets the aim of this study.

Following the literature of informal employment as a buffer employment in wait for job in formal sector, we assume that formal sector workers do not move to informal employment
nor become unemployed.\textsuperscript{21}. Giving this assumption, the initial distribution of employment statuses are adjusted so that the model formal-informal-unemployment fractions match the target employment status shares of agents below the compulsory retirement age, $J'$ which is 60 in Ghana. The data indicates that the share of high educated and low educated workers are 29\% and 71\% of the total labor force for workers with ages ranging from 21 to 59.

Gross wage income of a worker in employment sector $m$ and education status $e$ is given by $y_{j}^{m,e} = \eta_{j}^{m,e} l_{j} w_{m}^{e}$. We assume that $l_{j}$ is exogenous for $j = 1, \ldots, J' - 1$ and becomes elastic after age $j \geq J'$. $w_{m}$ is the aggregate wage per labor efficiency unit in sector of employment $m$. $\eta_{j}^{m,e}$ represents deterministic age-dependent productivity at age $j$ for an individual with education level $e$ working in employment sector $m$.

The specific deterministic component of labor income is calibrated to the life-cycle wage rate per unit of time. The wage-age profile is estimated for both formal and informal workers based on wage information from GLSS 6. Specifically, the following OLS equation is estimated for workers in each sector of employment\textsuperscript{22}:

$$\log(w_i) = \beta_0 + \beta_1 \text{age} + \beta_2 \text{age}^2 + X_i \gamma$$ (16)

where $X$ is other covariates including education, sex, and location. The coefficients of $\text{age}$ and $\text{age}^2$ is used to construct age-income profile for workers in each sector. The estimated wage profile given by the efficiency index $\eta_j$ is intended to provide a realistic cross-sectional age distribution of earnings at a point in time. The life-cycle wage profile of formal and informal workers are shown in Figure 4.

We normalize $w_{inf}$ to one and calibrate $w_{f}$ so that the ratio of average net wage income of formal and informal employment matches the ratio from the data.

### 4.4 Health Shocks

The age dependent probability of encountering permanent health shock that renders old agent unable to work to earn income is also calculated from the GLSS 6 data. The probability is estimated from a question that ask reasons why old agents do not work. The responses that include disability and sickness are used to calculate the probability of old person of age $j$ experiencing the negative health shock that force them out of the labor market activities.

\textsuperscript{21} Giving labor protection in the country, few workers are laid off in the formal sector in special circumstance such as firm collapse. Indeed, the transition matrix provided evidence of limited movement from formal to informal or unemployment.

\textsuperscript{22} Due to insignificant of data for low educated formal workers, we construct their profile to match the ratio of high educated formal workers income to that of low formal workers. The profiles are then adjusted to match the ratio of formal workers income to that informal workers.
4.5 Social Security System and Government

Social security system collects contribution from formal sector workers and pay pensions to retired formal sector workers. We use statutory contribution rates for both basic pension and fully funded pension. Statutory contribution rates are 11% and 5% for basic pension and fully funded tier 2 pension respectively. While basic pension pays annuity pension, the second tier pension pays lump sum upon retirement. The replacement rates of the basic tier 1 pension is chosen to target the ratio of total contribution by formal sector workers to total benefit payment to retired formal sector workers. The ratio is 3.1 (see Social Security and National Insurance Trust (SSNIT) (2012)). In this way we are able to capture institutional savings through compulsory savings which forms significant part of savings in Ghana. Thus, The amount of periodic annuity benefit payment $ss$ is calculated as follows:

$$ss = b * W_{fr-1}^{fe}$$ (17)
where $W_{Jr-1}^{fe}$ is the formal sector wage income for individual with education $e$ at age $J_r - 1$. A replacement rate ($b$) of 0.375 which is the rate associated with the minimum number of years (15) of contributions required to be eligible for pension is selected. It must be also noted that the transition to formal employment in the model also generates similar minimum working years of formal workers.

The tier 2 pension is given as lump sum upon reaching the compulsory retirement age $J'$. Thus, at the end of period $J' - 1$, the value of tier two pension is converted into ordinary savings account which is liquid and therefore available for consumption.

We assume that the government administer income transfer to non-working people in the economy. It would also pay for the matching contributions expenditure or savings subsidy in our policy experiments. The income transfer old disable and unemployed households is set arbitrarily to 10% of lowest formal sector wage. This is intended to ensure there is minimum consumption that households can consume.\footnote{since the results are likely to be affected by the amount of the income transfer, we perform sensitivity\textsuperscript{23} We assume that the only}
instrument available to government is consumption tax. In developing countries, due to the smaller share of formal sector, the large part of government revenue are usually raised through consumption taxes instead of income taxes. The consumption tax rate is adjusted to ensure balanced budget in every period.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Interpretation</th>
<th>Value</th>
<th>Comment/Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>( j )</td>
<td>Model period</td>
<td>1</td>
<td>equivalent to 1 year</td>
</tr>
<tr>
<td>( J' )</td>
<td>Compulsory Retirement age</td>
<td>40</td>
<td>equivalent to age 60</td>
</tr>
<tr>
<td>( J )</td>
<td>Maximum years after labor force entry</td>
<td>60</td>
<td>equivalent to 80 years</td>
</tr>
<tr>
<td>( \psi_j )</td>
<td>Survival probability at age ( j )</td>
<td>see text</td>
<td></td>
</tr>
<tr>
<td>( \sigma )</td>
<td>Risk aversion parameter</td>
<td>0.70</td>
<td></td>
</tr>
<tr>
<td>( \lambda )</td>
<td>degree of temptation</td>
<td>0.013</td>
<td></td>
</tr>
<tr>
<td>( \phi )</td>
<td>Weight on consumption</td>
<td>0.96</td>
<td>match elderly work hours</td>
</tr>
<tr>
<td>( { \kappa_1, \kappa_2 } )</td>
<td>Disutility of labor force participation</td>
<td>{0.0142, 0.916}</td>
<td>match elderly work hours</td>
</tr>
<tr>
<td>( \beta )</td>
<td>Annual discount factor</td>
<td>0.970</td>
<td>To match national savings rate</td>
</tr>
<tr>
<td>( R )</td>
<td>Gross rate of return</td>
<td>1.045</td>
<td></td>
</tr>
<tr>
<td>( \tau_1 )</td>
<td>Tier 1 Contribution rate</td>
<td>0.11</td>
<td></td>
</tr>
<tr>
<td>( \tau_2 )</td>
<td>Tier 2 Contribution rate</td>
<td>0.05</td>
<td></td>
</tr>
<tr>
<td>( \eta_m )</td>
<td>age-income profiles for worker in sector ( m )</td>
<td>see text</td>
<td></td>
</tr>
<tr>
<td>( P_{jm}(m'</td>
<td>m) )</td>
<td>Employment status transition matrix</td>
<td>see text</td>
</tr>
<tr>
<td>( P_{jh}(h'</td>
<td>h) )</td>
<td>Health shock</td>
<td>see text</td>
</tr>
</tbody>
</table>

### 4.6 Welfare Evaluation measure

An ex-ante life-time value of an agent in the benchmark economy is defined as

\[
V^{bm} = E_0 \left[ \sum_{j=1}^{J} \beta^{j-1} \left( \prod_{t=1}^{j-1} \psi_t \right) U \left( c_j^*, l_j^*, \hat{c}_j^* \right) \right] \tag{18}
\]

Welfare change for a policy reform is measured by consumption equivalence variation (CEV) as consumption equivalent lump-sum compensation required to make sure agents are indifferent between living in the benchmark economy and living in the economy with the policy change.

\[
V^{reform} = E_0 \left[ \sum_{j=1}^{J} \beta^{j-1} \left( \prod_{t=1}^{j-1} \psi_t \right) U \left( (1 + CEV)(c_j^*), l_j^*, (1 + CEV)(\hat{c}_j^*) \right) \right] \tag{19}
\]
Giving the utility function in equation 12,

\[ CEV = \left( \frac{V_{\text{reform}}}{V_{\text{bm}}} \right)^{\frac{1}{\phi(1-\sigma)}} - 1 \] (20)

The \( CEV \) denotes the fraction by which consumption must be increased in the baseline to compensate for the decrease in welfare generated by the reform. A positive \( CEV \) suggests that a given reform increase welfare in comparison with the baseline. A negative \( CEV \) on the other hand implies that baseline policy is preferred to the alternative reform.

5 Results

In order to obtain numerical solutions to the model and conduct a quantitative analysis of retirement scheme, we need to choose particular values for the parameters of the model. The strategy of numerical analysis that we use first establishes a reasonable benchmark model economy that characterizes some key features of the current economy.

In this section, we first present the calibration result of the benchmark model with no matching contributions for informal pensions and discuss how our model matches the data. Next, we specify and discuss a variety of implementations of the voluntary pension programs for informal sector workers on market aggregates and welfare in the context of developing countries.

5.1 Benchmark economy

We match our benchmark economy with option for voluntary retirement savings to key variables such as old age employment rate and participation in voluntary retirement scheme by informal workers as well as the age-consumption profile in Ghana. It is important to emphasize that the objective of the calibration exercise is not to exactly estimate the fundamental parameters (RRA and discount factor) of the Ghanaian economy but to search for parameters that makes the model consistent with the consumption profile. Our model economy is able to match key variables: the employment shares, average working hours of old people. The benchmark model outcomes and data are shown in Table 2. The model consumption profile for workers matches well (qualitatively) the consumption profile from the data. \(^{24}\)

\(^{24}\)We match pre-retirement consumption profile because informal workers who contribute to the pension scheme are yet to experience retirement.
### Table 2: Model Outcomes

<table>
<thead>
<tr>
<th>Variable</th>
<th>Baseline Model</th>
<th>Data</th>
</tr>
</thead>
<tbody>
<tr>
<td>Formal employment share (%)</td>
<td>12.83</td>
<td>12.37</td>
</tr>
<tr>
<td>Informal employment share (%)</td>
<td>83.05</td>
<td>83.23</td>
</tr>
<tr>
<td>Unemployment share (%)</td>
<td>4.12</td>
<td>4.41</td>
</tr>
<tr>
<td><strong>Old age employment rate</strong> (%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Old people working hours</td>
<td>0.3102</td>
<td>0.32</td>
</tr>
<tr>
<td>Participation in Retirement Scheme (%)</td>
<td>1.915</td>
<td>1.50</td>
</tr>
</tbody>
</table>

5.2 **Introducing government Sponsored Matching contributions**

We start the benchmark economy without a matching contributions program for informal sector workers and calibrate this version to the economy of Ghana. We then assume that
the government introduces a matching contributions to all informal sector workers who are below age 60 and make contribution to the voluntary pension scheme. The generosity of the government matching is determined by the magnitude of the matching rate \( \tau_q \). The magnitude of the matching rate determines the returns on contributing to pension scheme relative to ordinary savings account that also serves as buffer stock saving for precautionary purpose (Deaton,1991). In all our policy experiment we assume that the government can finance the expenditure on matching contributions using revenue from consumption taxes.

We consider a policy reform of introducing a tax-financed matching contributions program with 100% matching rate\(^{25}\). Three different benefits payment options of the scheme are considered including lump sum payments, partial annuity (75\% lump sum and 25\% annuity), and full annuity payments are considered. We report the impact of these reforms on key aggregate variables and welfare in subsections below.

Following Fehr and Kindermann (2010), when there is annuitization of retirement account assets, old agents at age \( j = J', ..., J \) receive fixed benefit \( x \) which is a function of accumulated assets at the time of retirement at \( J' \). This is calculated as follows:

\[
x_j = x_{j'} = \frac{(1 + r_{j'}) a_{j'}^R}{\sum_{j=J'}^{J} \prod_{i=J'+1}^{J'} (1 + r_i)^{-1}}
\]

where \( r_i = \frac{1+r_j}{1+r_{j'}} - 1 \) and \( r_{j'} = \frac{1+r_j}{1+r_{j'}} - 1 \). This implies that periodic returns for annuitized assets, \( r_i > r \). \( a_{j'}^R \) and \( r_{j'} \) are the accumulated savings in the pension account and periodic annuitized returns at the time of retirement, respectively.

The model is solved and stimulated for each of the policy options for 2000 individuals from ages of 21 to 80 receiving different draws of employment offer and health status shock across the life cycle for each policy option, and calculate cross-sectional averages across simulations. In solving and simulations, individuals face mortality risk along the life cycle. The simulated model is used to analyze the short-term and life cycle impacts of these government provided incentives.

5.2.1 Aggregate Effects

In this section we study the behavior of the key variables in the model including welfare, consumption, assets accumulation(ordinary savings and pension assets), old age labor supply and contribution to pension scheme.

\(^{25}\) Palacios and Robalino (2010) suggests a level of the matching of not less than 100\% in order to induce pension savings from informal workers.
Table 3: Quantitative Results of Policy Experiments

<table>
<thead>
<tr>
<th></th>
<th>Baseline</th>
<th>Lump sum</th>
<th>Partial Annuity</th>
<th>Full Annuity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Welfare change-High educated</td>
<td>—</td>
<td>-1.839</td>
<td>-1.012</td>
<td>1.050</td>
</tr>
<tr>
<td>Welfare change-Low educated</td>
<td>—</td>
<td>-0.502</td>
<td>1.189</td>
<td>4.677</td>
</tr>
<tr>
<td>Welfare change-Social Average</td>
<td>—</td>
<td>-0.898</td>
<td>0.535</td>
<td>3.595</td>
</tr>
<tr>
<td>Young Savings rate(%)</td>
<td>0.428</td>
<td>10.329</td>
<td>33.315</td>
<td>35.499</td>
</tr>
<tr>
<td>Old age consumption per capita</td>
<td>0.710</td>
<td>1.706</td>
<td>1.846</td>
<td>2.508</td>
</tr>
<tr>
<td>Pension Participation rate(%)</td>
<td>1.915</td>
<td>79.585</td>
<td>79.748</td>
<td>77.205</td>
</tr>
<tr>
<td>Old age Employment rate(%)</td>
<td>91.470</td>
<td>91.470</td>
<td>91.470</td>
<td>91.470</td>
</tr>
<tr>
<td>Old age work hours</td>
<td>0.310</td>
<td>0.288</td>
<td>0.285</td>
<td>0.272</td>
</tr>
<tr>
<td>Consumption tax rate(%)</td>
<td>0.424</td>
<td>4.648</td>
<td>4.903</td>
<td>4.701</td>
</tr>
</tbody>
</table>

In our framework, the government sponsored matching contributions to informal workers voluntary contributions to pension scheme has three effects. First, it provides redistribution from the rich formal workers and old people to the poor and young informal workers by subsidizing their future consumption. All consumers pay consumption tax but only informal workers who contribute to the pension scheme benefit from the program. The subsidy is expected to improve welfare since life-time consumption of poor informal workers improves after retirement. However, tax also affects consumption of all individuals including old people and this will reduce consumption and welfare. Thus, welfare effects can be negative or positive depending on the strength of each effect. Second, shielding large assets into pension scheme, matching contributions reduces the cost of self-control thereby increasing welfare (commitment effect) compared accumulating assets in ordinary savings account. Thus, by encouraging individuals to voluntary contribute into pension scheme, matching contributions helps to redistribute income from periods of relatively high and stable income but subject to overspending to old age period when labor income is unreliable and low. This inter-temporal redistribution of consumption improves welfare (Akerlof, 1998). Third, the compulsory purchase of annuity of pension assets which provides mortality premium or insurance for survival old agents may also improve social welfare.

The welfare effects of various reforms are indicated in the first three rows of Table 3. Negative values of the CEV measure indicate that welfare is higher under baseline policy of no matching contributions. For instance, CEV=-1.84% means that agents have a welfare loss of 1.84% of their lifetime equivalent consumption in the baseline economy with no matching contribution by moving to an economy with matching contributions and lump sum payments. Thus, moving from the baseline economy with no matching contributions to an economy with matching and full annuity of pension savings entails social average welfare gain equivalent to 3.60% of lifetime consumption.
The results as reported in Table 3 suggest that the policy would have differential effect on individuals with different education status. Low educated individuals, who usually work in the informal sector and therefore are eligible for matching contributions provided by government experience higher welfare gain when there is partial or full annuity compared to the gains of high educated individuals as indicated in row 1 and 2. Matching contributions policy with 100% matching rate and full annuitization of pension savings raises the welfare of low educated and high educated agents by 4.68% and 1.05% percent of consumption equivalent, respectively. High educated workers forms the larger proportion of formal sector workers and therefore would pay the high consumption tax resulting from matching contributions policy without having access to its benefit. However, there are some high educated workers who also benefit from the policy as they work in the informal sector. Thus, in the case of full annuity, the benefit of high educated informal workers outweighs that of high educated formal workers hence welfare gain equivalent to 1.05% of baseline consumption. The welfare change in terms of social average indicates that the policy of 100% matching and full annuity improves welfare equivalent to 3.60% of baseline consumption. The improvement of welfare with regard to matching contributions and full annuity results from redistribution and annuity. First, the matching contributions policy redistributes income from formal workers to informal workers (conditional on savings into pension account) through pensions savings subsidy. Jung and Tran (2012) also find that in developing countries with large income gap between formal and informal workers social pension program generates welfare gain. Second, through annuity informal workers benefit from insurance and therefore reduction in risks associated with becoming poor and a rise in lifetime income that result from sharing of accidental bequest to survival agents. Fehr and Kindermann (2010b) finds that, mandatory annuitization by by implicitly redistributing from future to existing generations through reduction in unintended bequest improves efficiency in a general equilibrium model. The annuitization of retirement savings provides longevity insurance against an uncertain life span (Hubbard and Judd, 1987). Annuity pays a mortality premium during the retirement period and higher reduction in welfare loss associated with self control costs. The reduction in self control costs associated with savings is generated by diverting savings into pension scheme and annuitization of pension assets. Savings in pension scheme provides commitment for agents who suffer from temptation and incur self control costs by accumulating large assets for longer period.

In the case of matching contributions and lump sum payments of pension savings, both high educated and low educated workers suffer welfare loss. Here, only redistribution effect through pension savings work. There is no annuity hence no insurance from pension. The
accumulated assets are used as insurance against the risk of low income during old age. Thus, in spite of the fact the poor informal workers benefits from redistribution, the rise in taxes to finance the redistribution dampens the effect of the redistribution hence generating welfare loss for all agents. Thus, the negative effects from consumption tax outweighs the benefit of redistribution and reduction in self control costs. Consumption tax rate rises from 0.42\% in the baseline economy to 4.65\% in the economy with matching contributions and lump sum payments policy. Moreover, since assets for deceased are not accounted for accumulating higher savings by postponing consumption from periods when survival are low to period of high survival also dampens the benefits of redistribution. Row 3 of Table 3 suggests that lump sum with matching policy is inferior to the current policy of no matching in spite of the intra-temporal and inter-temporal redistributions associated with these policies. Social average welfare reduced by consumption equivalent of 0.90\% of lifetime consumption in the baseline economy.

For Partial annuity, where only 25\% of accumulated pension savings are annuitized, matching contributions policy would generate welfare gains equivalent to 1.19\% of lifetime consumption in the base line economy for low educated workers who are the major beneficiary of the saving subsidy. High educated workers suffer welfare loss as negative welfare effect of a higher consumption tax generates welfare for formal educated workers is higher than the gains of redistribution accrued to informal high educated workers. However, the policy leads to social average welfare gain equivalent to 0.54\% of life-time consumption resulting from there higher proportion of low educated workers (71\%) in the economy. Tax on consumption rises from 0.42\% to 4.90\% in the case of partial annuity higher than tax rates in the economy with full annuity (4.70\%) and lump sum (4.65\%).

Table 3 indicates that the average savings rate by young cohort rises by about 23.25 percent, 75.40 per cent and 80.68 percent when government sponsored matching contributions of 100 per cent matching rate is accompanied by lump sum payments, partial and full annuity respectively. The high returns on retirement savings associated with matching contributions for informal workers encourage them to increase savings. The increase in overall savings rate among the young cohort result from redistribution from high income earners to low income earners. The redistribution in the form of matching from the rich formal workers to the poor informal workers help to increase overall savings rate among the young people. The rich formal workers have access to a certain future pensions and therefore have low propensity to save toward retirement. The poor informal workers without any pension, however, have relatively higher propensity to save for the old age. Thus, taxing consump-
tion to subsidize savings among the low income informal workers with high propensity to save improves the economy-wide savings.

In general, the matching contributions policy of providing pension to informal workers by subsidizing pension savings increase savings rate among the young workers who are below the retirement age. However, savings rate differs among the alternative benefits payment options. Full annuitization with matching contributions generates higher savings rate (35.50%) compared with partial annuity (33.32%) and lump sum payment (10.33%). In terms of percentage points changes from the baseline savings rate, savings rate is rises about 9.90 per cent, 32.89%, and 35.07% for lump sum, partial annuity and full annuity respectively.

5.2.2 The Role of Accidental bequest

In the previous sections, the accidental bequests were not accounted for. Thus, policies that encourage savings but does not redistribute accidental bequest may be welfare depressing for the society due to the loss of asset for the society when an agent is deceased. In Table 4 we allow government to tax all the accidental bequest of old agents and transfer them to the survival old individuals as lump sum. Here, there is no loss of asset for the society due to death hence the beneficial (welfare) effect of redistribution through matchings contributions assessed against the cost of financing the matching contributions expenditure. We then compare the results with a policy of matching contributions with lump sum and full annuity.

<table>
<thead>
<tr>
<th>Table 4: Effects of Transfer of Accidental Bequest</th>
</tr>
</thead>
<tbody>
<tr>
<td>Baseline+BEQ</td>
</tr>
<tr>
<td>Welfare change-High educated</td>
</tr>
<tr>
<td>Welfare change-Low educated</td>
</tr>
<tr>
<td>Welfare change-Social Average %</td>
</tr>
<tr>
<td>Young Savings rate(%)</td>
</tr>
<tr>
<td>Old age consumption per capita</td>
</tr>
<tr>
<td>Pension Participation rate(%)</td>
</tr>
<tr>
<td>Old age Employment rate(%)</td>
</tr>
<tr>
<td>Old age work hours</td>
</tr>
<tr>
<td>Consumption tax rate(%)</td>
</tr>
<tr>
<td>Matching EXP/GDP (%)</td>
</tr>
</tbody>
</table>

As can be seen in Table 4, both high educated and low educated workers get welfare gains equivalent to 0.33% and 2.34% life-time consumption in the baseline economy respectively. For social average welfare, the subsidy associated with matching contributions
and lump sum improves welfare of agents by about 1.75 percent of the baseline with bequest consumption. Compared to full annuity results repeated on column 4, the welfare improvements (high educated workers, low educated workers and social average) associated with matching contributions and full annuity is preferable to that of lump sum payments though full annuity entails higher consumption tax rate (4.70%) compared to lump sum (3.14%).

However, the availability of unconditional transfer to the survival old people through sharing of accidental bequests, the response to matching contributions policy is very low in terms of both participation and savings rate. Comparing lump sum when accidental bequest are distributed among the old people and full annuity, savings rate for lump sum is low (7.01%) compared to 35.50% for full annuity. The participation rate is 69.65% for lump sum compared to full annuity (77.21). The availability of accidental bequest reduces the necessity to save for retirement giving that the risk of fallen into poverty is reduced as bequests are distributed unconditionally. Thus, the accidental bequests weakened the effect of matching contributions (savings subsidy) by reducing pre-retirement savings. Hence low participation, low contribution and low savings rate. However, annuity provides conditional distribution of bequest hence it serves as incentive for pension participation, higher contributions and therefore higher savings rate. To benefit from accidental bequest, an agent need to participate and accumulate larger asset in the retirement account, leading high savings rate for full annuity.

The fiscal cost associated with matching contributions with lump sum payment option is lower than that of full annuity due to lower contributions and therefore low expenditure on subsidy payments or matching costs. Thus consumption tax of 3.14% associated with lump sum is lower than 4.70% for the case of full annuity. The higher pension participation and savings response to full annuity and matching contributions policy require high consumption tax to finance the subsidy. In terms of GDP, the matching contributions expenditure for lump sum and annuity payments amounts to 3.21% and 3.83% of GDP respectively.

5.2.3 Life Cycle Profiles

Table 5 and Figure 7 show pattern of pension participation rates and old age labor supply for the two policy options (matching contributions with lump sum (bequest) and full annuity as benefit payments options) and baseline with bequest.

**Pension Participation** Table 5 shows workers participation in pension scheme in response to 100% matching contributions by age groups and benefit payment options. Participation is defined as a positive contribution to the pension scheme. Comparing the column
with columns 3–4 in Table 5, it can be seen that matching contributions increases participation in pension scheme. The matching contributions induces workers (30+) to contribute into pension scheme. The results also indicates that participation in the voluntary pension scheme depend on the benefit payments option. Participation rate for 40+ olds workers is high when there is full annuity as the insurance, extra returns through mortality improves incentive for pension saving and therefore encourage higher participation.

<table>
<thead>
<tr>
<th>Age</th>
<th>Baseline(+BEQ)</th>
<th>Lump sum(+BEQ)</th>
<th>Full Annuity</th>
</tr>
</thead>
<tbody>
<tr>
<td>21-30</td>
<td>0.000</td>
<td>81.410</td>
<td>81.410</td>
</tr>
<tr>
<td>31-40</td>
<td>0.000</td>
<td>85.439</td>
<td>85.439</td>
</tr>
<tr>
<td>41-50</td>
<td>0.000</td>
<td>61.350</td>
<td>78.856</td>
</tr>
<tr>
<td>51-59</td>
<td>9.358</td>
<td>43.418</td>
<td>58.768</td>
</tr>
</tbody>
</table>

**Old age Labor supply** Old age employment rates and labor supply are low in countries with pension system with massive coverage. We examine the labor market implications of government matching contributions and benefit payment options for old people. The availability of high accumulated assets or annuity pension for informal workers during old age will likely reduce aggregate labor supply of the old people through income effect.

Figure 7 indicates that annuity by providing stable consumption throughout retirement period has substantial impact on old age labor supply. Jung and Tran (2012) through general equilibrium also found that social pension reduces elderly labor supply and participation in a model calibrated to Brazil. Access to old-age pension benefits is reported to have a strong effect on decision of retirement of rural workers in Brazil (Filho, 2008). This suggests that availability of secured periodic benefits such as pension allow old agents to make choice about labor supply and employment and in this case old age labor supply reduce substantially (Kidd and Whitehouse, 2009). Lump sum payments also lead to a decline in labor supply but at lower rate compared to the case of full annuity.

### 5.3 Optimal Matching Contributions Rate

In this section we characterize the optimal matching rate and discuss the implication of different matching rate on pension participation, contribution and consumption when there is compulsory annuitization. Many studies in developed countries find that matching contri-
butions affects participation but not contribution (see for example Marian, 2015 for review on this literature). Holzmann et al. (2015) also suggest that matching contributions is moderately effective in increasing program participation but less effective in raising contributions level in high income countries. Palacios and Robalino (2010) however suggest that the level of matching should be high relative to earnings to induce participation and amount of contribution in developing countries.

Table 6 presents results for different matching contributions rates with full annuity payment option. The results indicate that with the utilitarian welfare measure where average welfare of all agents are considered, the matching rate that maximizes social welfare is 159%. Matching contributions rate of 159% generates welfare gains equivalent to lifetime consumption of 5.82% and 0.698% of the baseline consumption for low educated and high educated workers respectively. The Rawlsian social welfare criterion which maximizes the welfare of the poor (low educated in this study) also suggests that a matching contributions rate of 159% that is used to subsidies the pension savings maximizes the welfare of the low
Table 6: Optimal Matching Contributions Rate with Full Annuity

<table>
<thead>
<tr>
<th></th>
<th>Baseline</th>
<th>0%</th>
<th>50%</th>
<th>100%</th>
<th>150%</th>
<th>159%</th>
<th>160%</th>
<th>175%</th>
<th>200%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Welfare change-High educated</td>
<td>—</td>
<td>0.662</td>
<td>0.991</td>
<td>1.050</td>
<td>0.797</td>
<td>0.698</td>
<td>0.651</td>
<td>0.238</td>
<td>-1.498</td>
</tr>
<tr>
<td>Welfare change-Low educated</td>
<td>—</td>
<td>1.029</td>
<td>3.129</td>
<td>4.676</td>
<td>5.701</td>
<td>5.815</td>
<td>5.790</td>
<td>5.713</td>
<td>4.465</td>
</tr>
<tr>
<td>Welfare change-Social Average %</td>
<td>—</td>
<td>0.920</td>
<td>2.494</td>
<td>3.595</td>
<td>4.234</td>
<td>4.284</td>
<td>4.252</td>
<td>4.074</td>
<td>2.677</td>
</tr>
<tr>
<td>Young Savings rate(%)</td>
<td>0.428</td>
<td>13.111</td>
<td>25.420</td>
<td>35.499</td>
<td>45.205</td>
<td>47.142</td>
<td>47.399</td>
<td>50.909</td>
<td>56.865</td>
</tr>
<tr>
<td>Old age consumption per capita</td>
<td>0.710</td>
<td>1.122</td>
<td>1.782</td>
<td>2.507</td>
<td>3.396</td>
<td>3.599</td>
<td>3.627</td>
<td>4.037</td>
<td>4.980</td>
</tr>
<tr>
<td>Pension Participation rate(%)</td>
<td>1.915</td>
<td>69.293</td>
<td>74.949</td>
<td>77.205</td>
<td>71.328</td>
<td>68.551</td>
<td>70.422</td>
<td>68.603</td>
<td>83.571</td>
</tr>
<tr>
<td>contribution per capita</td>
<td>0.000</td>
<td>0.049</td>
<td>0.049</td>
<td>0.060</td>
<td>0.073</td>
<td>0.076</td>
<td>0.077</td>
<td>0.086</td>
<td>0.117</td>
</tr>
<tr>
<td>Old age Employment rate(%)</td>
<td>91.470</td>
<td>91.470</td>
<td>91.470</td>
<td>91.470</td>
<td>86.432</td>
<td>82.022</td>
<td>81.930</td>
<td>68.521</td>
<td>62.759</td>
</tr>
<tr>
<td>Old age work hours</td>
<td>0.310</td>
<td>0.302</td>
<td>0.288</td>
<td>0.272</td>
<td>0.244</td>
<td>0.238</td>
<td>0.236</td>
<td>0.239</td>
<td>0.246</td>
</tr>
<tr>
<td>Consumption tax rate(%)</td>
<td>0.424</td>
<td>0.399</td>
<td>2.345</td>
<td>4.702</td>
<td>7.311</td>
<td>7.844</td>
<td>7.943</td>
<td>9.127</td>
<td>12.419</td>
</tr>
</tbody>
</table>

Educated (ex ante poor people in this model). In the Rawlsian social welfare function, the expected lifetime values of agents with lower education and therefore income is maximized by the government. Thus, the optimal matching contributions rate for Rawlsian welfare measure coincides with that of utilitarian welfare measure of social average. This is not surprising since low educated workers are about 71% of the total labor force. The need for higher matching contributions rate result from the fact that there is high inequality between high and low educated workers on one hand and between formal and informal workers. Hence, income is transfer from the rich to the poor to maximize welfare.

The higher consumption tax rate associated with increased matching contributions rate result partly from the fact that the higher incentive encourage higher participation and contribution. Also since more consumption are shifted to after retirement, the tax base shrink necessitating higher consumption tax to finance the increased expenditure on matching contributions.

Savings rate associated with the optimal matching rate of 159% is 47.14% compared to the baseline savings rate of 0.43%. The higher savings rate results from the higher pension participation average contribution of about 68.55% and 0.76 respectively. Consumption rate rises from 0.42% in the baseline economy to 7.84% in the optimal matching rate economy as higher revenues are raised by government to finance the expenditure on matching contributions. Employment rate and old age work hours also reduced from 91.47% and 0.31 hours in the baseline economy to 82.02% and 0.24 hours respectively in the optimal matching economy.

The results also indicate that annuity without any matching contributions (pure effect of annuity) improves welfare equivalent to 1.03% and 0.67% of lifetime consumption in the baseline economy for low and high educated workers respectively. Here, there is no pre-retirement saving subsidy on pension savings but conditional redistribution of deceased
assets. Thus, the policy provides mortality premium for survival old agents as well as insurance against longevity. Fehr and Kindermann (2010b) find similar results that mandatory annuitization of retirement savings leads increase contribution to the retirement account in order to gain from longevity insurance and still receives bequest from the deceased. The incentive created by these two benefits of annuity encourage participation of about 69.30% generating savings rate of 13.31%. Thus, if there is no self selection in pension savings due to differences in individual survival probabilities, then 0% matching rate with annuity is able to encouraged people to save into the pension scheme to have access to life time annuity income.

The implication of effect of 0% matching contributions rate suggest that developing countries without fiscal space to finance unfunded pension or unconditional transfer can still expand the coverage of their pension system by designing it with annuity component. By using pension or retirement account to redistribute bequest in the form of annuity, poverty could be reduced with higher savings rate.

The results from Table 6 also suggest a positive relationship between savings rate and matching contributions rate. Fehr and Kindermann (2010b) find that mandatory annuitization of withdrawals after retirement increase savings in tax-favored accounts leading to a rise in aggregate savings. A higher savings subsidy through matching contributions encourage higher savings through an increase in pension contributions. Since formal workers have access to pension and therefore are not saving toward retirement, the increase in consumption tax does not have its equivalent effect on savings rate. Thus, savings rate of workers increase. This implies that if targeted to low income households who are likely to save very little without subsidy, matching contributions may improve savings rate in the economy.

5.4 Sensitivity Analysis

5.4.1 Income Transfer

In this section, we examine how the incentives of informal workers could be affected by the income transfer. The transfer to non-working individuals (unemployed and sick people) could impact on incentive to save and also participate in the pension scheme.

Table 3 presents results of different rates of income transfer on pension participation and contributions in response to 100% matching contributions rate.

The results indicate that changes in minimum income transfer do not significantly affect pension participation rate and average contribution. A rise of minimum income transfer of about 500% increases participation by less than 0.6% and reduced contribution by 8.1%.
In addition, there is no significance changes in savings rate, employment rate and hours of work. The implication of this results is that the existence of better family support and other transfer may not have significant effect on the results of the matching contributions policy.

5.4.2 The role of Temptation and Self-control

In this section, we explore the role of self-control on the response to the matching contribution policy. The temptation parameter is set to zero ($\lambda = 0$) and we match the model to the consumption profile with discount factor of 0.95. The pension participation rate, savings rate, contribution and labor supply response from the baseline economy without temptation and self-control problems and an experiment with 100% matching contribution rates are shown in Table 8. For ease of comparison, we also report baseline and similar experiment with tempted and self-control agents ($\lambda = 0.013$).

Table 8 shows that in the baseline non-tempted agents do not participate and contribute to the pension scheme. This is not surprising since the pension scheme do not offer any advantage over ordinary savings account for the non-tempted agents. Moreover, the pension scheme lacks liquidity therefore non-tempted agents do not save in the pension scheme. However, for tempted agents, the opportunity to reduce self-control costs by saving into the pension scheme is an incentive for them to participate and contribute to pension scheme. Thus, the existence of temptation and self-control problem provide a fundamental trade off associated pension contributions reducing self-control cost vs lower liquidity. Thus, even without any advantage (in terms of returns) of pension scheme, tempted agents participate and contribute to pension account even though very low rate of participating of about 1.92% in the baseline. This supports Ashraf et al. (2006) empirical finding in Philippines that self-control agents signed for commitment savings accounts relative normal savings account. The importance holding of illiquid assets as commitment devices has been discussed by Laibson (1997) that tempted agents would save into illiquid assets so they can prevent over-consumption even if the interest rate on illiquid assets is less than the interest rate of liquid assets.

The tempted and self-control agents benefits from commitment provided by the pension

---

<table>
<thead>
<tr>
<th>Young Savings rate(%)</th>
<th>50% of BS</th>
<th>200% of BS</th>
<th>300% of BS</th>
<th>500% of BS</th>
</tr>
</thead>
<tbody>
<tr>
<td>35.888</td>
<td>35.499</td>
<td>34.987</td>
<td>34.427</td>
<td>33.439</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Pension Participation rate(%)</th>
<th>76.730</th>
<th>77.205</th>
<th>77.630</th>
<th>77.775</th>
<th>78.031</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Old age work hours</th>
<th>0.272</th>
<th>0.272</th>
<th>0.273</th>
<th>0.274</th>
<th>0.275</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Average contribution</th>
<th>0.060</th>
<th>0.060</th>
<th>0.059</th>
<th>0.058</th>
<th>0.056</th>
</tr>
</thead>
</table>
Table 8: The role of Temptation/Self-control

<table>
<thead>
<tr>
<th>Indicator</th>
<th>Self-control</th>
<th>No Self-control</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>baseline</td>
<td>Anuity with 100% MC</td>
</tr>
<tr>
<td>Column</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Young Savings rate(%)</td>
<td>0.428</td>
<td>35.499</td>
</tr>
<tr>
<td>Pension Participation rate(%)</td>
<td>1.915</td>
<td>77.205</td>
</tr>
<tr>
<td>Old age work hours</td>
<td>0.310</td>
<td>0.272</td>
</tr>
<tr>
<td>Average contribution</td>
<td>0.000</td>
<td>0.060</td>
</tr>
</tbody>
</table>

scheme in addition to the subsidy. The result indicates that even though temptation parameter is small, it induces large impact on the response to policy interventions as tempted agents value commitment device and therefore participate more in the pension scheme leading to high savings rate. Thus, the response of self-control agents to the policy in terms of participation, contributions and savings are higher compared to that of the non-tempted agents.

6 Conclusion

In this paper we have developed a life cycle model to examine welfare and savings impact of government sponsored matching contributions on voluntary pension scheme for informal workers in developing countries. Agents in this economy suffer from temptations with self-control costs of holding wealth à la Gul and Pesendorfer (2001). Our setup for the analysis consists of overlapping generations of 60-period lived ex ante heterogeneous individuals facing mortality risk and individual income risk emanating from employment and health status uncertainties. There is absence of private credit markets, including markets for private annuities. Individuals supply their labor inelastically whenever they are given an employment opportunity to work in formal or informal sector of employment until a mandatory retirement age. After mandatory retirement age for workers, individuals make employment decisions on participation and hours of work in the informal sector. To insure against uncertainties in income and for old-age consumption when labor income is relatively low even when work, individuals in our economy save through private asset holdings and personal retirement account. Old age consumption is supported by savings, retired formal workers pension and labor income from informal employment. The model is calibrated to data from Ghana for quantitative and qualitative analysis.

We find that informal workers can be incentivized to participate and contributes to pension system through ex ante redistribution (pension savings subsidy or matching contributions) and/or mandatory annuity. This would have the capacity to expand the pension
coverage, reduce old age poverty and improves welfare in developing countries. Welfare gains due to insurance and redistribution effects of pension savings subsidy and mandatory annuity dominate welfare losses emanating from consumption taxes. Low educated poor informal workers are net beneficiaries from the policy. Moreover, national savings rate among workers also increase in response to the matching contribution that subsidize pension contributions.

Our results also indicate that matching contributions rate (savings subsidy) of about 159% is optimal in terms of maximizing social average welfare and the welfare of the poor (low educated). The study also shows that a mandatory annuitization of pension savings even without government matching workers contributions still possess the ability to incentivize informal workers to contribute with welfare enhancing effect. This suggests that developing countries with limited fiscal space to finance transfer to the increasing aged population can still design pension system that expand the coverage to informal workers by mandating annuitization of pension savings. Our simulations result also suggests that higher matching contributions rate targeted to low income informal workers is associated with an increase in national savings.

Fiscal costs that would be incurred in implementing the matching contributions programs intended to encourage informal workers to contribute to pensions in an effort to expand pension coverage would depend on the matching rate. We estimate that consumption taxes would increase by 2.72 and 4.28 percentage points to implement matching contributions with lump sum and annuity payments respectively. In terms of GDP, the two programs are estimated to cost the Ghanaian government about 3.21% and 3.80% for lump sum payments and mandatory annuity respectively. However, mandatory annuitization of pension savings without matching contributions program would also improve welfare with no additional fiscal cost. Thus, depending on the fiscal space available for governments of developing countries, mandatory annuitization of pension savings with varying matching rates could be implemented to improve welfare of elderly and at the same time boost households savings.
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