

# Low Fertility, Rapid Aging and Fiscal Challenges with the Presence of Informal Employment

Tanyasorn Ekapirak<sup>1</sup>, Minchung Hsu<sup>1</sup>, Pei-Ju Liao<sup>2</sup>

<sup>1</sup> National Graduate Institute for Policy Studies (GRIPS), Tokyo

<sup>2</sup> Academia Sinica, Taipei

October 13, 2015

# Motivation

- Global trend of population aging : rapid decline in fertility and improvement in old-age survival rates in developing world
  - Decrease in labor force
  - Increase in old-age-dependency ratio
  - Increasing demand/cost of medical care
  - Getting old before getting rich

# Low fertility

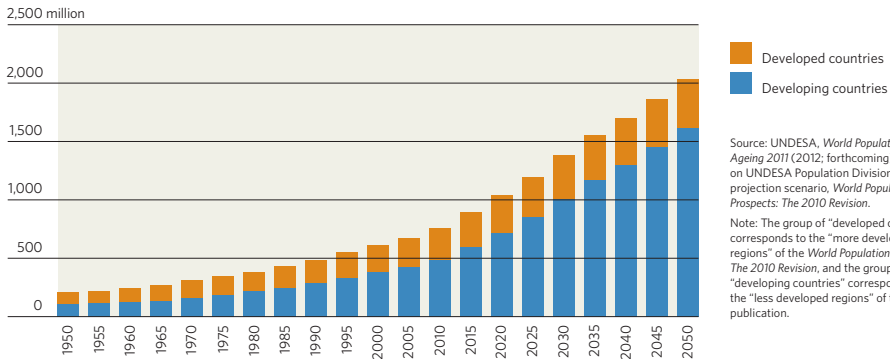
Table : Total Fertility Rate 2005-10

Lower income	India	Indonesia	Philippines	Vietnam
4.03	2.66	2.50	3.27	1.89
Upper-middle income	Brazil	China	Mexico	Thailand
2.09	1.90	1.63	2.37	1.49
High income	Australia	Japan	UK	US
1.65	1.89	1.34	1.88	2.06

Note: TFR of all countries – 2.44. Source: Lee et al (2014, Science)/UN.

# Global Aging: number of people aged 60+

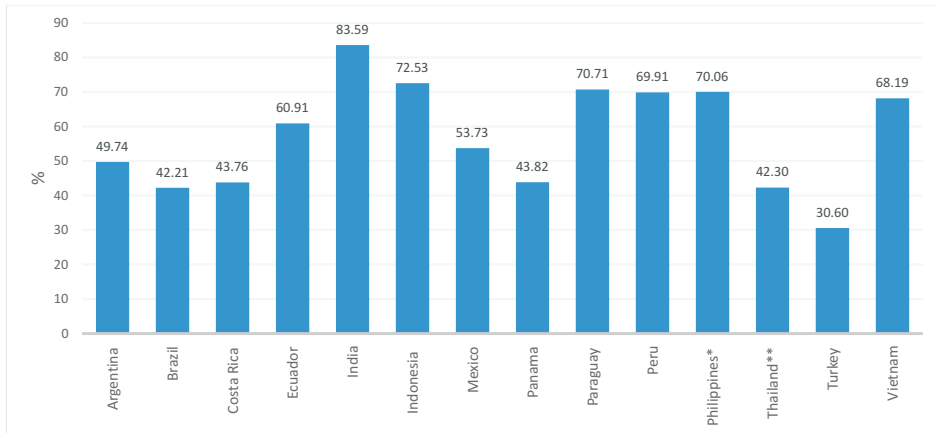
Fast increase in old people from developing countries



# Motivation (cont'd)

- Developing countries are encouraged to pursue a better social welfare system for their aging population,
  - Public pension (social security) and universal health insurance are recommended
  - Many are developing or even recently established such social programs, eg. China, India, Thailand, Vietnam, Mexico, Brazil...
- Fiscally sustainable with the fast aging population?
- Additional challenge: large informal employment
  - On average more than 50% of workers in non-agricultural sectors are informal (even higher with agriculture)
  - A strict constraint for government on income tax collection

# Informal Employment Share (non-agriculture 2009)



Source: ILO

# Questions of Interest

- What is the impact of aging on the social development in developing countries?
- Will a change in population policy to encourage fertility help?
- What is a better fiscal policy for financing the cost of aging?
- What is the role of the informal sector?

# Related Literature

- Quantity-quality trade-off and growth:
  - Pioneered by Becker (1960) – endogenous fertility/education choices
  - Following up studies linking fertility, demographic change and economic growth, e.g. Becker, Murphy, and Tamura (1990), Galor and Weil (1996), Doepke (2004), Doepke and Zilibotti (2005) and Liao (2011,2013)
  - Usually focusing on the early stage of economic development with a demographic transition from high to low fertility rates
- Population policy
  - Lee et al (2014) – optimal fertility rate; Zhang (1997) – population policies and growth



## Related Literature (cont'd)

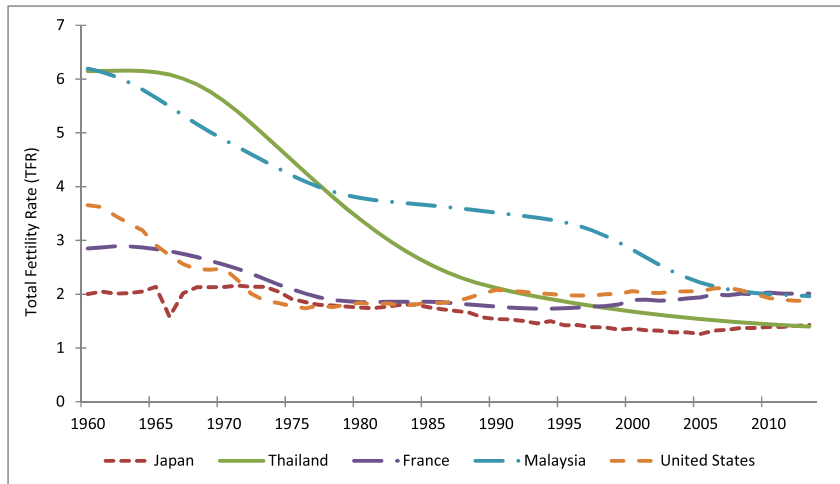
- Informal employment
  - Jung and Tran (2012) – Extending social security to informal sectors
- Fiscal policy and aging
  - Many studies on issues of financing pension/social security with the trend of aging
  - Eg. Kitao (2014, 2015)
  - Fertility is exogenously given

# What we do

- ➊ Combining the above strands of literature
- ➋ Focusing on developing economies in a later stage of development with low fertility
- ➌ An OLG model with endogenous fertility and education choices (quantity-quality trade-off)
- ➍ Taking into account the existence of large informal employment – both voluntary and forced informal workers
- ➎ Using Thailand as a representative for calibration and quantitative analysis
  - has a very low fertility rate (TFR 1.5) and expects rapid population aging
  - has a large informal sector – about 60% of employment is informal
  - recently established a public pension and a universal health care system
- ➏ Quantitative policy analysis

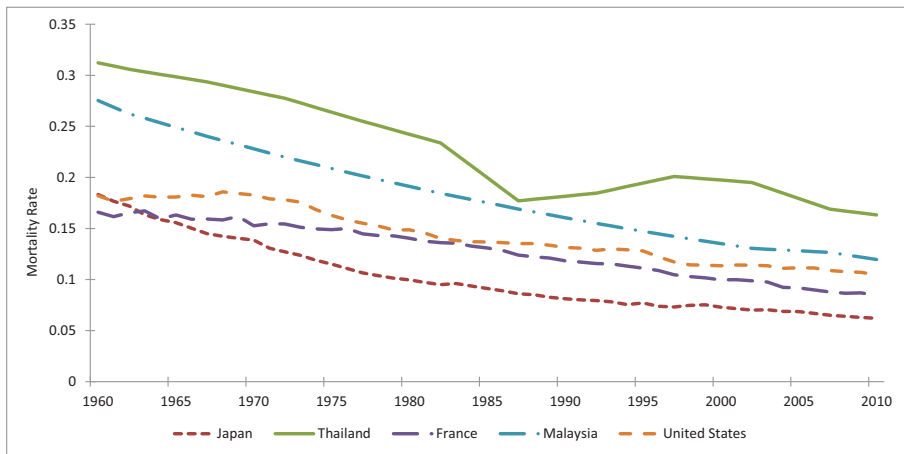
# Background Information (Thailand)

A dramatic transition in fertility: Thailand from 6 (1960s) to below 2 (2000s).



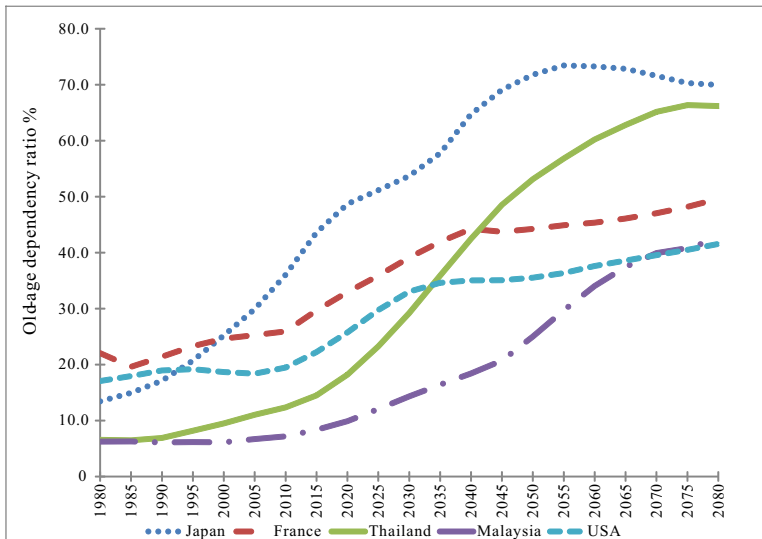
# Background Information (Thailand)

## Decreasing mortality



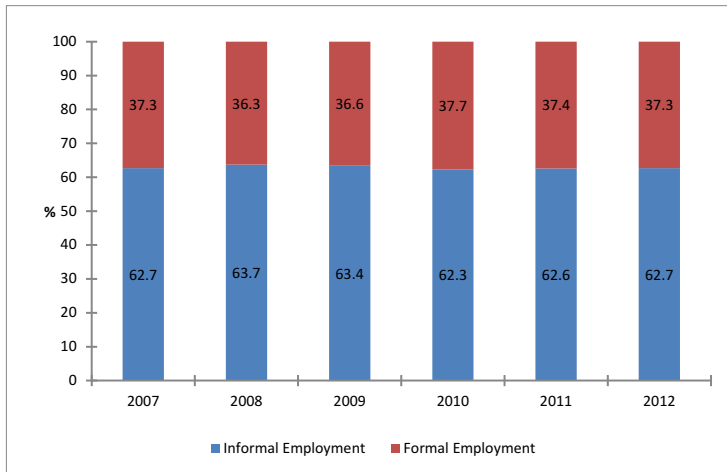
# Background Information (Thailand)

Increasing old-age dependency (declining labor force)



# Background Information (Thailand)

More than 60% of total labor are informal employment



# Background Information (Thailand)

## Income inequality between formal/informal employment

Table : Wage by Education and Employment

	Average monthly wage (baht)		
	2005	2006	2007
Social average	7,993	8,436	9,141
Formal workers	12,531	12,724	13,169
Informal workers	3,677	3,928	4,235

Source: HSES and Hsu et al (2014).

# Rest of the talk

- 1 Model
- 2 Calibration
- 3 Quantitative analysis
  - Impact of aging
  - Policy analysis: population/education/fiscal policies and role of informal sector
- 4 Conclusion



# Model features

## Demographics

- Life cycle is characterized by 3 stages (each 30 years): child, young adult, and old adult. Total population:

$$N = N^c + N^y + N^o$$

- $N^c = nN^y$ , where  $n$  is the average fertility per person
- Survival rate from young adults to old adults:  $\pi^y$ .

$$N^{o'} = \pi^y N^y$$

- Life expectancy:  $60 + 30\pi_y$ .

# Model features (cont'd)

## Production and Labor market

- Two sectors (formal and informal) – total production  $Y = Y^f + Y^x$
- CRS production technology with 3 input factors (capital  $K$ , skilled labor  $L_s$ , unskilled labor  $L_u$ ):

$$Y^f = A^f (K^f)^{\alpha_1} (L_s^f)^{\alpha_2} (L_u^f)^{\alpha_3}$$

$$Y^x = A^x (K^x)^{\gamma_1} (L_s^x)^{\gamma_2} (L_u^x)^{\gamma_3}$$

- Firms are competitive with labor market frictions (mobility constraints) – both voluntary and forced employment in the informal sector
- Wage inequality:  $w_s^f > w_u^f$ ,  $w_s^f > w_s^x$  and  $w_u^f > w_u^x$

# Model features (cont'd)

- **Informal employment**

- labor income is not monitored (taxed)
- informal income does not count for pension
- workers receiving much lower wage rates
- a constraint of moving to formal sector
- both voluntary and forced employment

# Model features (cont'd)

- **Education and Labor quality**

Two types of workers: skilled (if parents invested on education) and unskilled,  $i \in \{s, u\}$ .

- **Government**

- Funding 2 social programs
  - A public pension (PAYG) with a replacement rate  $\rho$  on registered labor income
  - A public health insurance covering a fraction,  $\omega$ , of individual medical expenditures
- Other (net) public expenditures  $G$
- Tax tools: labor income, consumption and capital income taxes

# Model features (cont'd)

- **Life-cycle**

- 1. Children depend on their parents (no decision making).
- 2. Young adults work and make decisions on – time allocation (formal labor, informal labor, child care), number of children  $n$ , children's education  $e$ , consumption  $c^y$ , and savings  $a'$ .
- 3. Old adults use their savings/pension for consumption  $c^{o'}$  and medical care  $m'$ .

# Individual's problem

An young adult with skill level  $i$  chooses current consumption  $c_i^y$ , asset holdings  $a_i'$ , number of kids  $n_i$ , education investment per kid  $e_i = \{0, \bar{e}\}$  and proportion of formal labor supply  $\theta_i \leq \bar{\theta}_i$  (limit of formal positions) to maximize her lifetime utility.

$$V_i = \max_{\{c_i^y, a_i', n_i, e_i, \theta_i \leq \bar{\theta}_i\}} \{u(c_i^y) + \beta \pi^y u(c_i^{o'}) + \psi n_i^{-\epsilon} [n_i V_j']\},$$

subject to

$$(1 + \tau_C)c_i^y + \pi^y a_i' + e_i n_i = (1 - \phi n_i)[\theta_i(1 - \tau_L)w_i^f + (1 - \theta_i)w_i^x];$$

$$(1 + \tau_C)c_i^{o'} + (1 - \omega)m' = [1 + (1 - \tau_K)r']a_i' + P_{g,i};$$

$$P_{g,i} = \rho w_i^f (1 - \phi n_i) \theta_i;$$

$$j = s, \text{ if } e_i = \bar{e} (= \rho_s w_s^f); j = u, \text{ if } e_i = 0$$

# Equilibrium features

- Focus on an equilibrium that both skilled and unskilled workers exist with an upward mobility
  - Skilled parents always invest on children's education
  - Some unskilled parents invest on education but the others don't : that implies an indifferent condition in the model equilibrium

$$\frac{V_{u,e=\bar{e}}}{P_s^{1-\epsilon}} = \frac{V_{u,e=0}}{P_u^{1-\epsilon}}$$

where

$P_s = \phi[\theta_i(1 - \tau_L)w_i^f + (1 - \theta_i)w_i^x] + \bar{e}$  is the total cost for having an educated child and

$P_u = \phi[\theta_i(1 - \tau_L)w_i^f + (1 - \theta_i)w_i^x]$  is the total cost for an un-(low-)educated child.

# Equilibrium features (cont'd)

- Optimal decisions:

- savings ( $\pi_y a'$ ) :  $u_{cy} = \beta(1 + (1 - \tau_K)r')u_{c'o'}$

- fertility (number of kids):

$$\psi(1 - \epsilon)(n_i)^{-\epsilon} V_j' = u_{cy} \{ \phi[\theta_i(1 - \tau_L)w_i^f + (1 - \theta_i)w_i^x] + e_i \}$$

- formal labor supply:

if not binding

$$\left[ (1 - \tau_L) + \left( \frac{\pi_y}{1 + r} \right) \rho \right] w_i^f = w_i^x; \quad \theta_i < \bar{\theta}_i$$

if binding

$$\left[ (1 - \tau_L) + \left( \frac{\pi_y}{1 + r} \right) \rho \right] w_i^f > w_i^x; \quad \theta_i = \bar{\theta}_i$$



# Equilibrium features (cont'd)

- Given the big wage gap between formal and informal sectors, it is not possible if none of the formal labor supply constraints are binding
- 2 possible cases:
  - Case 1: unskilled binding; skilled not binding

Skilled:

$$\begin{aligned} & \left[ (1 - \tau) + \left( \frac{\pi_y}{1 + r} \right) \rho \right] w_s^f = w_s^x; \quad \theta_s < \bar{\theta}_s \\ \Rightarrow & \left[ (1 - \tau) + \left( \frac{\pi_y}{1 + r} \right) \rho \right] \frac{A^f (K^f)^{\alpha_1} (L_s^f)^{\alpha_2 - 1} (L_u^f)^{\alpha_3}}{A^x (K^x)^{\gamma_1} (L_s^x)^{\gamma_2 - 1} (L_u^x)^{\gamma_3}} = 1 \\ \Rightarrow & \frac{L_s^f}{L_s^x} = \left[ (1 - \tau) + \left( \frac{\pi_y}{1 + r} \right) \rho \right] \frac{A^f (K^f)^{\alpha_1} (L_s^f)^{\alpha_2} (L_u^f)^{\alpha_3}}{A^x (K^x)^{\gamma_1} (L_s^x)^{\gamma_2} (L_u^x)^{\gamma_3}} \end{aligned}$$

Unskilled:  $\theta_u = \bar{\theta}_u$

- Case 2: both binding  $\Rightarrow \theta_u = \bar{\theta}_u$  and  $\theta_s = \bar{\theta}_s$  (not interesting)

## Equilibrium features (cont'd)

- Capital market clearing:  $r^f = r^x$ .
- Government budget balance every period:  $P_g + M_g + G = T_c + T_l + T_k$

# Calibration

- Benchmark: matching Thailand's demographic and other main economic variables in 2000s

# Parameters

Parameters	Value	Source/Target
<i>Survival Rates</i>		
$\pi^y$	0.47	life expectancy 74.18
<i>Preference</i>		
$\beta$	0.9383	capital-output ratio 1.9
$\psi$	0.234	TFR 1.54
<i>Informal employment and production</i>		
$\bar{\theta}_s$	–	not binding
$\bar{\theta}_u$	0.3	binding; data $L_u^f / (L_u^f + L_u^x) = 0.3$
$A^f$	10	normalization
$A^x$	6.53	data $L_s^f / (L_s^f + L_s^x) = 0.726$
$(\alpha_1, \alpha_2, \alpha_3)$	(0.67, 0.09, 0.24 )	data income shares (formal sector)
$(\gamma_1, \gamma_2, \gamma_3)$	(0.67, 0.045, 0.285 )	$w^f / w^x = 3.26$

# Parameters (cont'd)

Parameters	Value	Source/Target
<i>Child Schooling/Rearing Costs</i>		
$\phi_s$	0.127	skilled labor share 17.34% (formal sector)
$\phi$	0.243	child-rearing cost (to high school) 2004
<i>Tax Rates</i>		
$\tau_C$	10%	VAT 7% + other excise duty 3%
$\tau_K$	20%	corporate tax on net profit
$\tau_L$	15%	median tax rate on earnings
<i>Government Subsidy</i>		
$\omega$	67.5%	public medical expenditure share
$\rho$	25%	pension replacement rate

# Benchmark

	Data	Model (benchmark)
<b>Calibrated</b>		
Average TFR	1.54	1.53
Life expectancy	74	74
Skilled labor share (formal)	17%	17%
Capital-output ratio	1.90	1.90
$\theta_s (L_s^f/L_s)$	0.73	0.73
$\theta_u (L_u^f/L_u)$	0.30	0.30
$w^f/w^x$	3.26	3.28
<b>Not calibrated</b>		
$w_s^f/w_u^f$	1.79	1.80
$(G/Y) / (\text{Total Govt Exp}/Y)$	-/ 11.71%	7.79% / 11.24%
$n_{ss}$		0.3485
$n_{us}$		0.2991
$n_{uu}$		0.9272

# Features of a developing economy

- Lower development of human capital – 17% skilled labor share (formal sector)
- Large informal employment – 36% skilled labor and 70% unskilled labor

# Population Aging

- An increase in life expectancy from 74 to 83 as forecasted in 2065.
- An increase in medical expenditure to GDP ratio from 3.65% to 7.47% (estimated from cross-country data).
- Assume government expenditure  $G$  to GDP ratio fixed as in the benchmark.
- Baseline: labor income tax is used to ensure fiscal balance in the aging economy (new steady state).



# Impact of Aging

	Benchmark (2000s)	Aging (2065)
$n_{ss}$	0.349	0.336
$n_{us}$	0.298	0.278
$n_{uu}$	0.927	0.927
Average TFR	1.532	1.526
Life expectancy	74.1	83.1
Skilled labor share (formal)	17.1%	<b>14.7%</b>
$w_s^f / w_u^f$	1.80	2.16
Capital-output ratio	1.90	2.19
$(L_s^f / L_s)$	0.726	<b>0.679</b>
Labor income tax	15.0%	<b>29.4%</b>

# Impact of Aging (cont'd)

- Longer life expectancy –
  - need more savings for old age;  $K/Y \uparrow$
  - savings crowd out fertility
- Higher labor tax (15%  $\rightarrow$  29%) for financing government expenditures –
  - lowers return of education investment (skilled labor share  $\downarrow$ )
  - pushes skilled labor to informal sector which has a lower TFP;  $L_s^f/L_s$ , 73%  $\rightarrow$  68%

# Fiscal policy with aging

- Alternative tax tools for financing government expenditures with aging

Financing tool	Aging economy		
	Labor tax	Consumption tax	Capital tax
$\tau_L$	<b>29.4%</b>	15.0%	15.0%
$\tau_C$	10%	<b>15.6%</b>	10.0%
$\tau_K$	20%	20.0%	<b>27.1%</b>
Average TFR	1.526	1.530	1.530
Skilled labor share (formal)	<b>14.69%</b>	17.14%	17.15%
Capital-output ratio	2.193	2.297	<b>2.186</b>
Social welfare	1.45	<b>1.56</b>	1.52
Welfare (skilled)	2.45	2.56	2.49
Welfare (unskilled)	1.37	1.48	1.44

## Fiscal policy with aging (cont'd)

- Labor tax distorts education investment and labor allocation
- Capital tax distorts capital accumulation
- Consumption tax is a better tool with less distortion on education investment, labor allocation, capital accumulation

# Encouraging fertility or education?

- A subsidy on child-rearing covering a part of the time cost
- An education subsidy
- Steady-state comparison

# Encouraging fertility or education? (cont'd)

	Baseline	10% child care	10% education
$n_{ss}$	0.336	0.404	0.345
$n_{us}$	0.278	0.305	0.299
$n_{uu}$	0.927	1.145	0.927
Average TFR	1.526	1.882	1.536
Skilled labor share	<b>14.69%</b>	<b>12.10%</b>	<b>15.67%</b>
$w_s^f / w_u^f$	2.158	2.699	2.000
Capital-output ratio	2.19	2.09	2.19
$(L_s^f / L_s)$	0.679	0.640	0.680
Labor income tax	<b>29.41%</b>	<b>37.61%</b>	<b>29.86%</b>
Social welfare	1.45	<b>1.34</b>	<b>1.45</b>
		<b>(CEV=-12.92%)</b>	<b>(CEV=0.42%)</b>
Welfare (skilled)	2.45	2.41	2.38
Welfare (unskilled)	1.37	1.27	1.37
Old/Young ratio	93.77%	75.40%	93.63%

# Encouraging fertility or education? (cont'd)

- Distortion of child-rearing subsidy
  - Unskilled children become cheaper
  - less education investment – worsening the skilled labor share
  - crowding out savings (capital)
  - higher tax burden and lower welfare

# Role of Informal Sector (I)

- Suppose the government improves its tax collection technology – informal income can be taxed
- Assume government extends its taxation capacity to tax income from both skilled and unskilled workers in the informal sector with a 50% probability.



# Role of Informal Sector (I)

	(1) Baseline	(2) taxing informal	(3) pension benefits fixed as in (1)
Average fertility	1.526	1.522	1.514
Skilled labor share (formal)	14.69%	<b>15.76%</b>	<b>16.48%</b>
Capital-output ratio	2.19	2.15	2.21
Labor income tax	<b>29.4%</b>	<b>25.4%</b>	<b>23.5%</b>
Social welfare	<b>1.45</b>	<b>1.40</b> <b>(CEV:-6.69%)</b>	<b>1.46</b> <b>(CEV: 0.97%)</b>
Welfare (skilled)	2.45	2.39 (CEV:-4.65%)	2.44 (CEV:-0.7%)
Welfare (unskilled)	1.37	1.32 (CEV:-6.85%)	1.38 (CEV:1.09%)

# Role of Informal Sector (I)

- 50% of informal labor income is taxed
- Taxing informal sector reduces the distortion on skilled labor allocation and education investment by labor tax
- An increase in pension payment hurts the aging economy (with a negative population growth)
- If pension payment is fixed as before (prior to taxing informal income), a positive welfare gain

## Role of Informal Sector (II)

- If both sectors pay taxes, which tax tool is better?

Financing tool	Aging economy		
	Labor tax	Consumption tax	Capital tax
$\tau_L$	<b>23.1%</b>	15.0%	15.0%
$\tau_C$	10%	<b>19.0%</b>	10.0%
$\tau_K$	20%	20.0%	<b>31.4%</b>
Skilled labor share (formal)	<b>16.5%</b>	17.6%	17.6%
Capital-output ratio	2.10	2.18	<b>2.00</b>
Skilled welfare	2.33	2.38	2.27
Unskilled welfare	1.27	1.35	1.28
Social welfare	1.35	<b>1.47</b>	1.36

## Role of Informal Sector (II)

- If both sectors pay taxes, consumption tax is still better
- If consumption tax is not available
  - labor tax toll and capital tax tool are similar in terms of social welfare
  - the skilled prefer labor tax and the unskilled prefer capital tax
  - labor tax still distorts the time cost of child-rearing and capital tax distorts saving

# Conclusion

- Impact of Aging :
  - Significant increase in tax burden to sustain social programs/government expenditures (labor income tax from 15% to 29%).
  - If labor income tax has to increase, there are distortions on education investment and labor allocation – because of the presence of the informal sector
- Fiscal policy on government financing with aging and informal employment
  - Consumption tax is the best and capital tax is better than labor income tax
  - less distortion on saving, employment and education investment
  - old people sharing some fiscal burden is good given the aging population
- Subsidy to increase fertility or education?
  - Not preferred in the long run
  - Skilled labor share decreases – distortion on education investment; uneducated kids are cheaper
  - Education subsidy improves social welfare

# Conclusion and future work

- Taxing informal sector?
  - lower labor tax rate, but social welfare is not improved unless pension benefit is unchanged
  - if both sectors pay taxes, consumption tax is still the best tool with aging
  - capital tax is not significantly better than labor tax
- Future work
  - Transition for policy comparison
  - Various benchmark scenarios – size of informal employment, level of human capital, TFR, income gap between two sectors...