Fertility Policies and Social Security Reforms in China

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Motivation

- China's unique fertility policies and imminent social security reforms
  - How do they affect national saving, domestic and global interest rates?
  - What are the necessary pension system adjustments to ensure viability?

- China's **One-Child Policy**
  - Hastened demographic aging
  - Large increase in household saving (Choukhmane, Coeurdacier, and Jin (2013))

Main Objective

- Key Innovation: endogenizing Fertility
  - **Feedback loop 1**: fertility affects social security which, in turn, affects fertility
  - **Feedback loop 2**: interest rates affect fertility which affect saving and interest rates
  - Creates an **additional (indirect) channel** through which policy, institutional reforms and economic development can impinge on national saving and the social security system.

$\Rightarrow$ Develop appropriate framework that accounts for GE and feedback effects of fertility, social security and interest rates with various levels of financial openness.

Model Ingredients

- 3-period overlapping generations model
  - Intergenerational transfers
- Production economy
  - capital accumulation
- Social security system
- Closed and open-economy cases

Production

- Production

$$Y_t = (K_{t-1})^{\alpha} \left[A_t \left(e_t L_{y,t} + L_{m,t}\right)\right]^{1-\alpha},$$

- Capital accumulation

$$K_t = (1-\delta)K_{t-1} + I_t.$$

- Wages

$$w^i_{y,t} = e_t(1-\alpha)A_t \left(k_{t-1}\right)^{\alpha}, \qquad w^i_{m,t} = (1-\alpha)A_t \left(k_{t-1}\right)^{\alpha},$$

- Rate of Return

$$R_t = 1 - \delta + \alpha \left(k_{t-1}\right)^{\alpha-1}$$

where $e < 1$ and $k_{t-1} \equiv K_{t-1}/[A_t(e_t L_{y,t} + L_{m,t})]$

The Social Security System

The social security system evolves according to

$$\tau_{t+1} w_{y,t+1} L_{y,t+1} + \tau_{t+1} w_{m,t+1} L_{m,t+1} + R_{t+1} B_t = \sigma_{t+1} w_{m,t} L_{o,t+1} + B_{t+1}$$

- Let $b_t \equiv \frac{B_t}{Y_t}$;
- τ taxes ; σ–replacement ratio
- $B = 0 \rightarrow$ PAYGO system
- $\overline{\sigma} \rightarrow$ defined benefits system
- $\tau_t = \sigma_{t+1}$ for all $t \rightarrow$ defined contribution system

Households

- Preferences

$$U_t = \log(c_{y,t}) + v \log(n_t) + \beta \log(c_{m,t+1}) + \beta^2 \log(c_{o,t+2})$$

where $v > 0$ (preference for children), and $0 < \beta < 1$.

- Sequence of budget constraints:

$$\begin{aligned} c_{y,t} + a_{yt} &= (1-\tau_t) w_{y,t} \\ c_{m,t+1} + a_{m,t+1} &= (1-\tau_{t+1}) w_{m,t+1} + R_{t+1} a_{y,t} + T_{m,t+1} \\ c_{o,t+2} &= R_{t+2} a_{m,t+1} + \sigma_{t+2} w_{m,t+1} + T_{o,t+2}. \end{aligned}$$

- Transfers:

$$T_{m,t+1} = -\left(\phi n_t + \psi \frac{n_{t-1}^{\varpi-1}}{\varpi} \right) w_{m,t+1}.$$

$$T_{o,t+2} = \psi \frac{n_t^{\varpi}}{\varpi} w_{m,t+2}.$$

- Assumption (1)

  Credit constraints:

$$a_{y,t+1} = -\theta \frac{w_{m,t+1}}{R_{t+1}},$$

  - Optimal Fertility

$$\frac{v}{n_t} = \frac{\beta}{c_{m,t+1}} \left(\phi w_{m,t+1} - \frac{\psi n_t^{\varpi - 1} w_{m,t+2}}{R_{t+2}} \right)$$

$\Rightarrow$ First relationship describing $\{k_t; n_{t-1}\}$ given $\{b_t; \tau_t; \sigma_t\}_{t \geq 0}$

- Optimal Saving:

$$
\begin{aligned}
a_{m,t+1} &= \frac{\beta}{1+\beta}\left[\left(1-\tau_{t+1}-\theta-\phi n_t-\frac{\psi n_{t-1}^{\varpi-1}}{\varpi}\right)w_{m,t+1}\right] \\
&- \frac{\psi n_t^{\varpi}}{(1+\beta)\varpi}\frac{w_{m,t+2}}{R_{t+2}}-\frac{\sigma_{t+2}}{1+\beta}\frac{w_{m,t+1}}{R_{t+2}}
\end{aligned}
$$

- Capital markets equilibrium

$$
L_{m,t+1}a_{m,t+1}+L_{y,t+1}a_{y,t+1}+B_{t+1}=K_{t+1},
$$

$\Rightarrow$ Second relationship describing $\{k_t; n_{t-1}\}$ given $\{b_t; \tau_t; \sigma_t\}_{t\geq 0}$

Long-Run Analysis

- $\sigma_t = \sigma$, $\tau_t = \tau$, $b_t = b$

Assumption (2)

Transfers are not subject to decreasing returns in children: $\varpi = 1$

Assumption (3)

$e = 0$

Assumption (4)

$\tau < 1 - \theta - \psi$

(So that a positive number of kids will be desired)

Three Key Relationships

1. Based on saving:

$$R_{KK}(\underset{+}{n}) = \frac{n g_A \Phi + \sigma}{\beta \left(1 - \tau - \theta - \phi n - \psi\right) + \left(1 + \beta\right) \frac{b}{1-\alpha}}. \qquad \textbf{(KK)}$$

where $\Phi \equiv (1+\beta)\left(\frac{\alpha}{1-\alpha} + \theta + \frac{\psi}{1+\beta}\right)$.

– Four channels where n affects saving: (1) MPK; (2) 'expenditure effect'; (3) 'transfer effect'; (4) share of young borrowers

- Partial eqb. comparative statics:

$$\frac{\partial R_{KK}}{\partial \theta} > 0; \ \frac{\partial R_{KK}}{\partial b} > 0; \ \frac{\partial R_{KK}}{\partial \alpha} > 0; \ \frac{\partial R_{KK}}{\partial g_A} > 0$$

Three Key Relationships

2. Based on fertility:

$$R_{NN}(\underline{n}) = \frac{n g_A \psi + \lambda_0 \sigma}{n\phi - \lambda_0 \left(1 - \tau - \theta - \psi\right)}, \qquad \textbf{(NN)}$$

where we denote $\lambda_0 \equiv \left(\frac{v}{v+\beta(1+\beta)}\right)$.

– Partial eqb. comparative statics:

$$\frac{\partial n}{\partial \phi} < 0;\ \frac{\partial n}{\partial v} > 0;\ \frac{\partial n}{\partial \theta} < 0;\ \frac{\partial n}{\partial g_A} > 0$$

Three Key Relationships

3. Based on social security dynamics:

$$\left(\frac{R}{ng_A} - 1\right) b = \frac{\sigma}{ng_A} - \tau, \qquad \textbf{(SS)}$$

- $R > ng_A \rightarrow$ need to run primary surplus to stabilize debt
- $R < ng_A \rightarrow$ can still run primary deficit even with debt
- Target a given level of b, let τ, σ adjust.

- **KK, NN, SS** curves combine to determine n^*, R^*.

PAYGO

- $b = 0$
- Long run: $\tau_t = \tau$ and $\sigma_t = \sigma$
- Scheme 1: $\bar{\tau}$
- Scheme 2: $\bar{\sigma}$
- Three key equations:

$$R_{KK}(n) = \frac{n g_A \Phi + \sigma}{\beta (1 - \tau - \theta - \phi n - \psi)} \qquad \textbf{(KK)}$$

$$R_{NN}(n) = \frac{n g_A \psi + \lambda_0 \sigma}{n\phi - \lambda_0 (1 - \tau - \theta - \psi)} \qquad \textbf{(NN)}$$

$$\tau = \frac{\sigma}{n g_A} \qquad \textbf{(SS)}$$

- Consider Scheme 1: $\bar{\tau}$, σ adjusts

$$n_{\bar{\tau}} = \frac{(1-\bar{\tau}-\theta-\psi)}{\phi}\left(\frac{\psi\beta+\lambda_0\Phi+\lambda_0(1+\beta)\bar{\tau}}{\psi\beta+\Phi+(1+\beta\lambda_0)\bar{\tau}}\right)$$

$$R_{\bar{\tau}} = \left(\frac{g_A}{\beta\phi}\right)\left(\frac{\psi\beta+\lambda_0\Phi+\lambda_0(1+\beta)\bar{\tau}}{1-\lambda_0}\right)$$

- Comparing LF ($\tau=\sigma=0$) and paygo ($\tau>0;\sigma>0$):
  - $R_{SS} > R_{LF}$ due to lower saving
  - $n_{SS} < n_{LF}$: children and social security are somewhat substitutable
  - Impact of a one-child policy is larger under LF

PAYGO: Endogenous Fertility

- paygo: $\sigma = \tau n g$

Proposition: Under endogenous fertility, a fall in productivity growth g_A lowers fertility under a paygo scheme where taxes endogenously adjust ($\bar{\sigma}$ scheme) but leave fertility unchanged if replacement rate endogenously adjust ($\bar{\tau}$ scheme). Interest rates fall in both cases but more so under a $\bar{\sigma}$ scheme. That is,

$$\frac{\partial n}{\partial g_A}\Big|_{\bar{\sigma}} > \frac{\partial n}{\partial g_A}\Big|_{\bar{\tau}}. = 0$$

$$\frac{\partial R}{\partial g_A}\Big|_{\bar{\sigma}} > \frac{\partial R}{\partial g_A}\Big|_{\bar{\tau}}. > 0$$

PAYGO: Constrained Fertility

Proposition: Implementing a binding fertility constraint $n = n_{max}$ raises saving by more under a paygo scheme where replacement ratios endogenously adjust than under a paygo scheme where taxes endogenously adjust. That is,

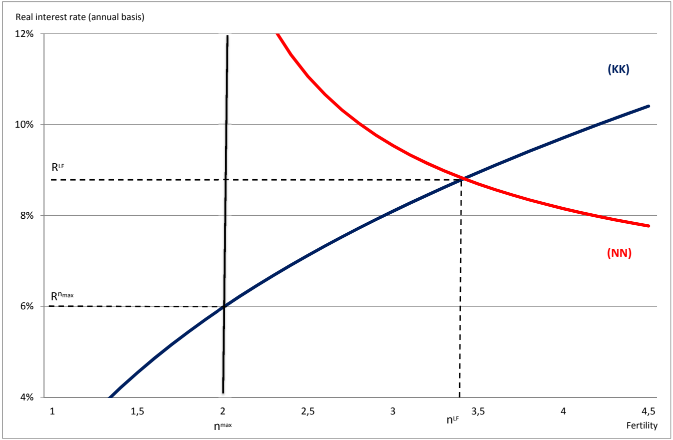
$$\frac{\partial R}{\partial n_{max}}\Big|_{\bar{\sigma}} > \frac{\partial R}{\partial n_{max}}\Big|_{\bar{\tau}}.$$

Illustrations: Parameter Values

Table : Benchmark Calibration

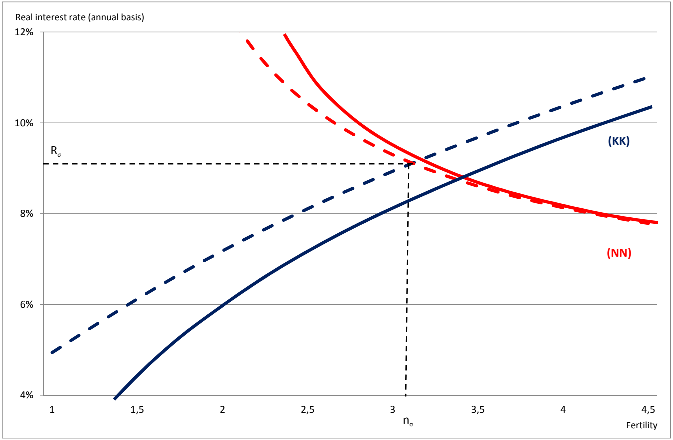
End. variable	Steady-state value	Comment/Description
$n_{\bar{\sigma}}$	1.43	Fertility of 2.86
$R_{\bar{\sigma}} - 1$	9.04%	Annual basis
$\tau_{\bar{\sigma}}$	7.6%	/
Parameter	**Calibrated value**	**Target/Description (Data source)**
β	0.99	Annual basis
$g_A - 1$	4.5%	Annual basis. Total Factor Productivity growth rate (1980-2010)
v	0.12	Targeted to match the fertility in 1970-1972 of 2.8-3 (Census)
θ	1%	Saving rate of the 20-25
α	30%	Capital Share
ω	0.7	Elasticity of transfers to elderly w.r.t the nb. of siblings (CHARLS)
ϕ	8%	Average education expenditures over income (UHS)
ψ	10%	Choukhmane et al. (2013), Curtis et al. (2011)
$\bar{\sigma}$	30%	Aggregate replacement ratios adjusted for coverage (UHS)
b	0	Paygo simulation

Figure : Laissez-Faire



Notes: $\tau = \sigma = 0$; benchmark parameters.

Figure : From Laissez-Faire to PAYGO

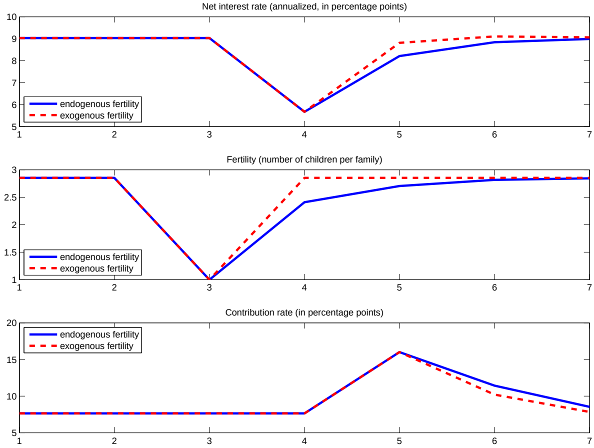


Notes: Move to $\sigma = 0.3$; benchmark parameters.

Policy and Growth Experiments

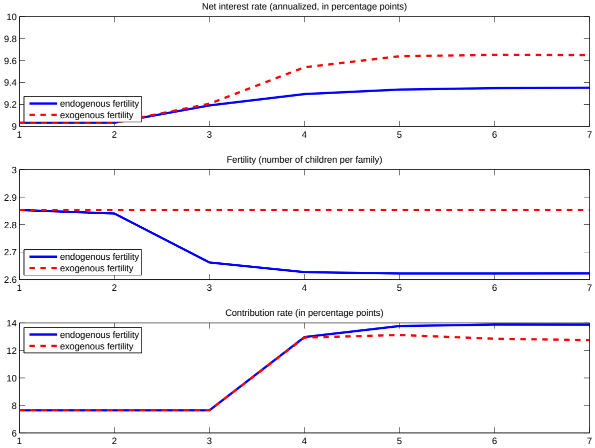
- Next, perform policy experiments
- Transitory Dynamics
- General case: $b \neq 0$
- $\bar{\sigma}$ scheme
- Compare endogenous and exogenous fertility in a closed-economy, later compare with open-economy cases

Figure : One Child Policy (Autarky)



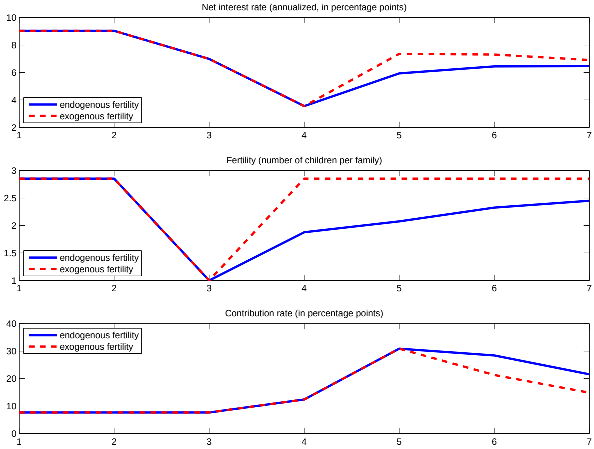
Notes: This figure illustrates the effect of implementing a one child policy constraint at $t = 3$, and relaxing it in $t = 4$.

Figure : A Permanent Increase in the Replacement Ratio (Autarky)



Notes: $\bar{\sigma} = 0.3$ increases permanently to $\bar{\sigma} = 0.5$.

Figure : One-child Policy + Permanent Growth Slowdown (Autarky)



Notes: one-child policy implemented in period 3 and relaxed in 4, a permanent growth slowdown from annual rate of 4.5% to 1.5% in period 4.

Small Open Economy

- In the general case where $b \neq 0$:

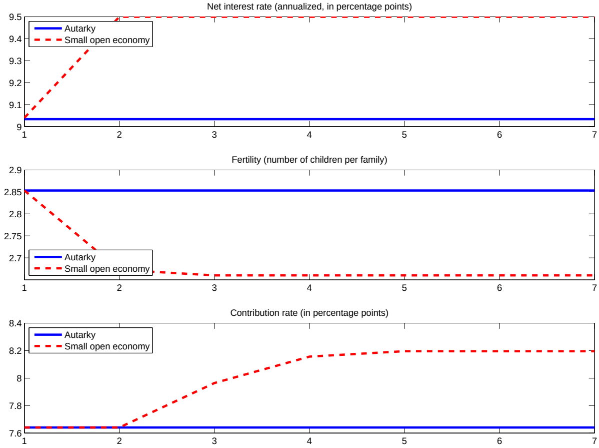
$$R^* = \frac{n g_A \psi + \lambda_0 \sigma}{n\phi - \lambda_0 \left(1 - \tau - \theta - \psi\right)}, \qquad \textbf{(NN)}$$

$$\left(\frac{R^*}{n g_A} - 1\right) b = \frac{\sigma}{n g_A} - \tau, \qquad \textbf{(SS)}$$

- Under $\bar{\sigma}$

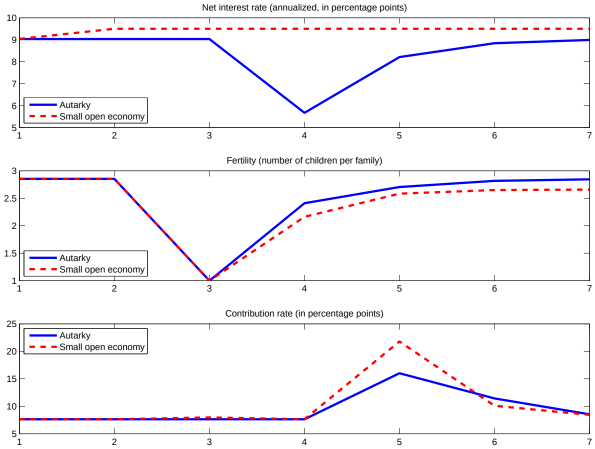
$$\begin{aligned} n_{\bar{\sigma}} &= \lambda_0 \frac{\left(1 - \tau_{\bar{\sigma}} - \theta - \psi\right) + \bar{\sigma}/R^*}{\phi - \psi\left(g_A/R^*\right)} \\ \tau_{\bar{\sigma}} &= \frac{\bar{\sigma}}{n_{\bar{\sigma}} g_A}. \end{aligned}$$

Figure : Financial Integration (SMOE)



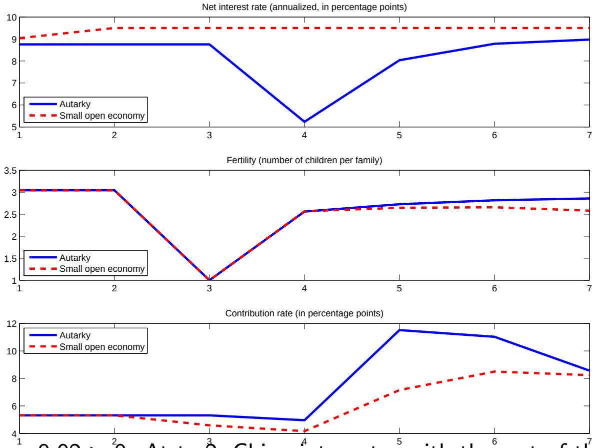
Notes: Integration takes place in t=2 , $R^* = 9.5\%$.

Figure : One-Child Policy (SMOE)



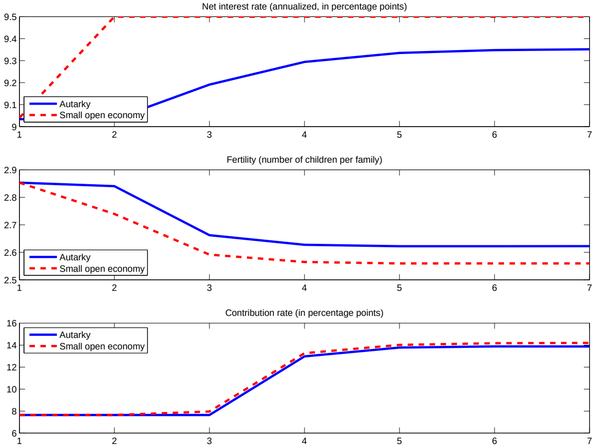
Notes: Benchmark parameters; one-child policy implemented in period 3 and relaxed in 4.

Figure : The one child policy: running down the trust fund (SMOE vs autarky).



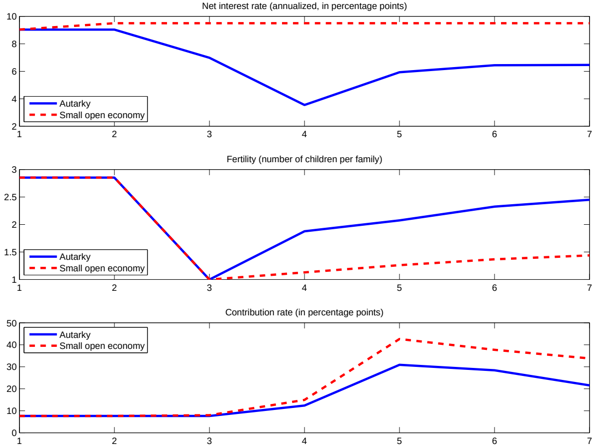
Notes: $b = 0.02 > 0$. At t=2, China integrates with the rest of the world characterized by $R^* = 9.5\%$. The one-child policy is implemented at t=3 and relaxed at t=4. China reduce b to 0.015 at t=4 and 0 at t=5.

Figure : A Permanent Increase in the Replacement Ratio (SMOE)



Notes: $\bar{\sigma} = 0.3$ rises permanently to $\bar{\sigma} = 0.5$ in period 3.

Figure : SMOE: One-child Policy + Permanent Growth Slowdown

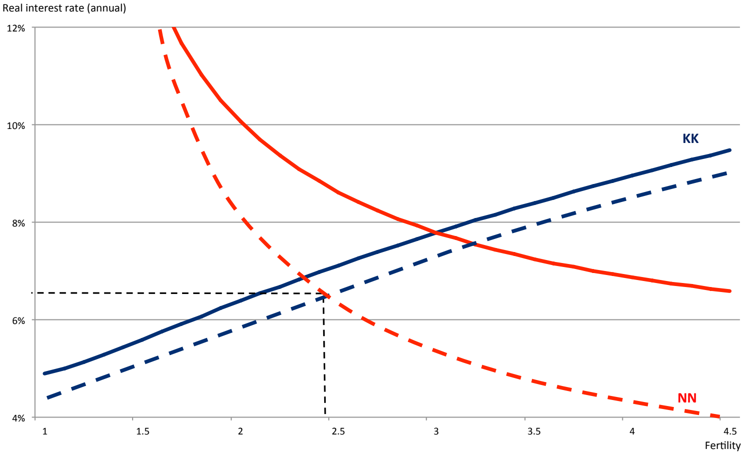


Notes: one-child policy implemented in period 3 and relaxed in 4, a permanent growth slowdown from annual rate of 4.5% to 1.5% occurs in period 4.

Conclusion

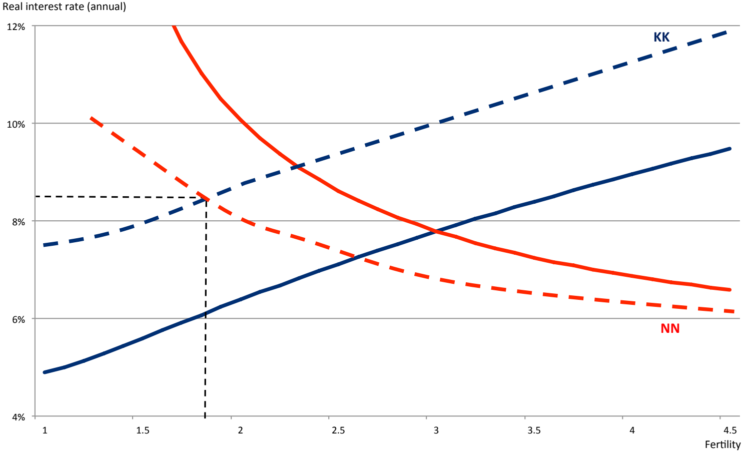
- Fertility and Social Security Interact
- Implications of fertility policies and reforms on required social security adjustment depends on endogenous responses of fertility and interest rates
- Social security schemes become also important given that their impact on fertility is different
- The framework can be used to study the impact of other economic, financial, and policy developments

Figure : PAYGO: A Fall in Intergenerational Transfers



Notes: This figure illustrates the effect of a fall in ψ from 10% to 5%., keeping $\bar{\sigma} = 0.3$ constant and allowing τ to vary.

Figure : A Loosening of Credit Constraints (PAYGO)



Notes: This figure illustrates the effect of increasing $\theta = 0.02$ to $\theta = 0.2$, keeping $\bar{\sigma} = 0.3$ and allowing τ to vary.