Credit Constraints and Growth in a Global Economy

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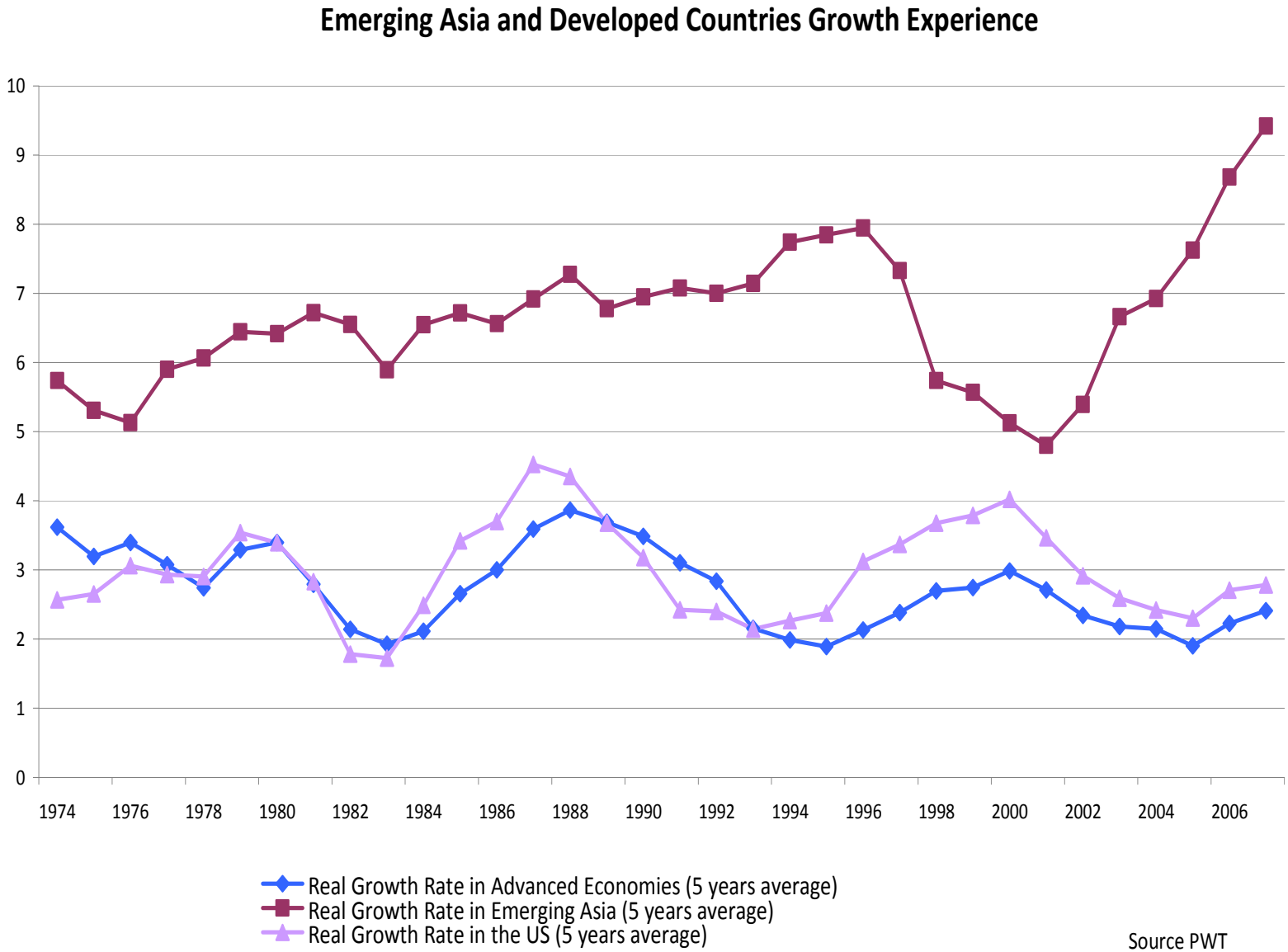
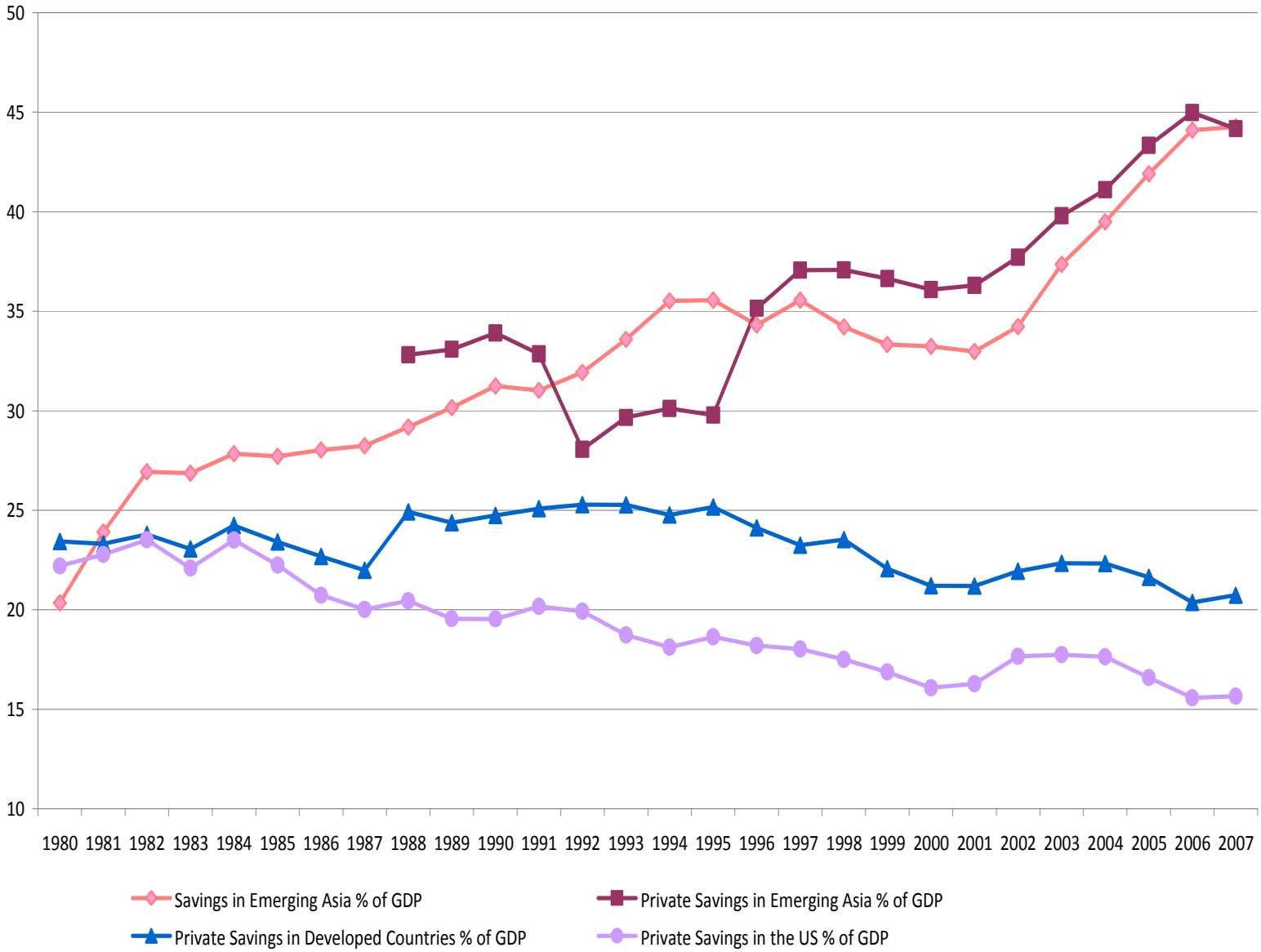
Motivation and stylized facts

- Two of the most striking trends in the past three decades:
  - Financial integration
  - Fast growth in Emerging Asia
- Accompanying trends:
  1. An **increase in private savings rate** in Emerging Asia and a **fall in private savings rate** in Advanced Economies
  2. Global imbalances, large current account **surplus** in Asia
  3. A **fall** in the world long-term interest rate
- Opposite of what standard open economy models predict.

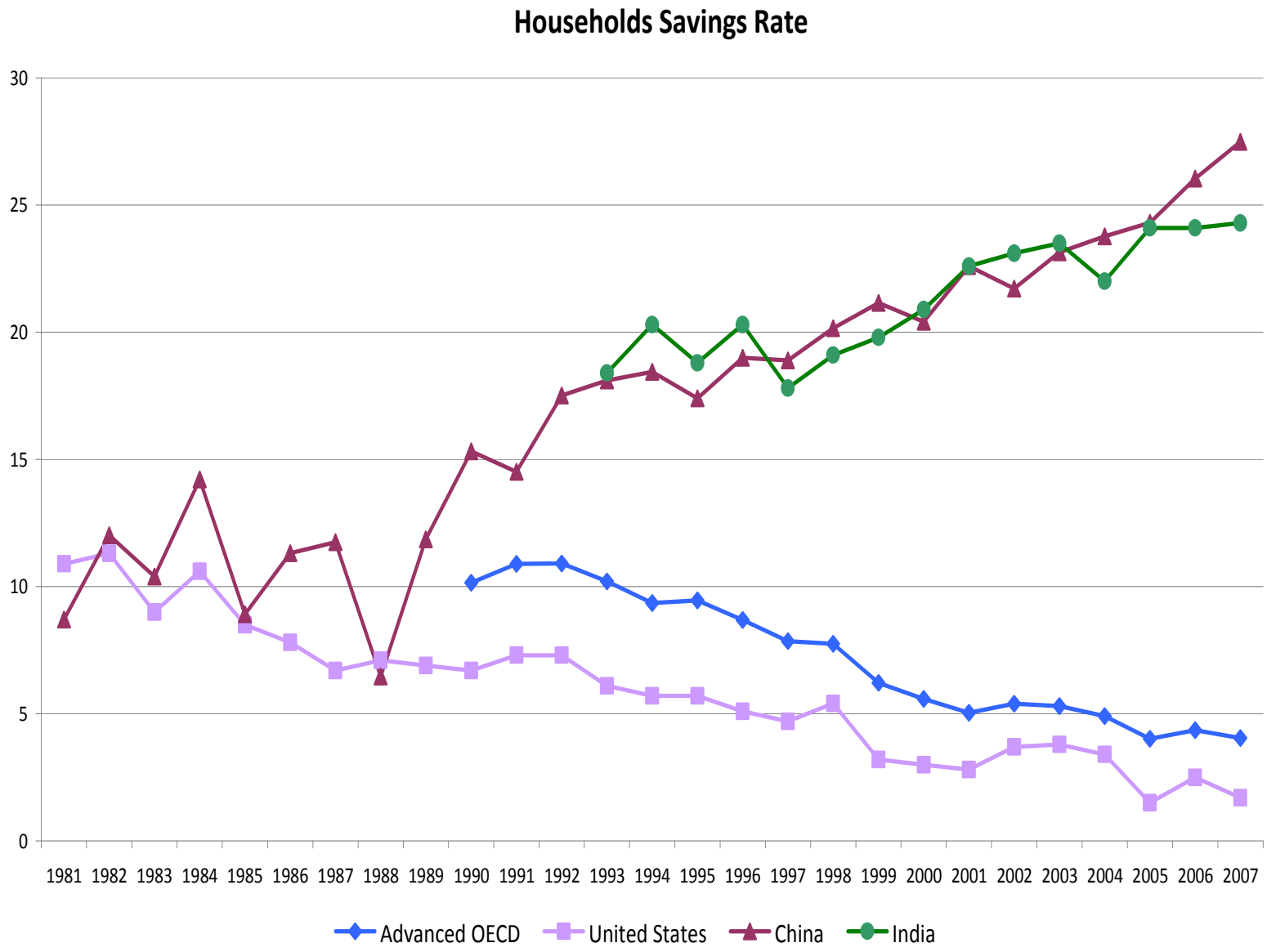
Fast growth in emerging Asia



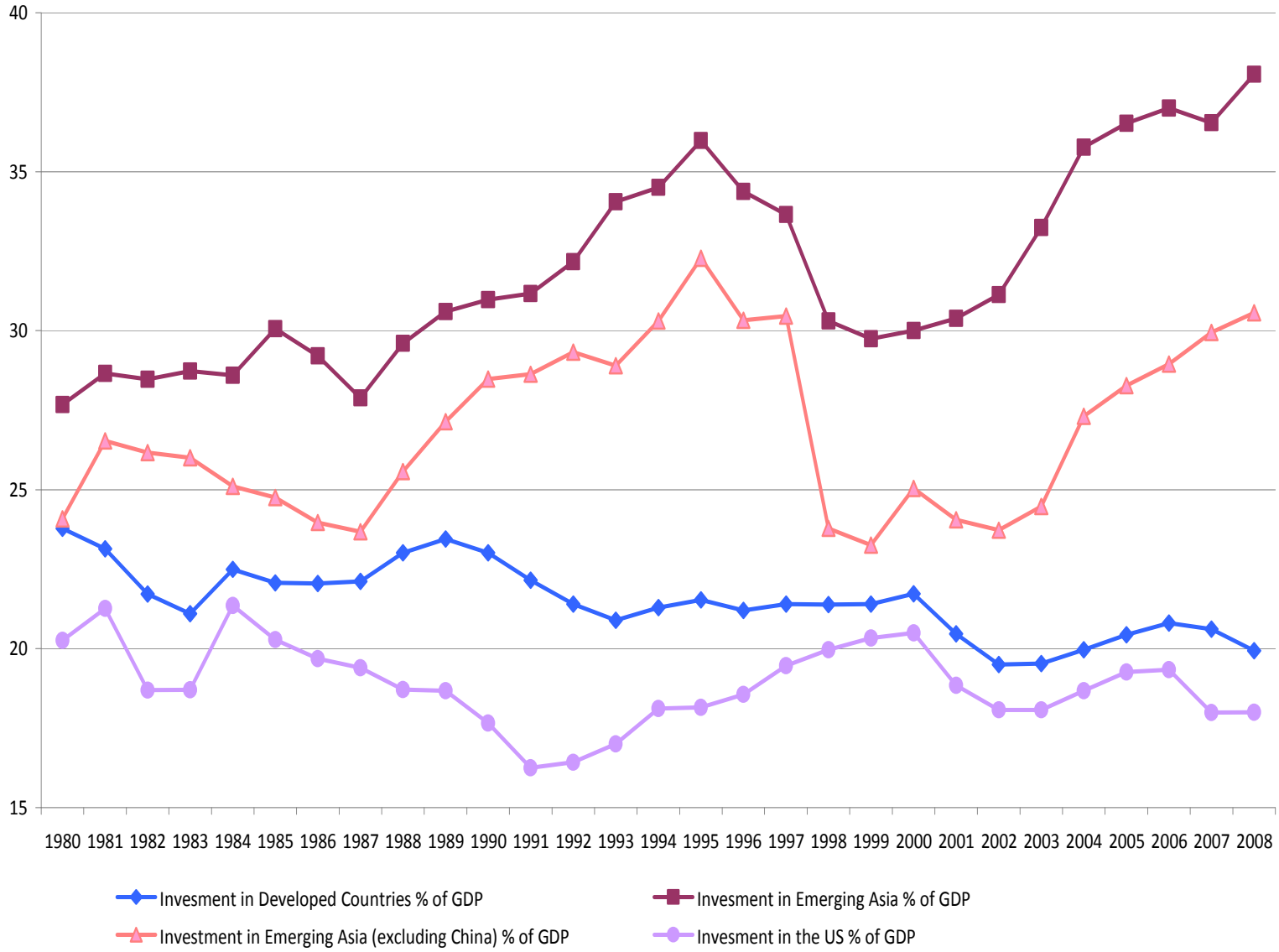
Private savings



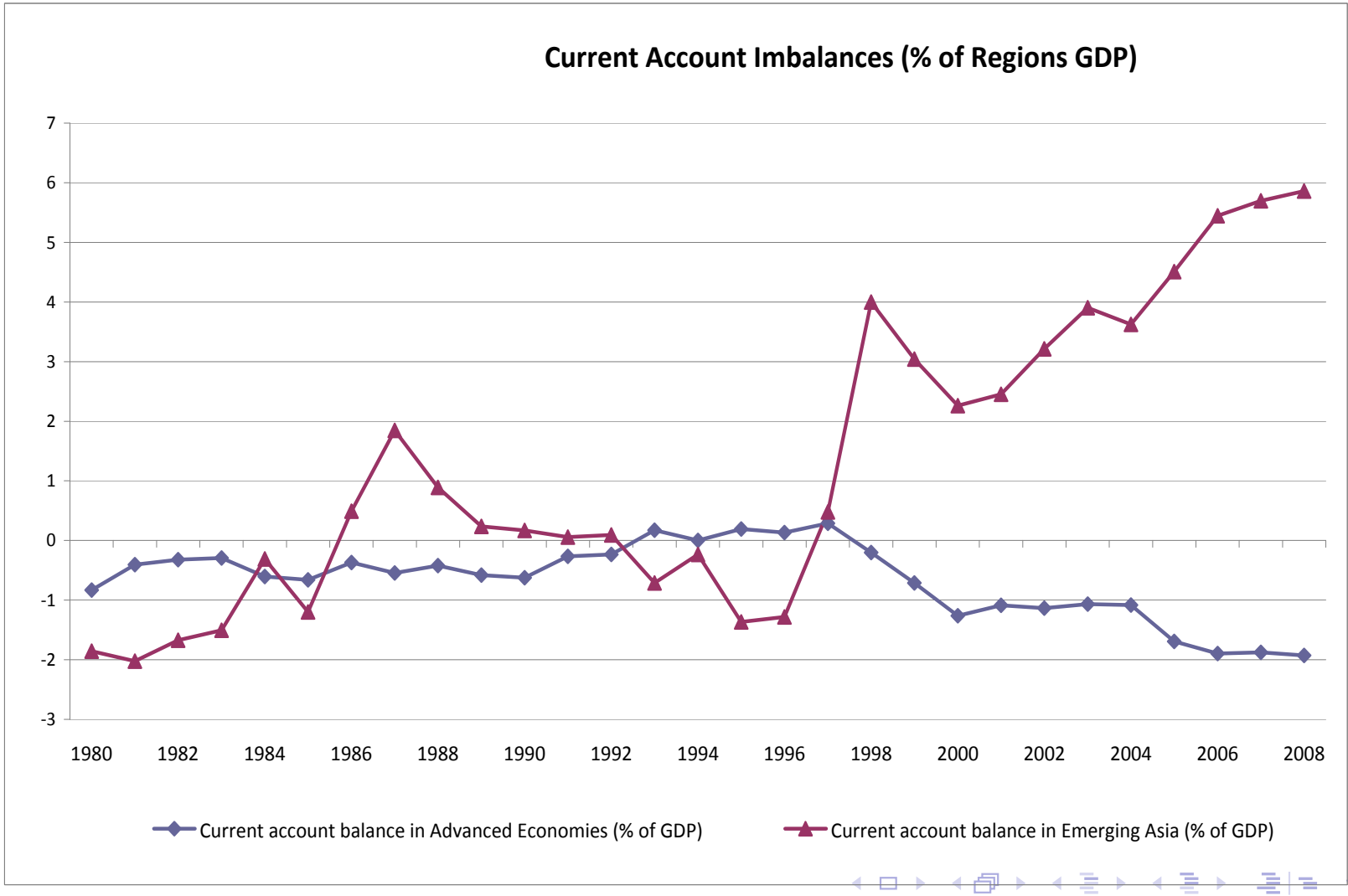
Household savings



Investment

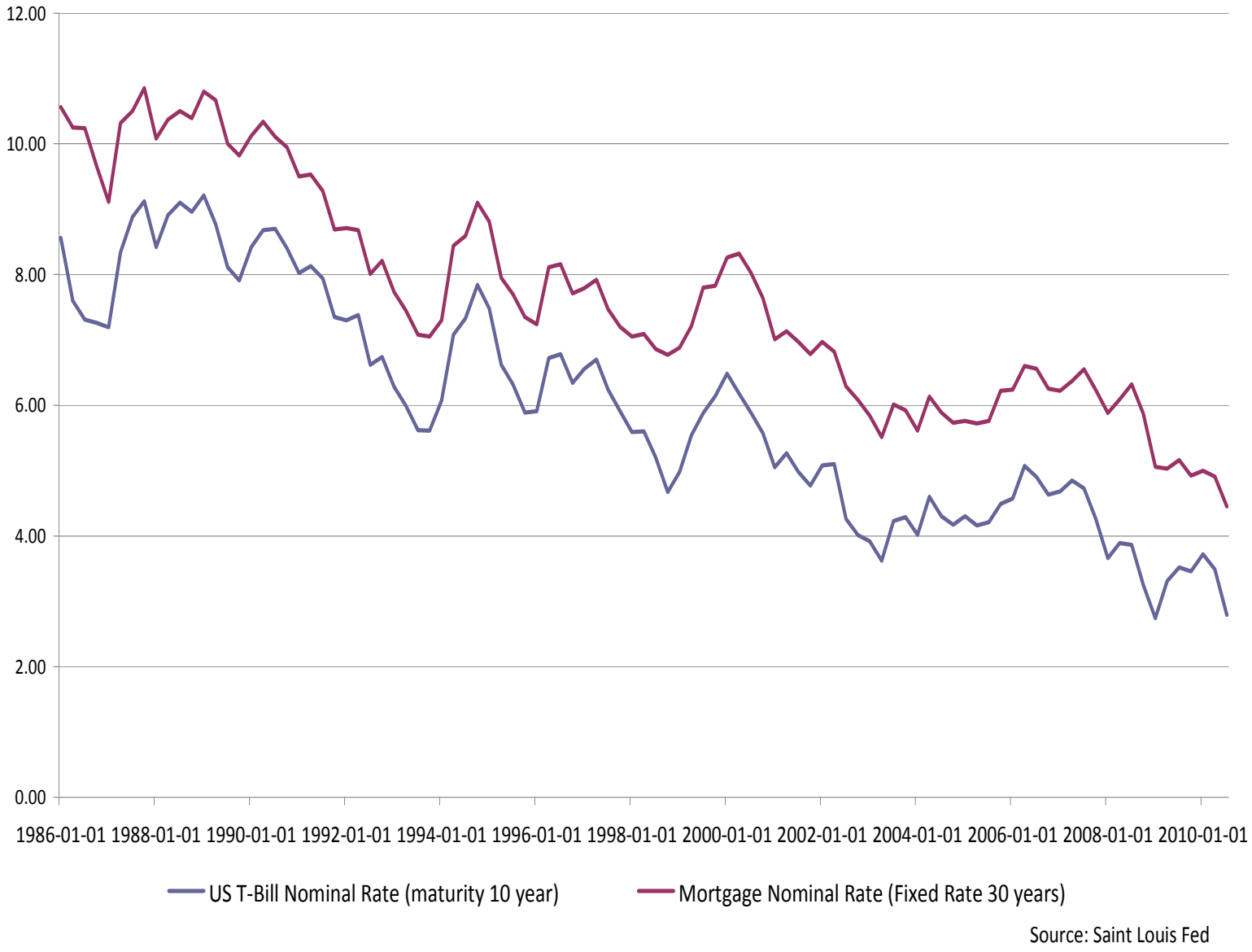

40
35
30
25
20
15
1980 1981 1982 1983 1984 1985 1986 1987 1988 1989 1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008
Invesment in Developed Countries % of GDP
Invesment in Emerging Asia % of GDP
Investment in Emerging Asia (excluding China) % of GDP
Invesment in the US % of GDP

Global imbalances



Source WEO

Long-term interest rates



Source: Saint Louis Fed

This paper

- Incorporates household liquidity constraints (the extent of which is asymmetric across countries) into an open economy, general equilibrium OLG model.
- Analyzes the interaction between growth and credit constraints and its impact on the global equilibrium.
- We show that fast growth in Emerging Asia can generate the key trends observed in macro data.
- Main finding: Asymmetric response of saving rates to a fall in world interest rate leads to greater dispersion in saving rates.

Main finding

- Asymmetric credit constraints translate into different weights placed on borrowers vs savers across economies.
  - More constrained economy: greater weight on the savings of the middle-aged, less weight on the (dis)savings of the young.
- A fall in world interest rate causes the young to borrow more and the middle-aged to save more (income effect).
- Different weights on borrowers vs savers lead to asymmetric responses of saving rates across countries.
  - Fall in saving rate in less constrained economy driven by the increased borrowing of the young.
  - Rise in saving rate in more constrained economy driven by the increased savings of the middle-aged.
- We provide micro evidence on saving behavior across age groups for US and China that is broadly supportive of our model predictions.

Related literature

- Allocation puzzle: Gourinchas and Jeanne (2009)
- Investment:
  - Benhima (2009), Song, Storesletten and Zilibotti (2009)
- Saving:
  - Caballero, Farhi and Gourinchas (2008)
  - Mendoza, Quadrini and Rios-Rull (2009), Jeanne and Ranciere (2006), Carroll and Jeanne (2009)
  - Corporate Saving: Benhima and Bachetta (2011), Sandri (2010)
- Closed-economy setup: Jappelli and Pagano (1994)

Model

Key ingredients

- One-good model of n large open economies
- OLG structure with three-period lived agents

= the young 'borrowers', the middle-aged 'workers and savers', the old retired.

- Borrowing constraints: the young can only borrow up to a fraction of their discounted future labor income.

– Asymmetry: tighter credit constraints in Asia

- No uncertainty.

Production

- Output in country i

$$Y_t^i = \left(K_t^i\right)^{\alpha} \left(Z_t^i L_{m,t}^i\right)^{1-\alpha} = Z_t^i L_{m,t}^i (k_t^i)^{\alpha}$$

where $k_t^i \equiv \frac{K_t^i}{Z_t^i L_{m,t}^i}$ denotes the capital-effective-labor ratio.

- Wages and rental rates of capital

$$\begin{aligned} w_t^i &= (1-\alpha) Z_t^i \left(k_t^i\right)^{\alpha}, \\ r_{K,t}^i &= \alpha \left(k_t^i\right)^{\alpha-1}. \end{aligned}$$

- Given capital depreciation rate δ, the (gross) rate of return earned between periods $t-1$ and t is

$$R_t^i = 1 - \delta + r_{K,t}^i.$$

Households

- Lifetime utility of an agent born in period t in country i

$$U_t^i = u(c_{y,t}^i) + \beta u(c_{m,t+1}^i) + \beta^2 u(c_{o,t+2}^i).$$

- Isoelastic utility with i.e.s coefficient $\sigma \leq 1$

$$u(c) = \frac{c^{1-\frac{1}{\sigma}} - 1}{1 - \frac{1}{\sigma}}.$$

Household budget constraints

- An agent born in period t faces the following sequence of budget constraints:

$$\begin{aligned} c^i_{y,t} + a^i_{y,t+1} &= 0, \\ c^i_{m,t+1} + a^i_{m,t+2} &= w^i_{t+1} + R^i_{t+1} a^i_{y,t+1}, \\ c^i_{o,t+2} &= R^i_{t+2} a^i_{m,t+2}. \end{aligned}$$

- The old decumulate all their assets (no bequests).
- We also consider extensions with first-period income and bequest motive.

Credit constraints

- Young agents can only borrow up to a fraction θ^i of the present value of their future labor income

$$a^i_{y,t+1} \geq -\theta^i \frac{w^i_{t+1}}{R^i_{t+1}}.$$

(lower $\theta \rightarrow$ tighter credit conditions)

- Constraint binding in all i and all t requires

$$\theta^i < \frac{\beta^{-2\sigma}(R^i_{t+1})^{1-\sigma}(R^i_{t+2})^{1-\sigma}}{1+\beta^{-\sigma}(R^i_{t+2})^{1-\sigma}[1+\beta^{-\sigma}(R^i_{t+1})^{1-\sigma}]}, \quad \text{for all } t.$$

Household asset holdings

- Binding credit constraints on the young imply:

$$a^i_{y,t+1} = -\theta^i \frac{w^i_{t+1}}{R^i_{t+1}} \qquad (< 0).$$

- FOC for the middle-aged gives:

$$a^i_{m,t+1} = \frac{1}{1+\beta^{-\sigma}(R^i_{t+1})^{1-\sigma}}(1-\theta^i)w^i_t.$$

- Aggregate asset position of generation $\gamma \in \{y, m\}$ in period t

$$A^i_{\gamma,t+1} \equiv L^i_{\gamma,t} a^i_{\gamma,t+1}.$$

Autarky equilibrium

- Capital market equilibrium:

$$K^i_{t+1} = A^i_{y,t+1} + A^i_{m,t+1}.$$

$\hookrightarrow$ difference equation driving the dynamics of k^i_t.

- Example for $\sigma = 1$ and $\delta = 1$:

$$k^i_{t+1} = \frac{1}{1+g^i_{t+1}} \frac{\beta}{1+\beta} \frac{\alpha(1-\alpha)(1-\theta^i)}{\alpha+\theta^i(1-\alpha)} \left(k^i_t\right)^\alpha.$$

Autarky steady state

Special case when $\sigma = 1$ and $\delta = 1$

- Suppose effective labor $Z^i L_m^i$ grows at constant rate g^i. The steady state level of k^i is

$$k^i = \left[\frac{1}{1+g^i} \frac{\beta}{1+\beta} \frac{\alpha(1-\alpha)\left(1-\theta^i\right)}{\alpha+\theta^i(1-\alpha)} \right]^{\frac{1}{1-\alpha}}, \qquad \frac{dk^i}{d\theta^i} < 0.$$

- The autarkic rate of return in the steady-state is

$$R^i = (1+g^i) \frac{1+\beta}{\beta} \frac{\alpha+\theta^i(1-\alpha)}{(1-\alpha)\left(1-\theta^i\right)}.$$

$\frac{dR^i}{d\theta^i} > 0$, i.e., tighter constraints imply lower interest rate

Open-economy equilibrium

- Equilibrium condition under financial integration:

$$\sum_i K^i_{t+1} = \sum_i \left(A^i_{y,t+1} + A^i_{m,t+1} \right).$$

- Financial integration in period t implies

$$R^i_{t+1} = R_{t+1}, \quad \text{for all } i.$$

and

$$k^i_{t+1} = k_{t+1}, \quad \text{for all } i.$$

Integrated steady state

Special case when $\sigma = 1$ and $\delta = 1$

- Steady state: $g^i = g$, and $\lambda^i \equiv \frac{Z_t^i L_{m,t}^i}{\sum_j Z_t^j L_{m,t}^j}$.
- World steady state interest rate:

$$R = (1+g)\frac{1+\beta}{\beta}\frac{\alpha + \bar{\theta}(1-\alpha)}{(1-\alpha)\left(1-\bar{\theta}\right)}, \qquad \bar{\theta} \equiv \sum_i \lambda^i \theta^i.$$

Aggregate saving rates in steady state

$$\frac{S^i}{Y^i} = -g(1-\alpha)\frac{\theta^i}{R} + \frac{g}{1+g}(1-\alpha)\frac{1-\theta^i}{1+\beta^{-\sigma}R^{1-\sigma}} + \delta k^{1-\alpha}$$

for (autarkic or integrated) steady-state values of k and R.

- Interaction between g and credit constraints is key.
  - In the absence of growth ($g = 0$), net saving rates are all zero.
- Under integration, saving rates differ across countries in the long run: saving rate higher in more constrained countries.
- Suppose we start from an integrated steady state and after an episode of high growth in the more constrained countries, the world reaches a new steady state. Lower $\bar{\theta} \rightarrow$ fall in R.
  - Saving rates across countries respond differently:

$$\frac{\partial^2(S/Y)}{\partial\theta\partial R} > 0 \;\rightarrow\; \text{fall in } R \text{ leads to more dispersion in saving rates.}$$

Investment

- Aggregate investment in country i

$$I_t^i \equiv K_{t+1}^i - (1-\delta)K_t^i$$

- Investment rate:

$$\frac{I_t^i}{Y_t^i} = \frac{(1+g_{t+1}^i)k_{t+1}^i - (1-\delta)k_t^i}{(k_t^i)^\alpha}.$$

- For $\delta = 1$, $\frac{I_t^i/Y_t^i}{I_t^j/Y_t^j} = \frac{1+g_{t+1}^i}{1+g_{t+1}^j}$ under integration.

Investment rates converge in the long run.

Two-country experiments

Advanced economies vs. Emerging Asia

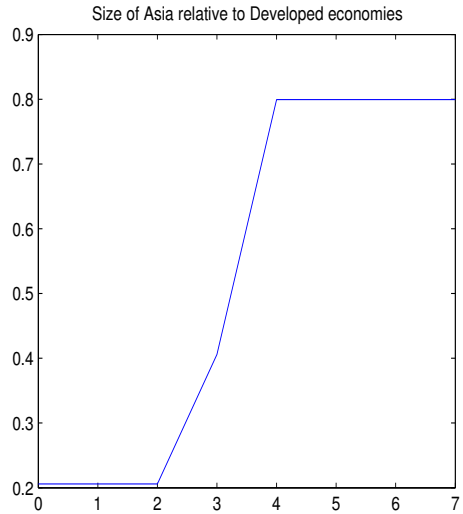
Calibration:

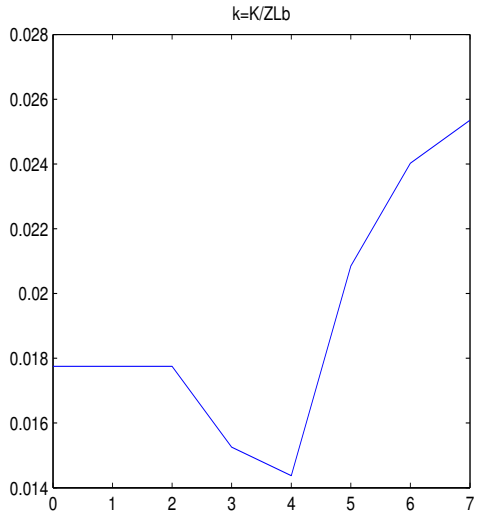
- Each period lasts 20 years.
- Technology: $\alpha = 0.28$, $\delta = 9\%$ on an annual basis.
- Preference parameters: $\beta = 0.97$ on an annual basis, $\sigma = 0.5$.
- Constraints: $\theta_H = 0.25$ (developed) and $\theta_F = 0.03$ (Asia).

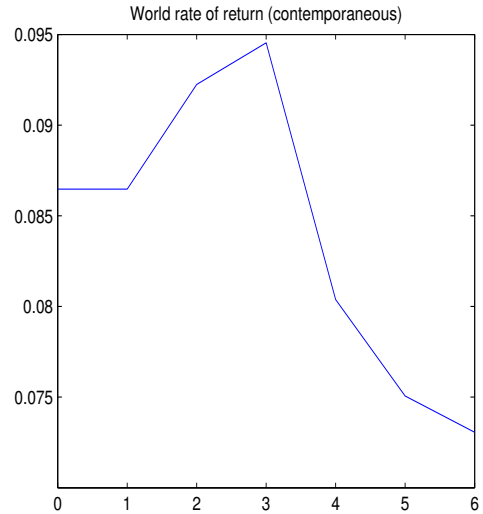
Growth experiment

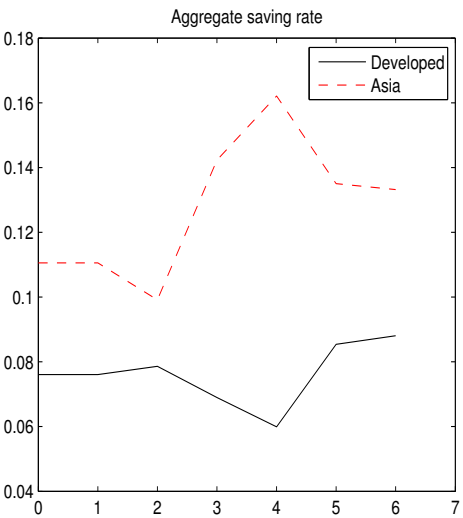
- We start from an integrated steady state where Asia accounts for 18% of world output: $(ZL)_F/(ZL)_H = 0.21$.
- Developed countries grow at $g_H = 2.5\%$ throughout, whereas $g_F = 6\%$ for two periods (between $t = 2$ and $t = 4$).
- In the final steady state, Asia accounts for 45% of world output, and both countries grow at $g = 2.5\%$.

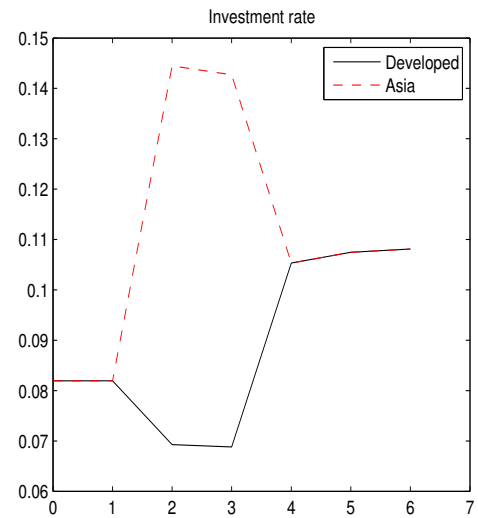
Growth experiment

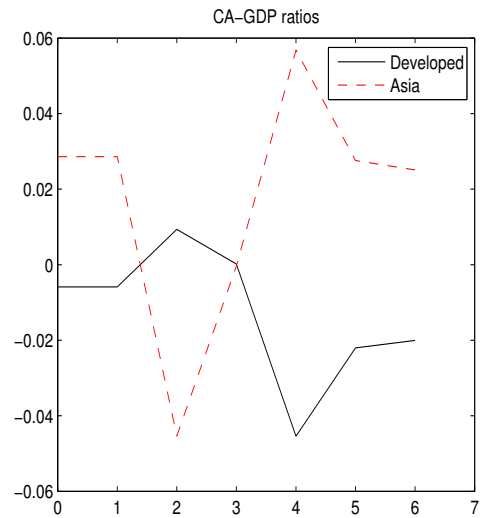










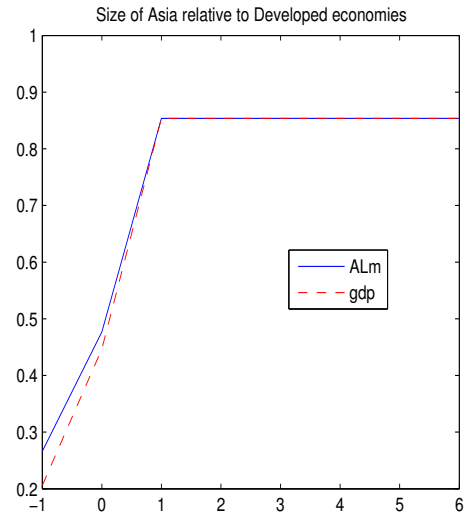


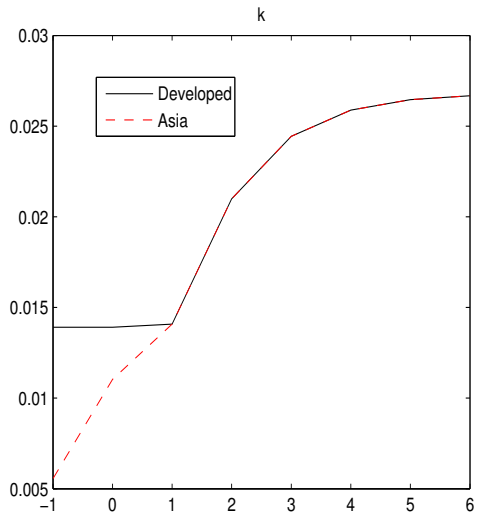
Integration & growth experiment

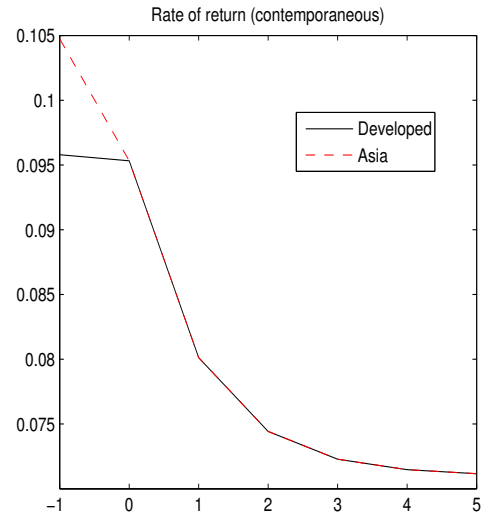
Timing and calibration

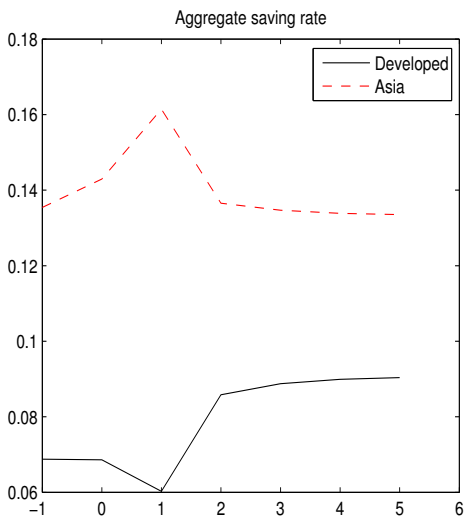
- Financial opening occurs in period 0 ($= 1990$).
- In initial period -1 ($= 1970$), advanced economies are at their own autarkic steady state, whereas Asia is capital-scarce.
- Assume $g_H = 2.5\%$ throughout, and Asia grows faster than advanced economies between periods -1 and 1.
- We choose initial values of $(ZL)_F/(ZL)_H$, k_F/k_H and growth path for Asia to match:
  - Asia's share of advanced economies GDP in 1970 and 2010
  - relative capital-per-efficiency unit of labor measured by Hall and Jones for 1990.

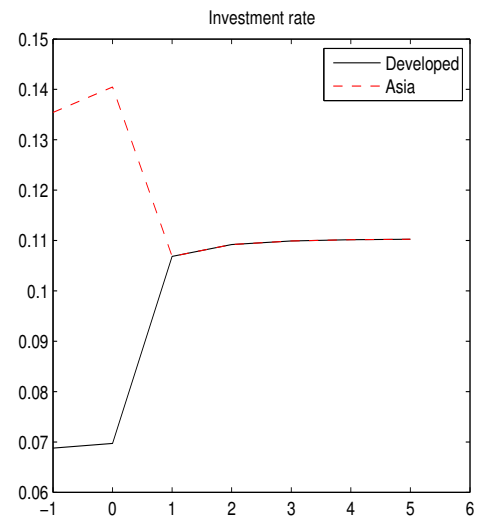
Integration & growth experiment

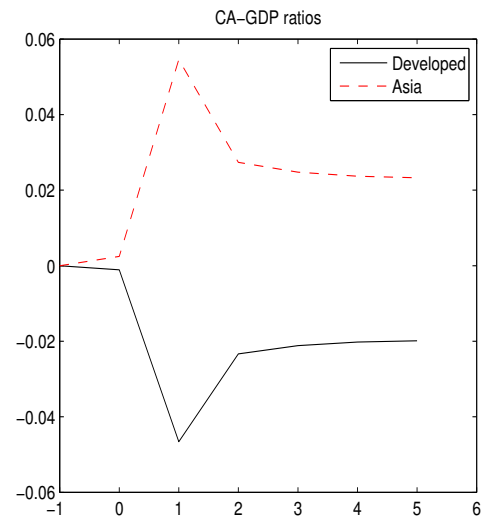




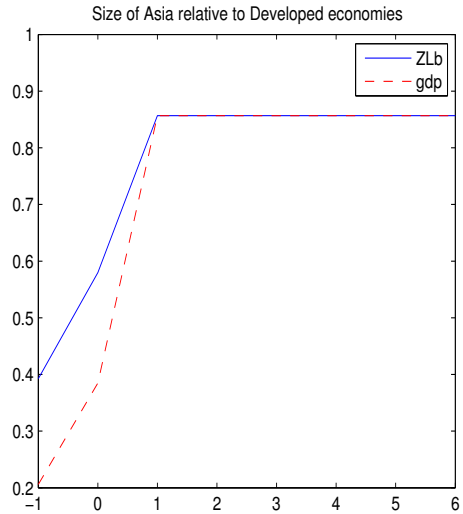


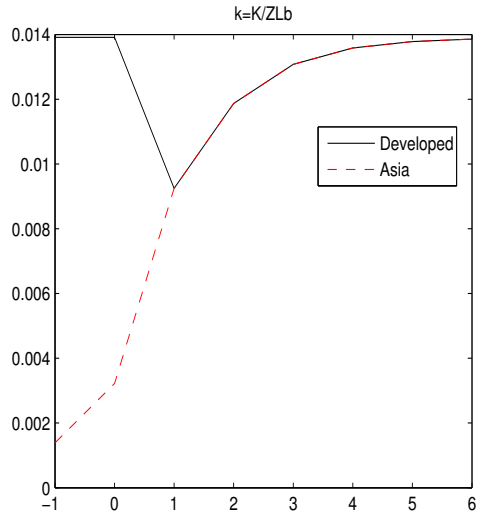


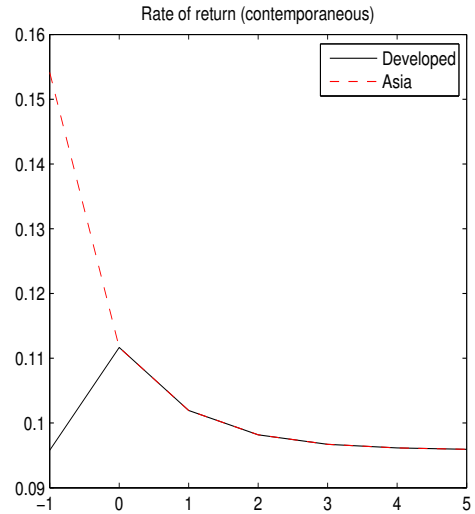


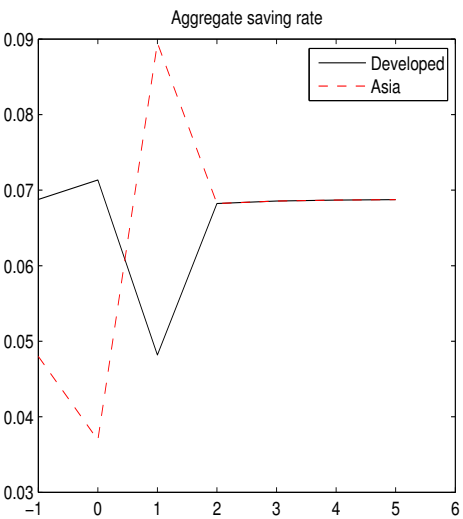


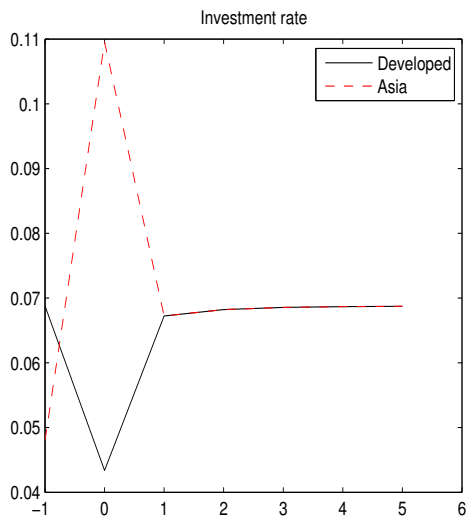
Role of credit constraint heterogeneity: $\theta_H = \theta_F = 0.25$

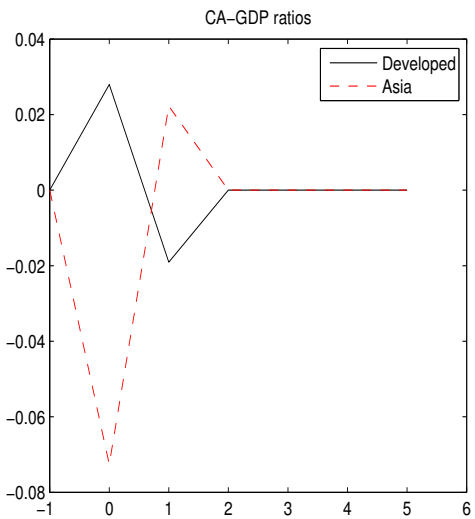








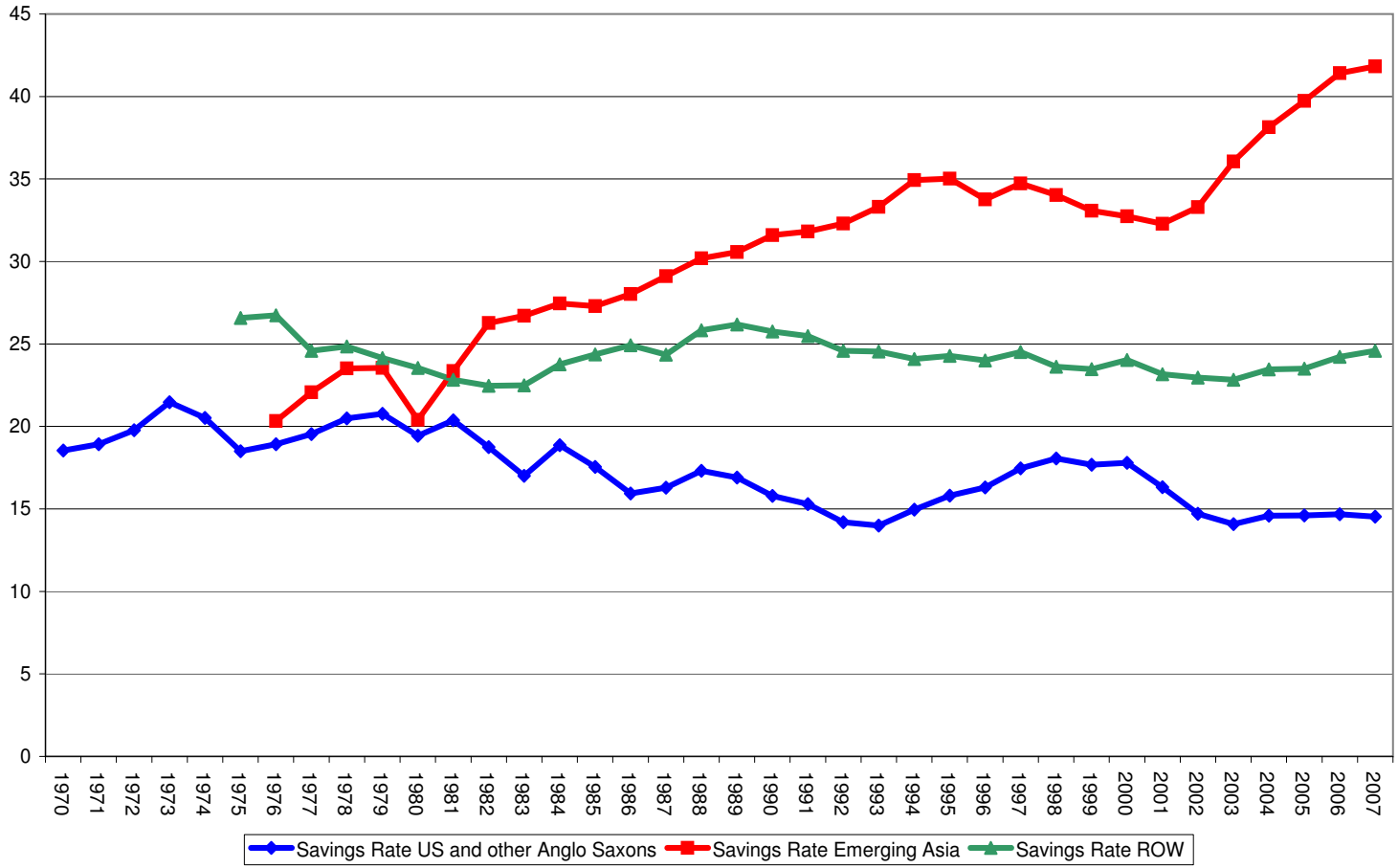




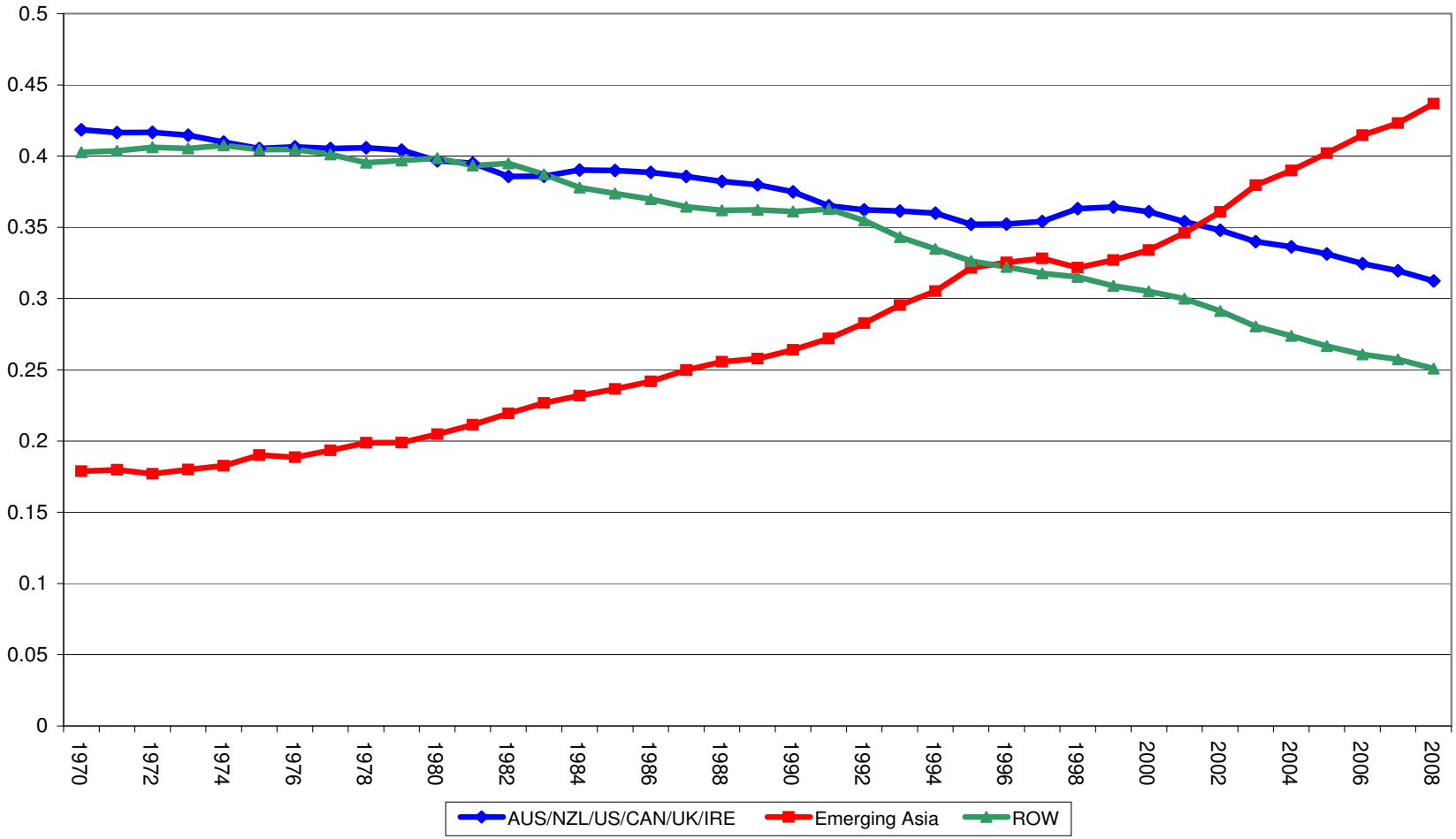
Three-country experiment

- Heterogeneity among developed countries: some large debtors (US, UK, New Zealand, Australia...) and some large creditors (Germany, Japan, Switzerland...).
- We group developed countries in the following way:
  - Group 1: US, UK, IRE, CAN, AUS, NZL
  - Group 2: Rest of developed countries
- Private savings fell mostly in the first group and stayed roughly constant in the second.
- The first group has been growing at a slightly higher rate over the period 1990-2008 (1% more on average)

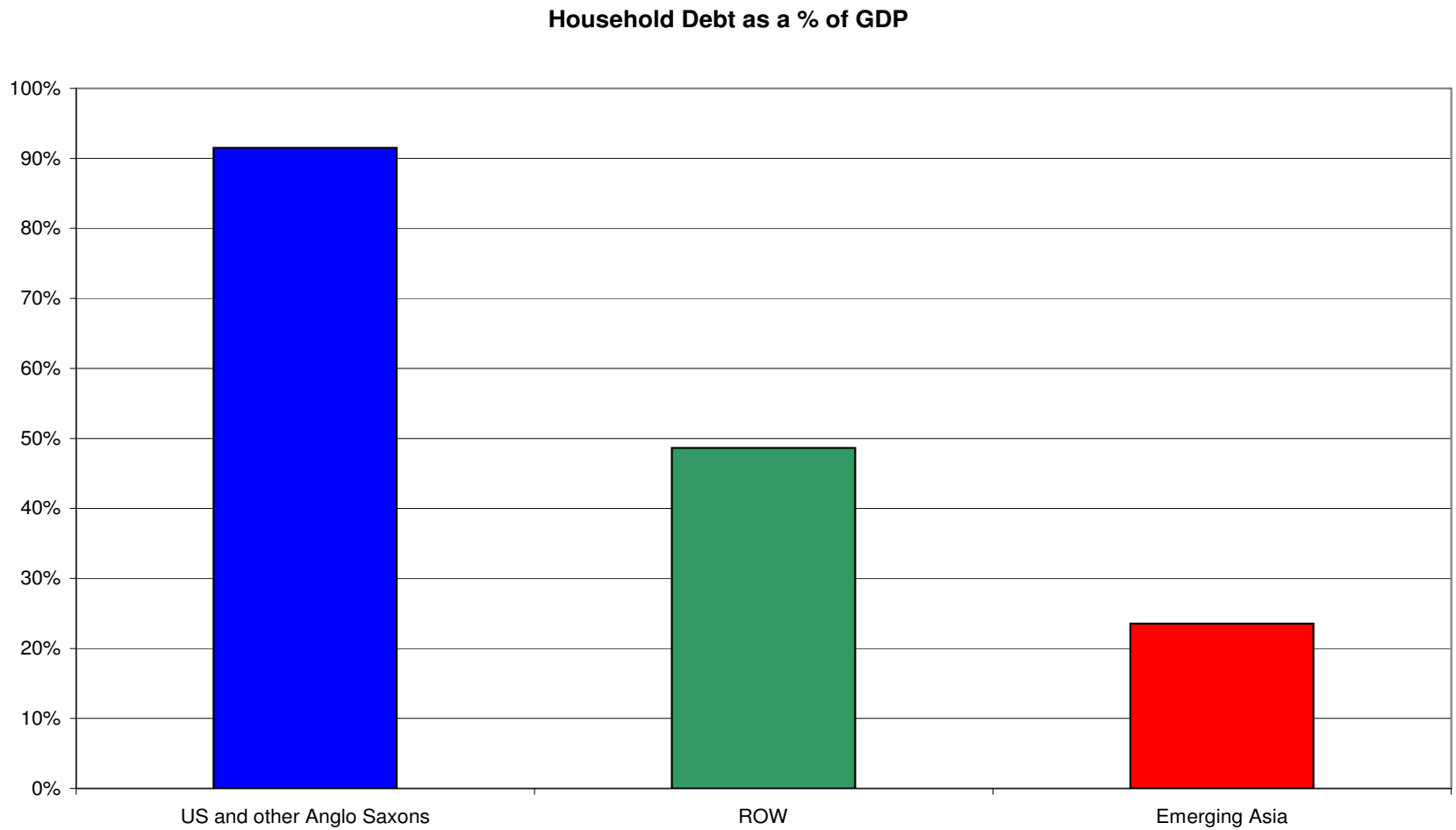
Saving rates across regions



Growth differentials



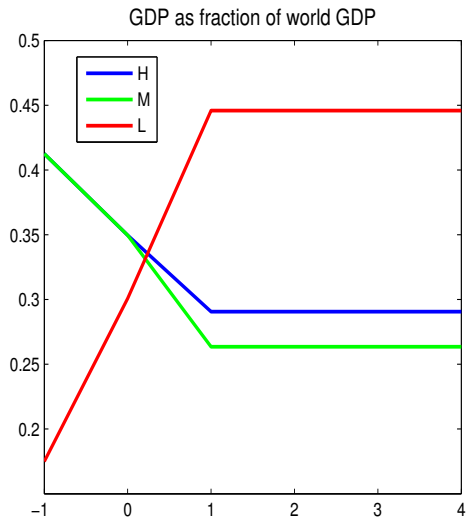
Heterogeneity in household debt

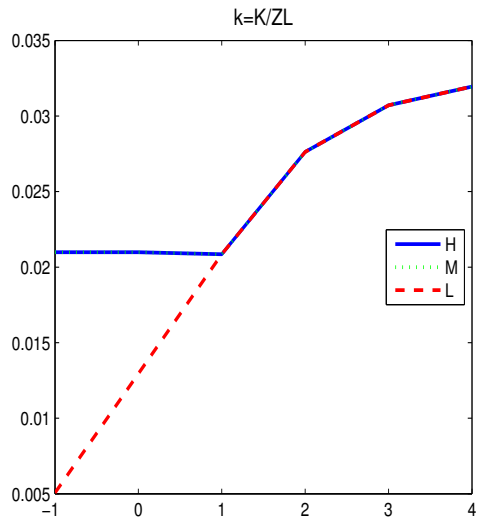


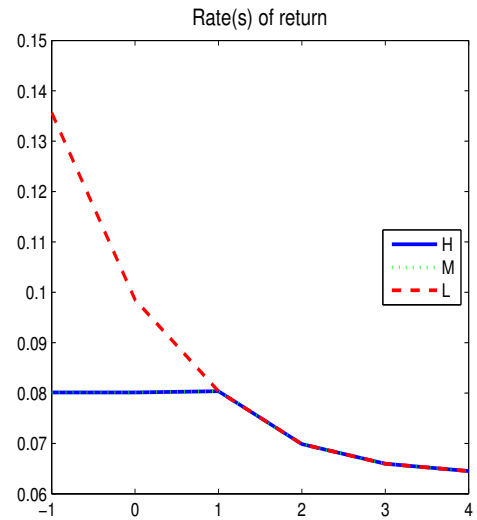
Three-country experiment: Calibration and timing

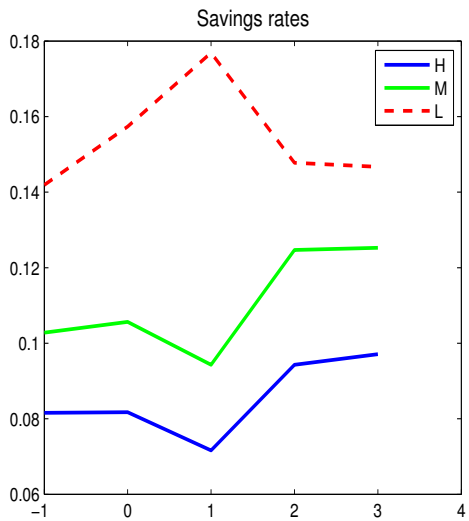
- $\theta_H = 0.25$ (US), $\theta_M = 0.125$ (Europe), $\theta_L = 0.03$ (Asia)
- In period -1, US and Europe (H & M) are integrated and at their steady state, whereas Asia (L) starts in autarky and is capital-scarce.
- Integration of Asia occurs at $t = 0$.
- Calibration to GDP data:
  - Initially, $Y_L/Y_W = 0.18$ and $Y_H/Y_W = Y_M/Y_W = 0.41$
  - US grow at 2.5% throughout
  - Asia grows faster between $t = -1$ and $t = 1$
  - Europe experiences slower growth between $t = 0$ and $t = 1$.

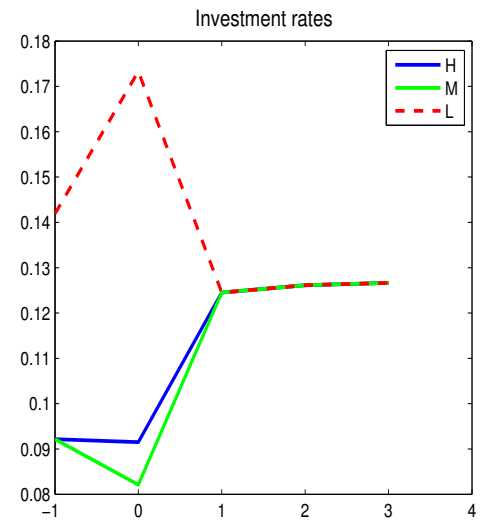
Three-country experiment: Results

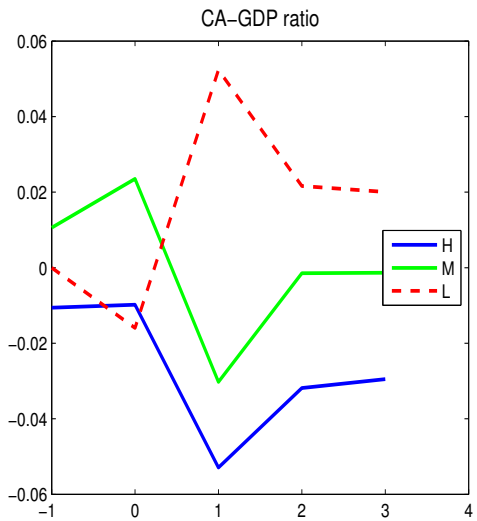












Evidence at cohort level

- Our model has implications for the evolution of saving rates by age groups.
- In the two-country "integration & growth" experiment:

  1. the saving rate as function of age, in level and in change, has an inverted-U shape in both Developed Economies and Emerging Asia;

  2. the fall in the saving rate of the young dominates in Developed Economies, whereas the rise in the saving rate of the middle-aged dominates in Emerging Asia.

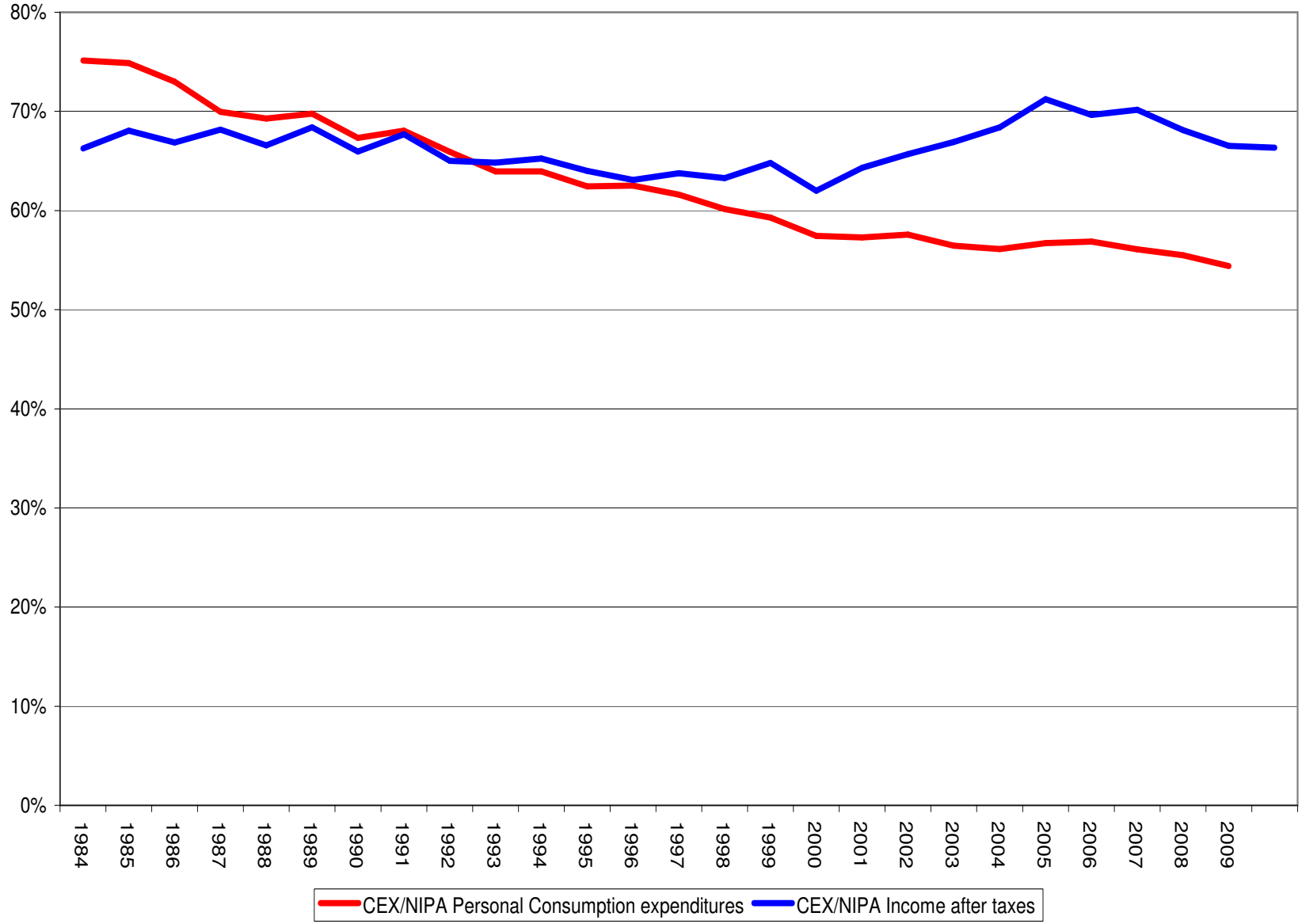
- We look at cohort-level data for the US and China to see if these predictions hold.

US Evidence

- We use annual consumption and income data by age groups, over the period 1986-2008.
- Source: Consumer Expenditure Survey (CEX) from the US Bureau of Labor Statistics.
- Key concern: CEX data suffer from under-reporting biases.
  - Aggregate CEX consumption and income data do not match with NIPA.
  - See Slesnick (1992), Battistin (2003), Laitner and Silverman (2005), Heathcote, Perri and Violante (2010).
- Whereas income reporting bias remained roughly constant, consumption under-reporting has gotten worse over time.

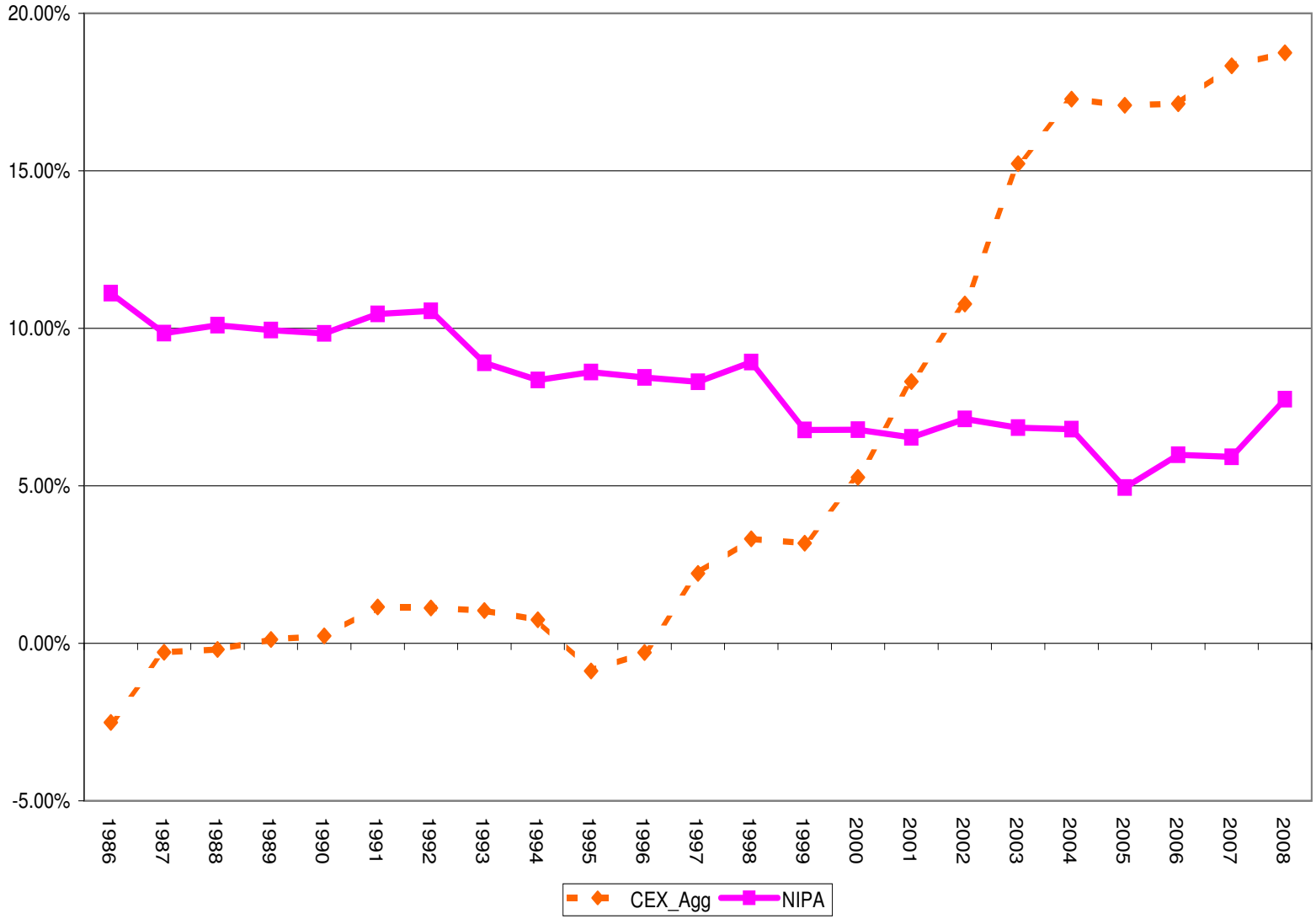
CEX vs NIPA

Aggregate consumption and income

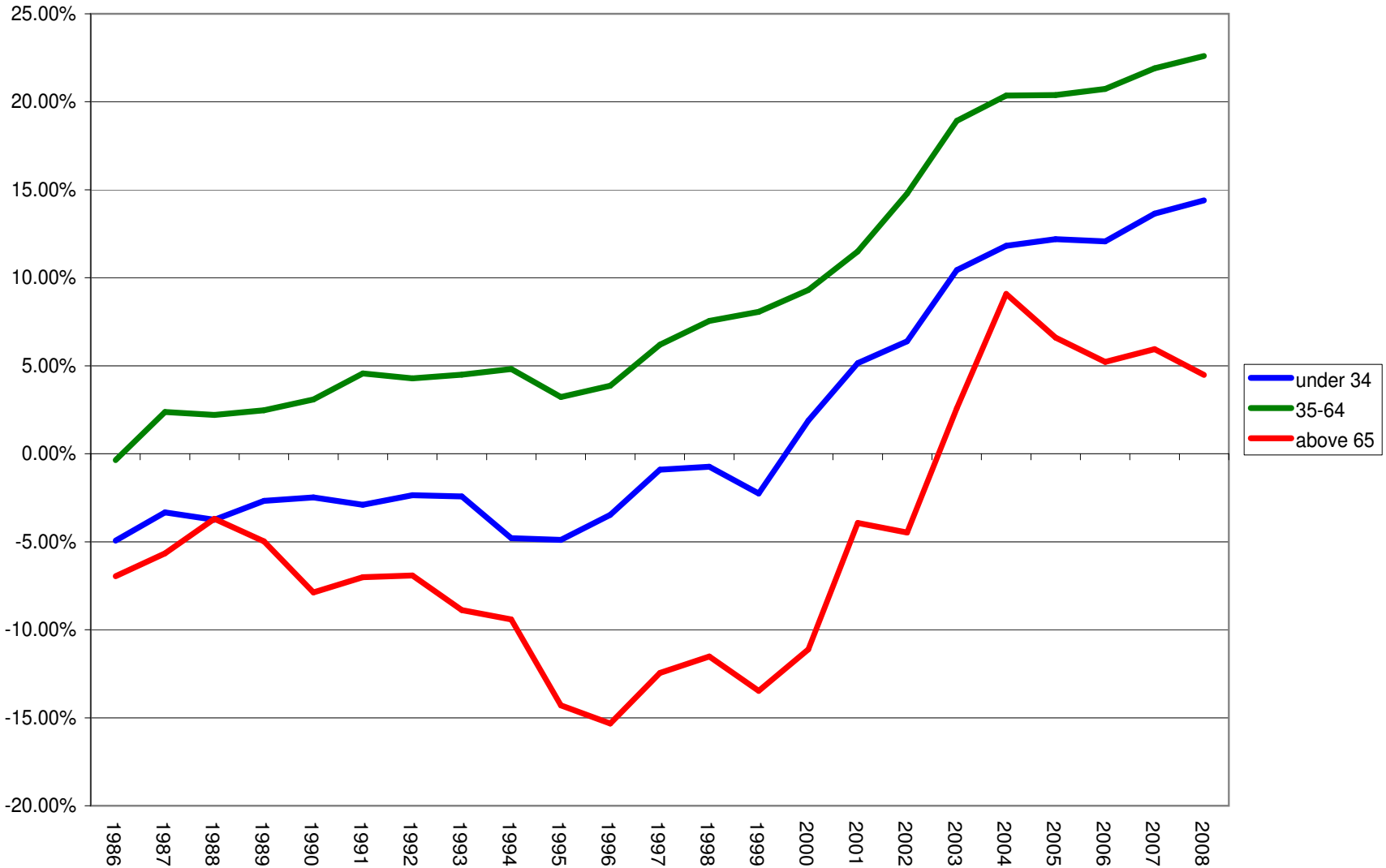


CEX vs NIPA

Aggregate saving rate



US saving rate by age groups – Unadjusted CEX



Correction method (1)

- Let $c_{g,t}^{CEX}$ and $y_{g,t}^{CEX}$ denote average consumption and income in CEX, for age group g in year t.
- Let C_t^D and Y_t^D denote aggregate consumption and income in dataset $D \in \{CEX, NIPA\}$.
- Adjustment to consumption:

$$\hat{c}_{g,t} = \frac{C_t^{NIPA}}{C_t^{CEX}} c_{g,t}^{CEX}$$

- Adjustment to income:

$$\hat{y}_{g,t} = \frac{Y_t^{NIPA}}{Y_t^{CEX}} y_{g,t}^{CEX}$$

- Potential problem if the degree of under-reporting varies across types of goods AND the composition of the consumption basket varies across age groups.

Correction method (2)

Parker et al. (2009)

- Use disaggregated consumption data for 15 sectors.
- For each type of good i, define

$$\chi_{it} = C_{it}^{NIPA} / C_{it}^{CEX}$$

- Adjust CEX consumption data to match NIPA in each sector:

$$\hat{c}_{git} = \chi_{it} c_{git}^{CEX}, \qquad \hat{c}_{g,t} = \sum_i \hat{c}_{git}$$

- Problem with health: medical expenses covered by Medicare and Medicaid included in NIPA but not in CEX, $\chi_{health,t} \simeq 5$.

  $\Rightarrow$ Very large medical expenses are imputed to the old people as "out-of-the-pocket" health expenditures constitute a high share of their consumption basket in CEX ($\simeq 12\%$).

Correction method (3)

- To address this problem and still match NIPA aggregate consumption, we use adjustment factor

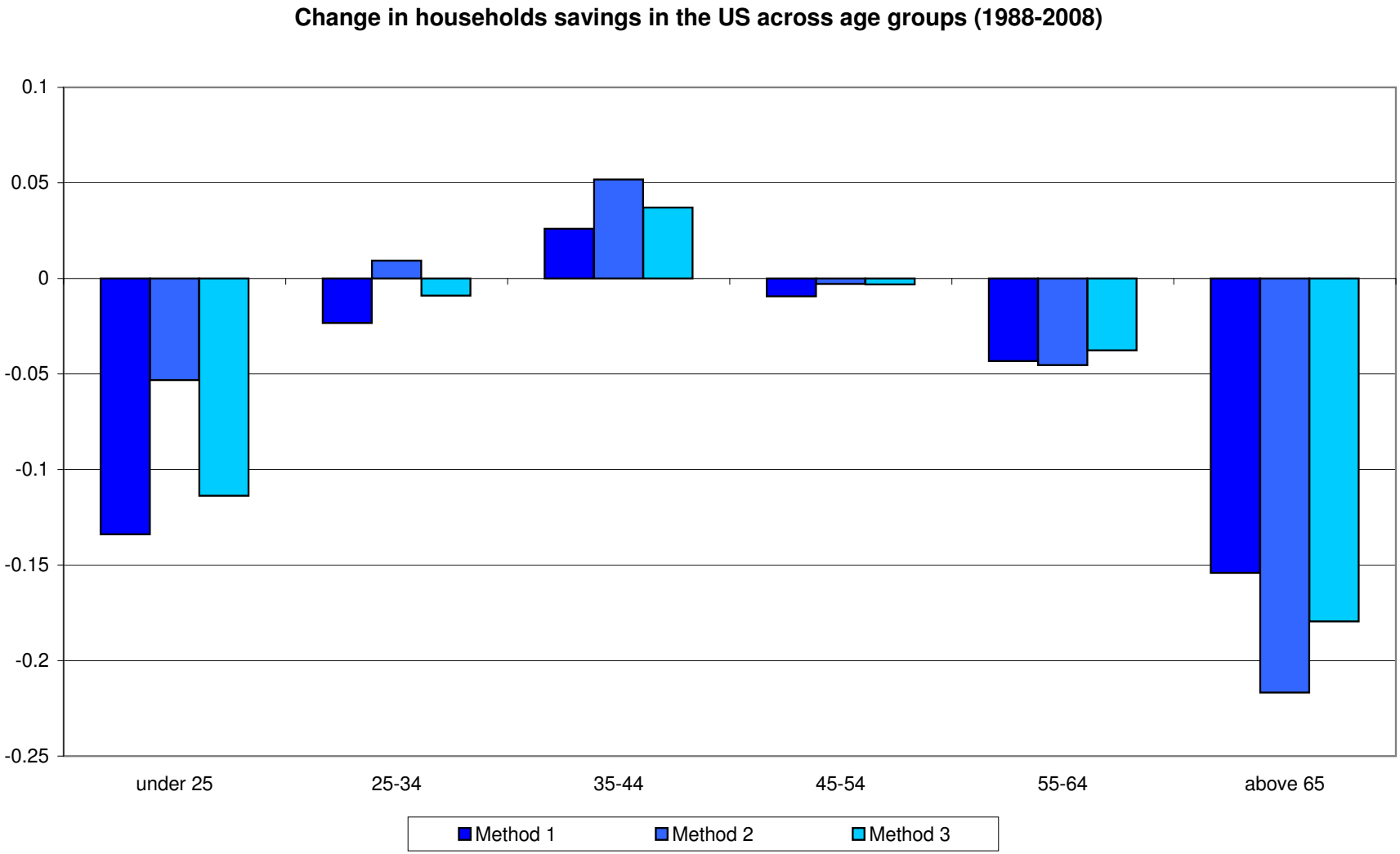
$$\chi_{health,t} = \frac{\sum_{i \neq health} C_{it}^{NIPA}}{\sum_{i \neq health} C_{it}^{CEX}},$$

and for other sectors $j \neq health$

$$\chi_{j,t} = \frac{C_{jt}^{NIPA}}{C_{jt}^{CEX}} \left[1 + \frac{C_{health,t}^{NIPA}}{\sum_{i \neq health} C_{it}^{NIPA}} - \frac{C_{health,t}^{CEX}}{\sum_{i \neq health} C_{it}^{CEX}} \right].$$

- Compared to the previous method, the adjustment factor for health is reduced while other factors are slightly increased.

US Evidence


Change in households savings in the US across age groups (1988-2008)
0.1
0.05
0
-0.05
-0.1
-0.15
-0.2
-0.25
under 25
25-34
35-44
45-54
55-64
above 65
Method 1
Method 2
Method 3

Evidence for China

- Data from CHIP (1995 and 2002) and UHS (1992-2009).
- Existing evidence goes against standard life-cycle motives and our predictions.
  - Song et al. (2010), Chamon and Prasad (2010), and Chamon, Liu and Prasad (2010).
- Argue that
  - the young have been saving more than the middle-aged in recent years;
  - the increase in Chinese saving rate is driven by the young and people above 50.

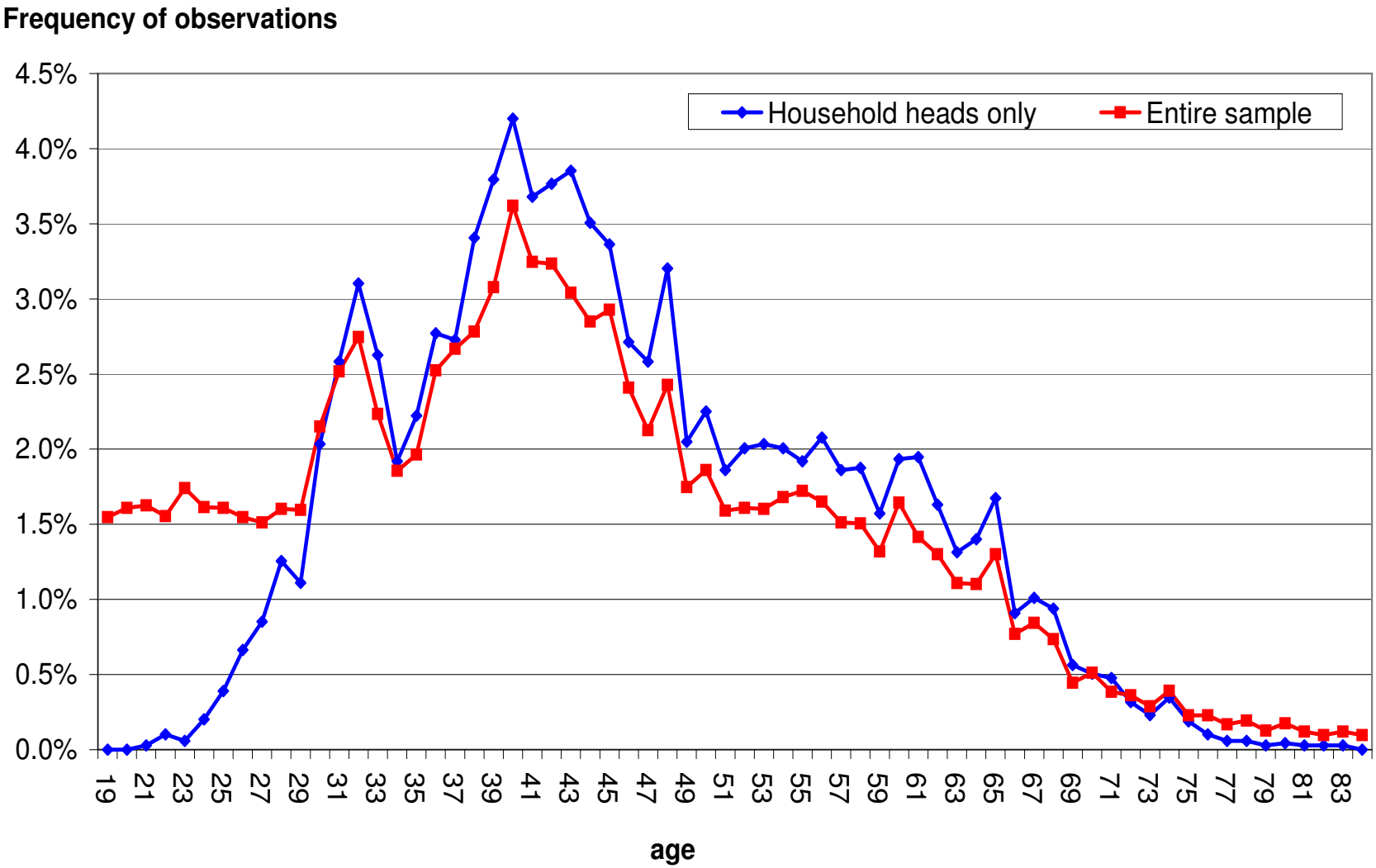
Evidence for China

Measurement issues

- Common practice: examine savings at the **household** level.
- As if average saving rate of households with *head* of age x = average saving rate of *individuals* of age x.
- Two issues:
  - **Selection bias:** household heads might not be random;
  - **Aggregation bias:** multi-generational households.

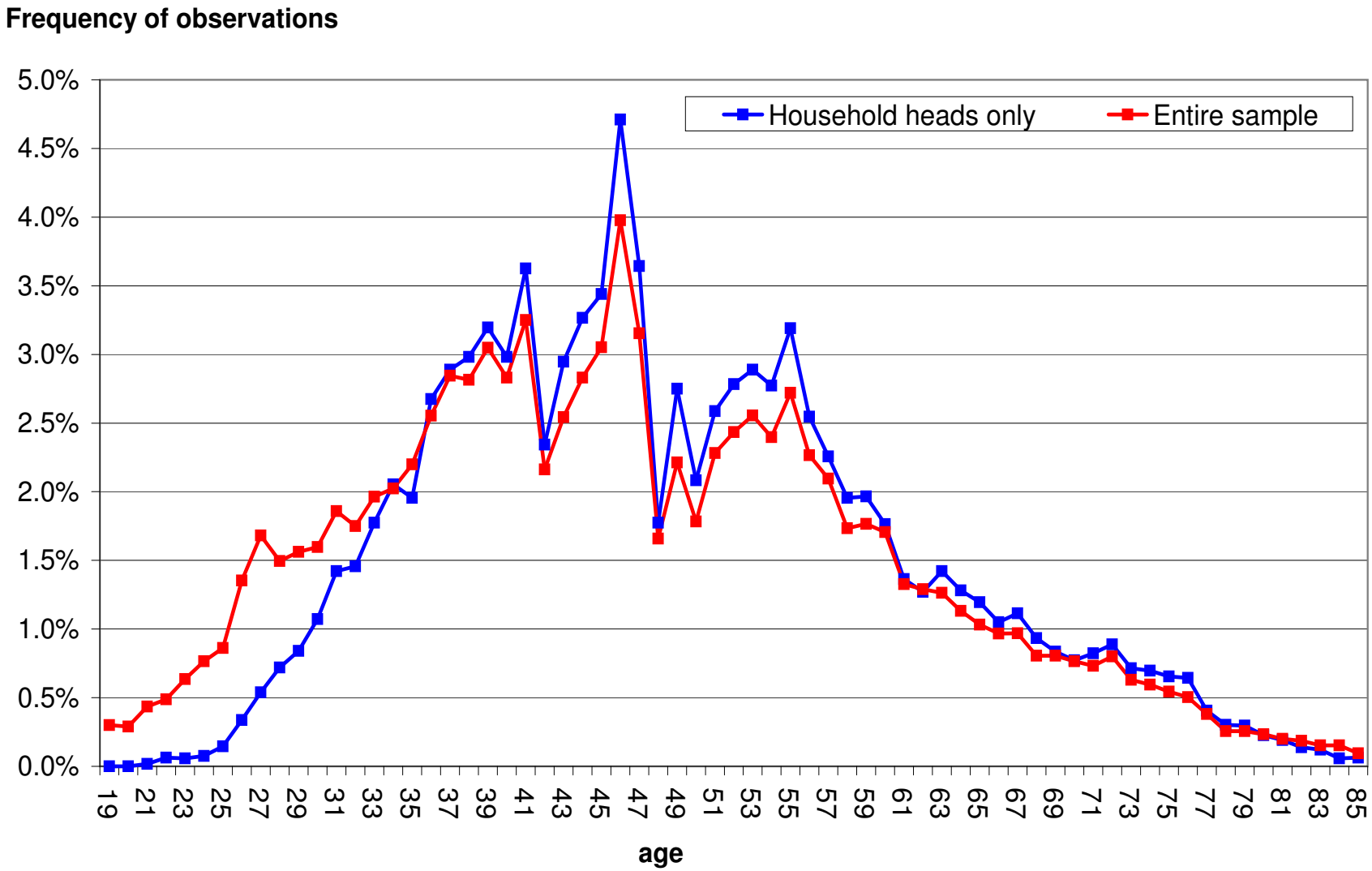
Evidence for China

Selection bias – Age distribution (1995)



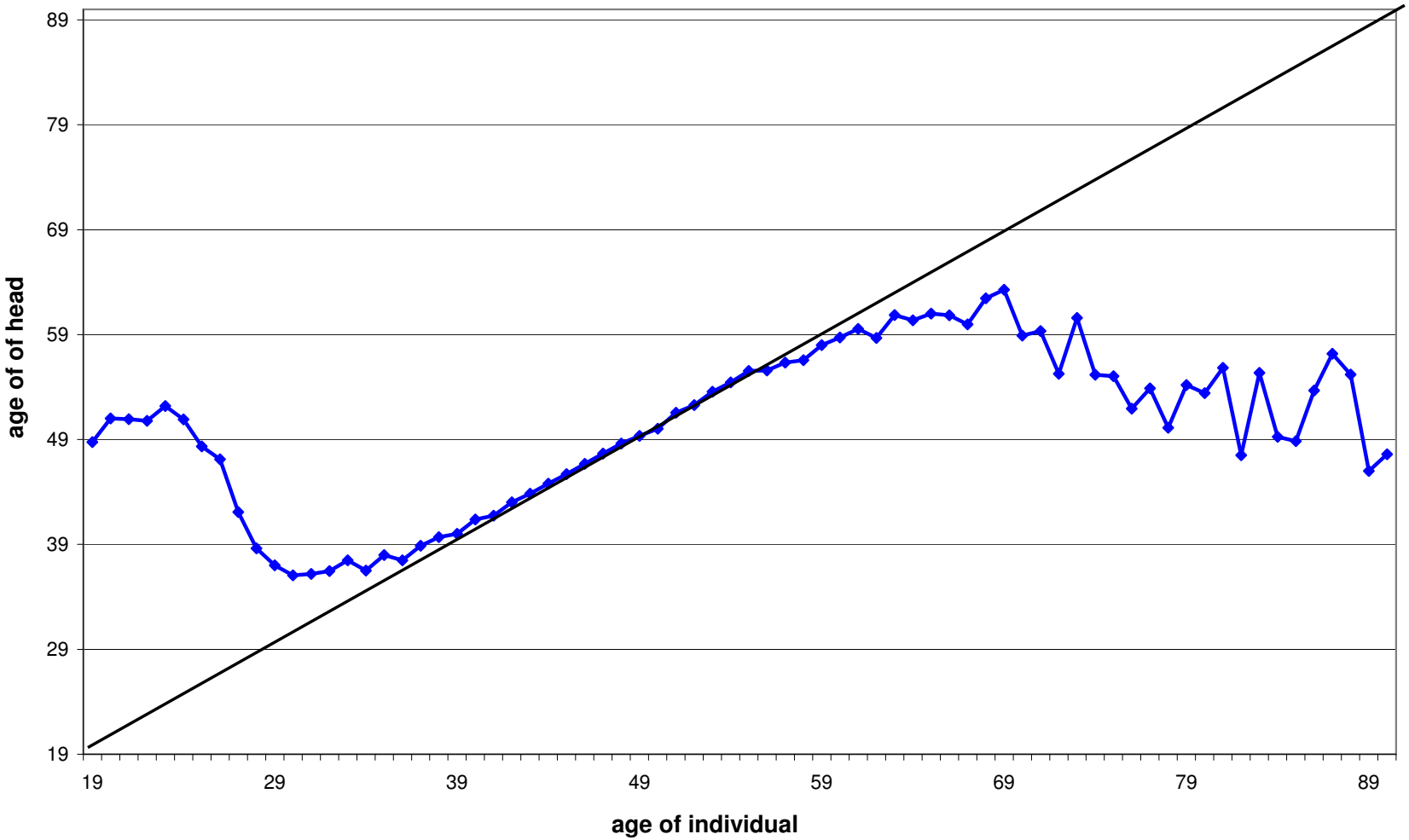
Evidence for China

Selection bias – Age distribution (2009)



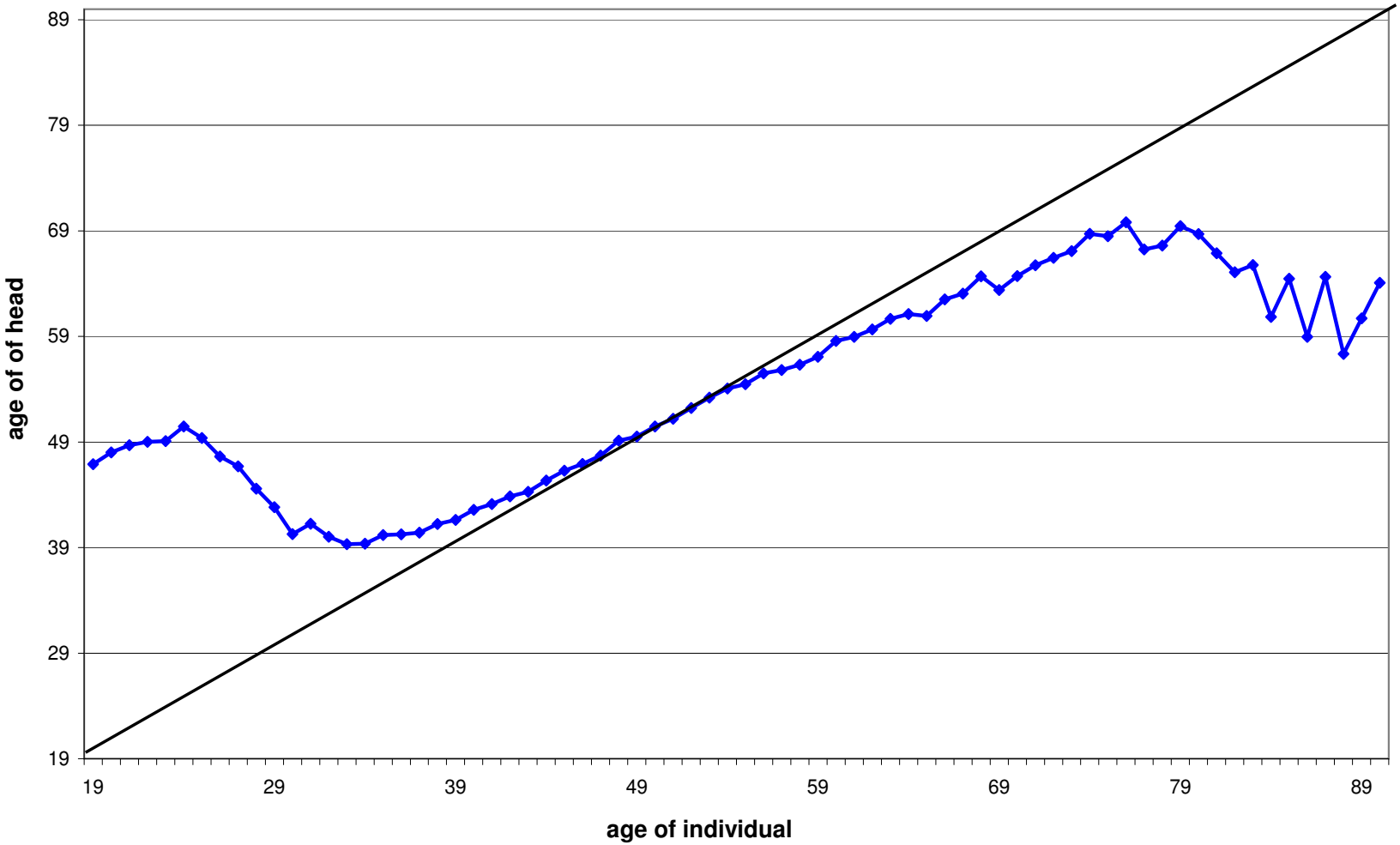
Evidence for China

Age of individual vs. age of household head (1995)



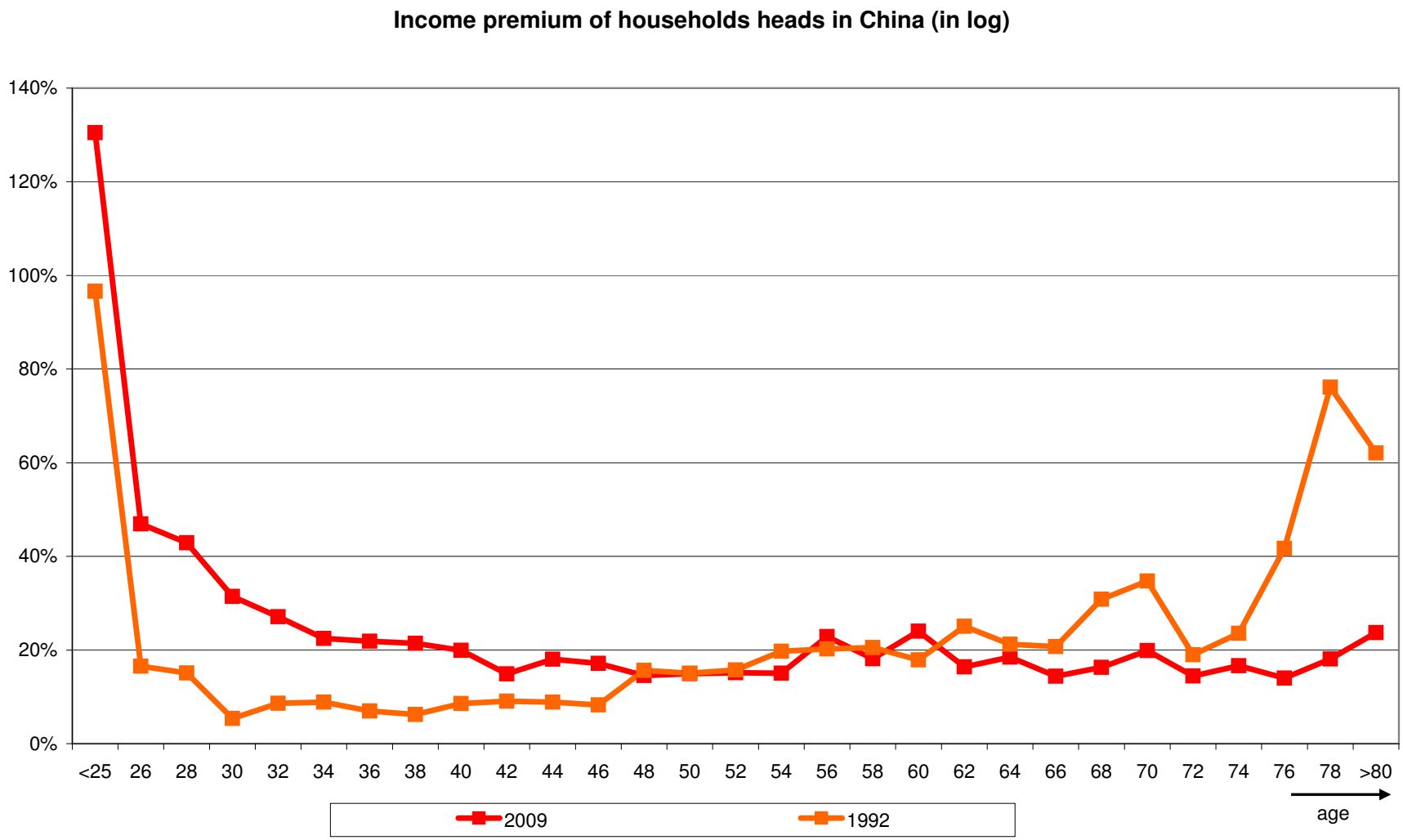
Evidence for China

Age of individual vs. age of household head (2009)



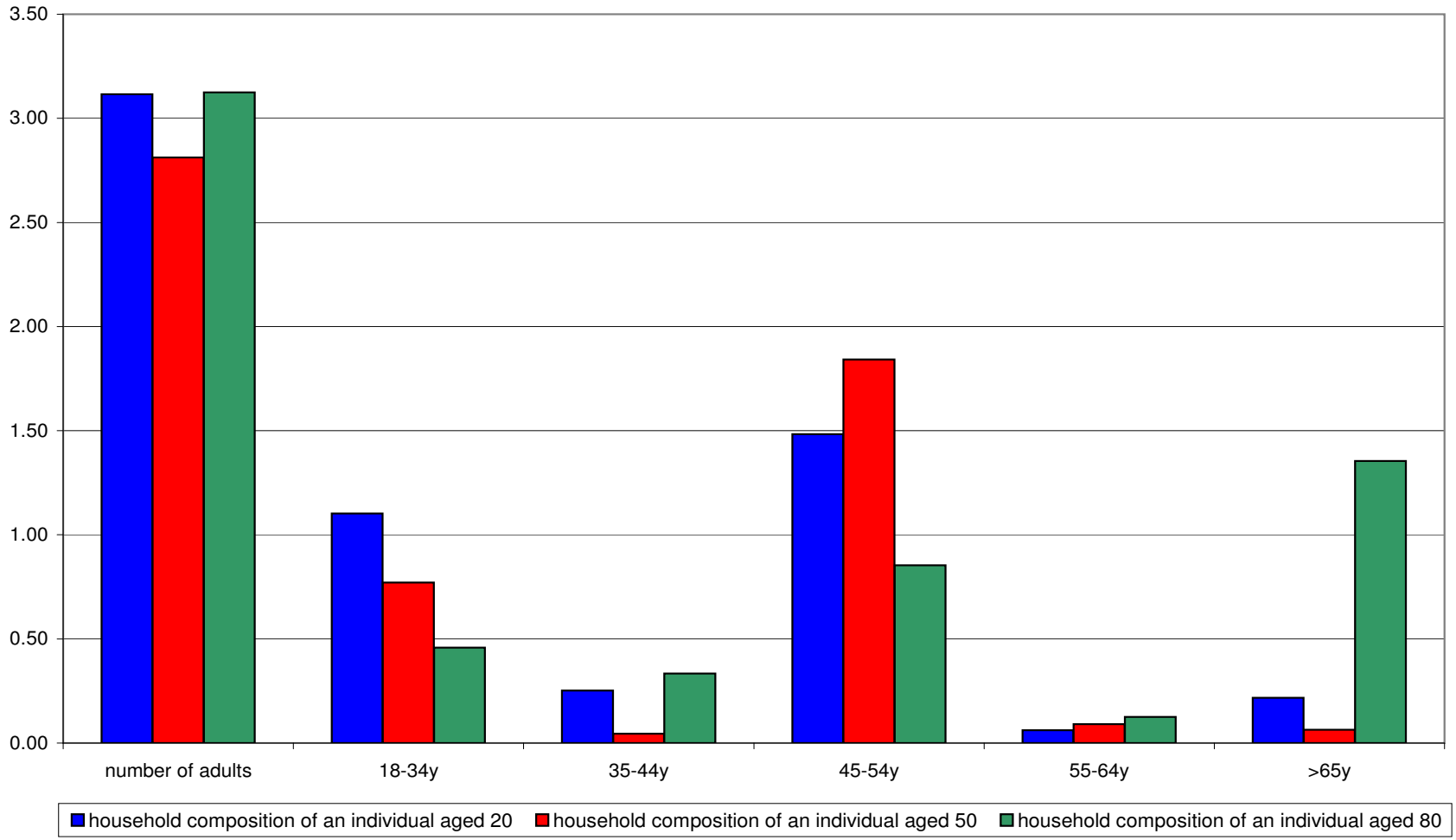
Evidence for China

Selection bias: Income premium by age of household head



Evidence for China

Multi-generational households



Evidence for China revisited

Correcting for biases

- Selection bias overstates level and growth of savings of the young.
- Aggregation bias understates level and growth of savings of the middle-aged.
- Correcting for these biases brings the data more in line with our theoretical framework.
- Differences in the evolution of saving rates between US and China broadly supportive of our predictions.

Evidence for China revisited

Bias correction methodologies

- Main issue: we have individual income but only observe expenditures at household level.
- Crude/naive approach: compute individual expenditures as total household expenditures divided by the number of adults (i.e., income earners above 18).
- Two alternative approaches to correct for biases.
  - Method 1: keep only non-multigenerational households.
  - Method 2: disaggregation method, following Chesher (1997).

Evidence for China revisited

Correction method 1

- **Method 1:** keep only non-multigenerational households to control for aggregation bias.
- To control for selection bias, we reweigh observations according to observables to match aggregate data.
  - We match the income and gender distribution by age.
- Caveat: lack of observations for very young/old, and other selection issues.

Evidence for China revisited

Correction method 2

- **Method 2:** projection method, Chesher (1997)
- The model to be estimated is

$$C_i^{hh} = \sum_{a=18}^{99} \{N_{i,a} C_{i,a}^{ind}\} + \epsilon_i.$$

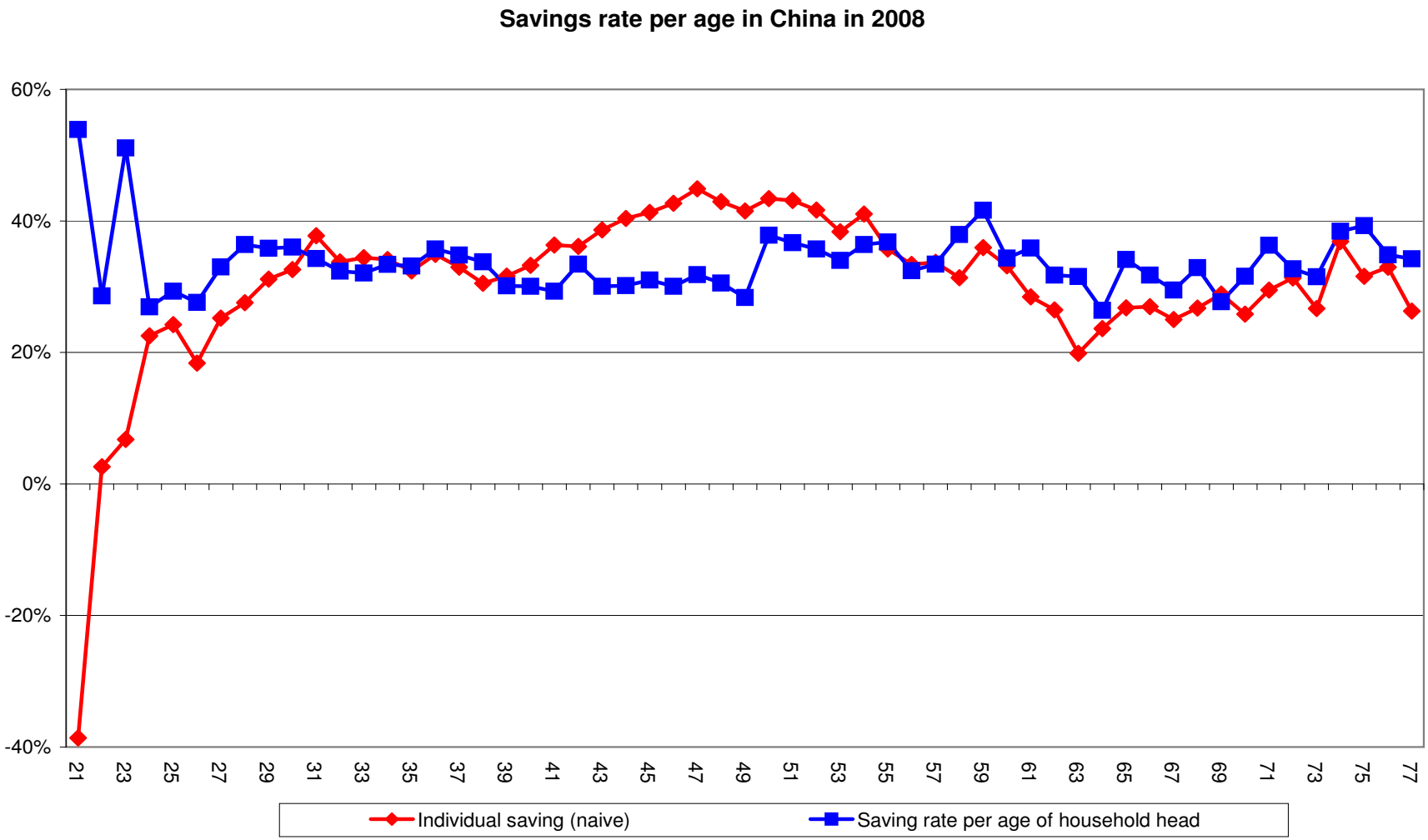
  Roughness-penalized estimation to insure smoothness.

- Caveat: non-interdependence assumption.
- Improvement by adding controls for household characteristics (household income, nb adults, nb children, etc.):

$$C_i^{hh} = \exp(\gamma.\mathbf{Z}_i) \left(\sum_{a=18}^{99} \{N_{i,a} C_{i,a}^{ind}\} \right) + \epsilon_i.$$

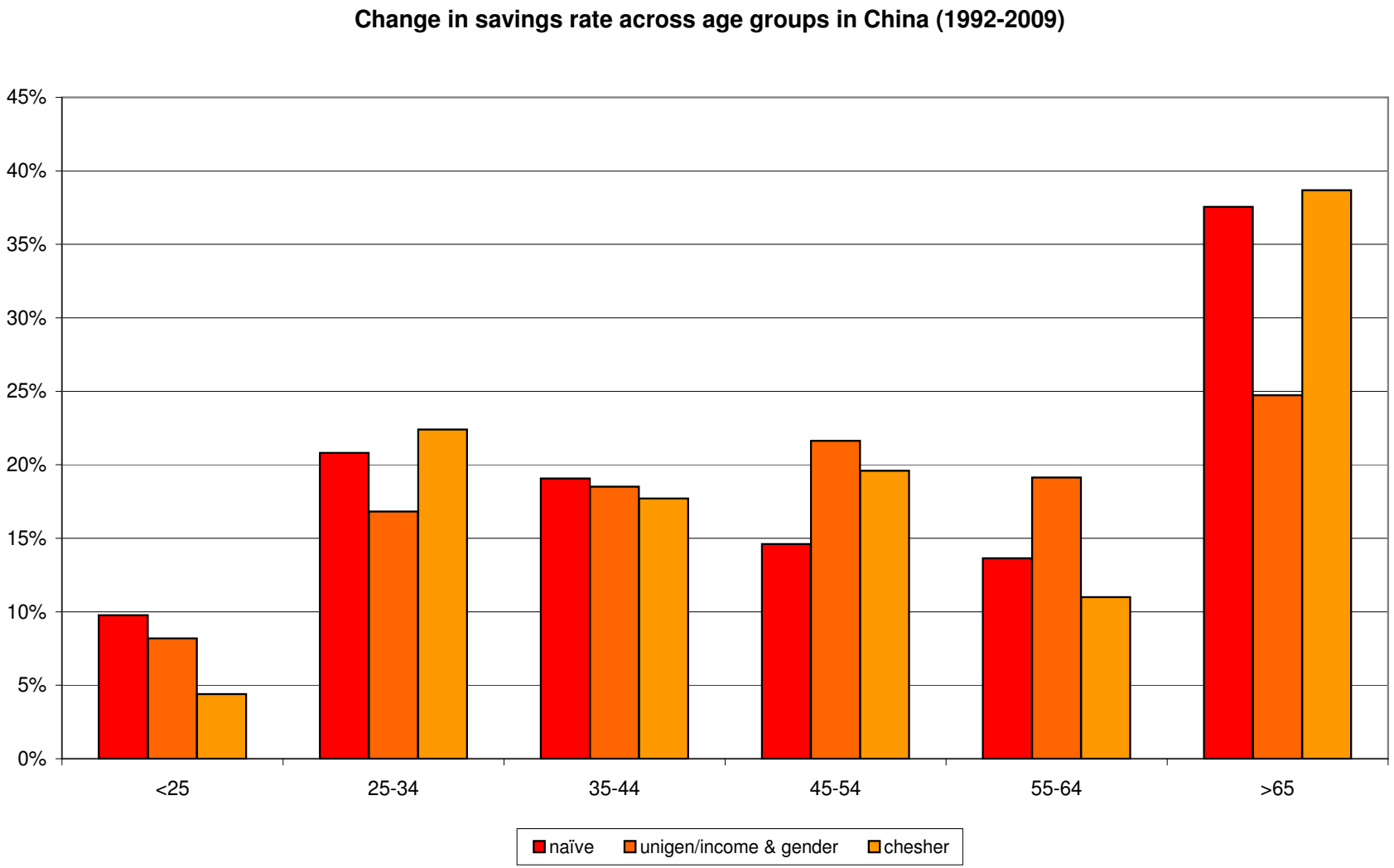
Evidence for China

Saving rates by age (2008)

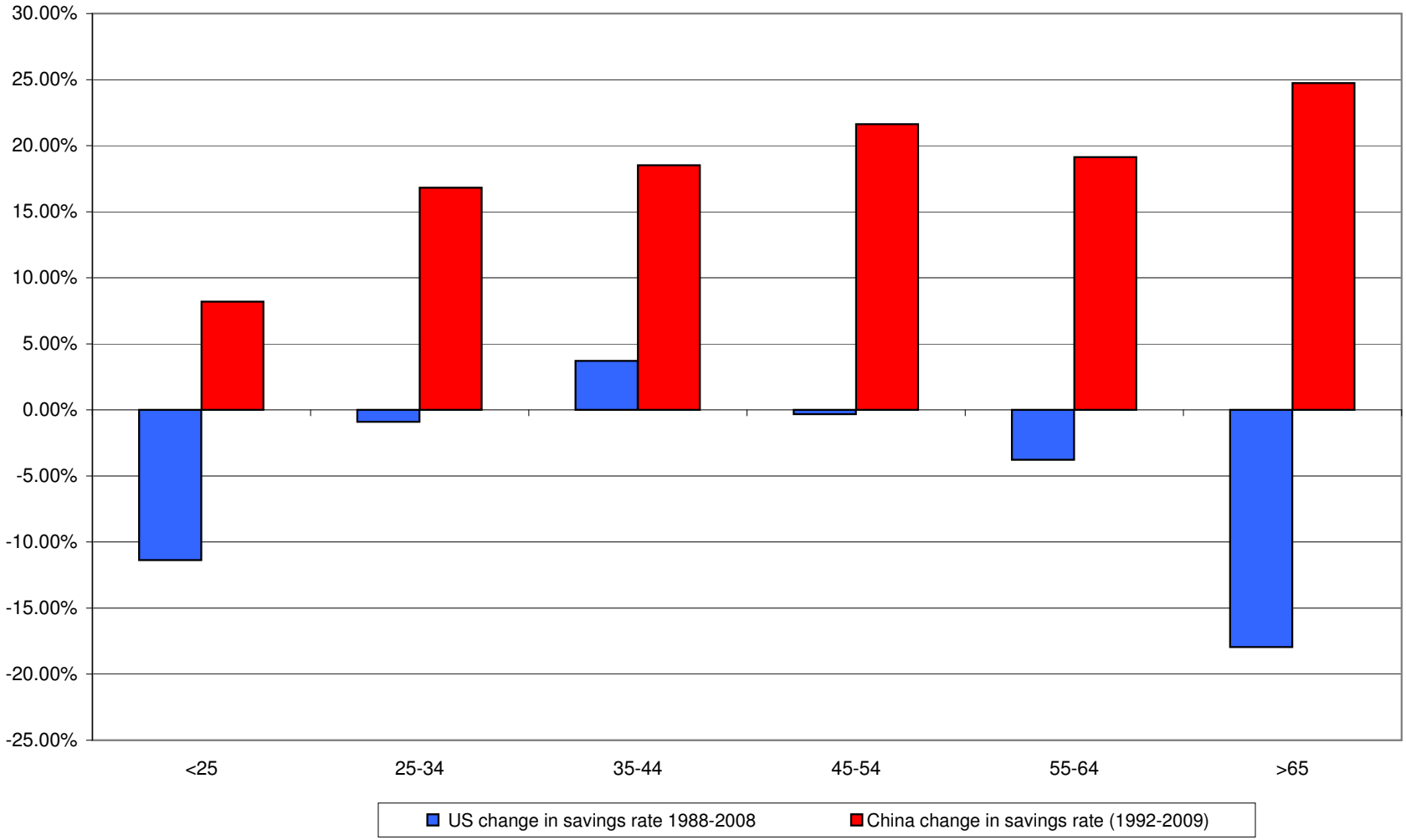


Evidence for China

Change in individual saving rates by age (1992-2009)



Evolution of saving rates by age: US vs. China



Quantitative exercise

Extended setup

- Preferences:

$$U_t^i = u(c_{y,t}^i) + \beta u(c_{m,t+1}^i) + \beta^2 u(c_{o,t+2}^i) + \chi\beta^2 u(b_{t+2}^i).$$

- Budget constraints:

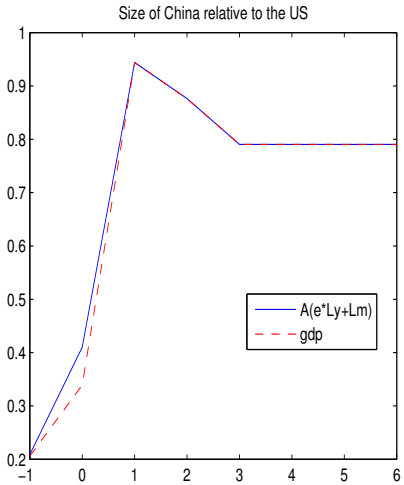
$$\begin{aligned} c_{y,t}^i + a_{y,t+1}^i &= w_{y,t}^i, \\ c_{m,t+1}^i + a_{m,t+2}^i &= w_{m,t+1}^i + R_{t+1}^i a_{y,t+1}^i + \frac{b_{t+1}^i}{1+g_{L,t}^i}, \\ c_{o,t+2}^i + b_{t+2}^i &= R_{t+2}^i a_{m,t+2}^i. \end{aligned}$$

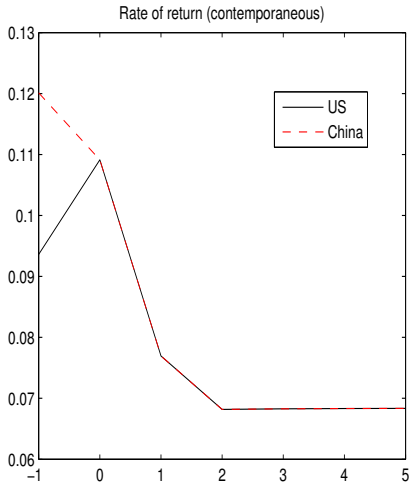
Quantitative exercise

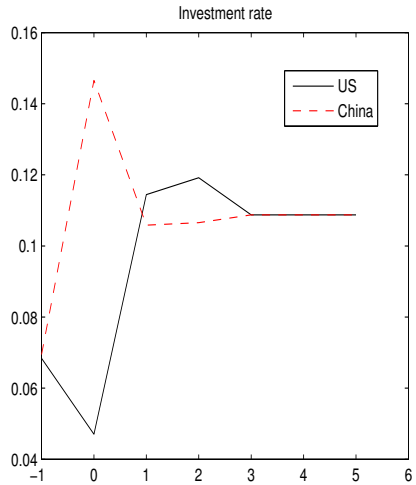
Calibration

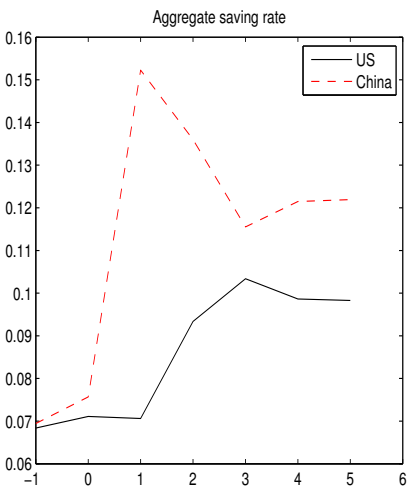
- Relative productivity shocks young vs. middle-aged to match life income profile in China and the US.
- Demographic shocks to match population structure in China and the US.
- θ_H and bequest motive intensity χ chosen to match levels of saving rates by age group in the US in 1990.
- θ_F/θ_H pinned down by ratio of household debt across US and China.
- Productivity shocks and initial capital-labor ratios calibrated as before.

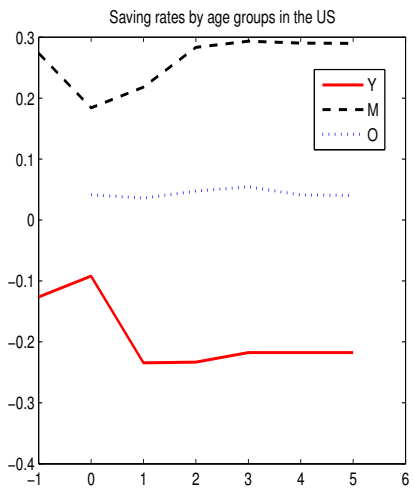
Results (1)

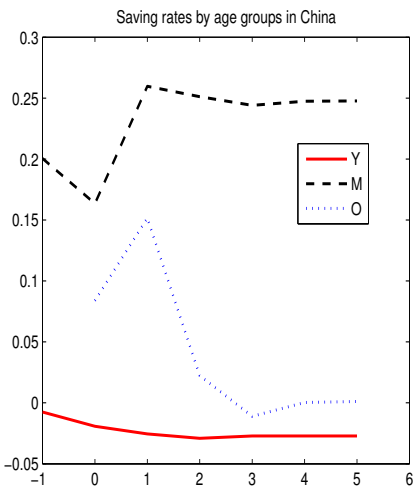

Size of China relative to the US
A(e*Ly+Lm)
gdp


Rate of return (contemporaneous)
US
China


Investment rate
US
China

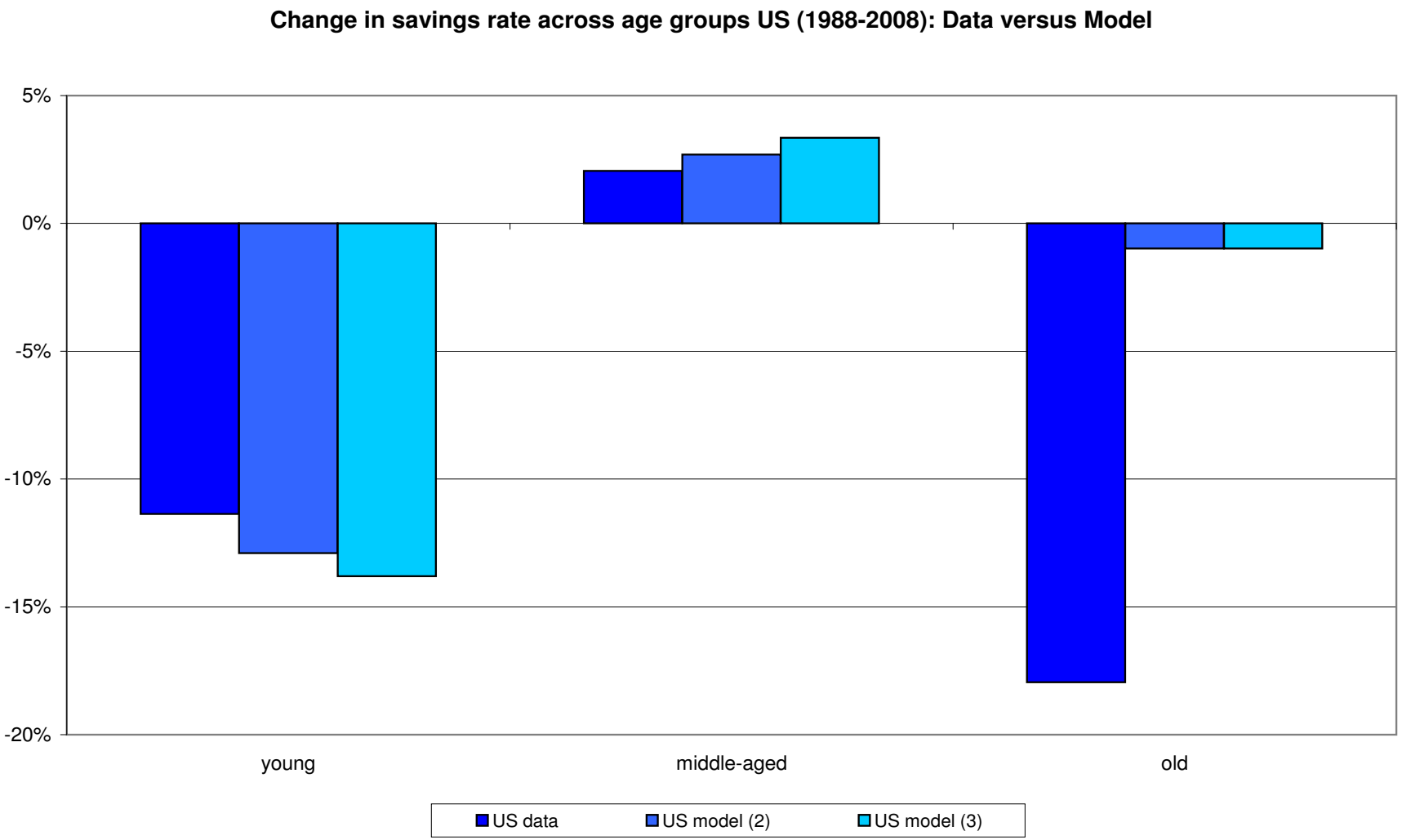

Aggregate saving rate
US
China


Saving rates by age groups in the US
Y
M
O


Saving rates by age groups in China
Y
M
O

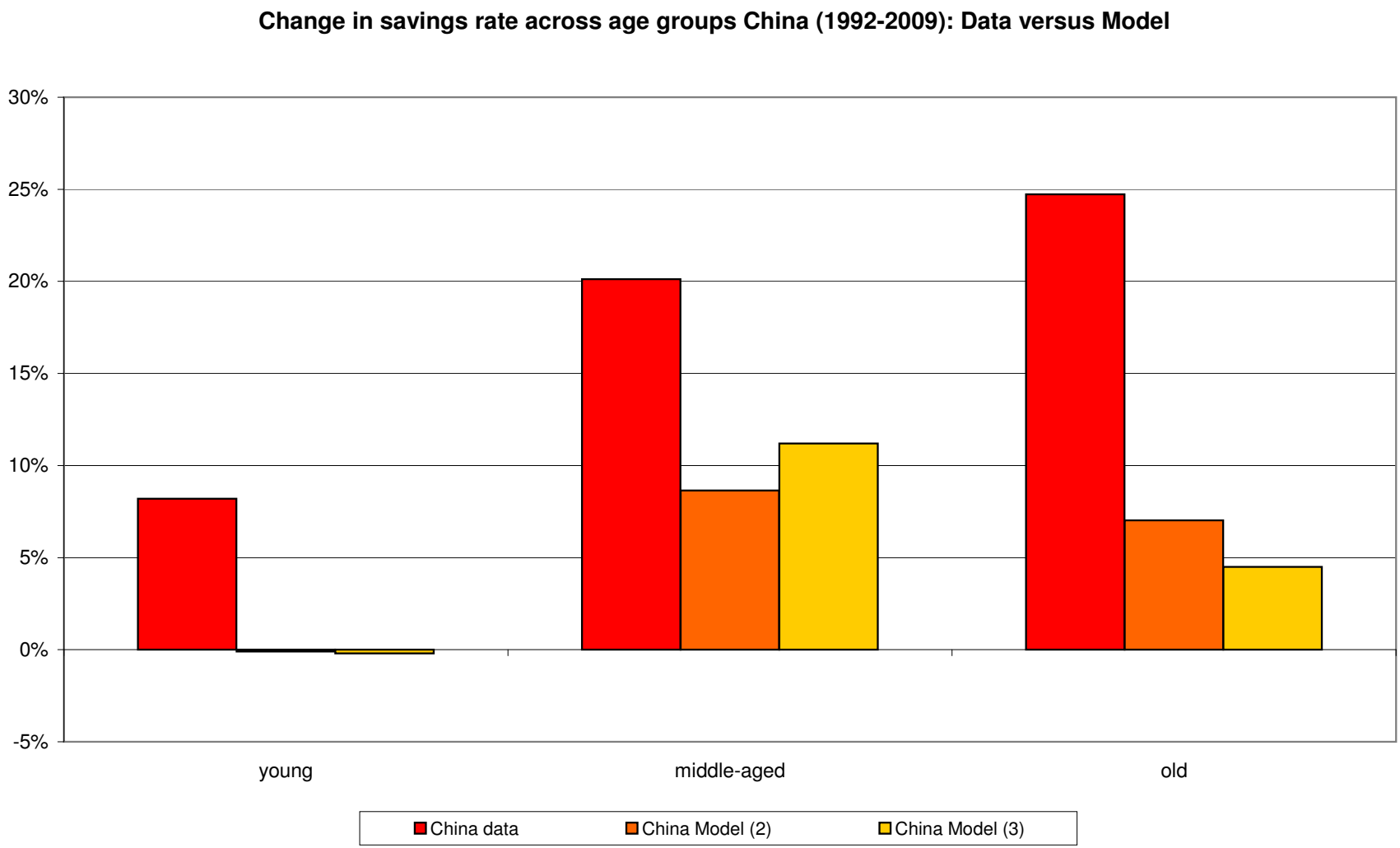
Results (2)

Change in saving rates by age in the US



Results (3)

Change in saving rates by age in China



Conclusion

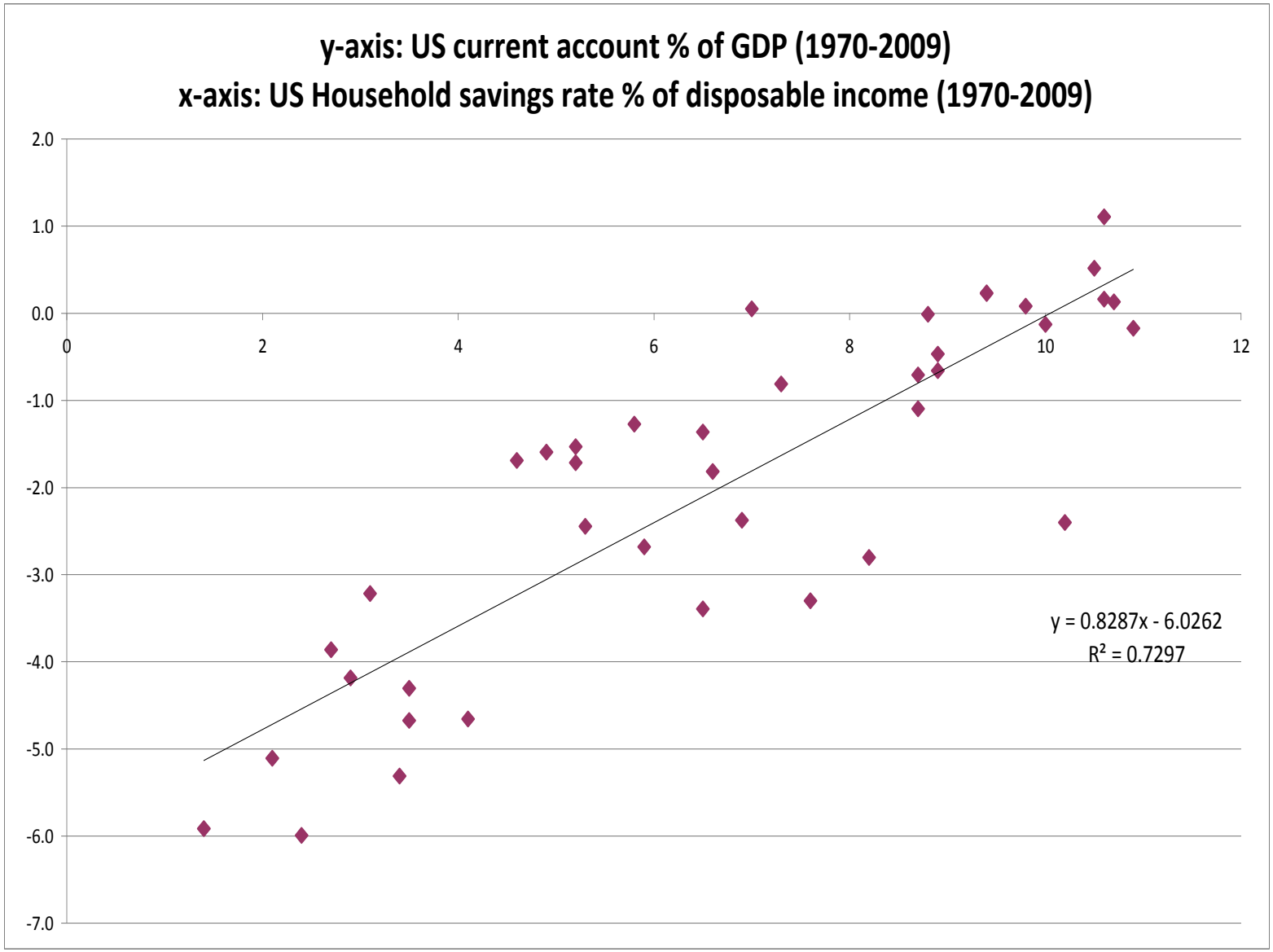
- Capital market integration of emerging countries and fast growth in these countries are two major shocks on global capital markets.
- We show how, unlike in a standard model, this can lead to:

  (1) a divergence in savings rate across countries, (2) current account deficits in developed countries and surpluses in Emerging Asia, (3) a fall in world interest rates.
- The key mechanism relies on differences in borrowing constraints across countries.
- Three-country experiment consistent with heterogeneity within developed countries.
- Broadly in line with micro evidence for China and US.

APPENDIX

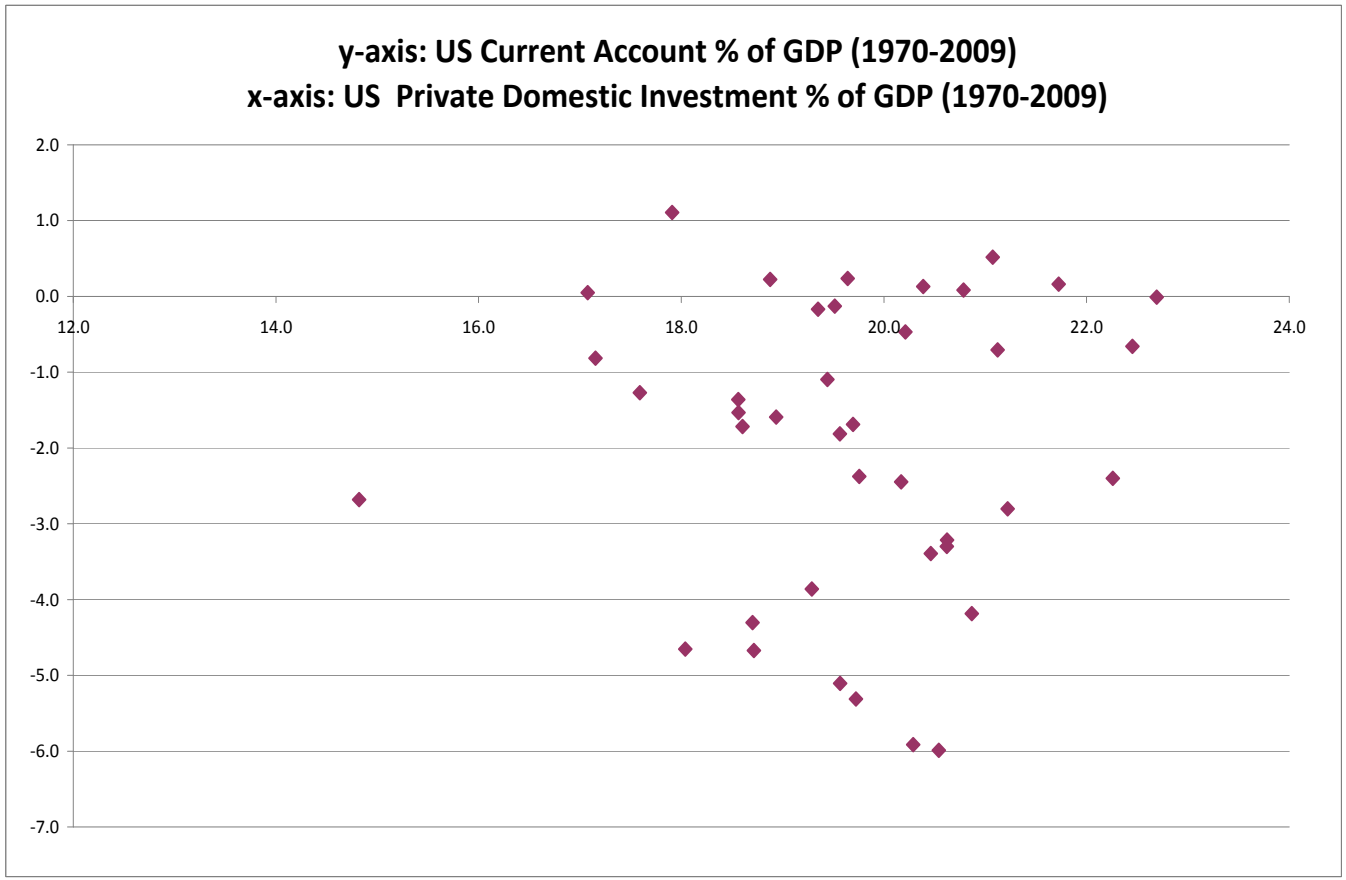
Current account imbalances

The US experience (1)



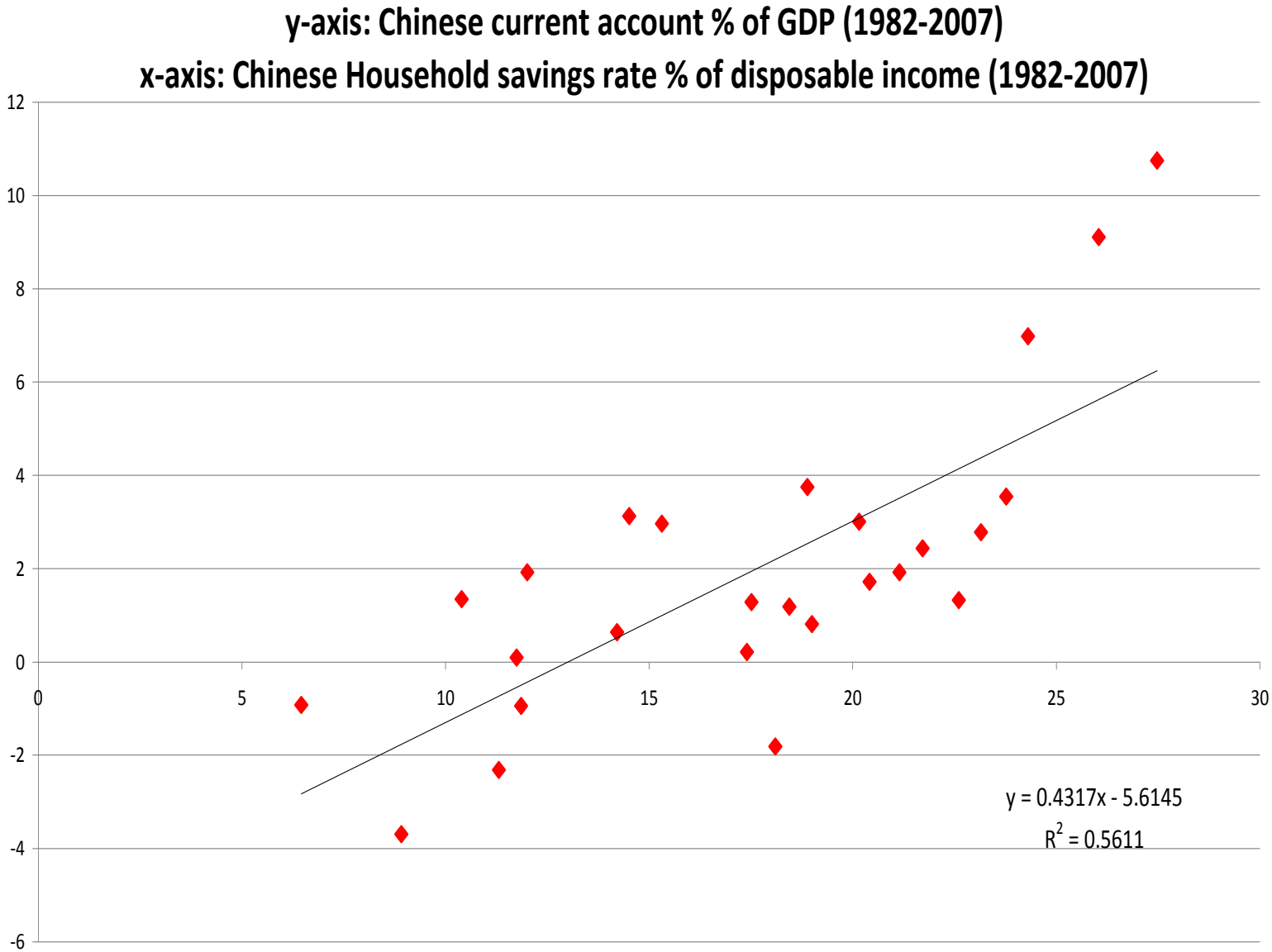
Current account imbalances

The US experience (2)



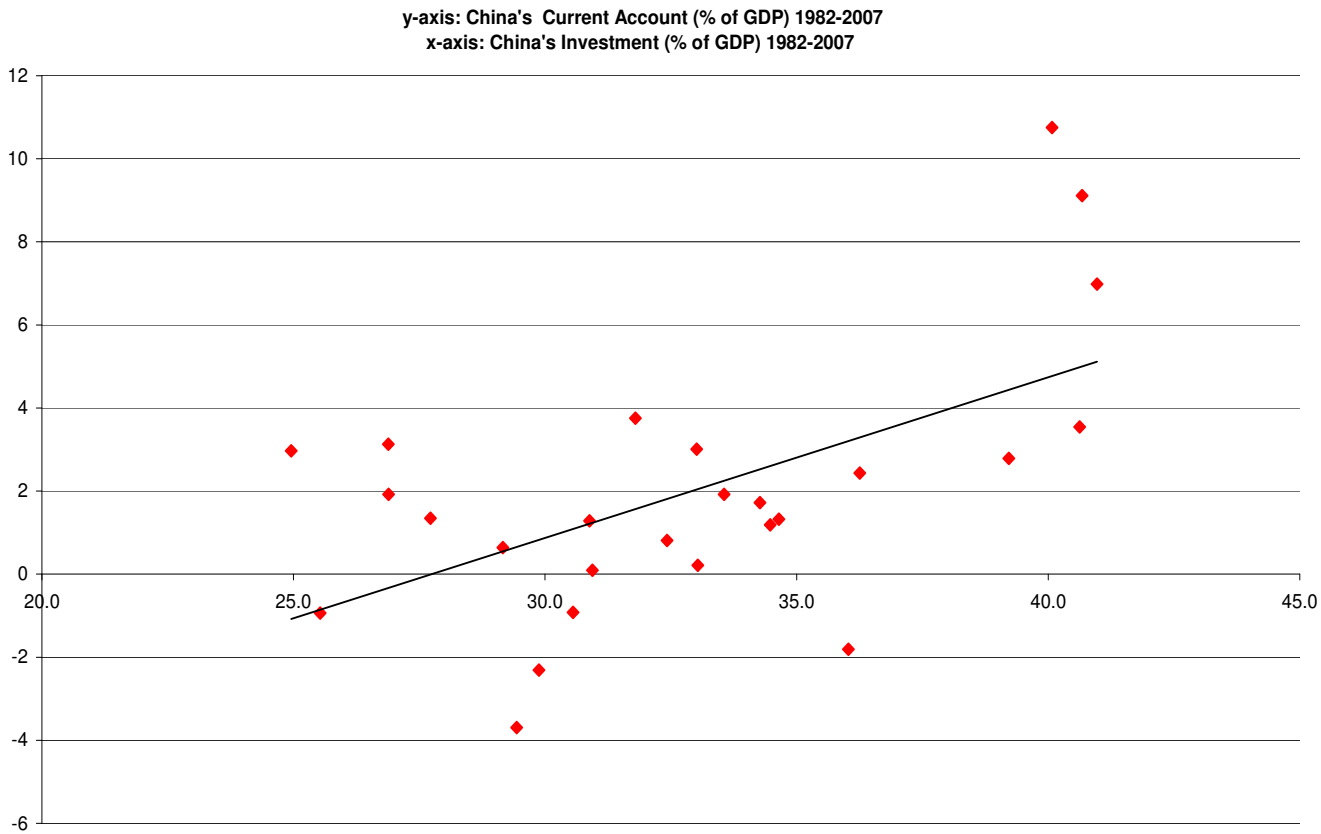
Current account imbalances

The Chinese experience (1)



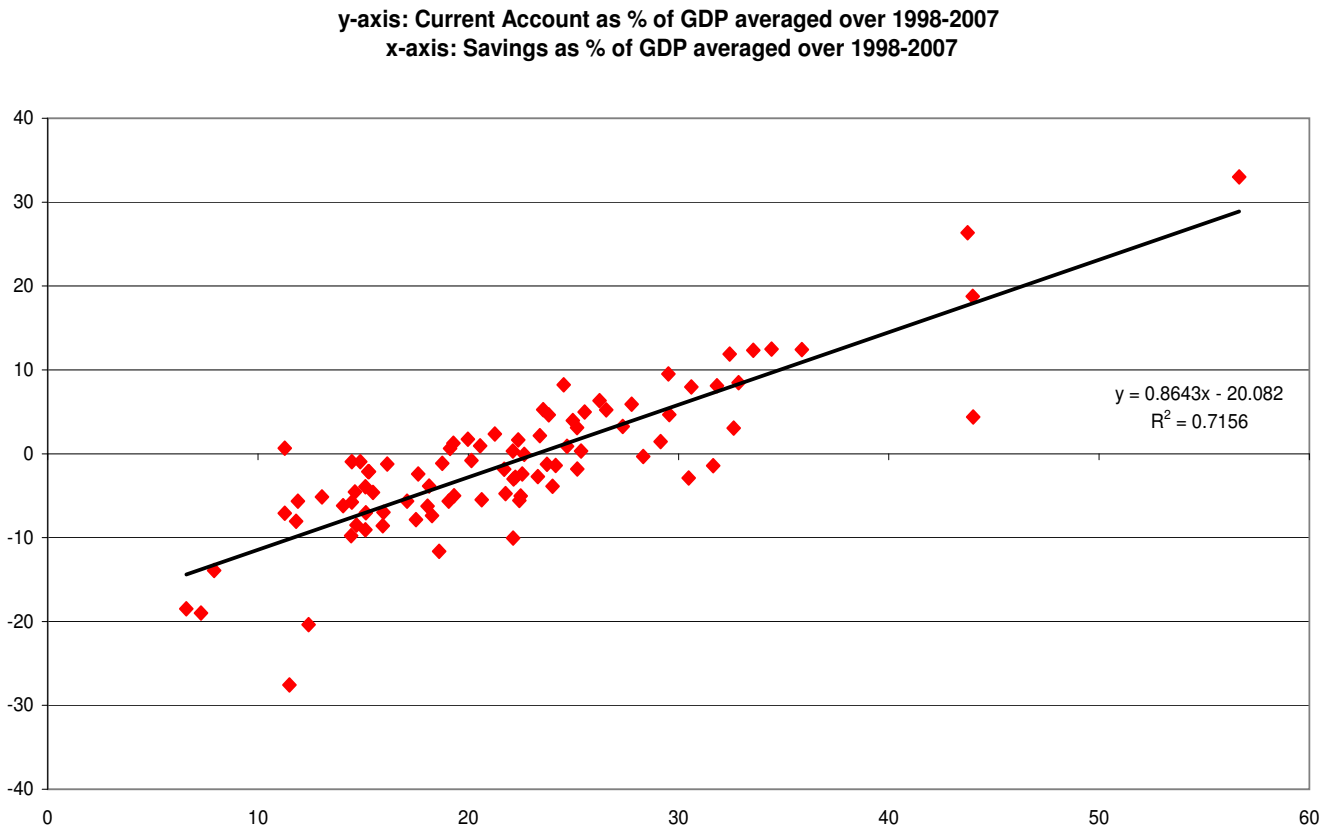
Current account imbalances

The Chinese experience (2)



Current account imbalances

Cross-country evidence on savings as key driver of current account over recent period



Savings

- Aggregate savings:

$$S_t^i \equiv Y_t^i + (R_t - 1)NFA_t^i - C_t^i.$$

- Note: $Y_t^i = W_t^i + r_{K,t}K_t^i$ and $NFA_t^i = A_{y,t}^i + A_{m,t}^i - K_t^i$.

- We can write $S_t^i = S_{y,t}^i + S_{m,t}^i + S_{o,t}^i$ where

$$\begin{aligned} S_{y,t}^i &= -C_{y,t}^i, \\ S_{m,t}^i &= W_t^i + (R_t - 1)A_{y,t}^i - C_{m,t}^i, \\ S_{o,t}^i &= r_{K,t}K_t^i + (R_t - 1)(A_{m,t}^i - K_t^i) - C_{o,t}^i. \end{aligned}$$

Current account

- Definition

$$CA_t^i \equiv NFA_{t+1}^i - NFA_t^i$$

- Equivalently:

$$CA_t^i = S_t^i - I_t^i.$$

Evidence for China

Changes in saving rates by age, 1995-2008