Credit Constraints and Growth in a Global Economy

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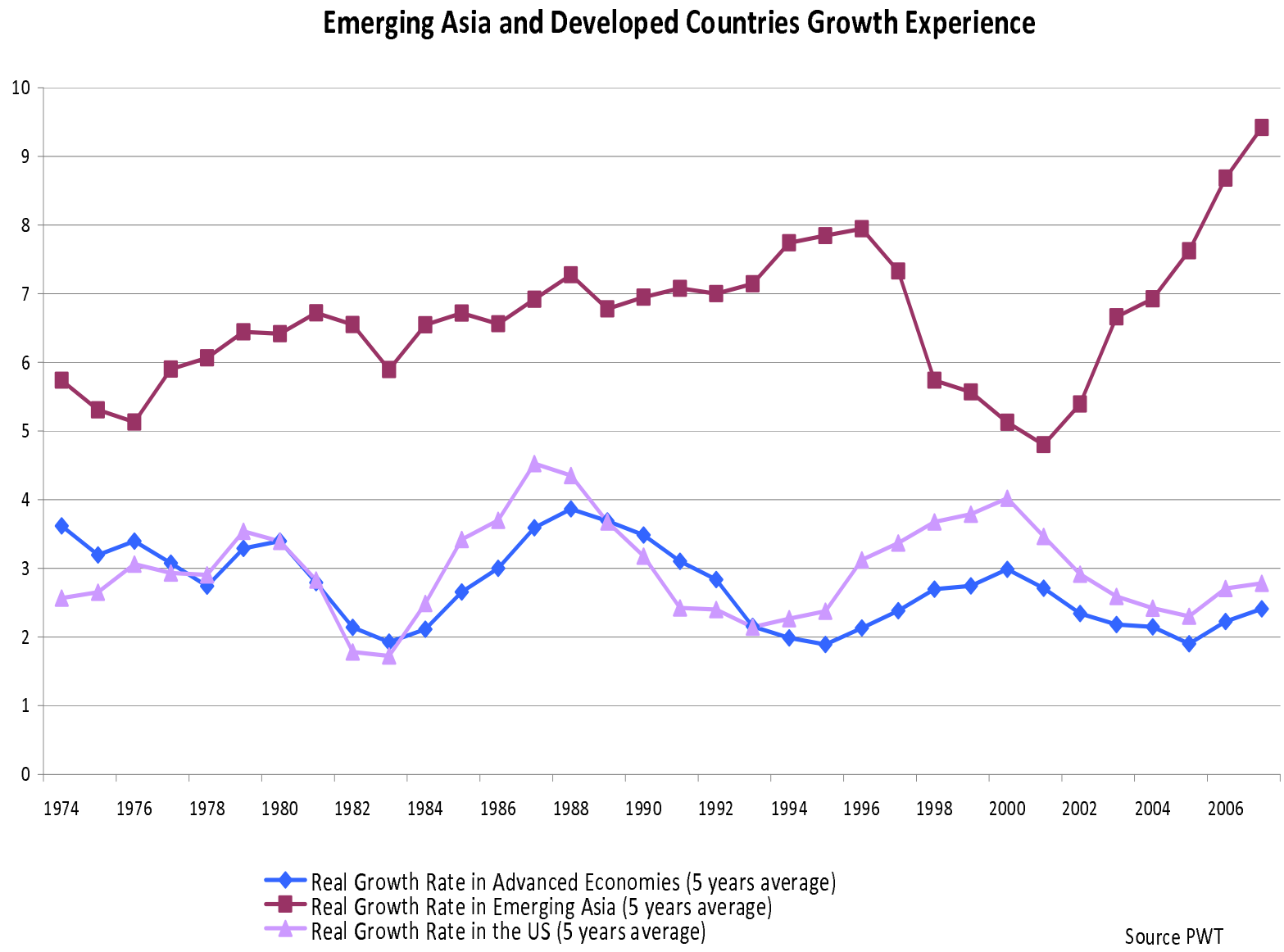
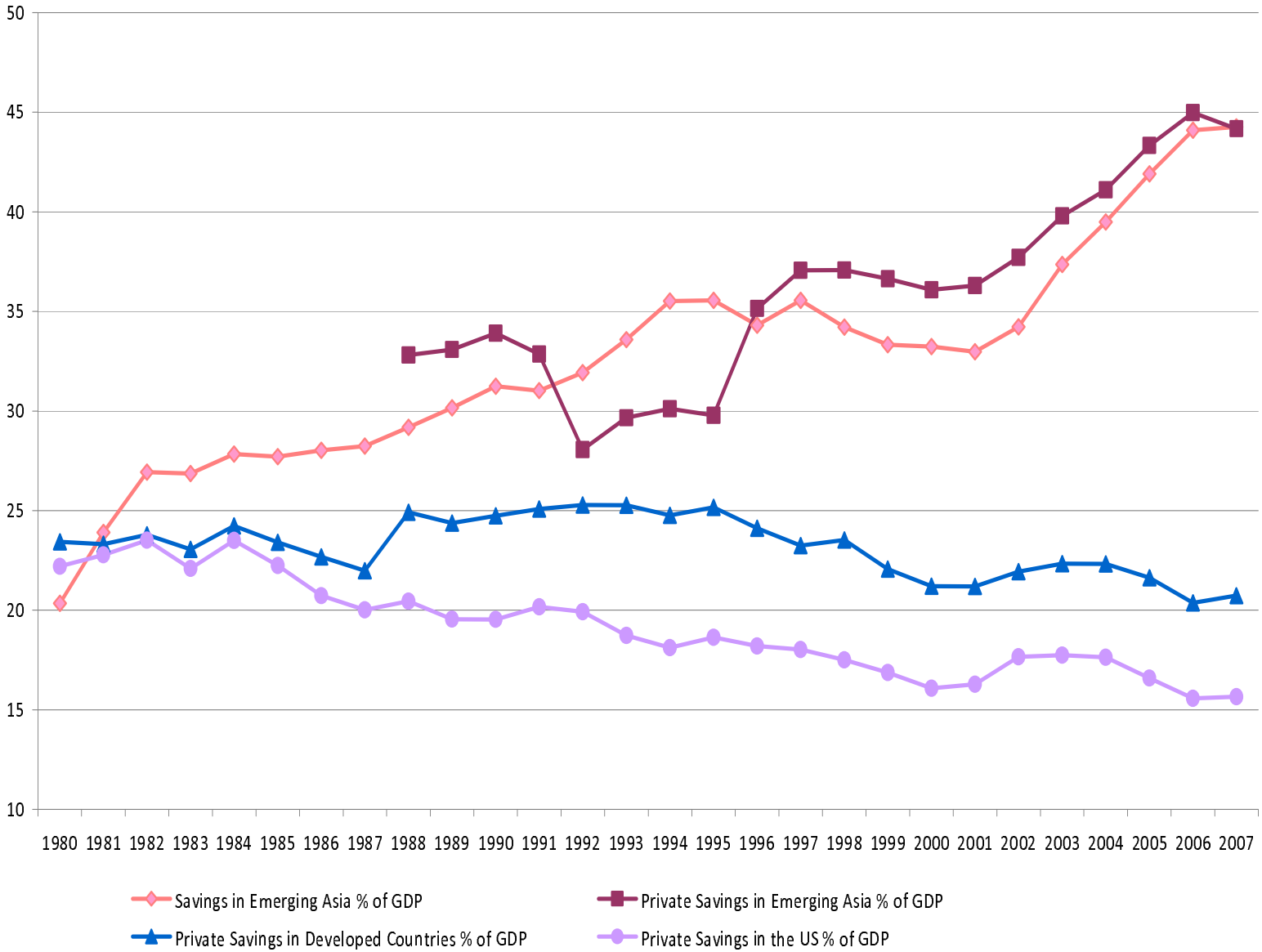
Motivation and stylized facts

- 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.

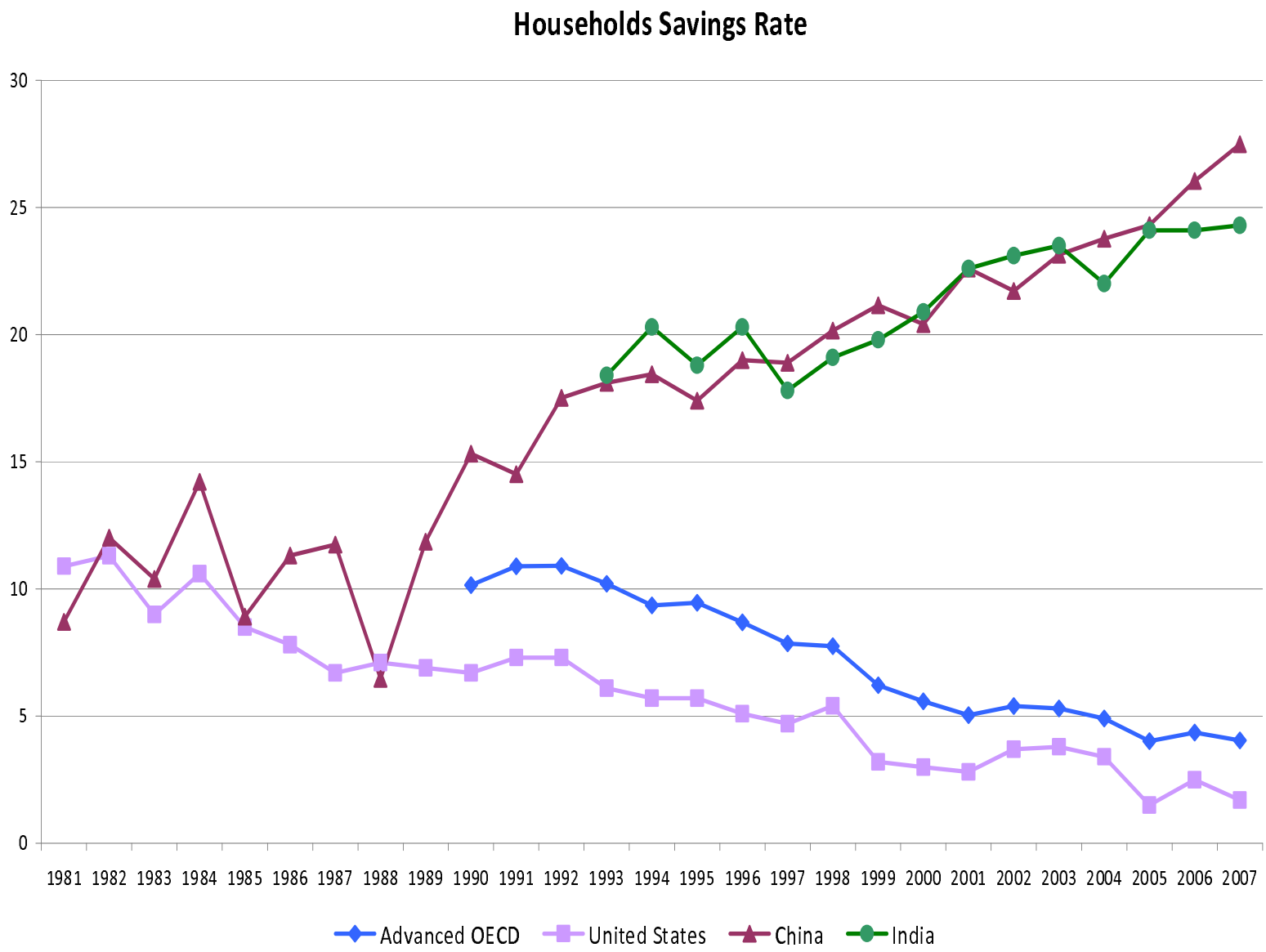
Fast growth in emerging Asia



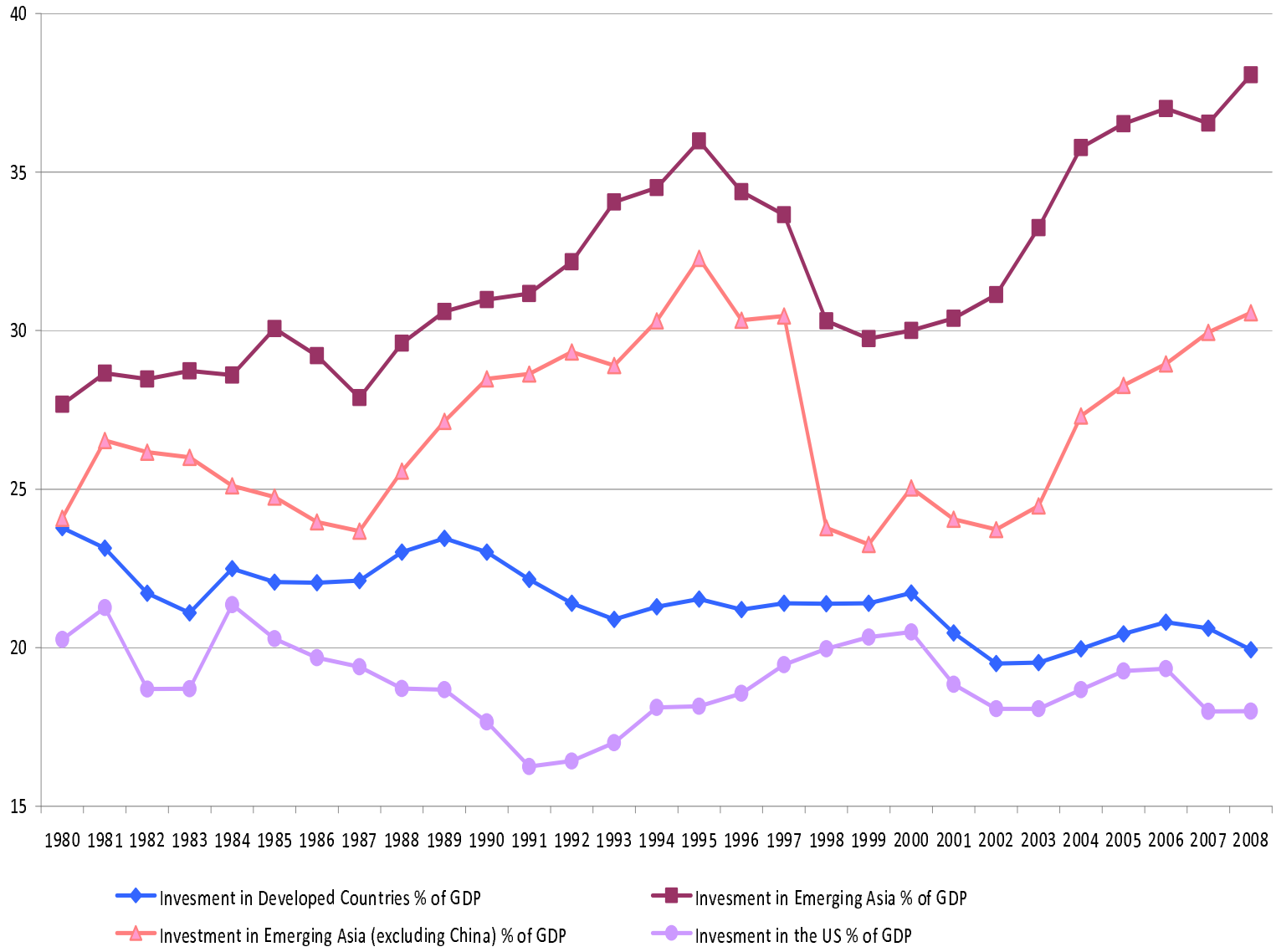
Private savings



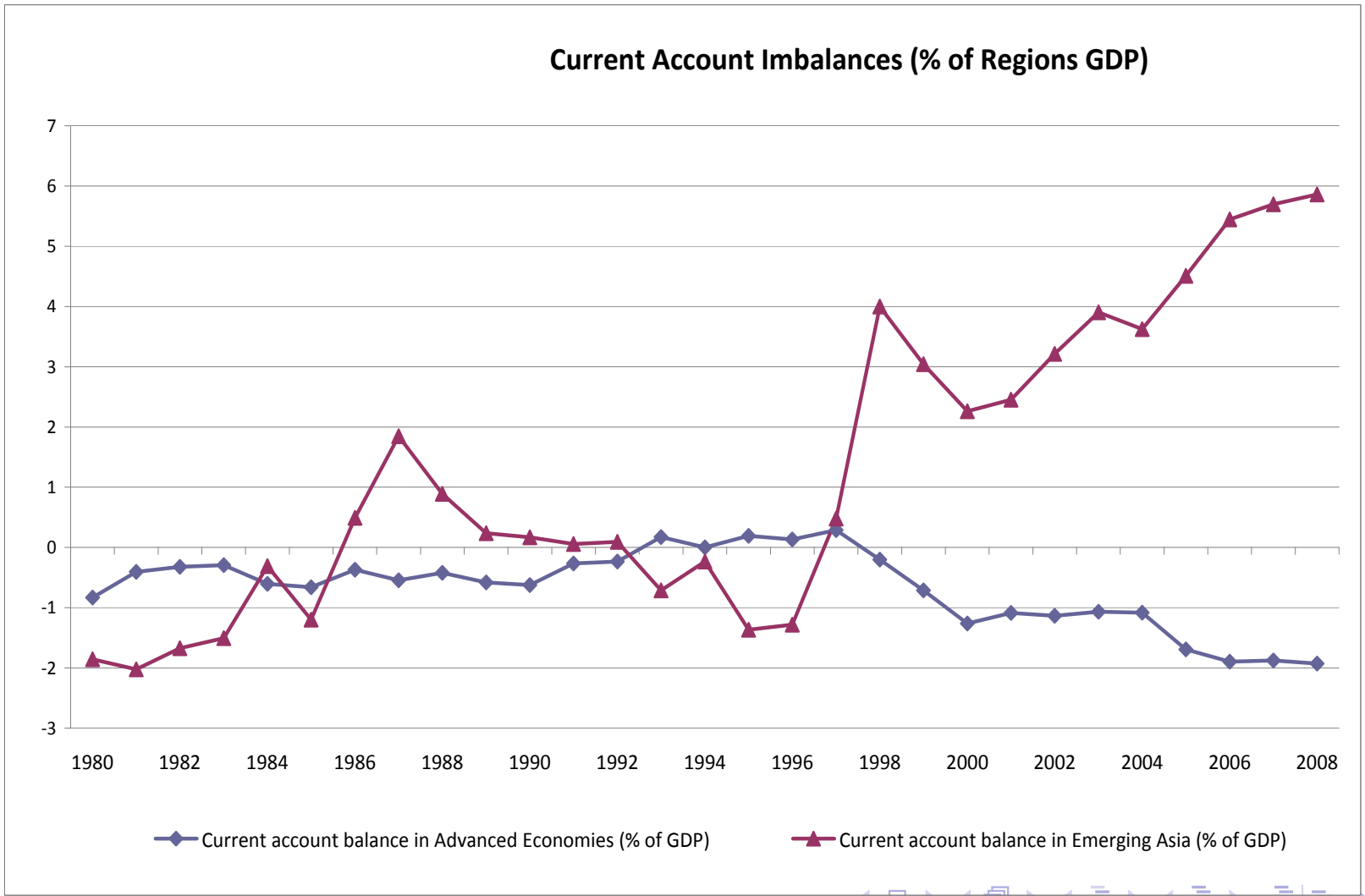
Household savings



Investment

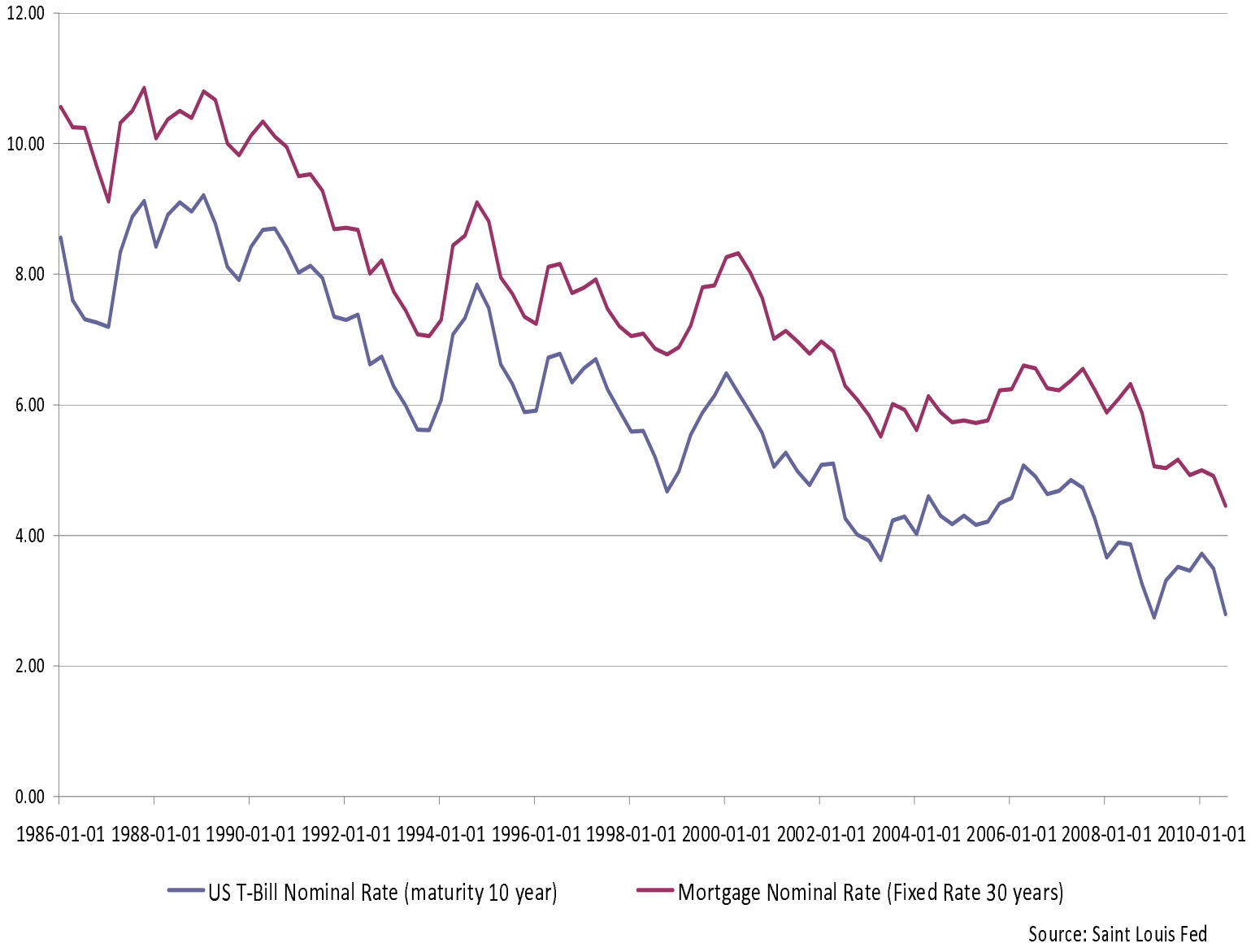

40
35
30
25
20
15
1980 1981 1982 1983 1984 1985 1986 1987 1988 1989 1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008
Invesment in Developed Countries % of GDP
Invesment in Emerging Asia % of GDP
Investment in Emerging Asia (excluding China) % of GDP
Invesment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

= young 'borrowers', middle-aged 'savers', 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

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

- Wages and rental rates of capital

$$\begin{aligned} w_{m,t}^i &= (1-\alpha) A_t^i \left(k_t^i\right)^{\alpha} \qquad w_{y,t}^i = e_t^i w_{m,t}^i, \\ r_{K,t}^i &= \alpha \left(k_t^i\right)^{\alpha-1}, \end{aligned}$$

  with capital-effective-labor ratio $k_t^i \equiv K_t^i / \{A_t^i (e_t^i L_{y,t}^i + L_{m,t}^i)\}$.

- 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 $\sigma \leq 1$

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

Household budget constraints

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

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

- The old decumulate all their assets (no bequests).
  - We incorporate a bequest motive later in quantitative exercise.

Credit constraints

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

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

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

- Constraint is binding if life income profile is steep enough.
  - We restrict our attention to parameter values for which the constraint is always binding in equilibrium.

Household asset holdings

- Binding credit constraints on the young imply:

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

- FOC for the middle-aged gives:

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

Autarky equilibrium

- Capital market equilibrium:

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

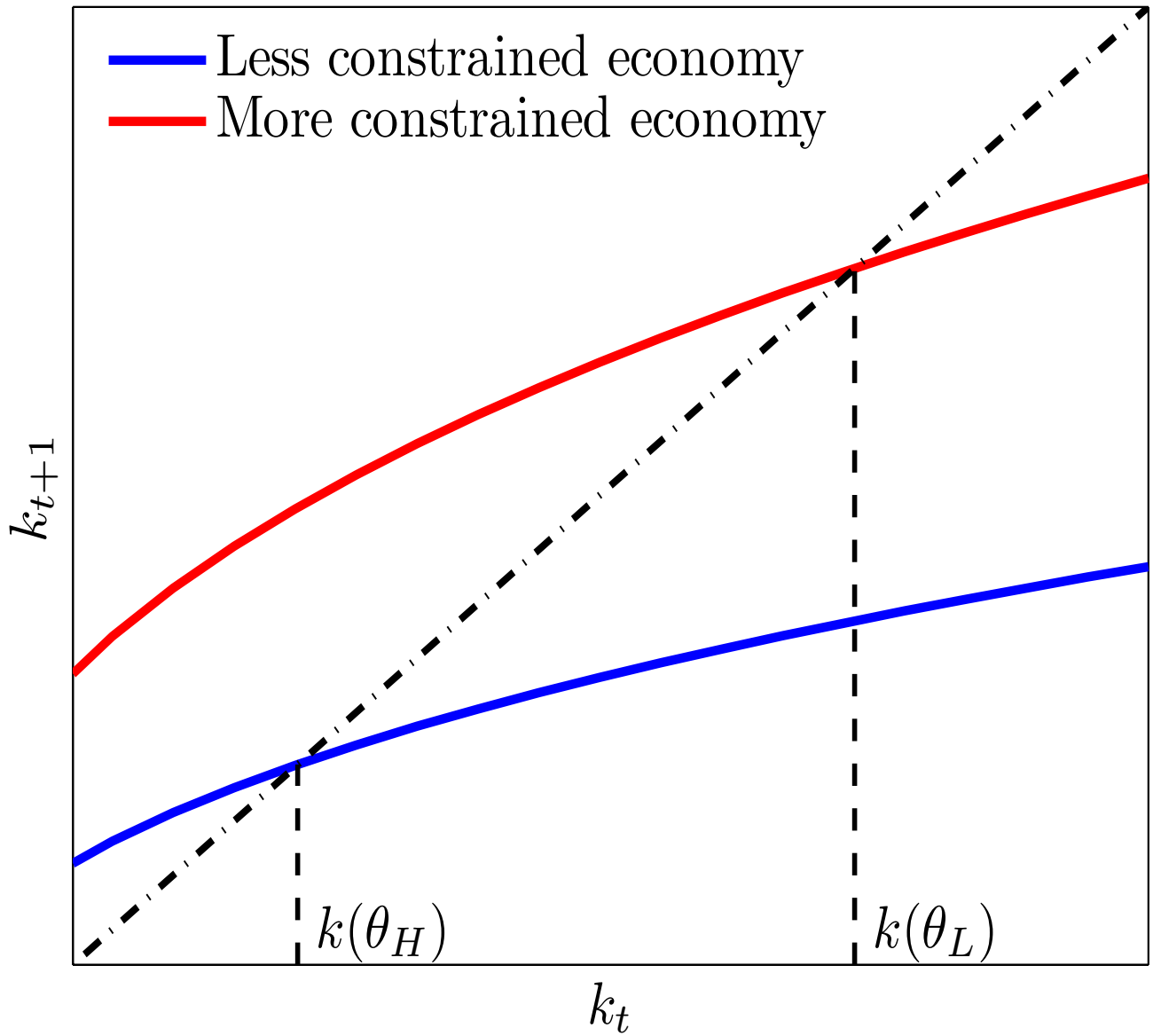
$\hookrightarrow$ difference equation driving the dynamics of k^i_t.

- Autarky rate of return in steady-state (for $\sigma = \delta = 1$)

$$R^i = (1 + g_A)(1 + g_L)\frac{1+\beta}{\beta}\frac{\alpha[1 + e(1 + g_L)] + \theta^i(1-\alpha)}{(1-\alpha)(1-\theta^i)}.$$

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

Autarky equilibrium



Integrated equilibrium

- Equilibrium condition under financial integration:

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

- Financial integration in period t implies

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

and

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

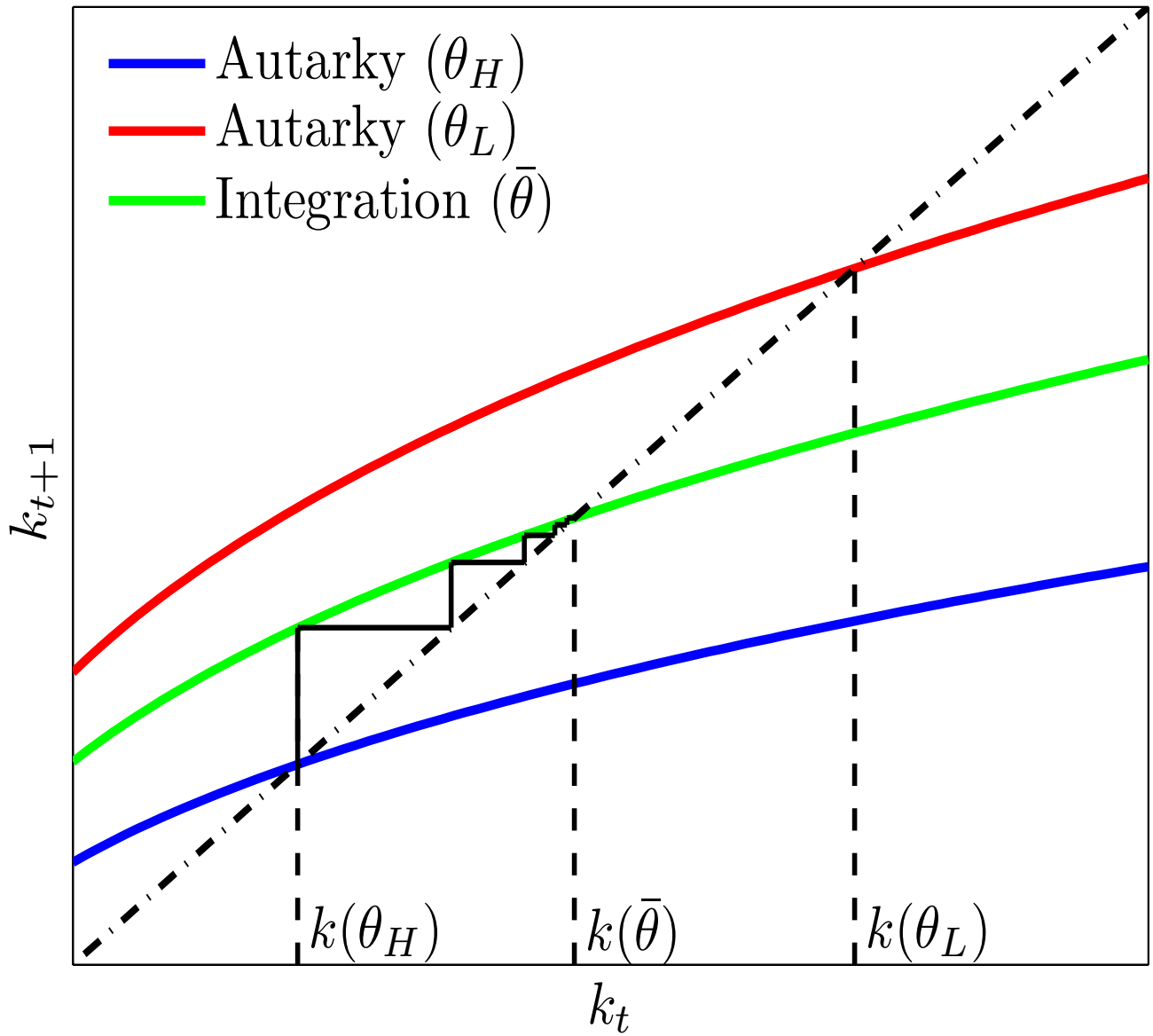
Integrated equilibrium (steady state)

- Steady state: $g_A^i = g_A$, $g_L^i = g_L$, and $e^i = e$.
- Let $\lambda^i \equiv \frac{A_{i,t}(eL_{y,t}^i + L_{m,t}^i)}{\sum_j A_{j,t}(eL_{y,t}^j + L_{m,t}^j)}$ and $\bar{\theta} \equiv \sum_i \lambda^i \theta^i$.
- World steady state interest rate (for $\sigma = \delta = 1$):

$$R = (1 + g_A)(1 + g_L)\frac{1+\beta}{\beta}\frac{\alpha[1 + e(1 + g_L)] + \bar{\theta}(1 - \alpha)}{(1 - \alpha)\left(1 - \bar{\theta}\right)}.$$

- R falls as more constrained economies become larger.

Integrated equilibrium



Aggregate saving rates in steady state

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

where $g \equiv (1+g_A)(1+g_L) - 1$.

- Under integration, saving rates differ across countries in the long run: saving rate higher in more constrained countries.
- Interaction between g and credit constraints is key.
  - In the absence of growth ($g = 0$), net saving rates are all zero.
- 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 respond differently across countries:

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

Cohort-level savings

- Young borrowers

$$\frac{S^i_{y,t}}{Y^i_t} = -(1+g^i_{A,t+1})\frac{1+g^i_{L,t}}{1+e^i_t(1+g^i_{L,t})}\frac{\theta^i(1-\alpha)}{k^\alpha_t}\left(\frac{\alpha}{R_{t+1}}\right)^{\frac{\alpha}{1-\alpha}}.$$

- Middle-aged savers

$$\frac{S^i_{m,t}}{Y^i_t} = \frac{1}{1+e^i_t(1+g^i_{L,t})}\left[\frac{1-\theta^i}{1+\beta^{-\sigma}R^{1-\sigma}_{t+1}}+\frac{\theta^i}{R_t}\right](1-\alpha).$$

Investment

- Aggregate investment in country i

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

- When $\delta = 1$, investment rates under integration satisfy

$$\frac{I_t^i / Y_t^i}{I_t^j / Y_t^j} = \frac{1+\tilde{g}_{t+1}^i}{1+\tilde{g}_{t+1}^j},$$

where $\tilde{g}_{t+1}^i$ denotes the combined growth rate in productivity and effective labor input in country i.

$\Rightarrow$ Investment rates converge in the long run.

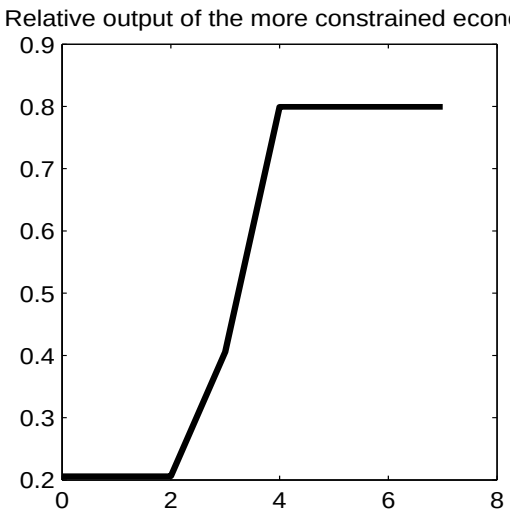
Calibration:

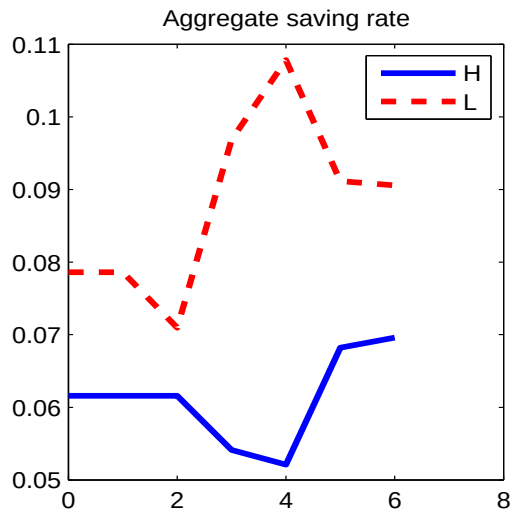
- Each period lasts 20 years.
- Technology: $\alpha = 0.28$, $e = 0.33$, $\delta = 9\%$ on an annual basis.
- Preference parameters: $\beta = 0.97$ on an annual basis, $\sigma = 0.5$.
- Constraints: $\theta_H = 0.21$ (advanced) and $\theta_L = 0.03$ (Asia).

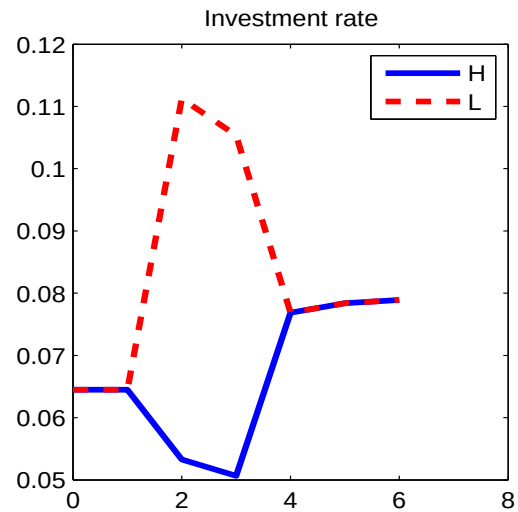
Growth experiment

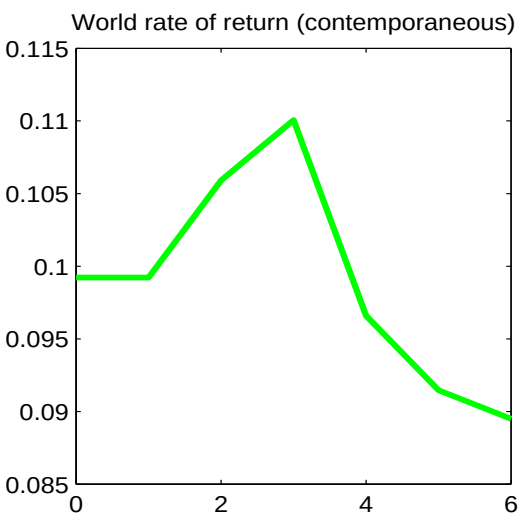
- We start at $t = 0$ from an integrated steady state where the output of Asia relative to advanced economies is equal to 0.21.
- Labor force growth rate fixed at 1% in both countries.
- Productivity grows at 1.5% (annually) in advanced economies. Productivity in Asia grows at 5% between $t = 2$ and $t = 4$.
- In the final steady state, the relative size of Asia's output is 0.82, and both countries grow at $g = 2.5\%$.

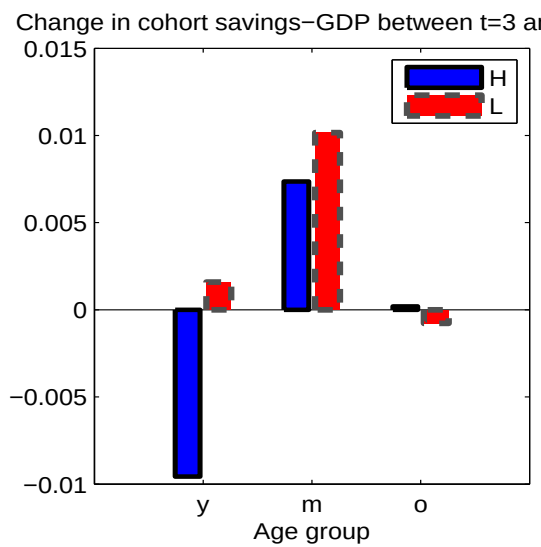
Growth experiment

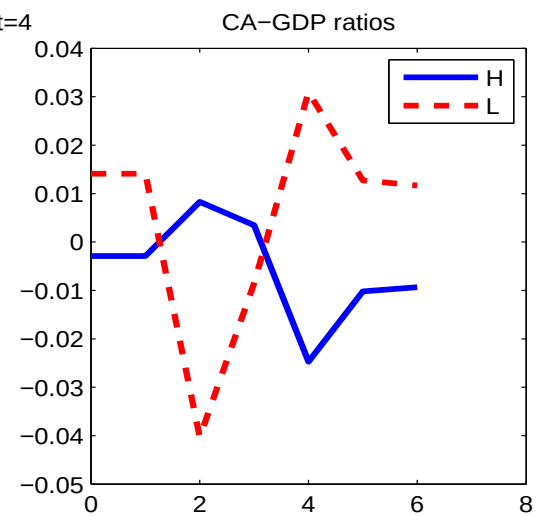








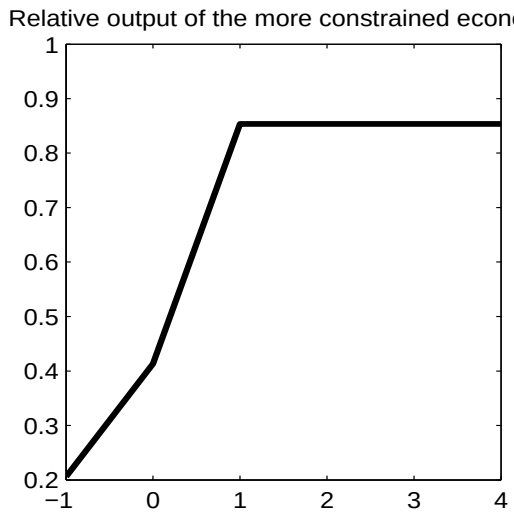


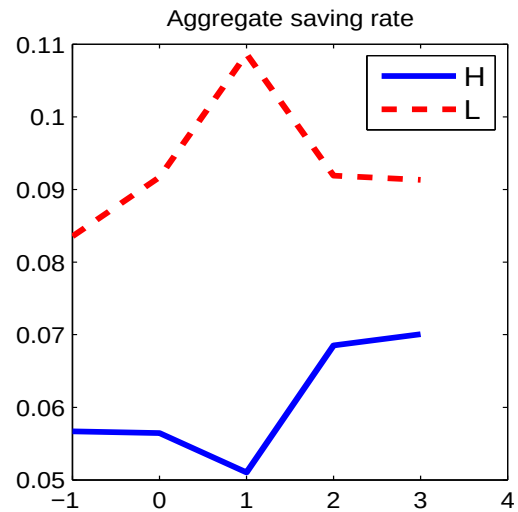


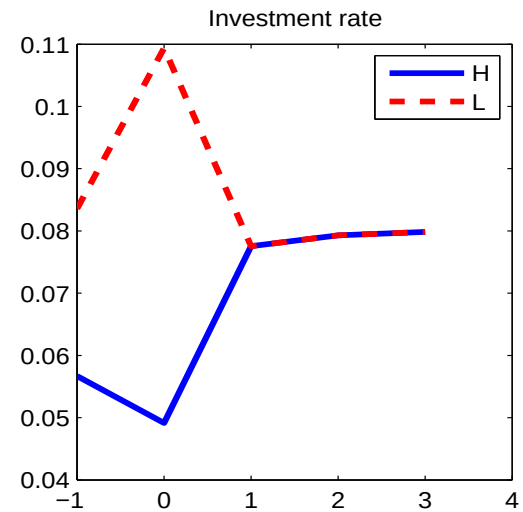
Integration & growth experiment
Timing and calibration

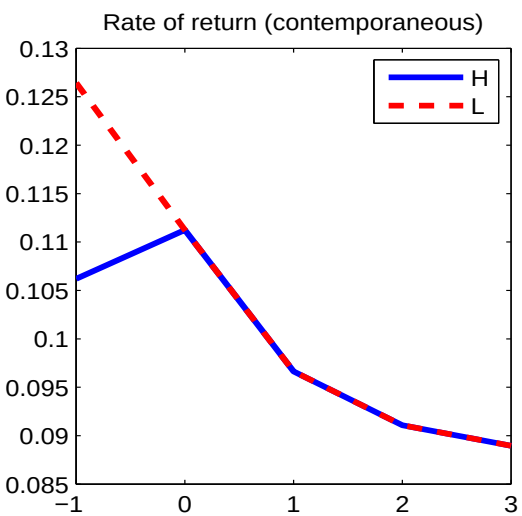
- Financial opening occurs in period 0 ($= 1990$).
- In initial period -1 ($= 1970$), advanced economies are at their own autarkic steady state, whereas Asia is capital-scarce.
- Asia grows faster than advanced economies between periods -1 and 1.
- We set initial conditions and productivity growth to match:
  - relative outputs in 1970 and 2010;
  - relative capital-effective-labor ratios as measured by Hall and Jones for 1990.

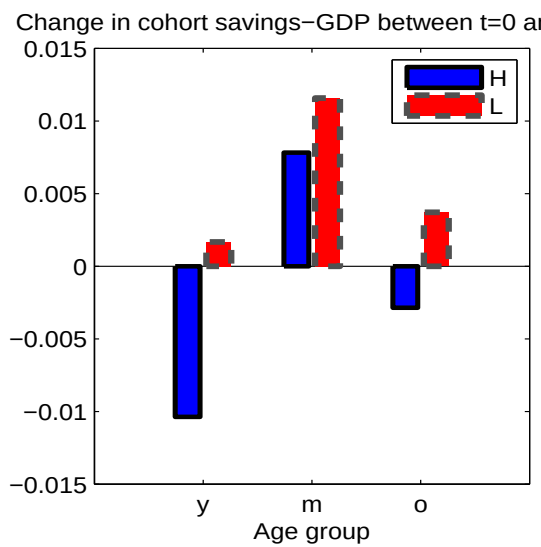
Integration & growth experiment

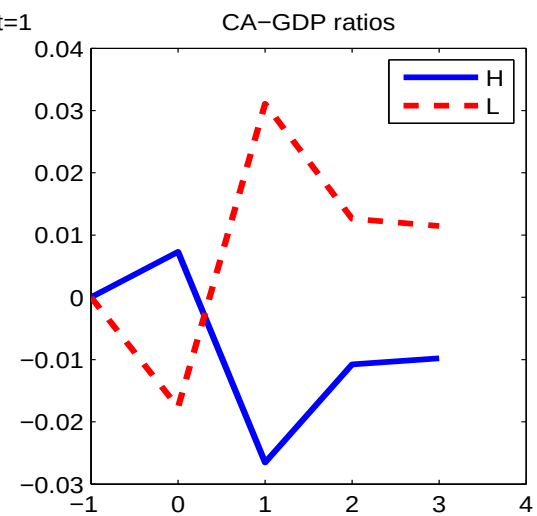












Evidence at cohort level

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

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

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

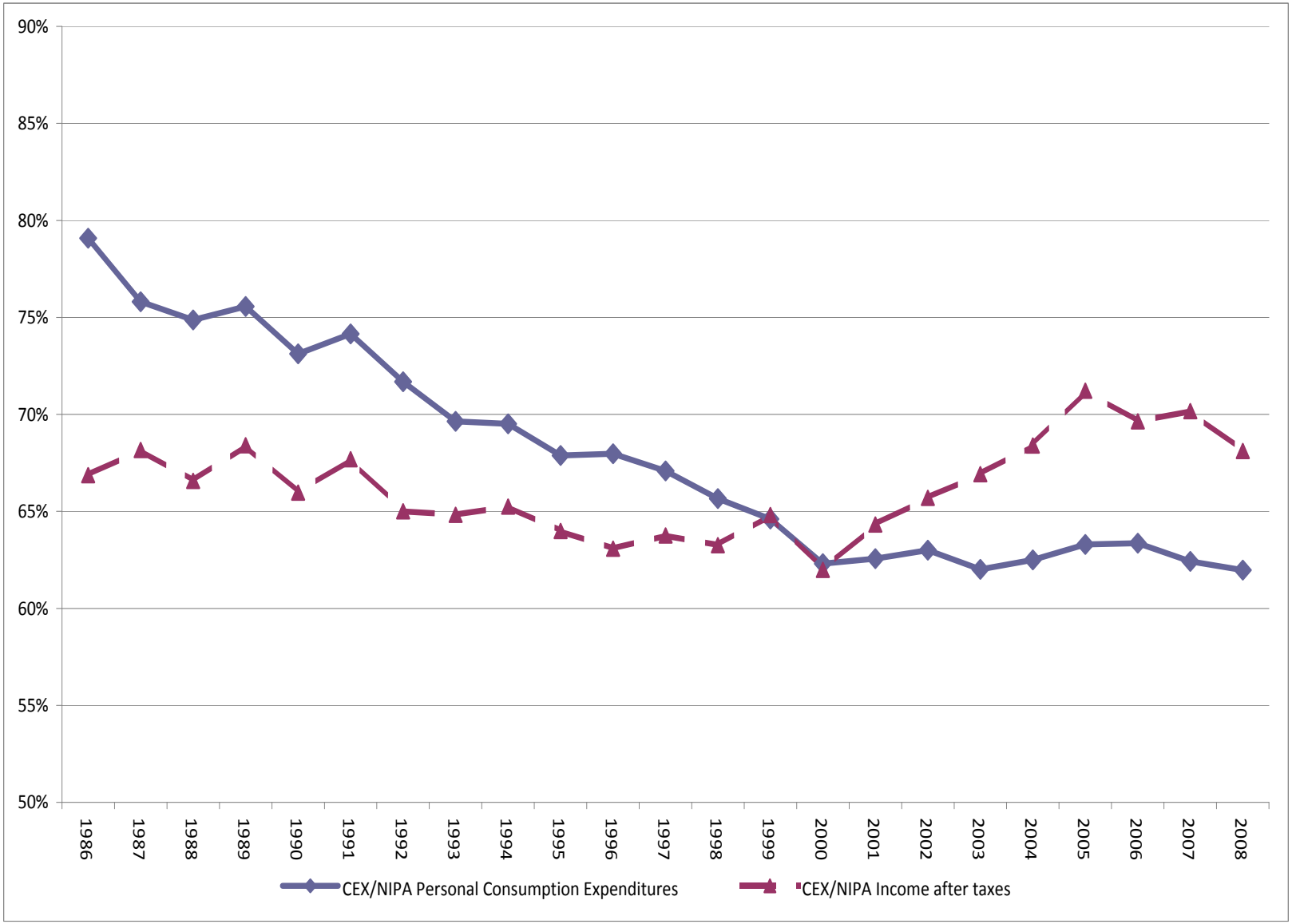
- We look at cohort-level data for the US and China to see if these predictions hold.

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.

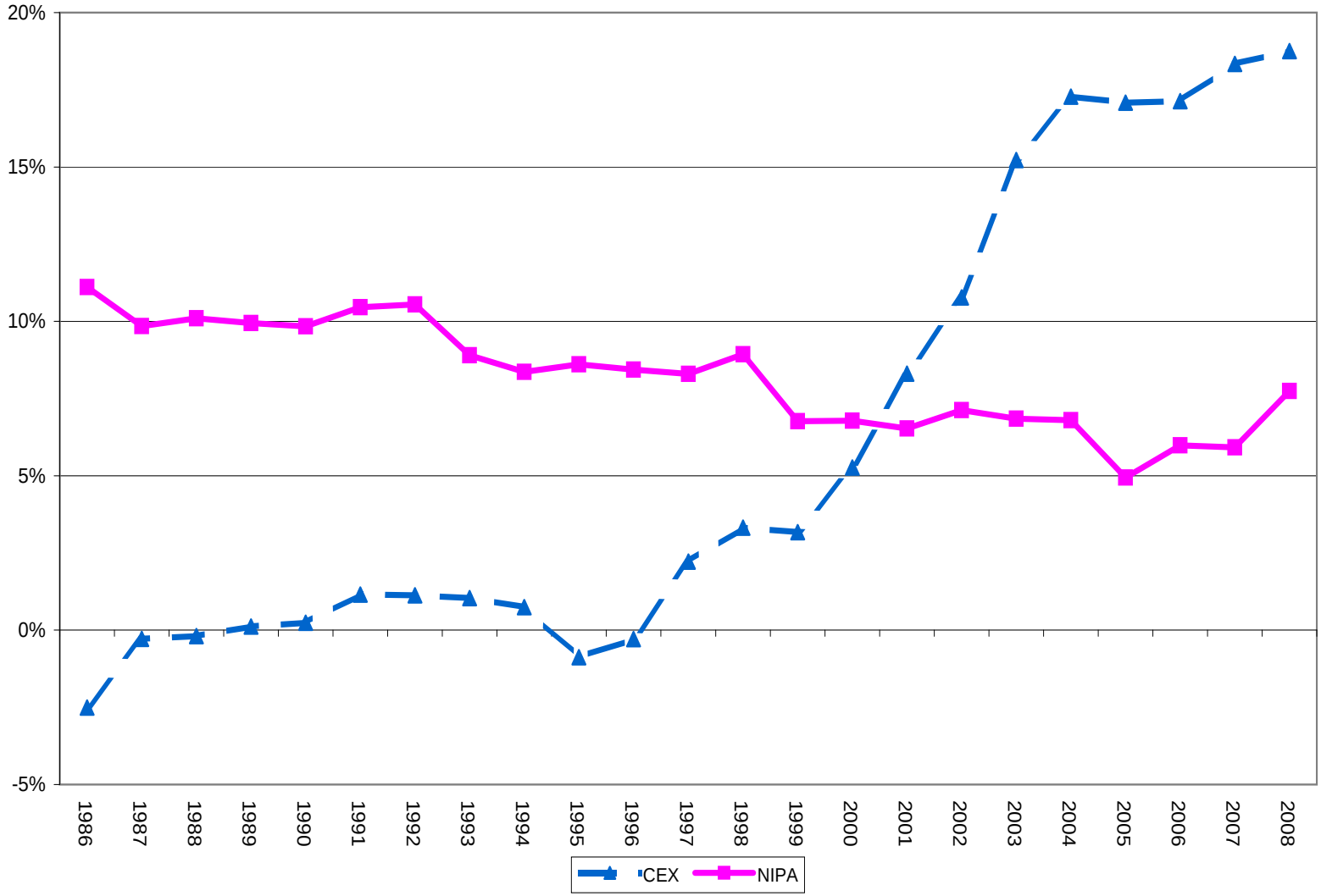
CEX vs NIPA

Aggregate consumption and income



CEX vs NIPA

Aggregate saving rate



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 $C_t^{\mathcal{D}}$ and $Y_t^{\mathcal{D}}$ denote aggregate consumption and income in dataset $\mathcal{D} \in \{CEX, NIPA\}$.
- 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 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

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

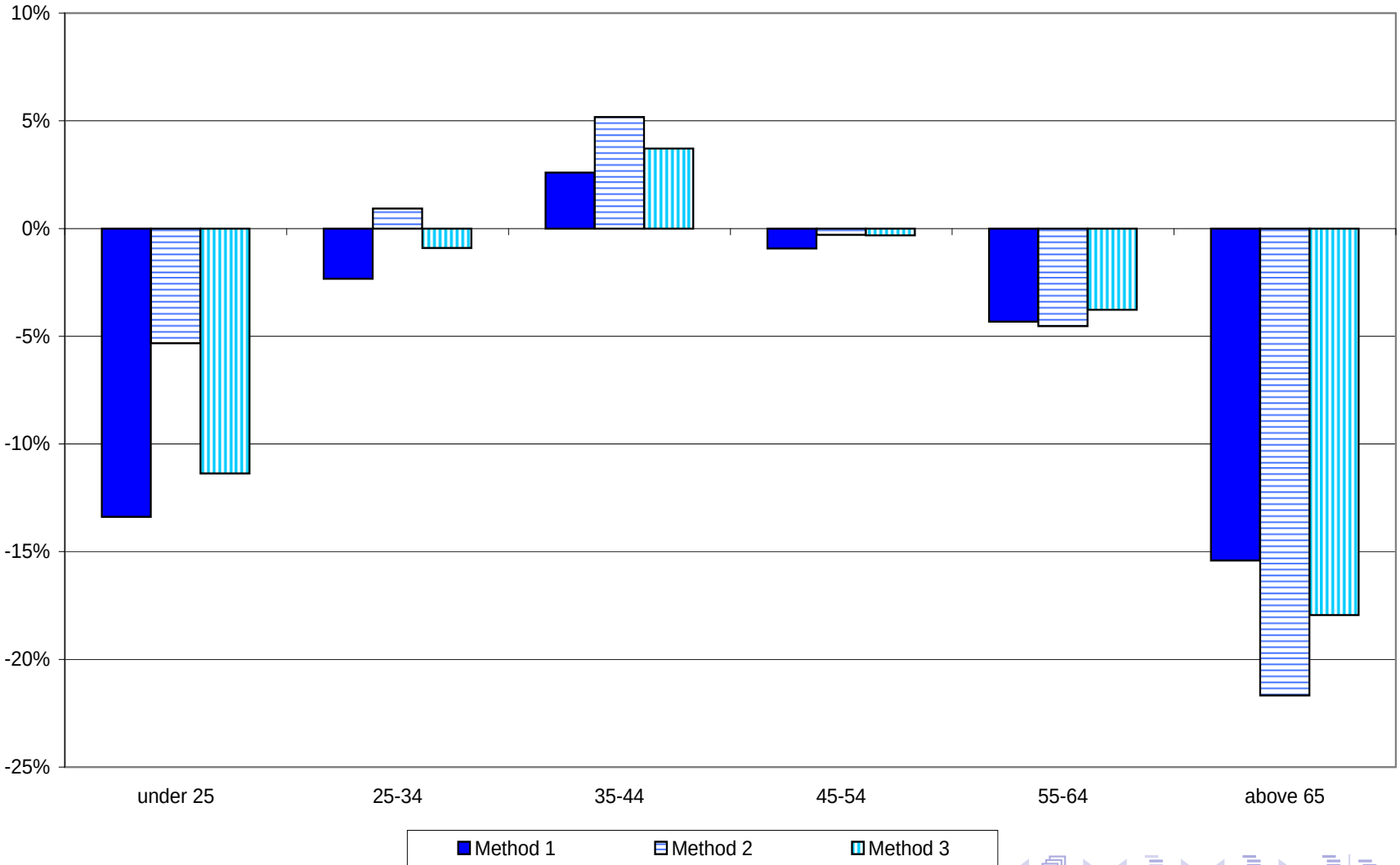
and for other sectors $j \neq health$

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

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

US Evidence

Change in individual saving rates by age group between 1988-2008



Evidence for China

- Data from UHS (1992-2009) and CHIP (1995 and 2002).
- 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:
  - **Aggregation bias:** multi-generational households;
  - **Selection bias:** household heads might not be random.

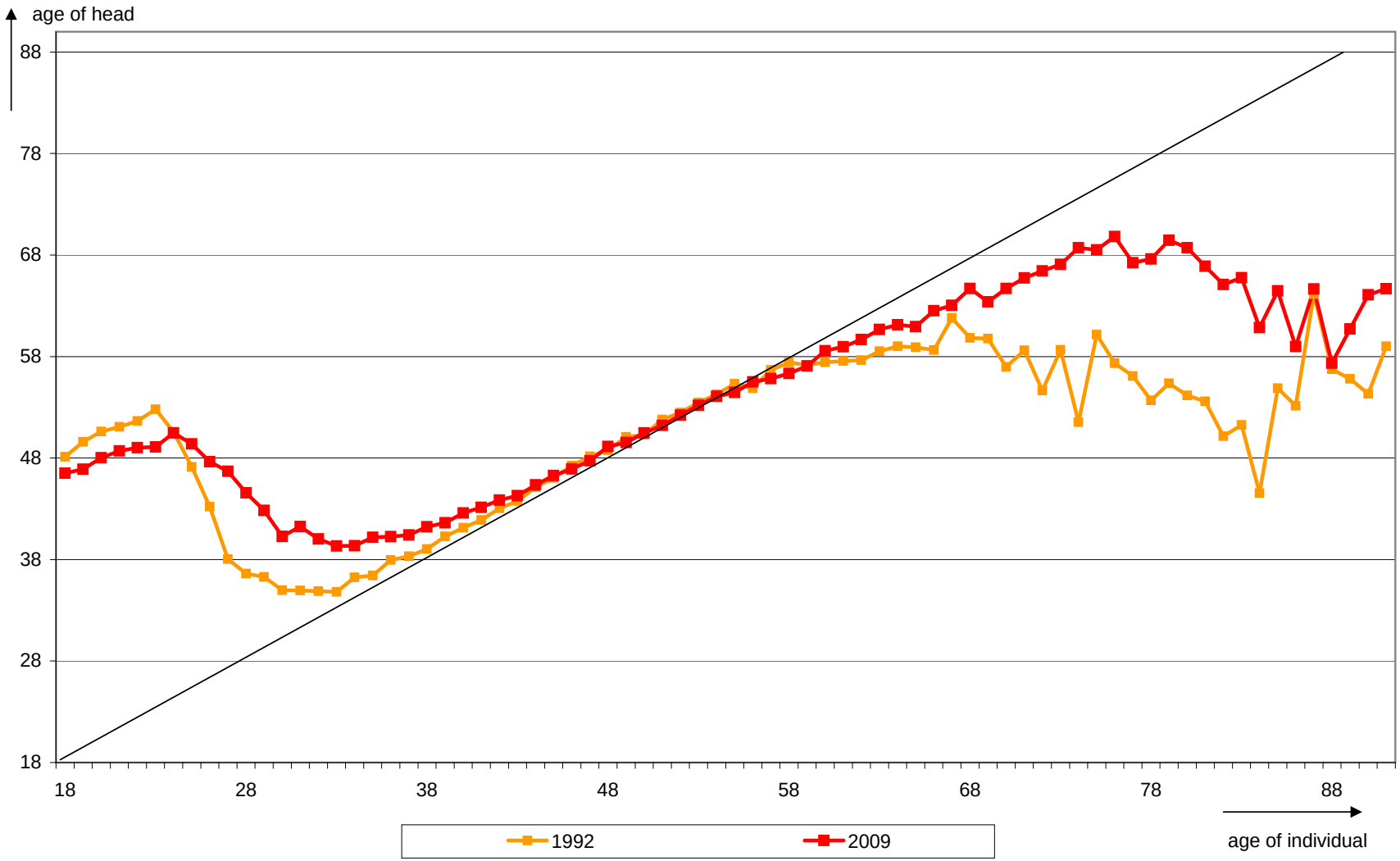
Evidence for China

Frequency of multi-generational households

	UHS 1992	UHS 2009
2 generations	41%	37%
3 generations	15%	18%

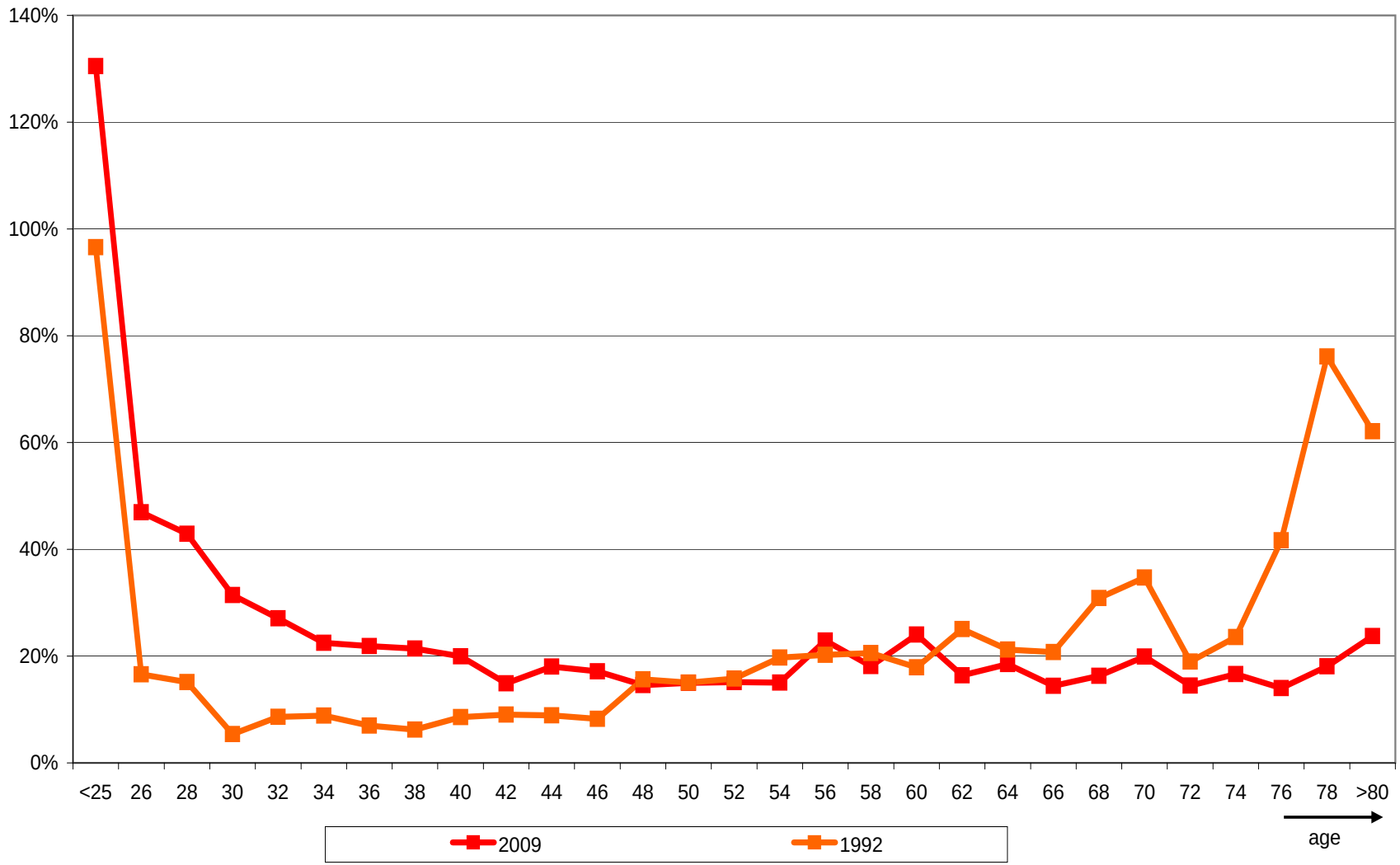
Evidence for China

Average age of household head by age of individual, in 1992 and 2009



Evidence for China

Selection bias: Income premium by age of household head (in log)



Evidence for China revisited

- Aggregation bias understates level and growth of savings of the middle-aged.
- Selection bias overstates level and growth of savings of the young.
- 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.

Bias correction methodologies

- Main issue: we have data on individual income but only observe expenditures at household level.
- Two alternative approaches to correct for biases.
  - Method 1: keep only non-multigenerational households.
  - Method 2: disaggregation method, following Chesher (1997).

Correction method 1

- Keep only non-multigenerational households (40% of sample) to control for aggregation bias.
  - Individual consumption inferred from household consumption assuming equal-sharing rule.
- 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.

Correction method 2

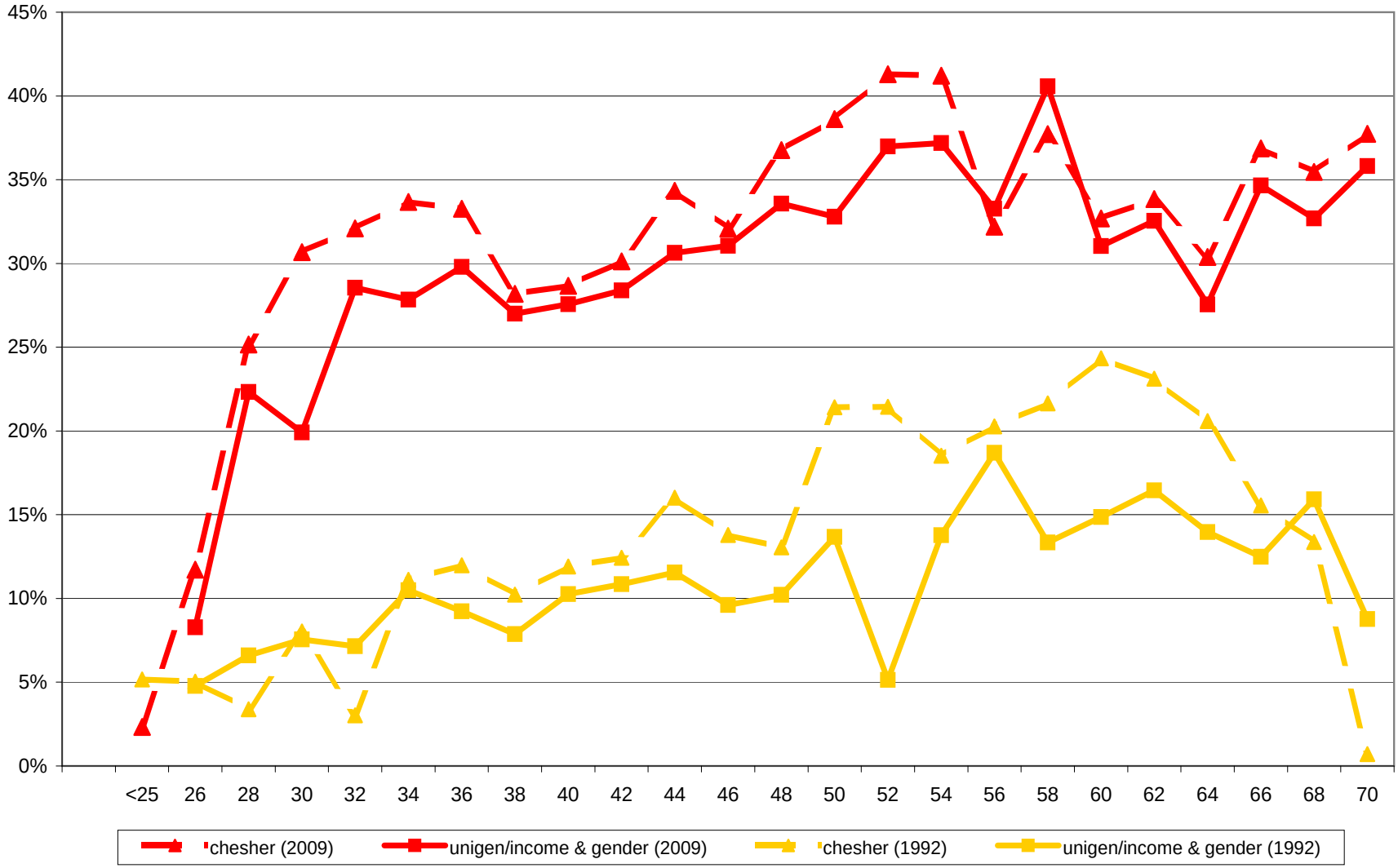
- Projection method, Chesher (1997)
- The model to be estimated is

$$C_h = \exp(\gamma.\mathbf{Z}_h)\left(\sum_{a=18}^{99} c_a N_{h,a}\right) + \epsilon_h.$$

  - Controls ($\mathbf{Z}_h$): household income, nb adults, nb children, etc
  - Non-linear least square estimation with roughness penalty to insure smoothness.
- Estimated consumption of an individual of age a living in a household with characteristics $\mathbf{Z}_h$ is $\exp(\hat{\gamma}.\mathbf{Z}_h)\hat{c}_a$.

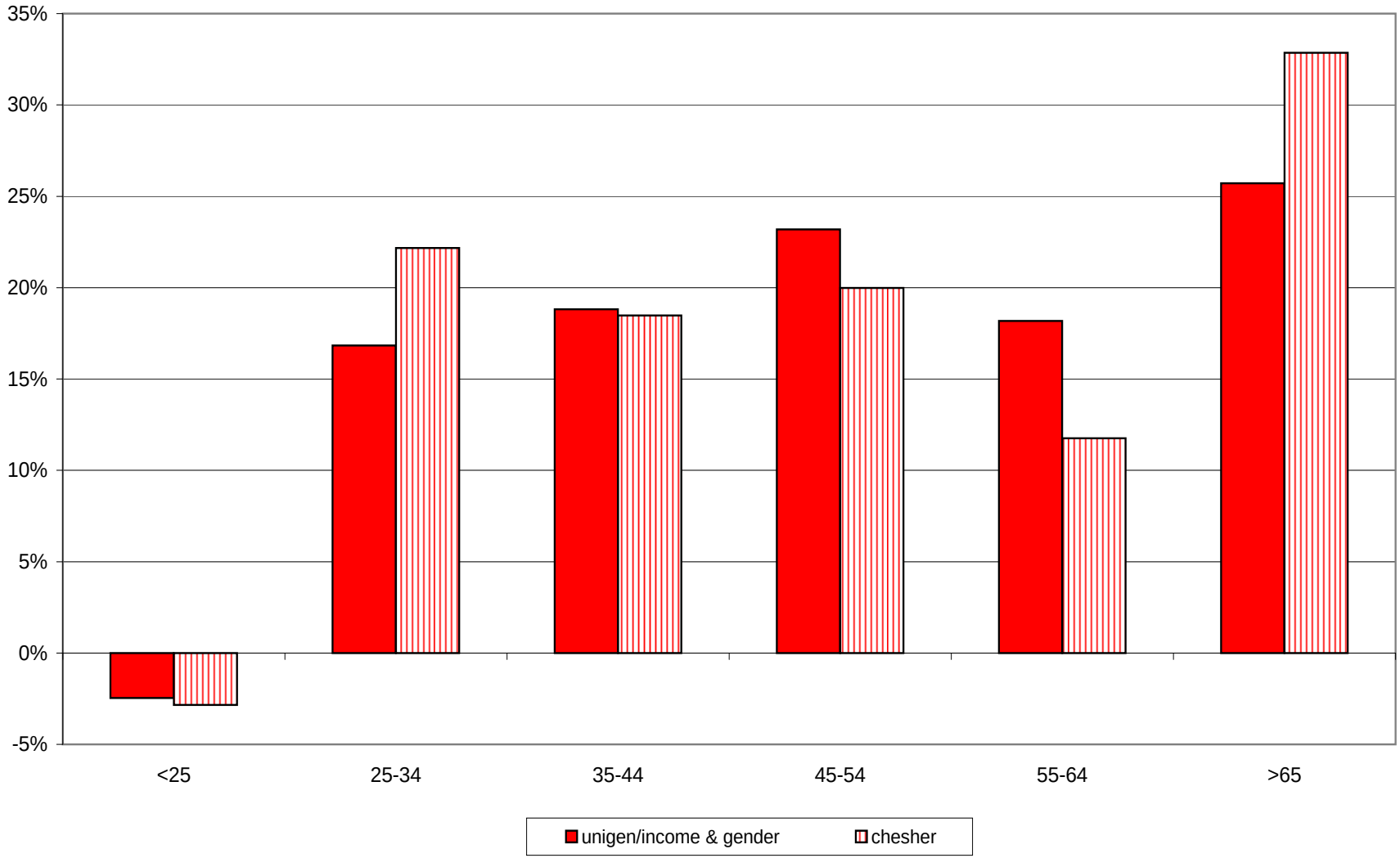
Evidence for China

Estimated age-saving profile, in 1992 and 2009



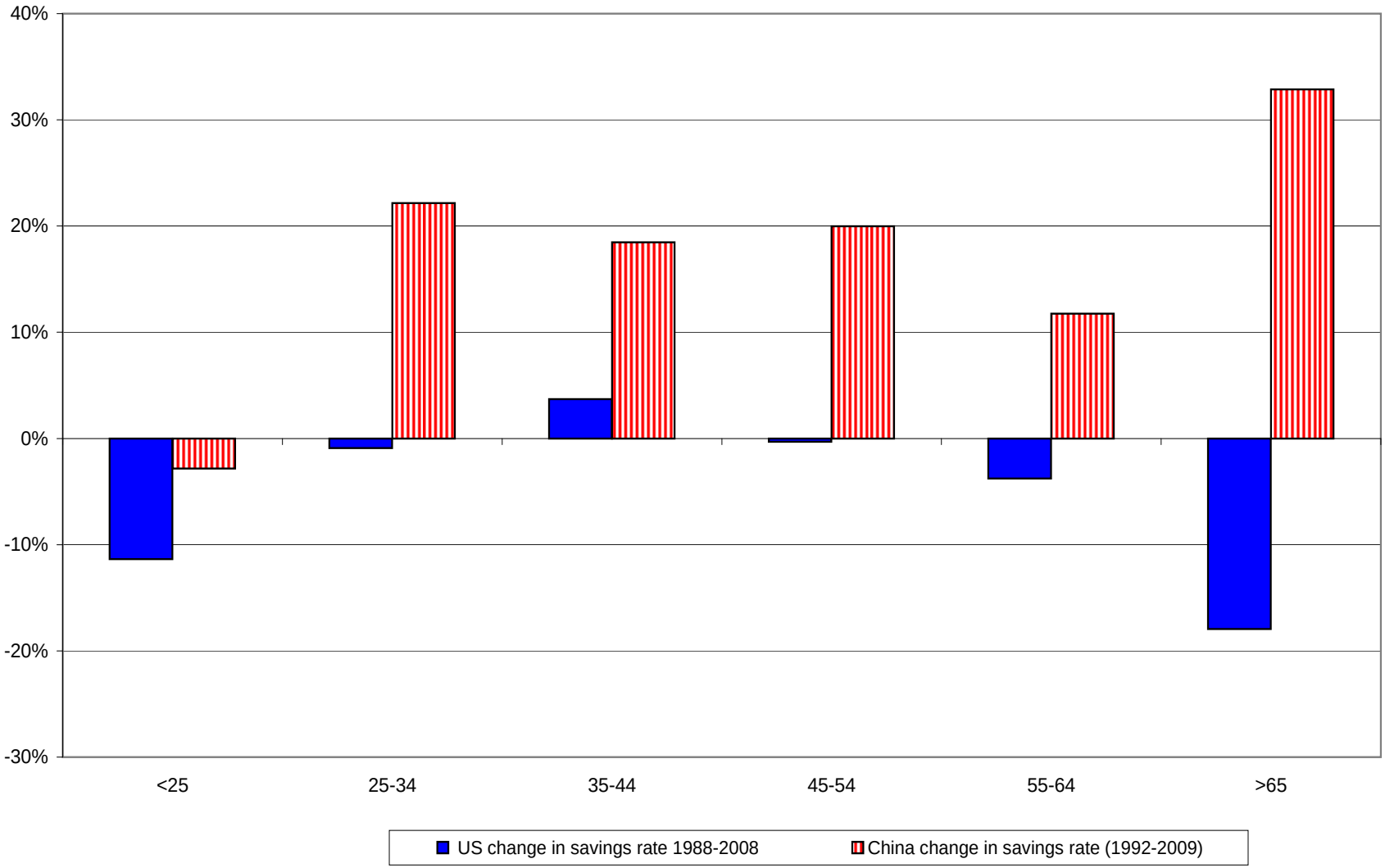
Evidence for China

Change in individual saving rates by age group between 1992-2009



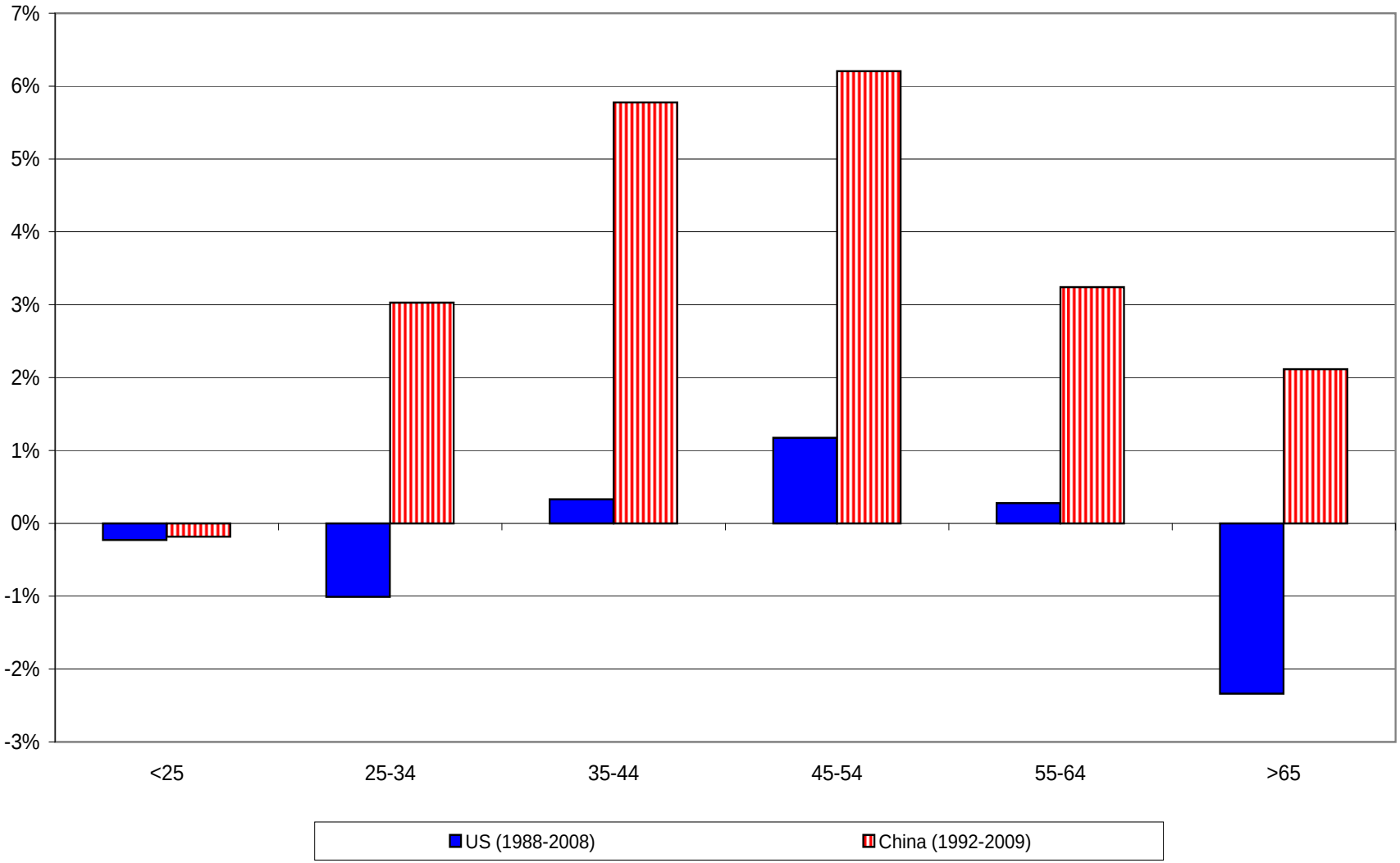
Summary of micro evidence

Change in saving rate by age group: US vs. China



Summary of micro evidence

Decomposition of the change in aggregate saving rate by age group: US vs. China



Quantitative exercise
Extended setup with bequests

- Preferences:

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

- Budget constraints:

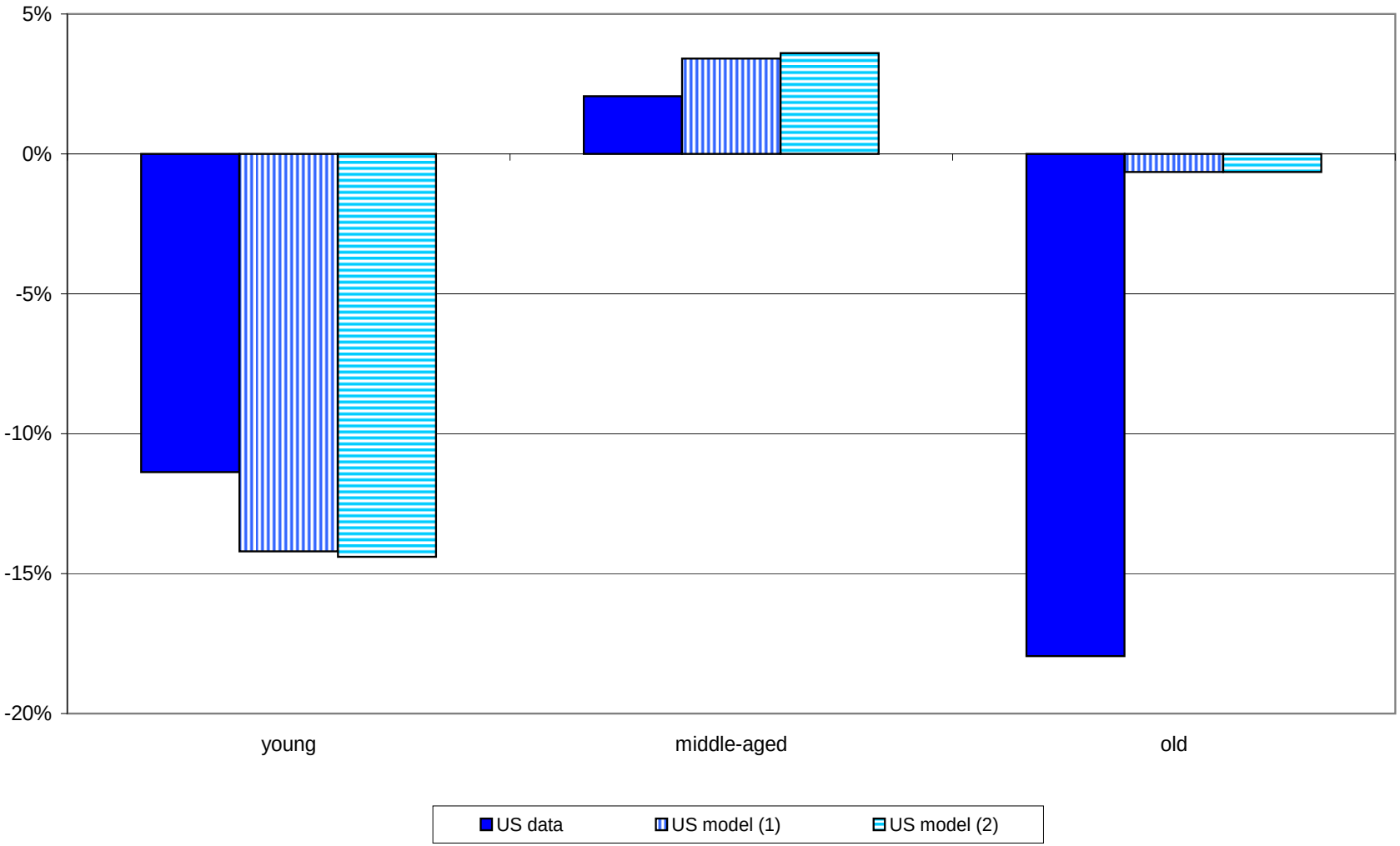
$$\begin{aligned} c_{y,t}^i + a_{y,t+1}^i &= w_{y,t}^i, \\ c_{m,t+1}^i + a_{m,t+2}^i &= w_{m,t+1}^i + R_{t+1}^i a_{y,t+1}^i + \frac{b_{t+1}^i}{1 + g_{L,t}^i}, \\ c_{o,t+2}^i + b_{t+2}^i &= R_{t+2}^i a_{m,t+2}^i. \end{aligned}$$

Quantitative exercise
Calibration: US vs China

- We enrich the 'integration & growth' experiment.
- Demographic evolution to match population structure in China and the US.
- Evolution of the relative efficiency of young workers to match income profile by age in China and the US.
- Productivity growth and initial capital-labor ratios calibrated as before.
- Credit constraints and bequest parameters are chosen to match cohort-level saving rates in 1990.
  - Model 1 imposes $\phi^{China} = \phi^{US}$.
  - Model 2 allows ϕ^{China} and ϕ^{US} to differ.

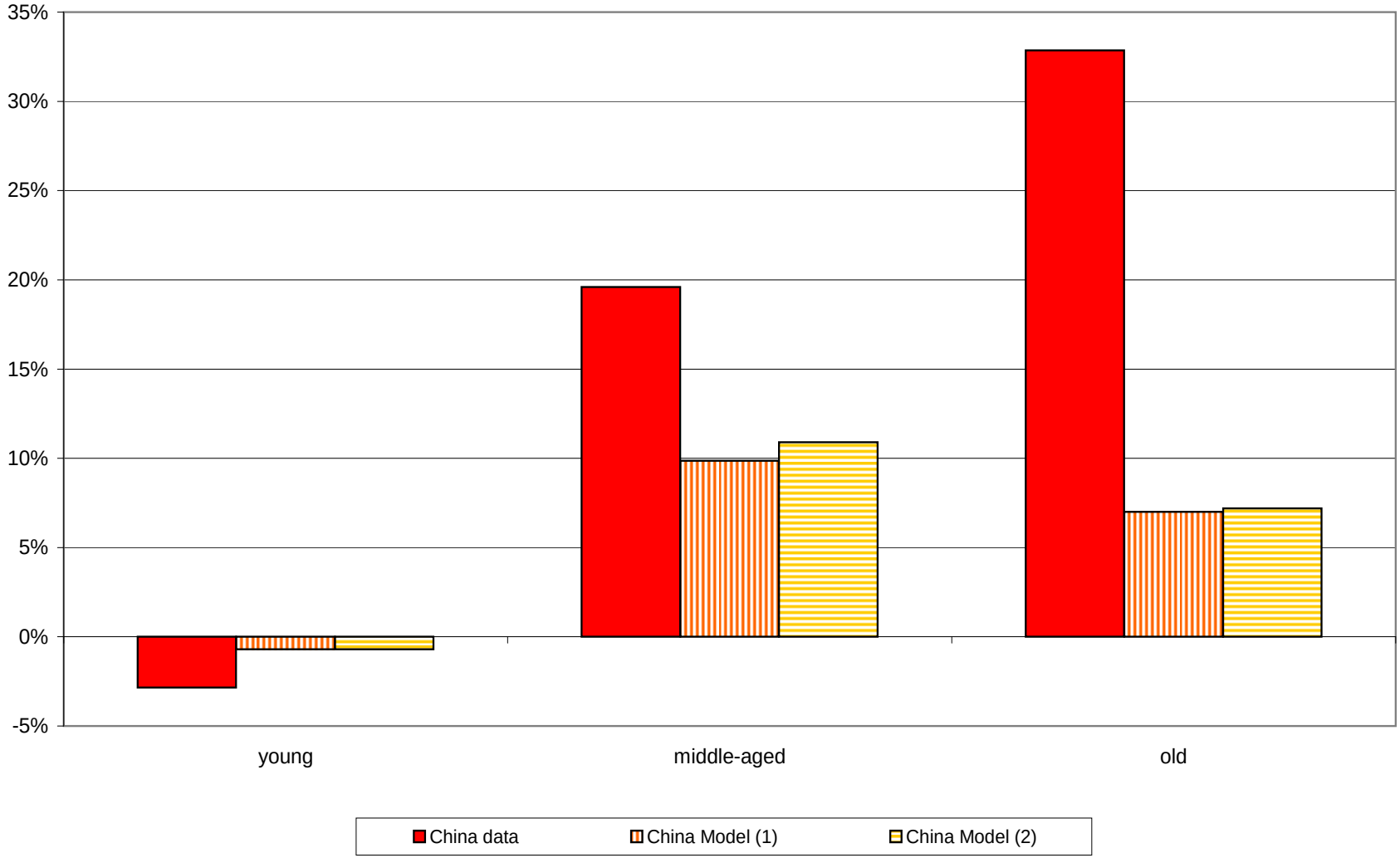
Model vs. data for the US

Change in saving rates by age group, 1988-2008



Model vs. data for China

Change in saving rates by age group, 1992-2009



Conclusion

- Two major events have affected global capital markets:
  - Capital market integration of emerging countries;
  - fast growth in these countries.

- We show that in the presence of **asymmetric credit constraints**, unlike in the standard model, these can lead to:

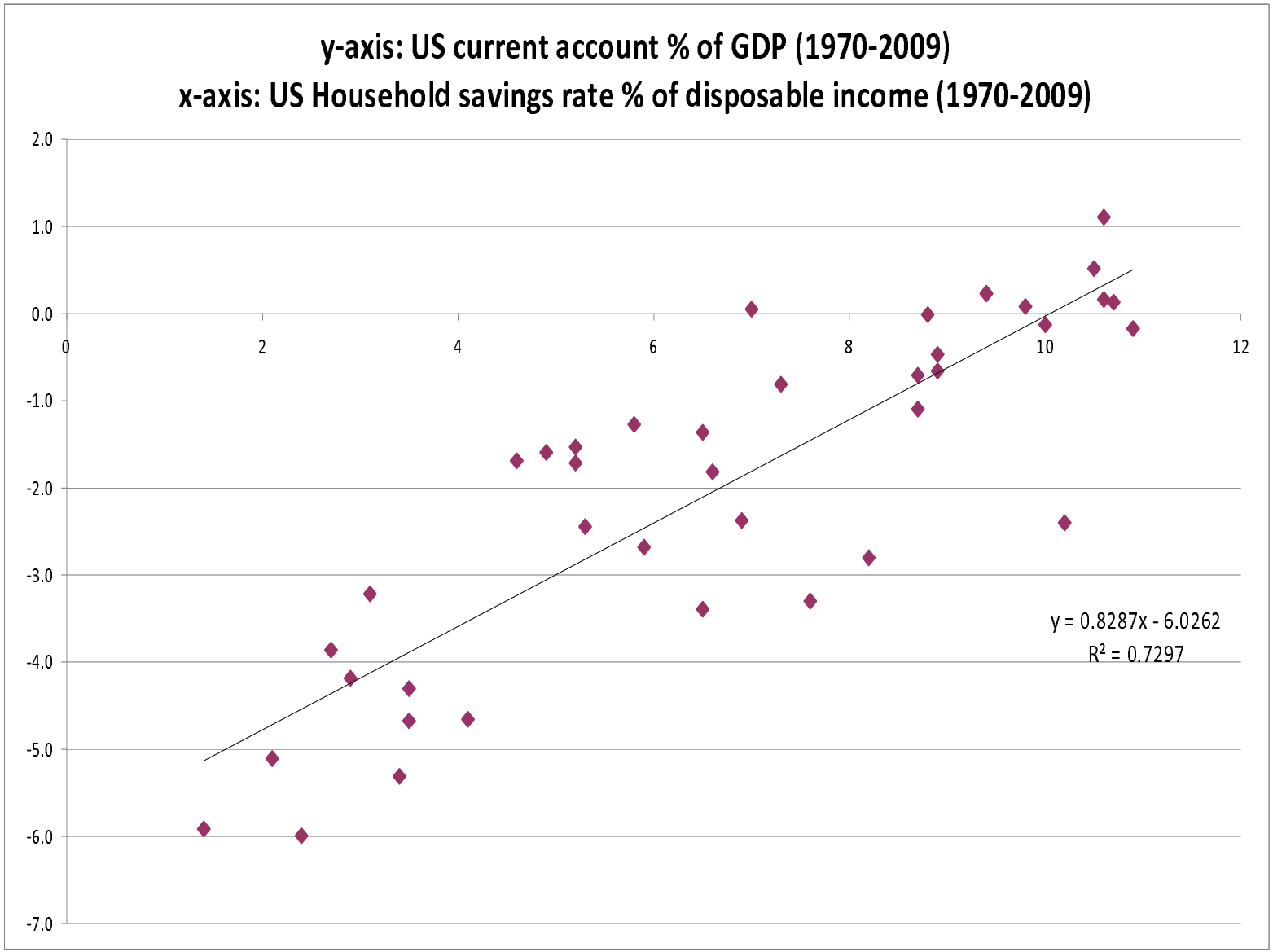
  (1) a divergence in savings rate across countries, (2) current account deficits in developed countries and surpluses in Emerging Asia, (3) a fall in world interest rates.

- Broadly in line with micro evidence for US and China.

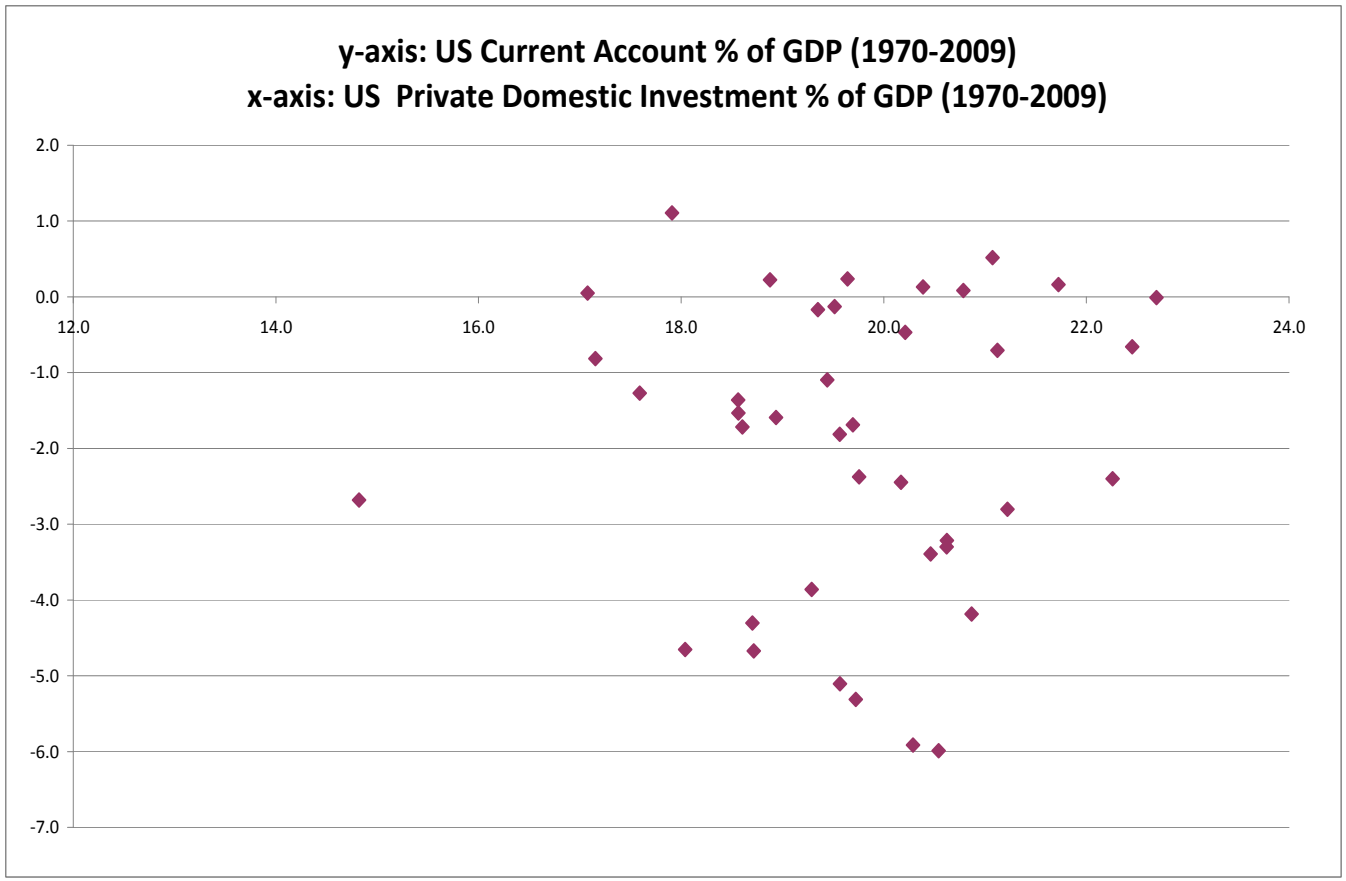
APPENDIX

Current account imbalances

The US experience (1)

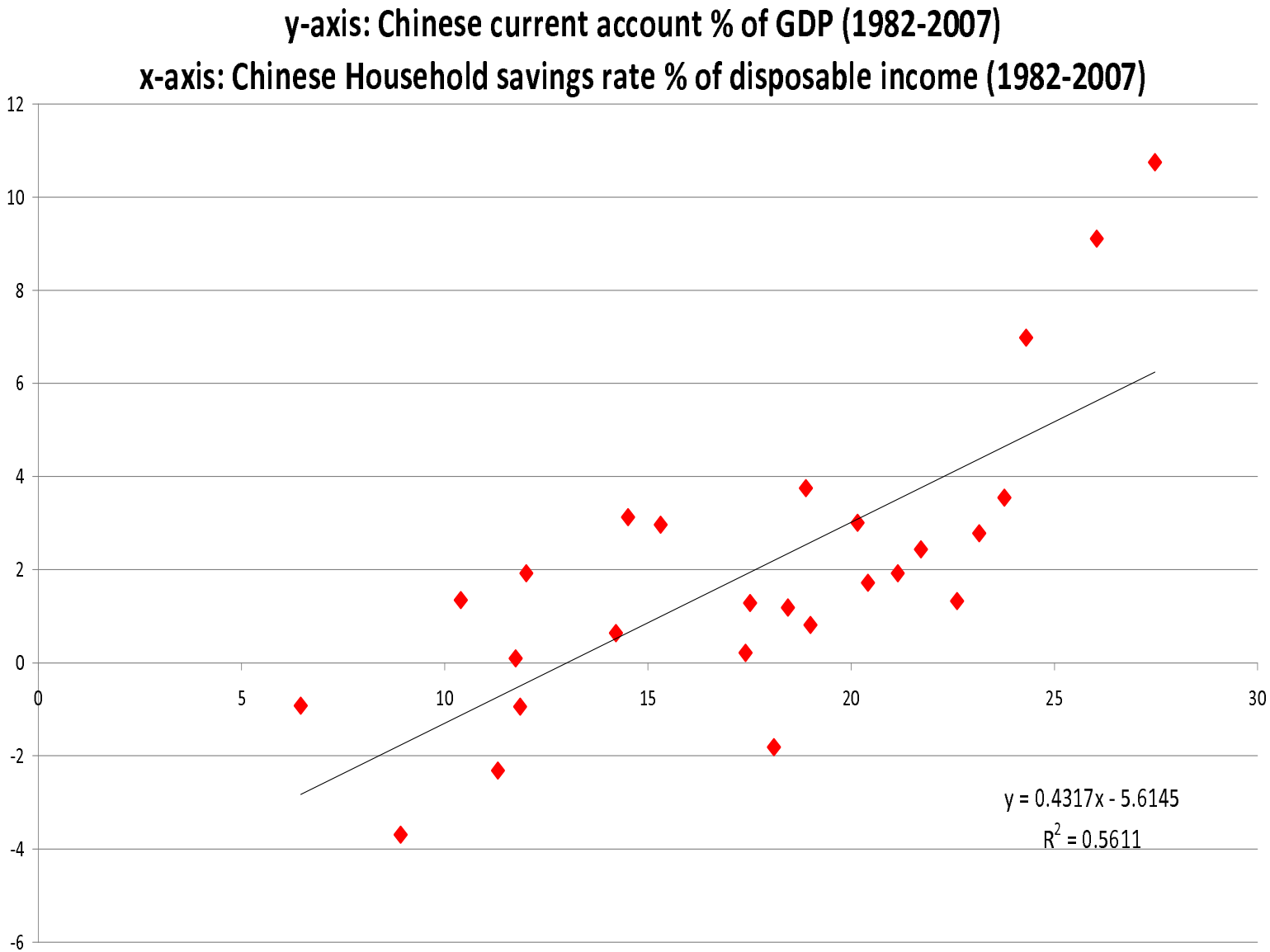


Current account imbalances
The US experience (2)

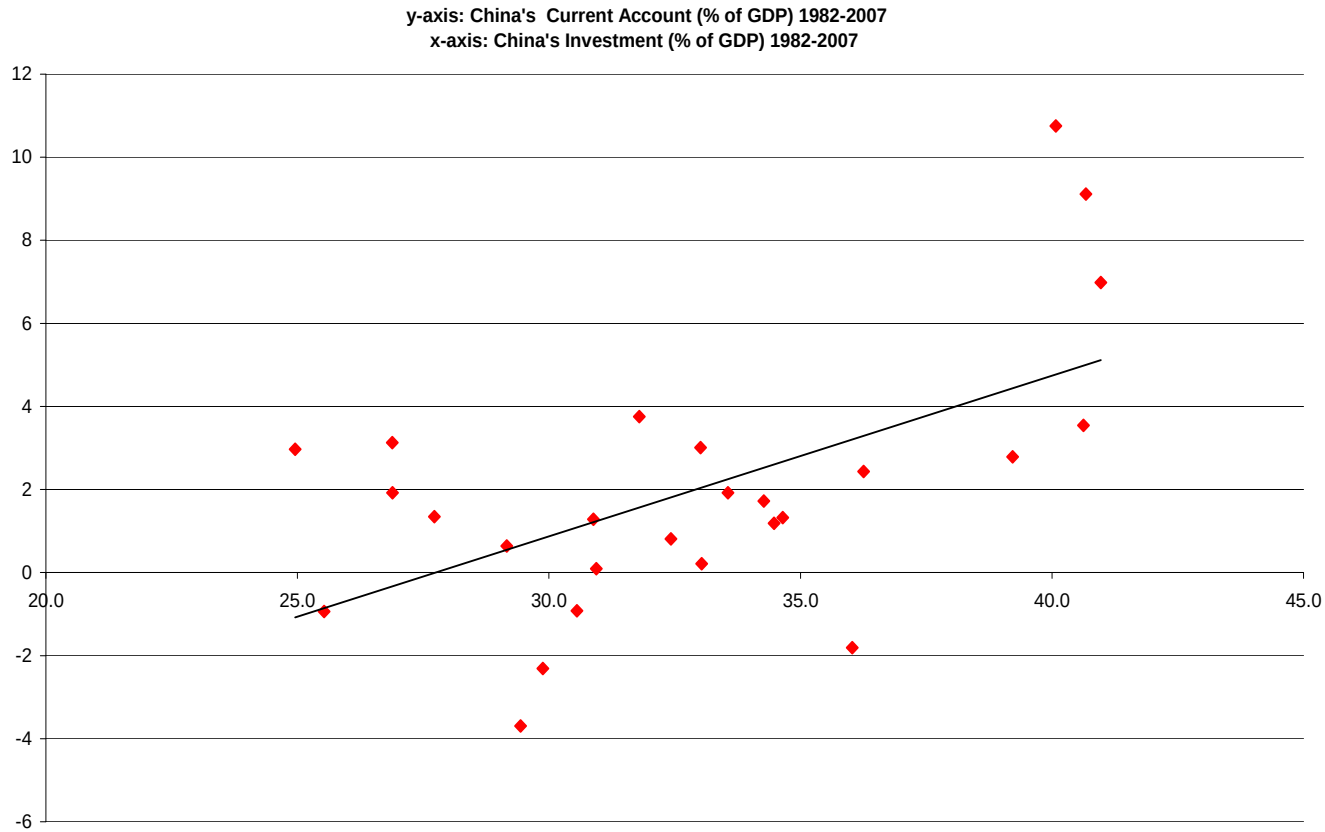


Current account imbalances

The Chinese experience (1)

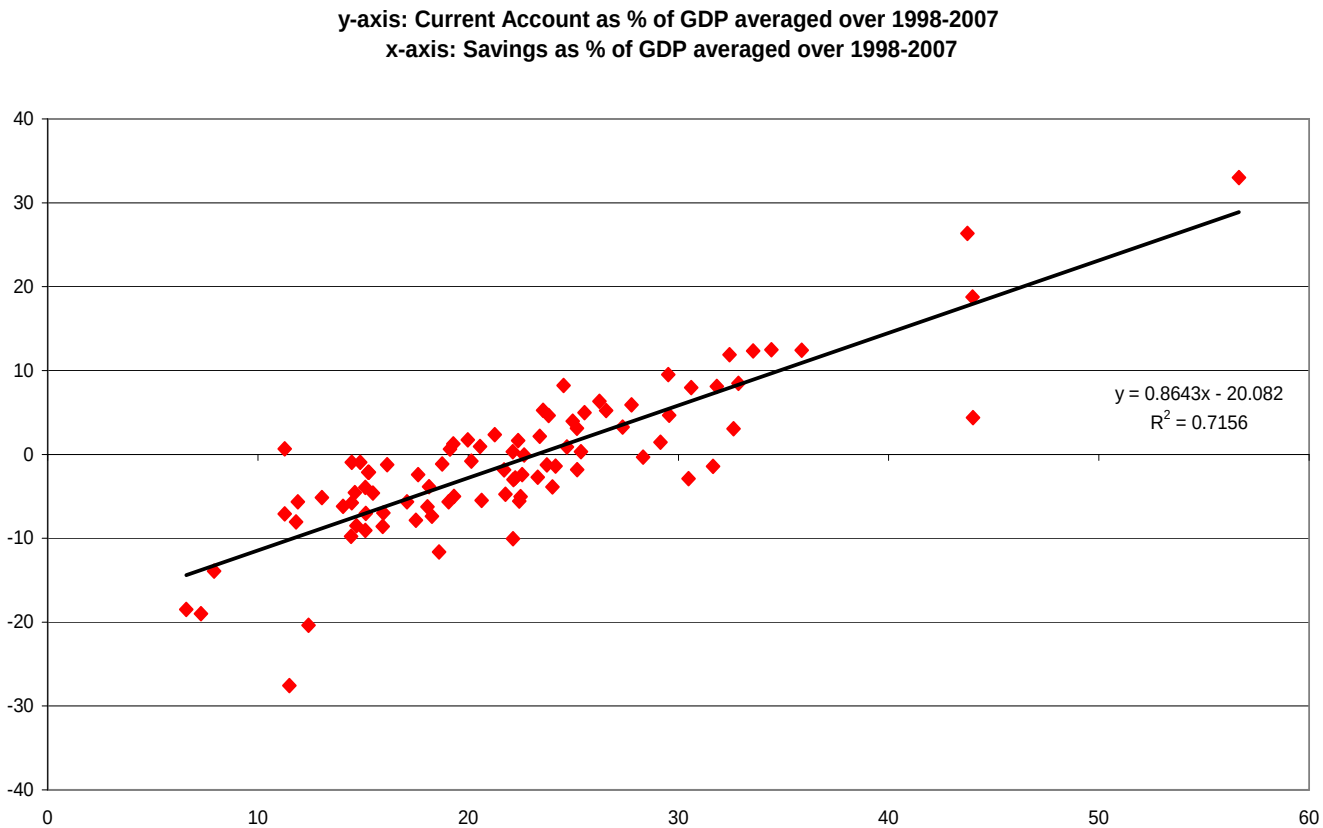


Current account imbalances
The Chinese experience (2)



Current account imbalances

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



Age-saving profile in China by household method