External imbalances between China and the US: a dynamic analysis with a life-cycle model

Julia Niemeläinen

Department of Political and Economic Studies
University of Helsinki

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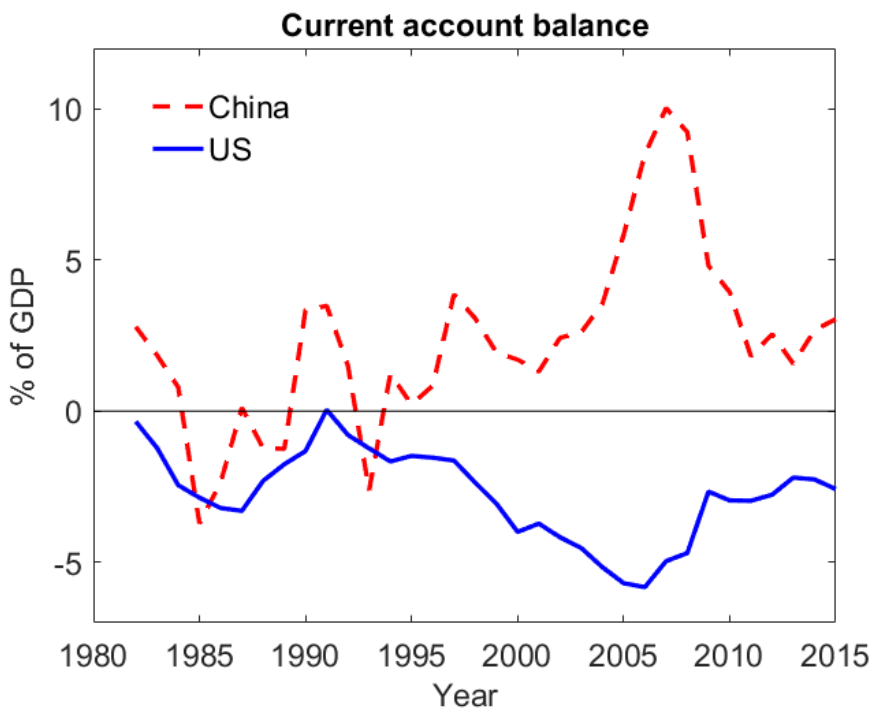
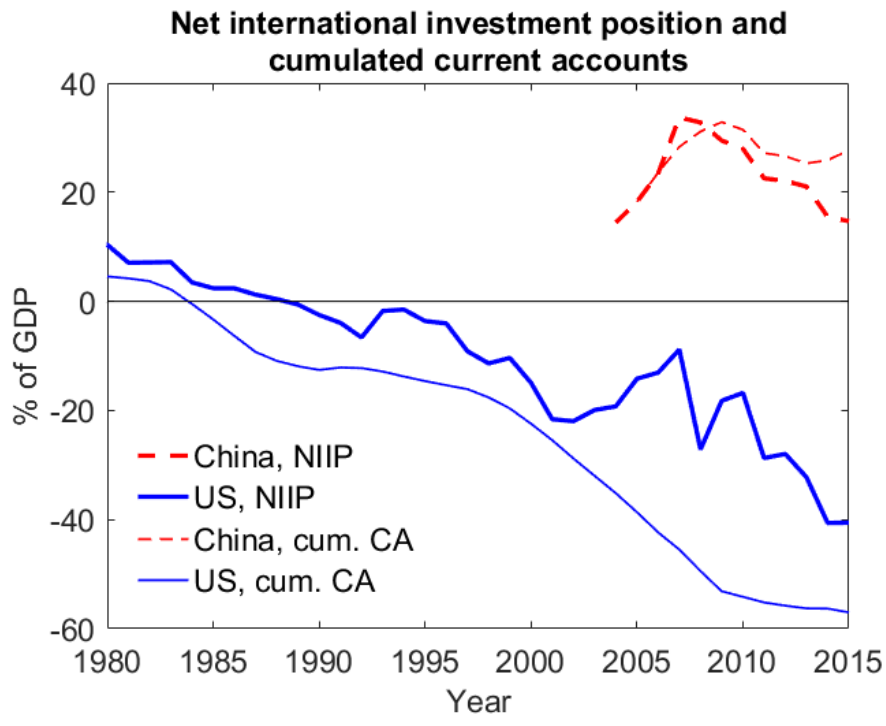
Outline

Motivation





Source: IMF Balance of Payment Statistics and author's calculations.

Motivation

- The puzzle: high productivity growth attracts resources from abroad and leads to high consumption rates, weakening the external balance
  - Discussion in Gourinchas & Rey (NBER 2013)
  - E.g. Ferrero (JME 2010):
    "current levels of US external imbalances versus the G6 are mainly the manifestation of productivity growth and demographic differentials across the two regions"
    BUT
    "China experiences huge [counterfactual] trade deficits over the entire sample, averaging about -11%"
- Literature:
  - Imperfections in financial markets: demand for assets not met by financial markets in emerging economies, resulting in capital outflows (Song et al., AER 2011, Mendoza et al., JPE 2009, Caballero et al., AER 2008)
  - Social security: a country with no pay-as-you-go system has higher saving and experiences capital outflows (Eugeni, JIE 2015)

This paper

The research question:

Can social security, together with demographics, fiscal policy and productivity, explain the dynamics of external imbalances between China and the US between 1980 and 2015?

The approach:

- A dynamic general equilibrium model with a life-cycle structure, productivity growth and fiscal policy *à la* Gertler (1999)/Ferrero (2010)
- Introduce a pay-as-you-go pension system to both countries, endogenous labour supply and distortionary taxation

Results:

- The model predicts positive net foreign asset position and trade balance for China for most years in the sample period
- Key drivers: population ageing and differences in social security across the countries

The model

- Two large economies consisting of households, firms and the government
- Firms produce the single (traded) good with Cobb-Douglas production technology
- Government pays pension benefits and spends with tax income and debt
- An international financial market with no frictions
  - The market clearing condition pins down the world real interest rate

Life cycle structure:

- Workers N_t^w
  - In period t, the probability to stay in labour force is $\omega_{t,t+1}$
  - Number of new workers born in period t: $\left(1-\omega_{t,t+1}+n_{t,t+1}\right) N_t^w$
  - Law of motion for aggregate number of workers:
    $N_{t+1}^w = \left(1-\omega_{t,t+1}+n_{t,t+1}\right) N_t^w + \omega_{t,t+1} N_t^w = (1+n_{t,t+1}) N_t^w$
- Retirees N_t^r
  - In period t, the probability to survive to the next period is $\gamma_{t,t+1}$
  - Law of motion for retirees: $N_{t+1}^r = \left(1-\omega_{t,t+1}\right) N_t^w + \gamma_{t,t+1} N_t^r$

The model

Households: workers

- A worker born in period j chooses consumption C_t^{jw}, saving A_{t+1}^{jw} and labour supply l_t^{jw} to maximize

$$V_t^{jw} = \left\{ \left[\left(C_t^{jw} \right)^{v} \left(1 - l_t^{jw} \right)^{1-v} \right]^{\rho} + \beta \left[\omega_{t,t+1} V_{t+1}^{jw} + \left(1 - \omega_{t,t+1} \right) V_{t+1}^{jr} \right]^{\rho} \right\}^{\frac{1}{\rho}}$$

subject to

$$A_{t+1}^{jw} = R_t A_t^{jw} + W_t l_t^{jw} \left(1 - \tau_t \right) - C_t^{jw}$$

- Consumption is a fraction of the present value of wealth

$$C_t^{jw} = \pi_t (R_t A_t^{jw} + H_t^{jw} + P_t^{jw})$$

The model

Households: retirees

- A retiree born in period j and retired in period i chooses consumption $C_t^{jr}(i)$, saving $A_{t+1}^{jr}(i)$ and labour supply $l_t^{jr}(i)$ to maximize

$$V_t^{jr}(i) = \left\{ \left[\left(C_t^{jr}(i) \right)^{v} (1 - l_t^{r})^{1-v} \right]^{\rho} + \beta \gamma_{t,t+1} \left(V_{t+1}^{jr}(i) \right)^{\rho} \right\}^{\frac{1}{\rho}}$$

subject to

$$A_{t+1}^{jr}(i) = R_t A_t^{jr}(i) / \gamma_{t-1,t} + W_t \xi l_t^{jr}(i)(1 - \tau_t) + S_t^{jr}(i) - C_t^{jr}(i)$$

Preferences

- Consumption is a fraction of the present value of wealth

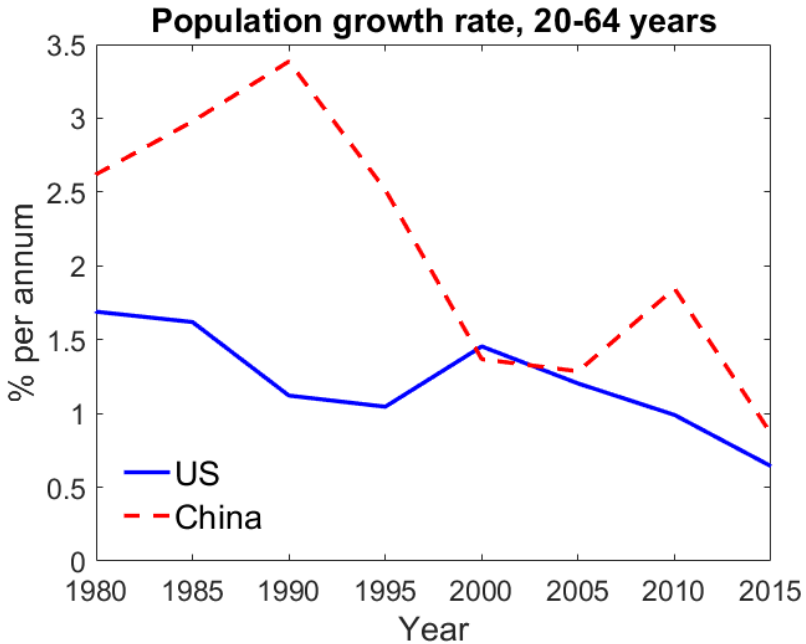
$$C_t^{jr}(i) = \varepsilon_t \pi_t \left(R_{W,t} A_t^{jr}(i) / \gamma_t + H_t^{jr}(i) + P_t^{jr}(i) \right)$$

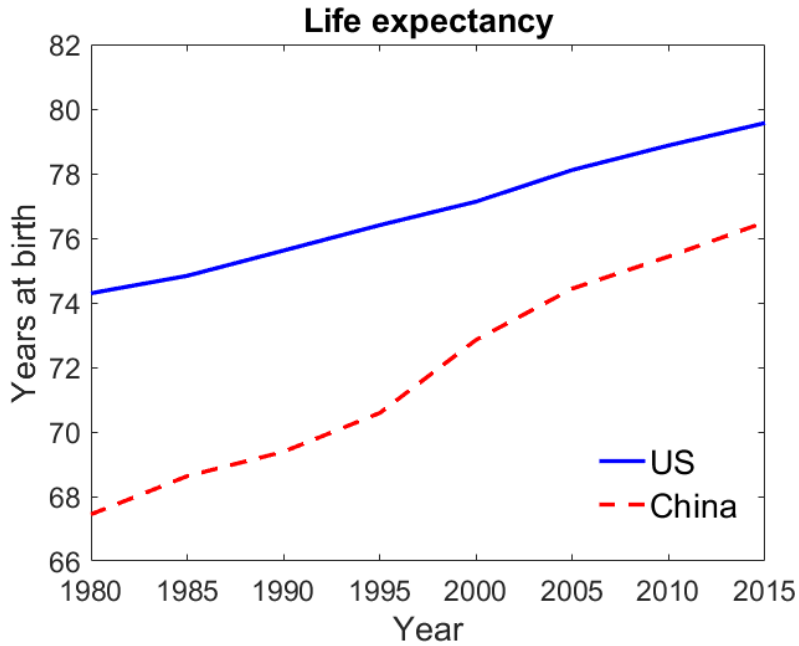
A dynamic analysis: 1980-2015

- Simulate the calibrated model for China-US for 1980-2015
  - For China, a period of transition from a centrally planned economy to a market economy & integration to the world economy
  - Coincides with the formation of large external imbalances in China and the US
- The simulation captures:
  - Demogaphic factors: permanent and temporary differences
  - Public pension expenditures and other government expenditures: permanent and temporary differences
  - Productivity fluctuations: temporary differences
- Two solution methods: standard deterministic simulation (I) and deterministic simulation with learning (II)

Demographic trends

Data:





Source: UN World population prospects, The 2015 Revision

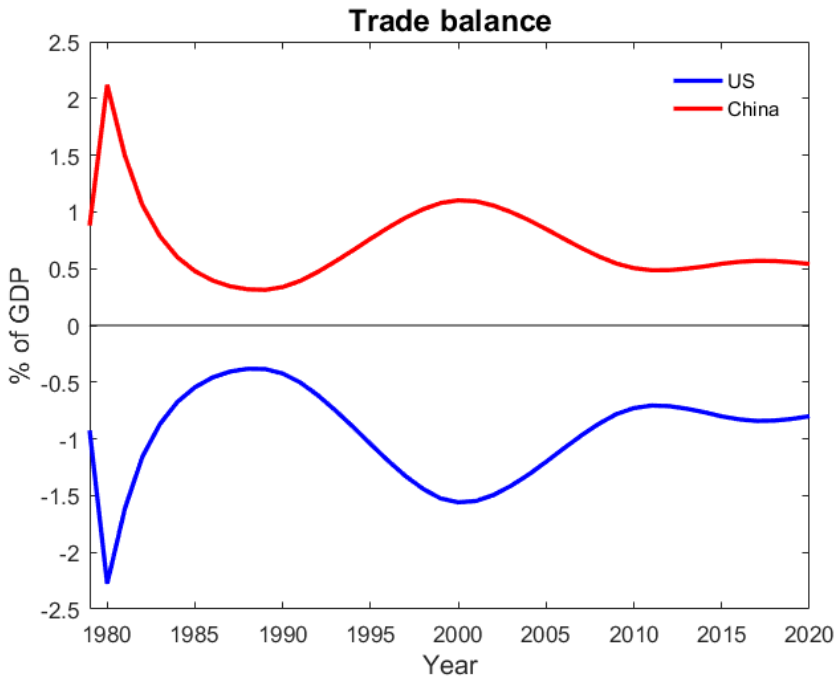
Model (simulation I):

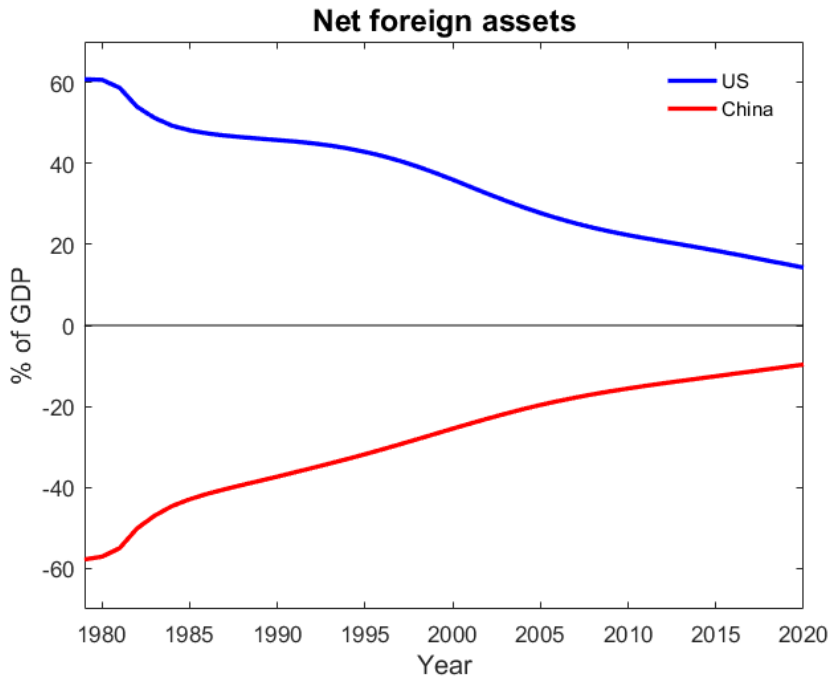
- Population growth slows down:
  $n_{1980}^{w,US} = n_{1980}^{w,China} = 2.15\% \rightarrow n_{2015}^{w,US} = n_{2015}^{w,China} = 0.5\%$
- Life expectancy increases:

  $\gamma_{1980}^{US} = 0.894$ (74.3 years) $\rightarrow \gamma_{2015}^{US} = 0.932$ (78.9 years);
  $\gamma_{1980}^{China} = 0.764$ (67.5 years) $\rightarrow \gamma_{2015}^{China} = 0.925$ (75.4 years)

Simulation I: China-US trade balance and net foreign asset position 1980-2015

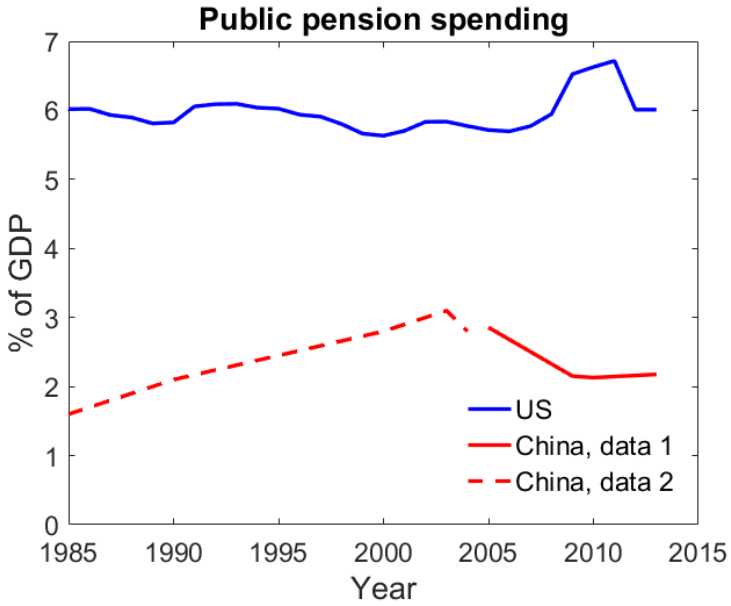
Effects of demographic trends





Social security

Data:



Sources: OECD Data on Social Protection and Asian Development Bank: Social Protection Index Database (data 1); Naughton (2007) (data 2).

China

- Current II-tier system since 1998:
  - I) public basic pension funded on a pay-as-you-go basis, defined benefit
  - II) mandatory employee contribution to a second-tier plan
- Coverage: 27.7 % of population aged 15-65 (OECD 2015)

US

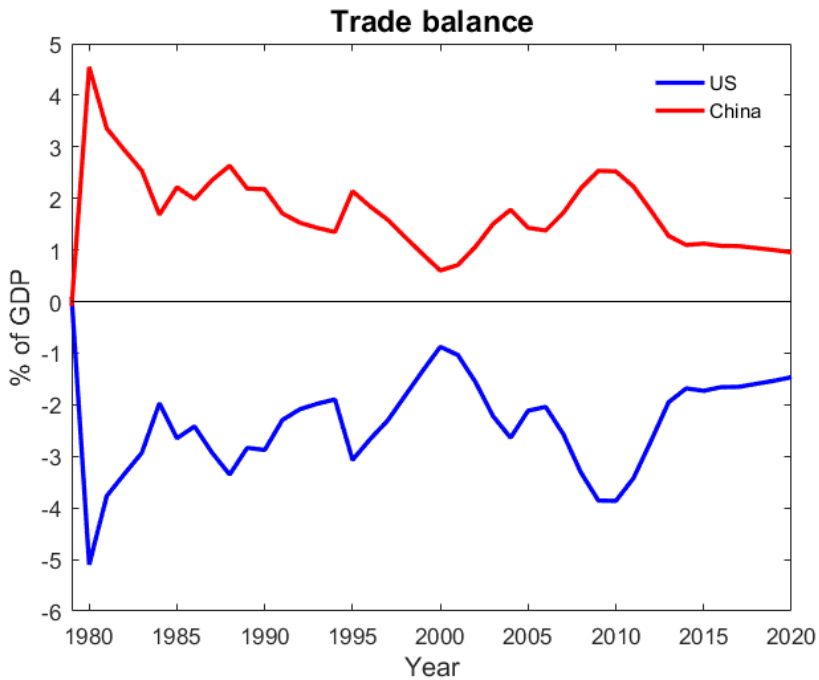
- Defined benefit public pension scheme "Social Security", partly funded (85% of insurance income from payroll taxes in 2015, SSA 2017)
- Coverage: 71.4 % of population aged 15-65 (OECD 2015)

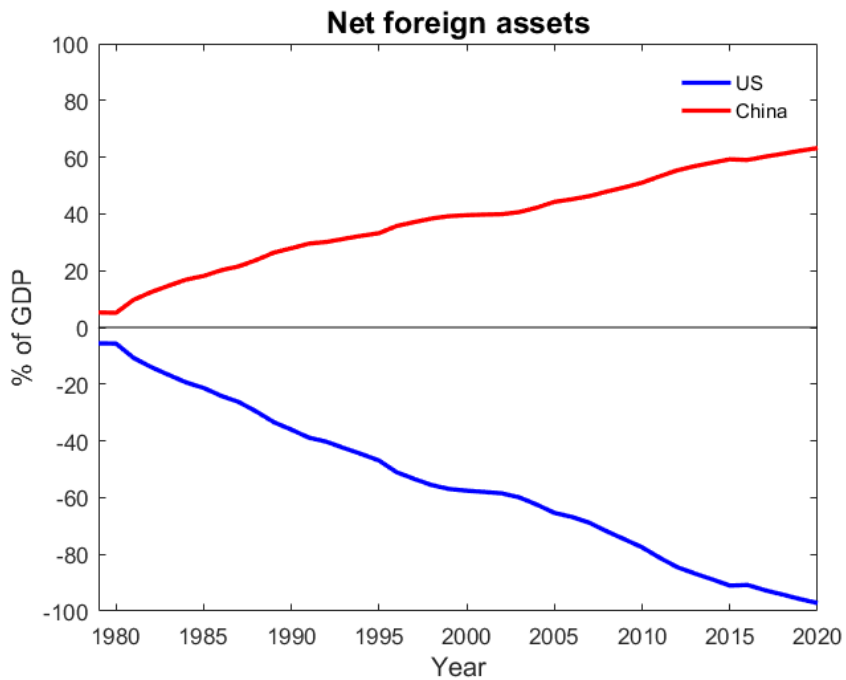
Model (simulation I):

- Social security expenditures (public pension spending) permanently higher in the US:
  $s_{US,1980} = 6\% \rightarrow s_{US,2015} = 7\%$
  $s_{China,1980} = s_{China,2015} = 2\%$

Simulation I: China-US trade balance and net foreign asset position 1980-2015

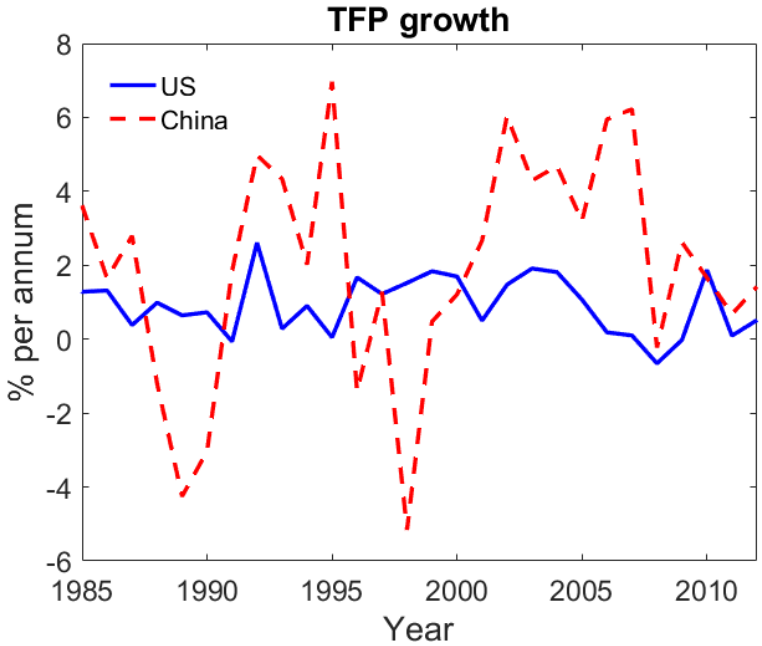
Effects of demographic trends, social security and government expenditures





Productivity growth

Data:



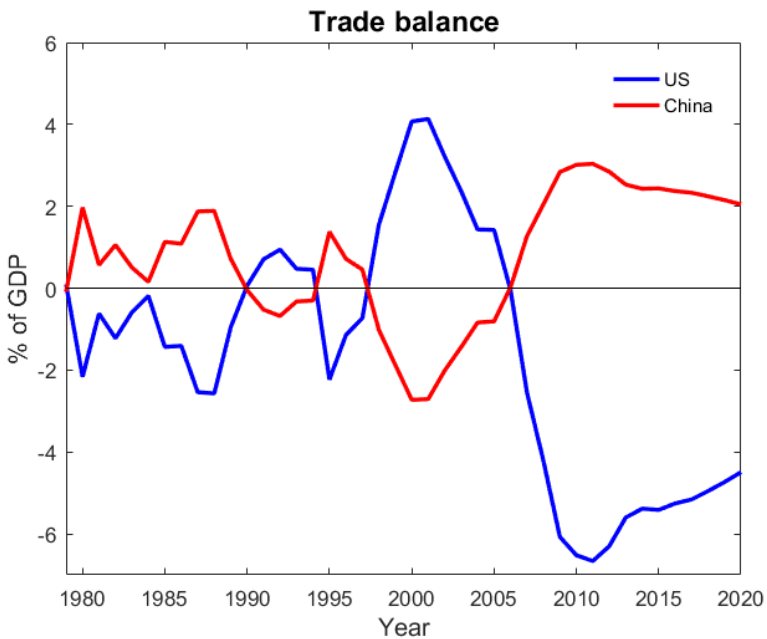
Source: Penn World Table 9.0

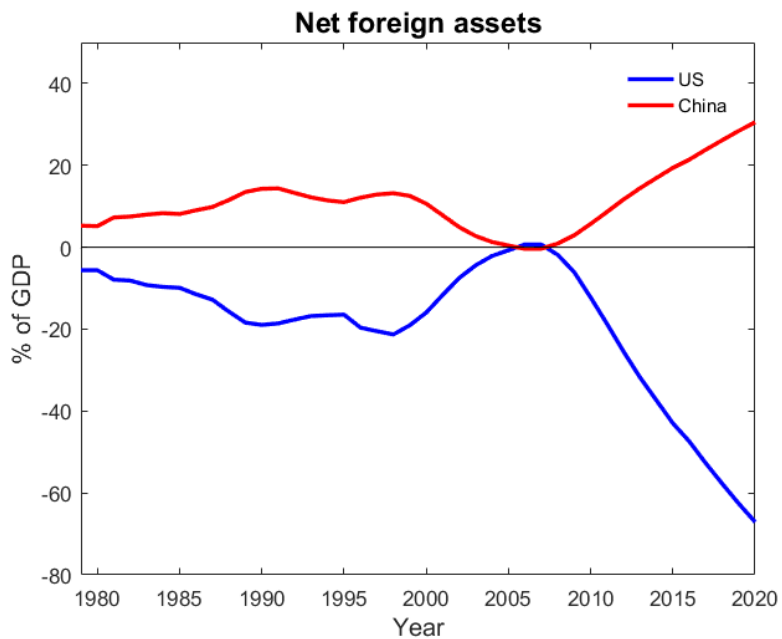
Model (simulation I):

- By assumption, no permanent changes in productivity growth
  $x_{US,1980} = x_{China,1980} = x_{US,2015} = x_{China,2015} = 1\%$

Simulation I: China-US trade balance and net foreign asset position 1980-2015

Effects of demographic trends, social security, government expenditures and TFP growth



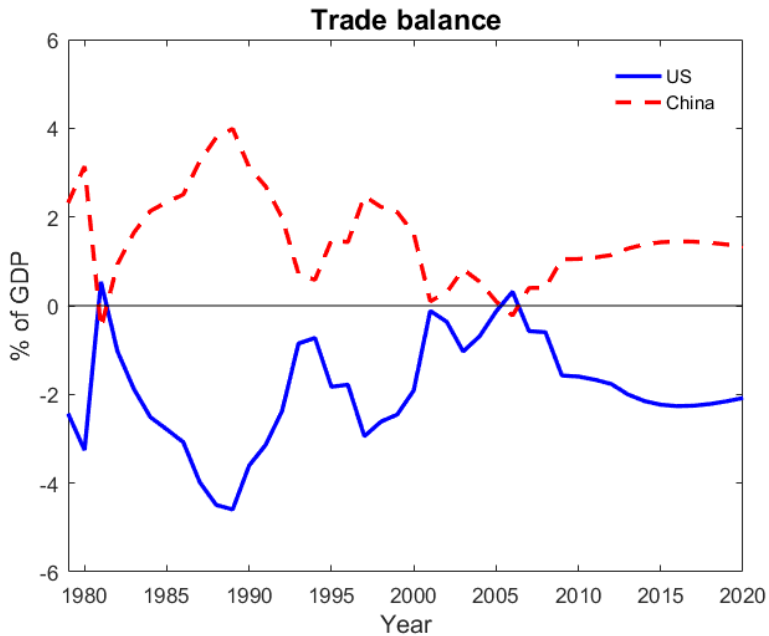


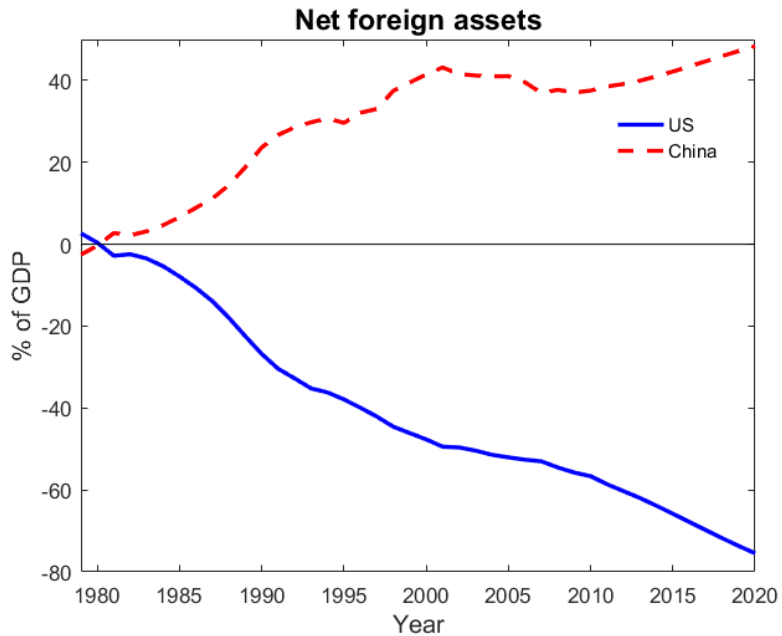
Simulation II: Deterministic solution with learning

- Alternative solution: in each period, there are unanticipated innovations in exogenous variables
  - After the shock, TFP and government expenditures are assumed to slowly converge back to the permanent levels
  - Demographic variables are assumed to evolve as predicted by the most recent vintage of the UN population forecast
- The transition paths of all variables are compiled from different rounds of simulation
  - Compiled series of exogenous variables exactly match the data

Simulation II: China-US trade balance and net foreign asset position 1980-2015

Effects of demographic trends, social security, government expenditures and TFP growth





Conclusions

- The paper focuses on the effects of demographics and social security on aggregate savings, consumption, investment and the external balance
  - It abstracts from financial market frictions; but offers a complementary explanation
- In the model, fast increase in life expectancy in China helps to explain why the country has accumulated foreign assets in the past decades
- Low level of social security can explain why the savings in China are high despite the relatively young population
- The effect of social security and demographics is quantitatively significant
  - The model predicts a trade surplus for China for the majority of the years in the simulation

Calibration

Parameter		Model
β	discount factor	0.99
α	labour share	$\frac{2}{3}$
δ	discount rate	0.2
σ	elasticity of intertemporal substitution	0.55
ξ	productivity of a unit of labour, retiree to worker	0.5
v	elasticity of period utility with respect to consumption	0.7
x	growth rate of technology	0.01
n	population growth rate	0.0215
$\gamma_1/\ \gamma_2$	probability to survive (if retired)	0.894/0.764
$\omega_1/\ \omega_2$	probability to stay in the labour force	0.978/0.977
$b_1/\ b_2$	government debt, % of gdp	0
$g_1/\ g_2$	government spending, % of gdp	0.155/0.144
s_1/s_2	social security spending, % of gdp	0.06/0.02
ϕ	adjustment cost parameter	3
$\frac{XN}{X^*N^*}$	relative size of the countries	0.99

Calibration for the initial steady state between the US and China (1980). Data sources: see appendix.

Dynamic equations

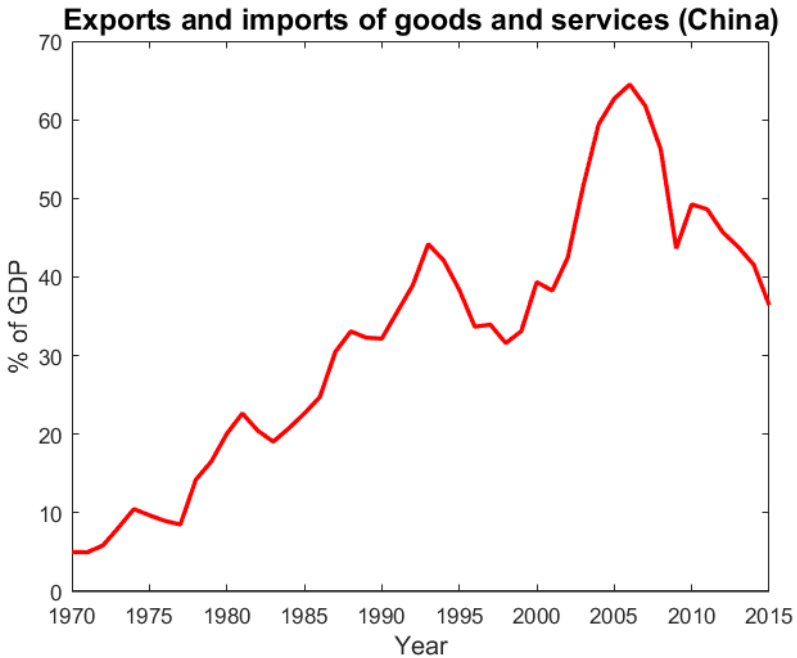
- Retirees' marginal propensity to consume out of wealth is

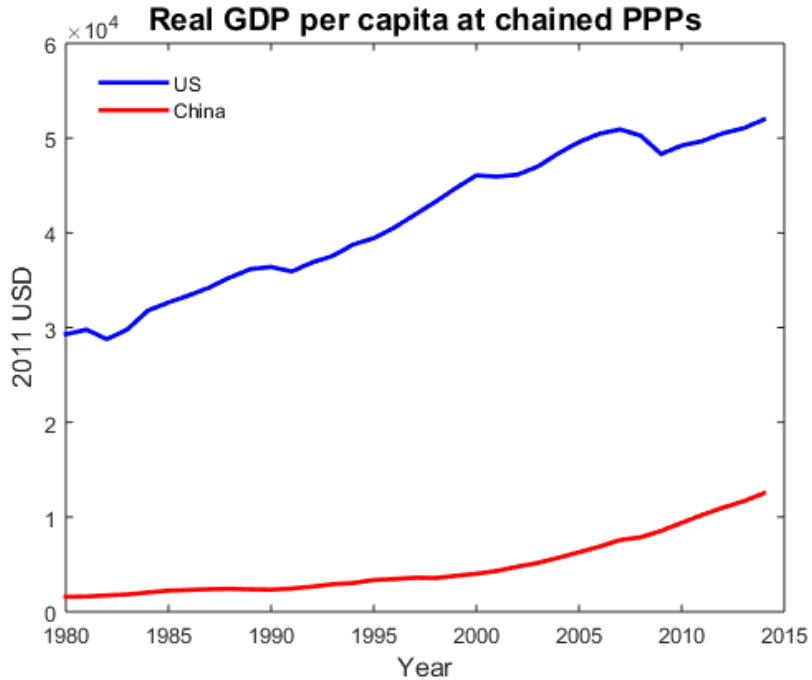
$$\varepsilon_t \pi_t = 1 - \frac{\varepsilon_t \pi_t}{\varepsilon_{t+1} \pi_{t+1}} \gamma_{t,t+1} \left(\frac{W_t(1-\tau_t)}{W_{t+1}(1-\tau_{t+1})} \right)^{\rho\sigma(1-v)} \beta^{\sigma} (R_{t+1})^{\rho\sigma} \ .$$

- Workers' marginal propensity to consume out of wealth is

$$\pi_t = 1 - \frac{\pi_t}{\pi_{t+1}} \left(\frac{W_t(1-\tau_t)}{W_{t+1}(1-\tau_{t+1})} \right)^{\rho\sigma(1-v)} \beta^{\sigma} (R_{W,t+1} \Omega_{t+1})^{\sigma-1} \ .$$

Foreign trade in China and real GDP per capita





Left panel: Merchandise trade in China as a share of GDP is the sum of merchandise exports and imports divided by the value of GDP, all in current U.S. dollars. Right panel: real GDP per capita at chained PPPs in the US and China. *Source: Left panel: World Bank World Development Indicators. Right panel: PWT 9.0: International comparison of production, income and prices.*

Why Epstein-Zin preferences?

Preferences

- *There are idiosyncratic risks in the model, that may complicate both the derivation and aggregation of individual decision rules (Gertler 1999) →mitigate the idiosyncratic risks*

1. *Death risk: retirees face a risk because of the uncertainty of the time of death*
   - *Eliminated by assuming a perfect annuities market following Yaari (1965) and Blanchard (1985), which provides perfect insurance against this risk*
2. *Retirement risk: the uncertainty of retirement time causes a risk to workers' wage income*
   - *Eliminate by assuming Epstein-Zin preferences, which allow to separate income risk aversion and elasticity of intertemporal subsitution, and assume that μ=1: agents are risk neutral with respect to income risk*

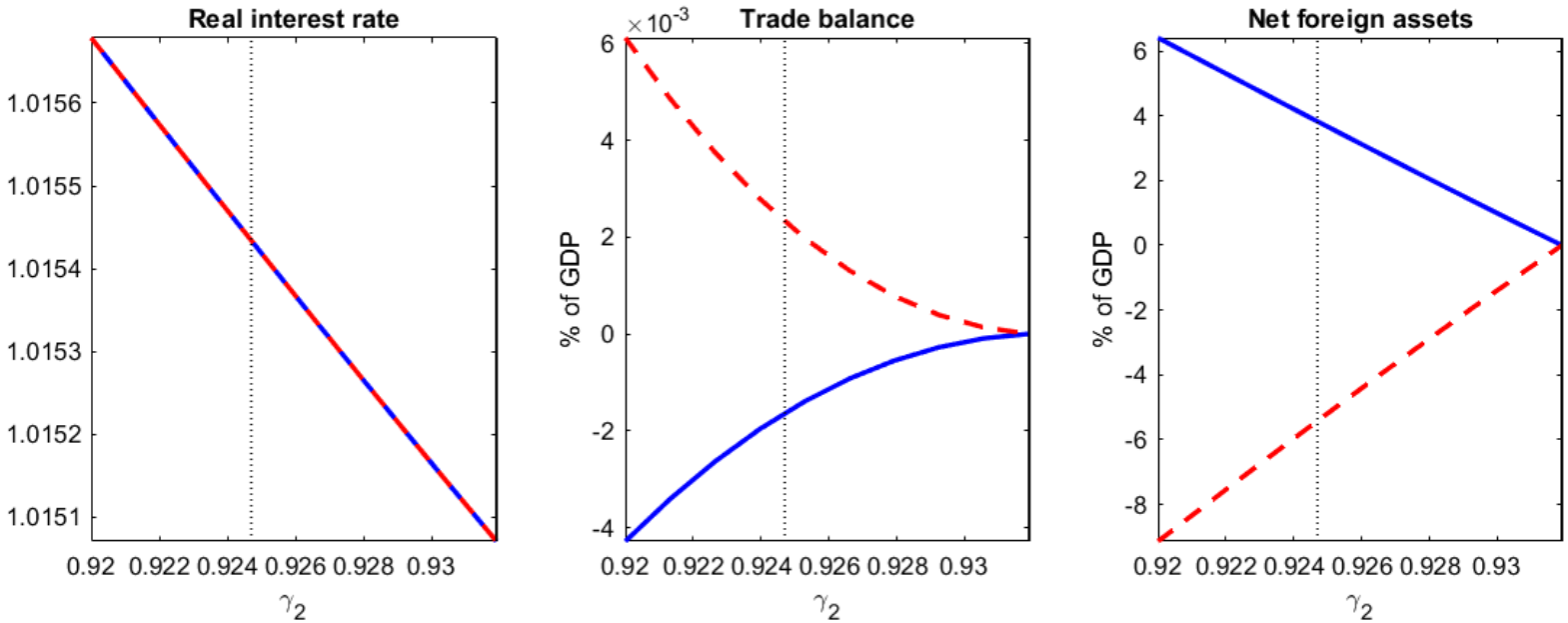
$$V_t^z = \left\{ \left[(C_t^z)^v (1 - l_t^z)^{1-v} \right]^\rho + \beta_{t,t+1}^z \left[E_t \left(V_{t+1} \mid z \right)^\mu \right]^{\frac{\rho}{\mu}} \right\}^{\frac{1}{\rho}} , \; z = \{w, r\} \; .$$

μ : *parameter for risk aversion*
ρ : *curvature parameter -* $\sigma = \frac{1}{1-\rho}$ *parameter for intertemporal substitution*

Why Epstein-Zin preferences?

- *This yields individual decision rules that are linear in wealth and independent of individual characteristics*
  - *All retirees and workers have the same marginal propensity to consume (mpc)*
- *In order to solve for aggregate consumption by retirees and workers, one (only) needs to keep track of the distribution of wealth between the groups ("the Gertler trick")*
- *Preferences allow to maintain elasticity of intertemporal substitution :*
  - *Agents care about consumption smoothing* $\rightarrow$ *Assume:* $\rho = x$ *ie* σ *is finite*
  - σ *is an important parameter in determining the quantitative effects of social security and population ageing*

Steady state effects of population ageing

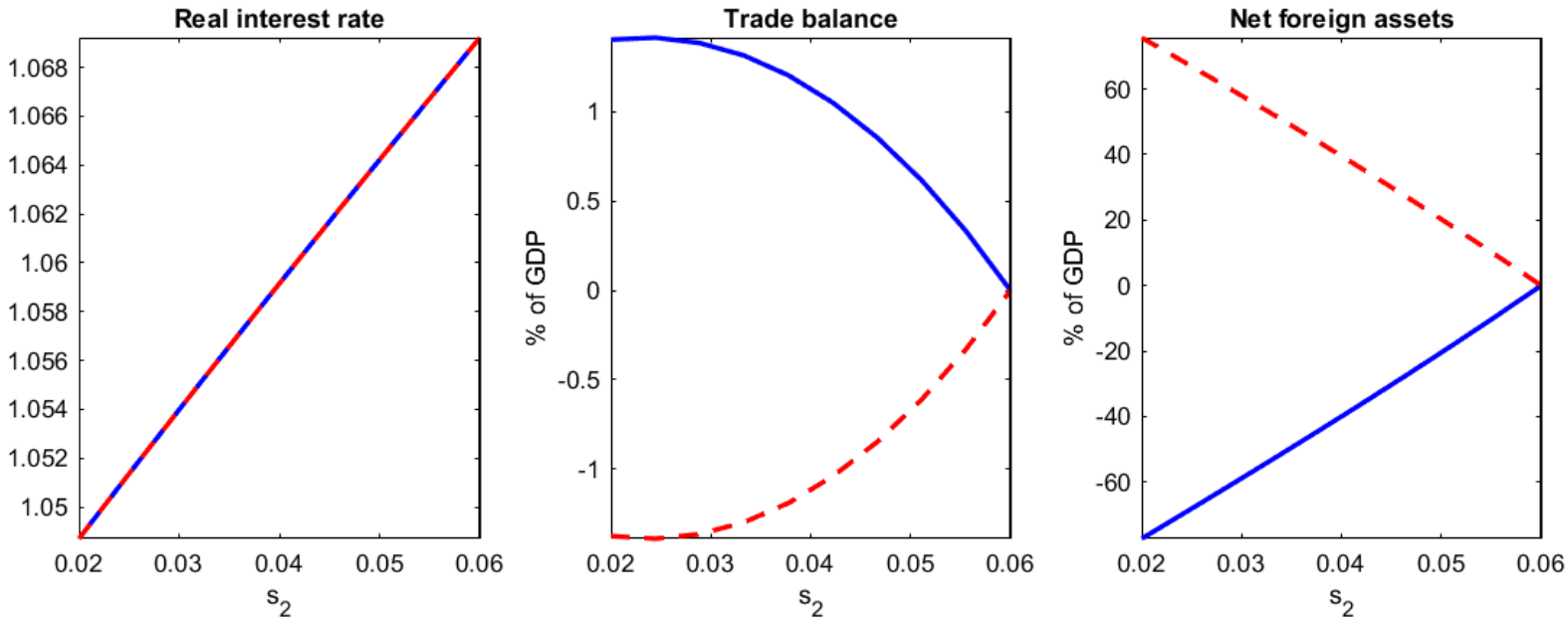


Steady states for $0.92 \leq \gamma_2 \leq 0.9319$ and $\gamma_1 = 0.9319$ (blue line = US and red dotted line = China).

Effects of population ageing

- Retirees' and workers' marginal propensities to consume fall because of higher life expectancy
- Composition effect increases consumption
  - The share of retirees increases: the old age dependency ratio in the steady state is $\psi = \frac{1-\omega}{1+n-\gamma}$ increases
  - $\varepsilon_t = \frac{mpc,retirees}{mpc,workers} \geq 1$: out of the present value of lifetime wealth, retirees consume more than workers
- The fall in the mpc's quantitatively dominates over the composition effect

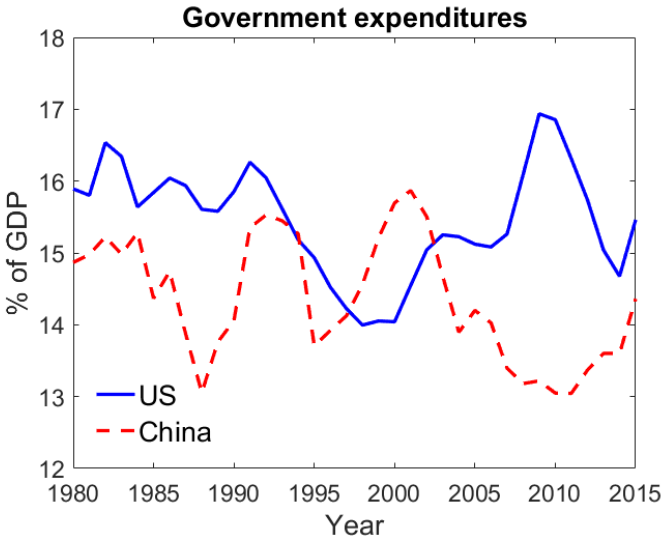
Steady state effects of social security



Steady states for $0.02 \leq s_2 \leq 0.06$ and $s_1 = 0.06$ with distortionary taxes (blue line = US and red dotted line = China).

Government expenditures

Data:



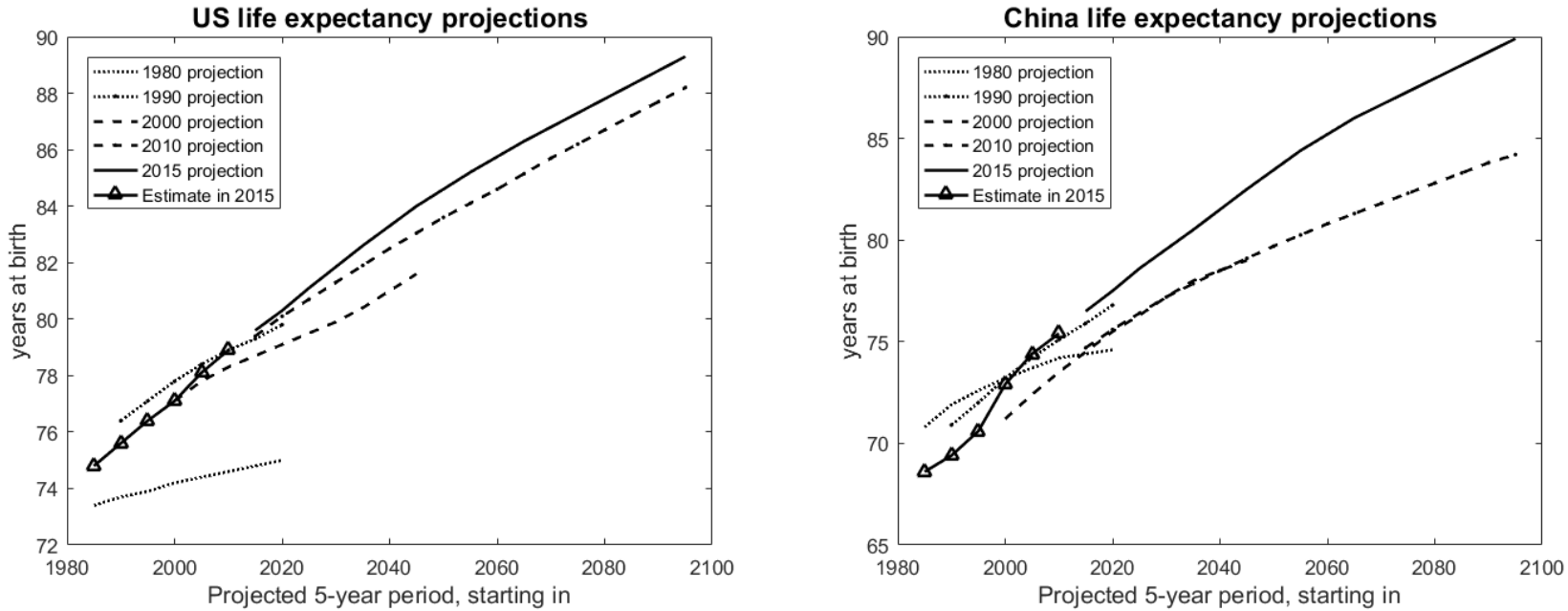
Source: World Bank, World Development Indicators 2016.

Model (simulation I):

- Steady state government expenditures permanently higher in the US:
  $g_{US,1980} = g_{US,2015} = 15.5\%$
  $g_{China,1980} = g_{China,2015} = 14.4\%$

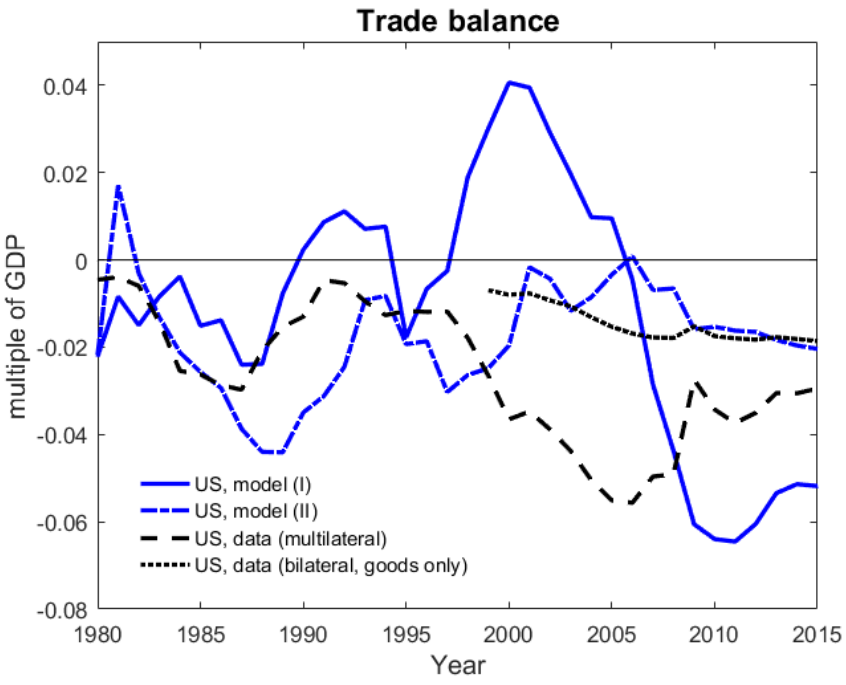
Simulation II: Deterministic solution with learning

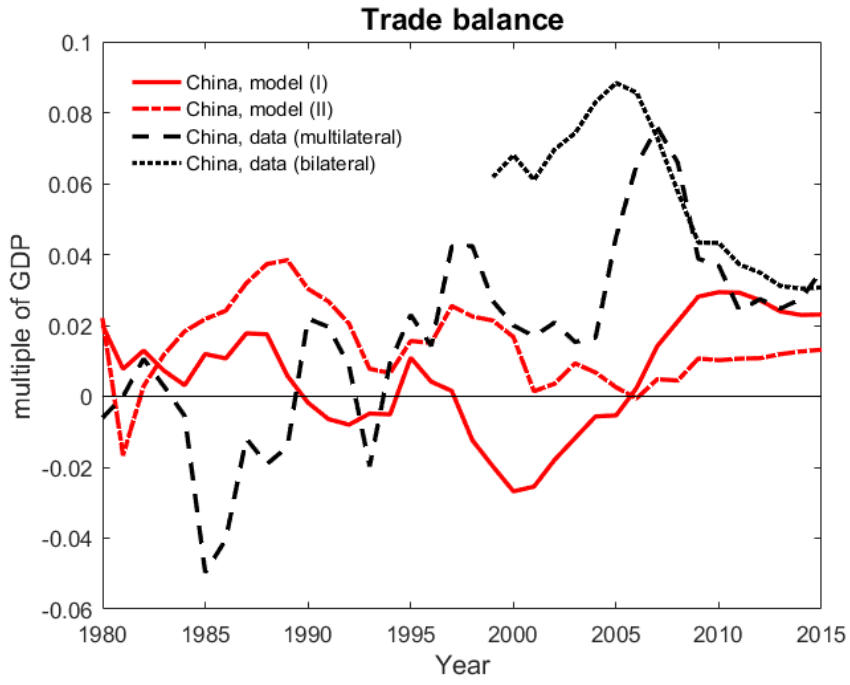
Example of learning: projections of life expectancy



Left panel: Life expectancy at birth, US. Right panel: Life expectancy at birth, China. Source: United Nations World Population Prospects: 1980-2015 Revisions.

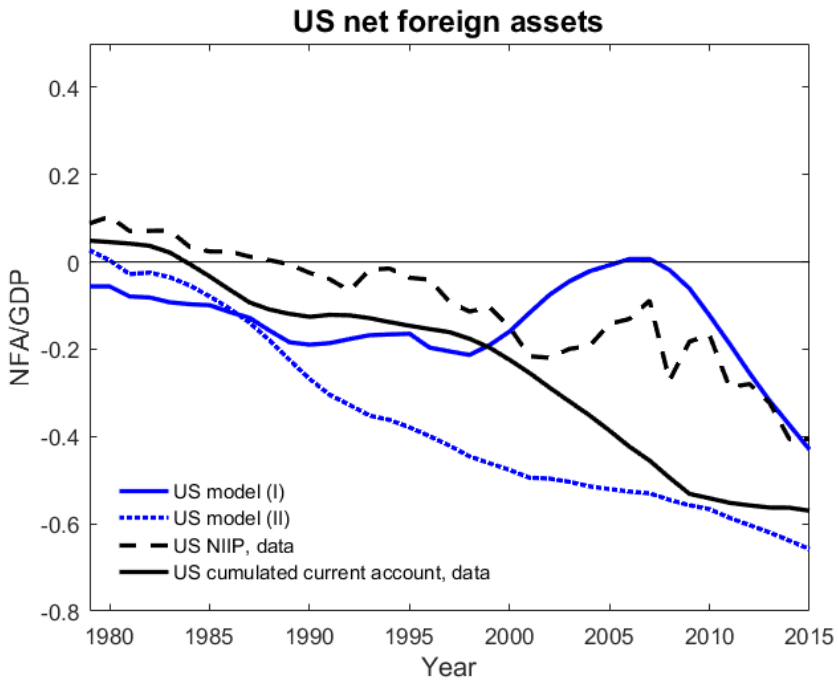
Models vs. data: trade balances

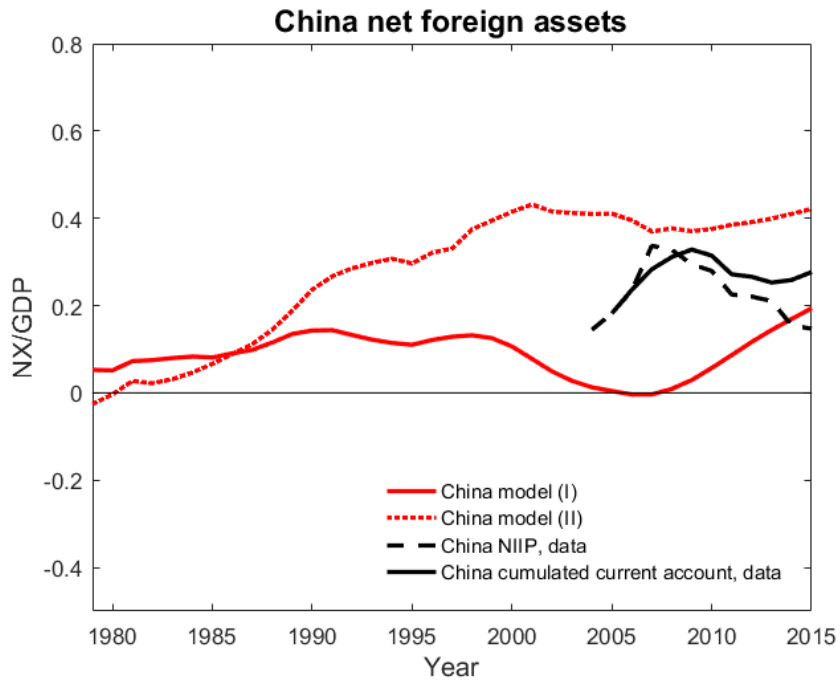




Source: Multilateral trade balance: World Bank, World Development Indicators.

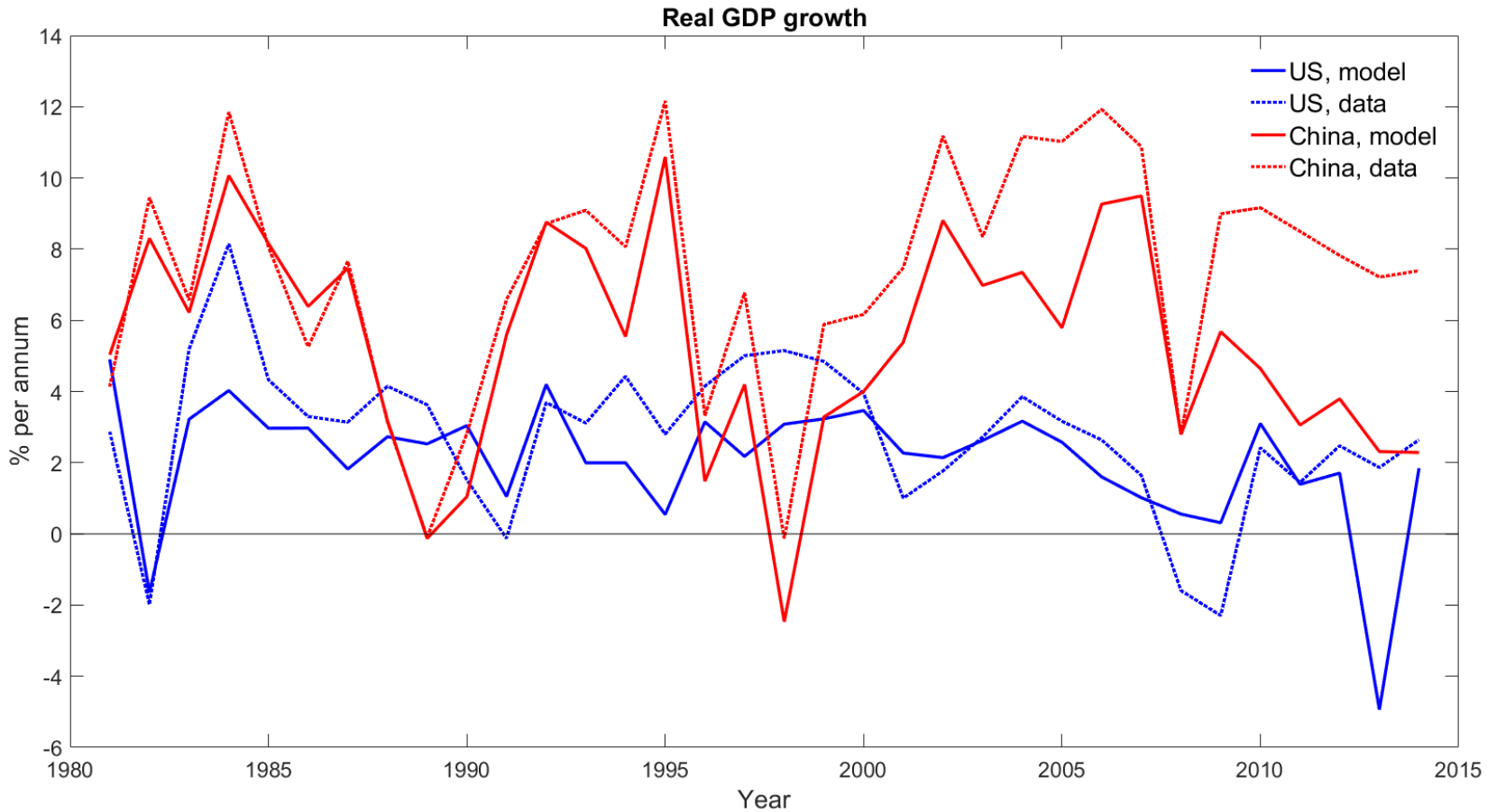
Models vs. data: net foreign assets





Source: IMF Balance of Payment Statistics and author's calculations.

Models vs. data: real GDP growth



Source: Penn World Table 9.0.