Global Imbalances
and Structural Change in the United States

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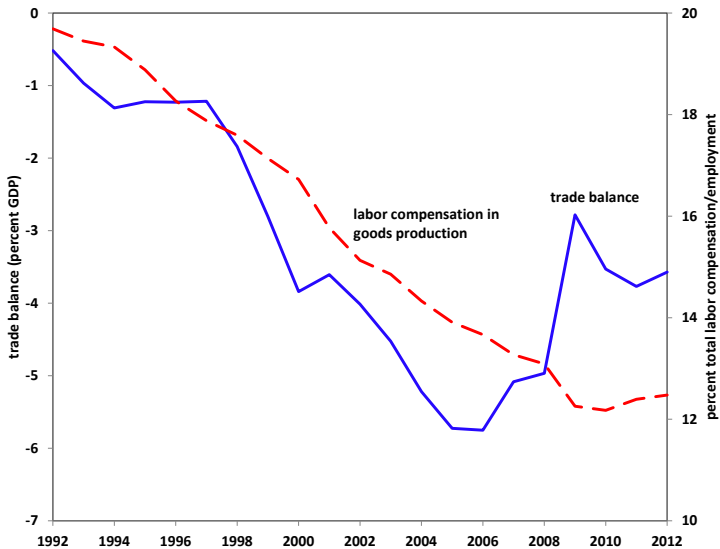and National Bureau of Economic Research

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Traded sector employment and trade deficit

Key questions

▶ How much of the decline in goods-sector employment is from . . .

▶ . . . traditional structural change forces?

   1. Faster productivity growth in goods sector + low elasticity

   2. Income effects from nonhomothetic preferences

   3. Differential capital shares

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- ► ... traditional structural change forces?

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  2. Income effects from nonhomothetic preferences

  3. Differential capital shares

- ► ... borrowing abroad?

  - ► By borrowing, receive tradable goods from ROW

  - ► Shift from domestic goods production to nontradables/services

  - ► End borrowing, increase goods-sector employment

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   ► End borrowing, increase goods-sector employment

► Provide the first measure of trade-deficit induced structural change

Global saving glut

*Why is the United States, with the world's largest economy, borrowing heavily on international capital markets – rather than lending, as would seem more natural?. . . [O]ver the past decade a combination of diverse forces has created a significant increase in the global supply of saving — **a global saving glut** — which helps to explain both the increase in the U.S. current account deficit and the relatively low level of long-term real interest rates in the world today.*
(Ben S. Bernanke, 2005)

▶ Large literature seeks to explain saving glut

   ▶ Example: Financial integration with asymmetric financial development (Mendoza et al., 2009; Caballero et al. 2008)

▶ We take the saving glut as given and focus on its impact on U.S. economy over past 20 years and in future

What we do

- Build GE model of United States and the rest of the world
  - Exogenous "saving glut:" increase foreign demand for U.S. bonds
  - Traditional structural change forces
  - Consistent with key facts about U.S. economy over past 20 years

▶ Build GE model of United States and the rest of the world

  ▶ Exogenous "saving glut:" increase foreign demand for U.S. bonds

  ▶ Traditional structural change forces

  ▶ Consistent with key facts about U.S. economy over past 20 years

▶ Counterfactual economy without saving glut

  ▶ Measure contribution of each force to structural change

  ▶ Compare future trajectories

▶ Contribution to the drop in goods-sector employment, 1992–2012

    ▶ Saving glut: 15%

    ▶ Nonhomothetic preferences: 6%

    ▶ Most due to faster productivity growth in goods production

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- Goods employment will continue to fall as U.S. repays debt
  - Services trade surplus reduces need to export goods

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▶ Goods employment will continue to fall as U.S. repays debt

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▶ Long-run U.S. trade balance about 1% of GDP larger
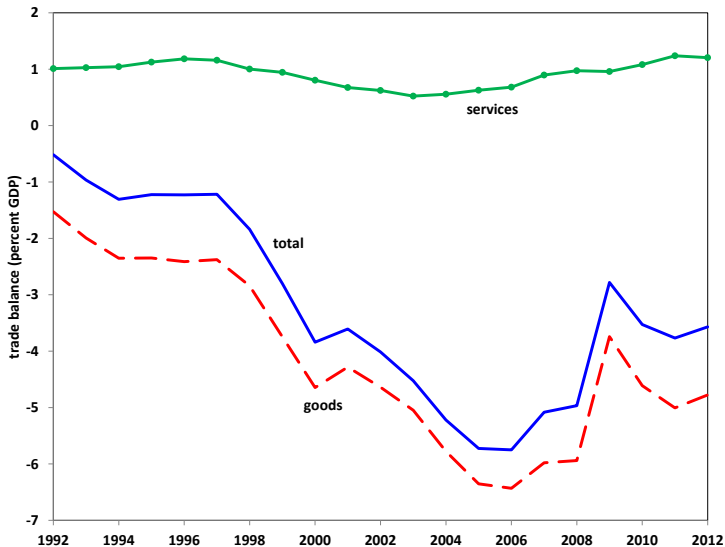
▶ Long-run U.S. real exchange rate 6% depreciated

Game plan

1. Key facts

2. Baseline model

3. Quantitative strategy and calibration

4. Model outcomes:

    ► Replicating key facts

    ► Saving glut versus no-saving-glut counterfactual
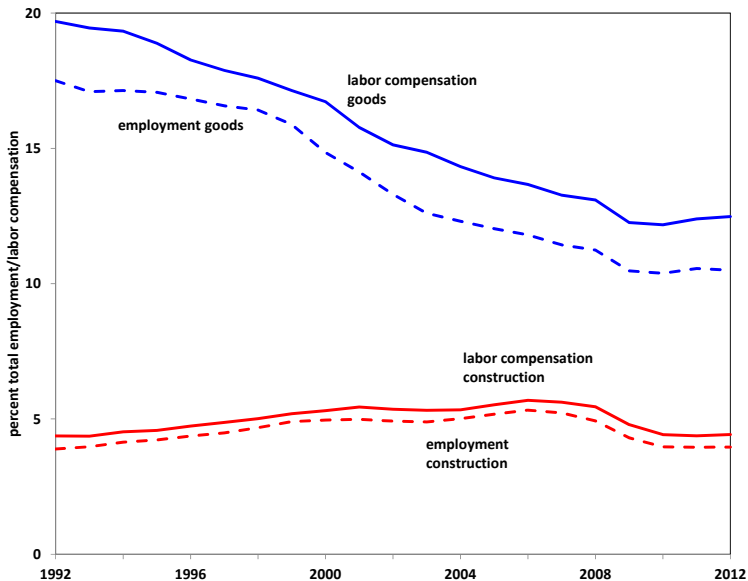
5. Two puzzles

Fact 1: U.S. real exchange rate appreciates, then depreciates
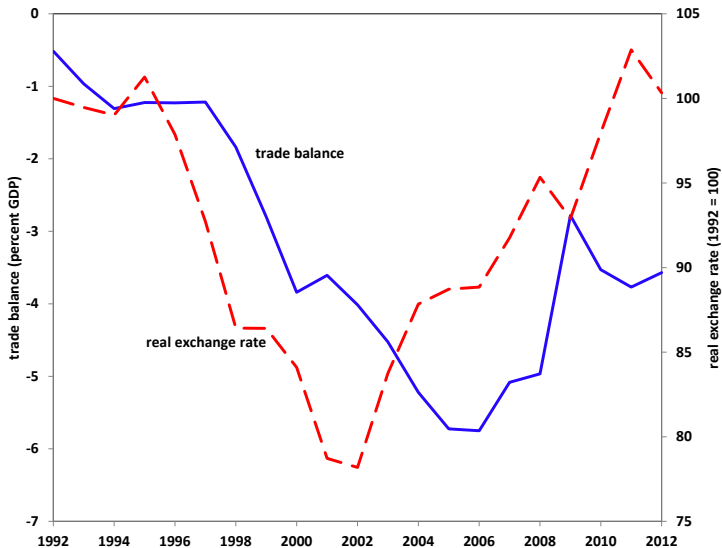
Fact 2: Trade deficit dynamics driven by goods trade

Fact 3: Goods-sector employment falls, construction grows

▶ Dynamic general equilibrium model with two countries:

    ▶ United States (U.S.), Rest of the world (R.W.)

▶ Multiple sectors with differential productivity growth:

    ▶ U.S.: goods, services, construction, investment

    ▶ R.W.: goods and services

▶ Key assumption that generates the saving glut:

    ▶ R.W.'s discount factor matches the U.S. in the long run

    ▶ R.W.'s discount factor varies over time (deterministically),
      calibrated to match the trade balance during 1992–2012

- The saving glut
    - In 1992, agents expect deterministic economy without saving glut; R.W.'s discount factor constant at long-run level
    - In 1993, saving glut starts unexpectedly, lasts through 2012

1992 Input-output matrix (U.S. GDP = 100)

		Intermediate inputs					Final demand				Gross output
		USA			ROW		USA			ROW	
		Goods	Services	Construction	Goods	Services	Consumption	Government	Investment	Consumption	
USA	Goods	21.52	9.96	3.14	3.10	1.14	7.66	1.91	5.26	2.72	56.41
	Services	11.74	39.23	2.99	0.90	1.35	54.97	13.68	3.01	0.47	128.33
	Construction	0.00	0.00	0.00	0.00	0.00	0.00	0.00	10.05	0.00	10.05
ROW	Goods	3.17	1.11	0.33	89.56	41.13	1.64	0.41	1.68	82.31	221.33
	Services	0.44	1.08	0.10	42.59	88.67	0.19	0.05	0.02	205.37	338.51
	Value added	19.55	76.96	3.50	85.18	206.22	0.00	0.00	0.00	0.00	391.40
	Gross output	56.41	128.33	10.05	221.33	338.51	64.47	16.05	20.02	290.87	

► Goods and services use domestic and foreign intermediates

► Construction: nontraded, used only in investment

▶ Perfect competition, representative firm

▶ Gross output in goods, services, and construction ($i = g, s, c$)

$$y_{it}^{us} = \Lambda_i^{us} \left(\lambda_i^{us} \left(\nu_{it}^{us} \right)^{\eta} + \left(1 - \lambda_i^{us} \right) \left(m_{it}^{us} \right)^{\eta} \right)^{\frac{1}{\eta}}$$

   ▶ Combine value added (ν) and intermediate-good bundle (m)

U.S. production: gross output and value added

▶ Perfect competition, representative firm

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▶ Value added

$$\nu_{it}^{us} = A_i^{us} \left(k_{it}^{us} \right)^{\alpha_i} \left(\bar{\gamma}_{it}^{us} \ell_{it}^{us} \right)^{1-\alpha_i}$$

  ▶ Labor productivity $\bar{\gamma}_{it}^{us}$ grows at different rates across sectors

▶ Intermediate-good bundle

$$m_{it}^{us} = \Pi_i^{us} \left\{ \sum_{j=g,s} \pi_{ij}^{us} \left[\mu_{ij}^{us} \left(m_{ijt}^{us,us}\right)^{\zeta_j} + (1 - \mu_{ij}^{us}) \left(m_{ijt}^{us,rw}\right)^{\zeta_j} \right]^{\xi/\zeta_j} \right\}$$

  ▶ μ_{ij}^{us} govern share of domestic vs. foreign input of j

  ▶ π_{ij}^{us} govern share of goods vs. services

► Intermediate-good bundle

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► In words

   ► Use domestic and foreign goods to create a good-intermediate

   ► Use domestic and foreign services to create service-intermediate

   ► Use good- and service-intermediate to create intermediate bundle

1992 Input-output matrix (U.S. GDP = 100)

| | | Intermediate inputs | | | | | Final demand | | | | Gross output |
| | | USA | | | ROW | | USA | | | ROW | |
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Final demand in U.S. (R.W. only consumption)

► Household consumption, $i = g, s$

$$c_{it}^{ush} = \Theta_i^{ush} \left(\theta_i^{ush} \left(c_{it}^{ush,us} \right)^{\sigma_i} + (1 - \theta_i^{ush}) \left(c_{it}^{ush,rw} \right)^{\sigma_i} \right)^{1/\sigma_i}$$

► Government consumption, $i = g, s$

$$c_{it}^{usg} = \Theta_i^{usg} \left(\theta_i^{usg} \left(c_{it}^{usg,us} \right)^{\sigma_i} + (1 - \theta_i^{usg}) \left(c_{it}^{usg,rw} \right)^{\sigma_i} \right)^{1/\sigma_i}$$

► Investment, $i = g, s$

$$x_{it}^{usx} = \Theta_i^{usx} \left(\theta_i^{usx} \left(x_{it}^{usx,us} \right)^{\sigma_i} + (1 - \theta_i^{usx}) \left(x_{it}^{usx,rw} \right)^{\sigma_i} \right)^{1/\sigma_i}$$

▶ Aggregate of goods, services and all of construction

$$x_t^{usx} = E^{usx} \left(\epsilon_g^{usx} \left(x_{gt}^{usx} \right)^\nu + \epsilon_s^{usx} \left(x_{st}^{usx} \right)^\nu + \epsilon_c^{usx} \left(y_{ct}^{us} \right)^\nu \right)^{1/\nu}$$

▶ Perfectly competitive market, representative firm

Bonds

▶ One-period bond: held by U.S. household, U.S. government, R.W.

▶ Denominated in units of U.S. CPI, P_t^{us}

▶ Q_t: period-t price of a bond that pays one unit of U.S. CPI in $t+1$

▶ Real interest rate in units of U.S. CPI given by

$$1 + r_{t+1} = \frac{P_t^{us}}{Q_t}$$

▶ Stone-Geary preferences generate income effects

$$u = \left(\left[\epsilon_g^{ush} \left(\frac{c_{gt}^{ush} - \bar{c}_{gt}^{ush}}{\bar{n}_t^{us}} \right)^{\rho} + \epsilon_s^{ush} \left(\frac{c_{st}^{ush} + \bar{c}_{st}^{ush}}{\bar{n}_t^{us}} \right)^{\rho} \right]^{\frac{\phi^{us}}{\rho}} \left[\frac{\bar{\ell}_t^{us} - \ell_t^{ush}}{\bar{\ell}_t^{ush}} \right]^{1 - \phi^{us}} \right)$$

▶ Subsistence requirement for goods $\bar{c}_g^{ush}$, endowment for services $\bar{c}_s^{ush}$

▶ Adult-equivalent $\bar{n}_t^{us}$ and working-age population $\bar{\ell}_t^{us}$

U.S. final demand: households

▶ Households choose consumption of goods and services, labor, investment, and bonds to maximize

$$\sum_{t=0}^{\infty} \beta^t u \left(c_{gt}^{ush}, c_{st}^{ush}, \ell_t^{ush}\right)^{\psi}$$

subject to

$$p_{gt}^{ush} c_{gt}^{ush} + p_{st}^{ush} c_{st}^{ush} + p_t^{usx} x_t^{usx} + Q_t b_{t+1}^{ush}$$
$$= w_t^{us} \ell_t^{ush} + P_t^{us} b_t^{ush} + (1 - \tau_k^{us}) r_{kt}^{us} k_t^{us} - T_t^{us}$$

$$k_{t+1}^{us} = (1 - \delta) k_t^{us} + x_t^{usx}$$

U.S final demand: government

▶ Spending, $\bar{c}_t^{usg}$, and debt, $\bar{b}_t^{usg}$, levels are exogenous

▶ Goods and services consumption maximize

$$\left(\epsilon_g^{usg} \left(c_{gt}^{usg}\right)^{\upsilon} + \epsilon_s^{usg} \left(c_{st}^{usg}\right)^{\upsilon}\right)^{1/\upsilon}$$

subject to :

$$b_t^{usg} = \bar{b}_t^{usg} GDP_t$$

$$p_{gt}^{usg} c_{gt}^{usg} + p_{st}^{usg} c_{st}^{usg} = \bar{c}_t^{usg} GDP_t$$

$$p_{gt}^{usg} c_{gt}^{usg} + p_{st}^{usg} c_{st}^{usg} = \tau_k^{us} r_{kt}^{us} k_t^{us} + T_t^{us} + P_t^{us} b_t^{usg} - Q_t b_{t+1}^{usg}$$

▶ Ricardian equivalence except for onset of saving glut

Rest of the world

▶ Solves a similar, but simpler problem

▶ Abstract from capital and the government

▶ CPI in R.W. computed as in United States

▶ Calculate real exchange rate using CPIs

$$rer_t = \frac{P_t^{rw}}{P_t^{us}}$$

▶ R.W. households choose consumption, bonds, and labor to maximize

$$\sum_{t=0}^{\infty} \bar{\omega}_t^{rw} \beta^t u \left(c_{gt}^{rw}, c_{st}^{rw}, \ell_t^{rw} \right)^{\psi}$$

subject to

$$p_{gt}^{rw} c_{gt}^{rw} + p_{st}^{rw} c_{st}^{rw} + Q_t b_{t+1}^{rw} = w_t^{rw} \ell_t^{rw} + P_t^{us} b_t^{rw}$$

   ▶ $\bar{\omega}_t^{rw}$ shift intertemporal marginal rate of substitution

   ▶ $\bar{\omega}_t^{rw}$ fall during 1992–2012, creating increased demand for saving

   ▶ $\bar{\omega}_t^{rw}$ reverts to one in the long run

Equilibrium

Given initial conditions $(\bar{k}^{us}_{1992}, \bar{b}^{ush}_{1992}, \bar{b}^{usg}_{1992})$ and $\{\bar{b}^{usg}_t, \bar{c}^{usg}_t, \bar{\omega}^{rw}_t\}^{\infty}_{t=t_0} \ldots$

. . . an equilibrium is sequences of prices and quantities that satisfy

▶ Households' optimality conditions

▶ Marginal product pricing conditions

▶ Government's budget constraint and consumption optimality condition

▶ Market clearing for output, bonds, and factors

Balanced growth path

► When $\{\bar{b}_t^{usg}, \bar{c}_t^{usg}, \bar{\omega}_t^{rw}, \bar{n}_t, \bar{\ell}_t\}_{t=t_0}^{\infty}$ are constant

► $\gamma_{it}/\gamma_{i,t-1} = g_\gamma$, $i = g, s, c$

► $\bar{c}_i^{ush}, \bar{c}_i^{rw}$ are zero

▶ When $\{\bar{b}_t^{usg}, \bar{c}_t^{usg}, \bar{\omega}_t^{rw}, \bar{n}_t, \bar{\ell}_t\}_{t=t_0}^{\infty}$ are constant

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▶ The model converges to a balanced growth path

  ▶ Quantities grow at g_γ (except labor supply)

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▶ Continuum of bgps, indexed by net foreign asset level

    ▶ Initial conditions + transition variables determines bgp

    ▶ Must solve for transition and bgp simultaneously

Game plan

1. Key facts

2. Baseline model

3. Quantitative strategy and calibration

4. Model outcomes:
   - ▶ Replicating key facts
   - ▶ Saving glut versus no-saving-glut counterfactual

5. Two puzzles

Overview of quantitative strategy

▶ ROW: weighted average of top 20 U.S. trade partners by imports

▶ Agents in 1992 do not expect saving glut

▶ Solve for equilibrium assuming bgp in 100 years

    ▶ Expect $\bar{\omega}_t$, $\bar{c}_t^{usg}$ constant

    ▶ Choose elasticities from literature

    ▶ Calibrate all parameters except ω_t^{rw} to match 1992 IO matrix

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  ► Calibrate all parameters except ω_t^{rw} to match 1992 IO matrix

► Calibrate ω_t^{rw} to match trade balance during 1992–2012

Calibration: production parameters

- Scaling factors (Λ_i, A_i, Π_i) so that U.S. GDP=100 in 1992

- Elasticity (Atalay, 2014)
    - Value added and intermediates $1/(1-\eta) = 0.05$
    - Intermediate goods and services $1/(1-\xi) = 0.03$

- Elasticity: home and foreign goods $1/(1-\zeta_g) = 3$

- Elasticity: home and foreign services $1/(1-\zeta_s) = 1$

- Labor productivity $\bar{\gamma}_i^{us}$: match growth rates in data, 1992–2012
    - Goods = 4.4%, services = 1.3%, construction = –0.84%
    - Converge to 2% in balanced growth path

Calibration: final demand parameters

▶ Scaling factors (Θ_i) so that U.S. GDP=100 in 1992

▶ Elasticity (Atalay, 2014)

  ▶ Goods and services in HH consumption $1/(1-\rho) = 0.65$

  ▶ Goods and services in Gov't consumption $1/(1-\upsilon) = 0.65$

▶ Elasticity: goods, services, construction in investment $1/(1-\nu) = 1.0$

▶ Population ($\bar{n}_t, \bar{\ell}_t$): data/UN projections

▶ Stone-Geary parameters ($\bar{c}_i^{ush}, \bar{c}_i^{rw}$): Herrendorf et al. (2013)

▶ Government spending and debt ($\bar{c}_t^{usg}, \bar{b}_t^{usg}$): data/CBO projections

Model fit: elasticities

▶ Elasticities taken from data

▶ Examine change in quantities to judge our choices

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Change in share, 1995–2012	Data	Model
Intermediate share of gross output	–1.04	–1.50
Goods share of intermediate use	–6.81	–5.40
Goods share of final consumption	–1.66	–2.68
Goods share of investment	–0.19	–0.00
Std. dev. goods trade balance	1.54	1.45
Std. dev. services trade balance	0.24	0.20

R.W.'s savings behavior calibrated to generate saving glut

trade balance (percent GDP)

no-saving-glut counterfactual

benchmark

benchmark + data
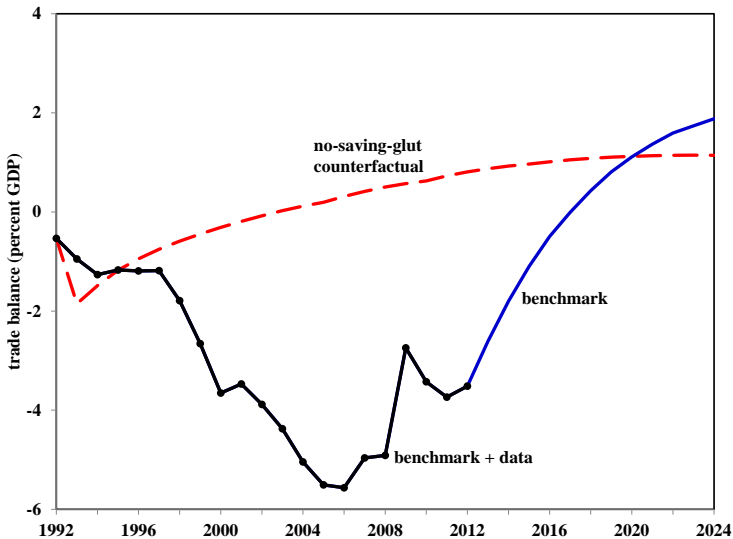
▶ Did the Chinese make us do it?

▶ We model source of global imbalances as being outside United States

▶ What if we alter preferences of U.S. households instead to generate observed borrowing?

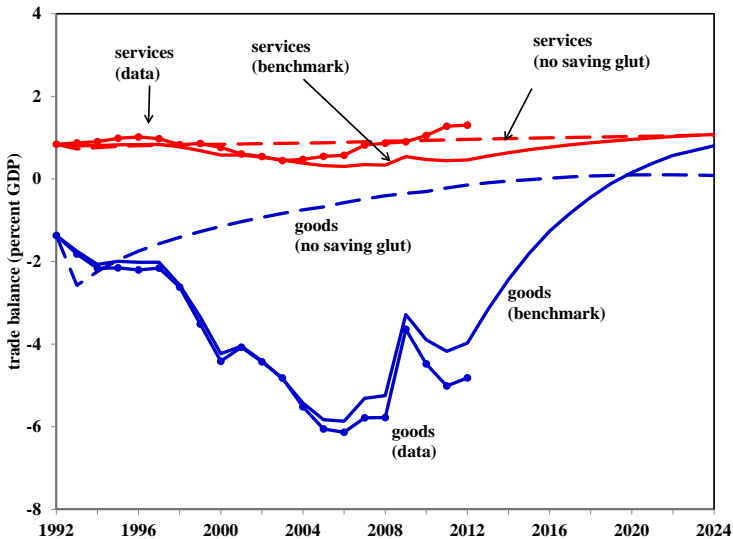▶ "Savings drought" (Chinn and Ito, 2007) in United States rather than saving glut in rest of world
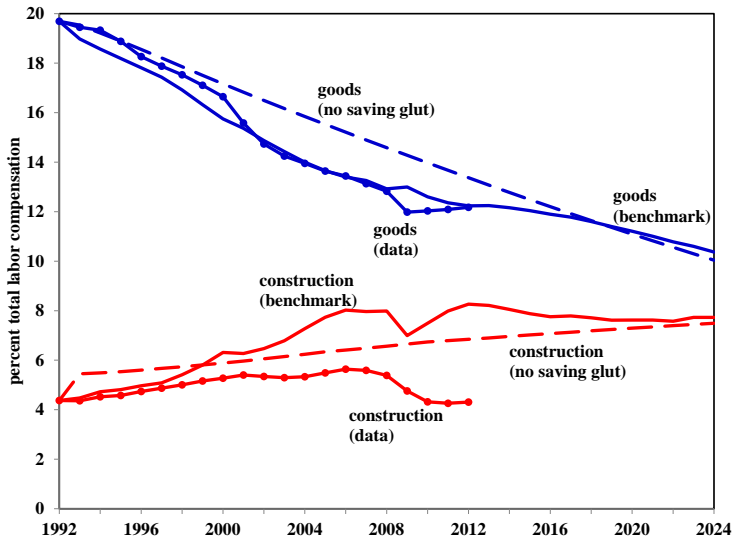
Saving drought model: investment
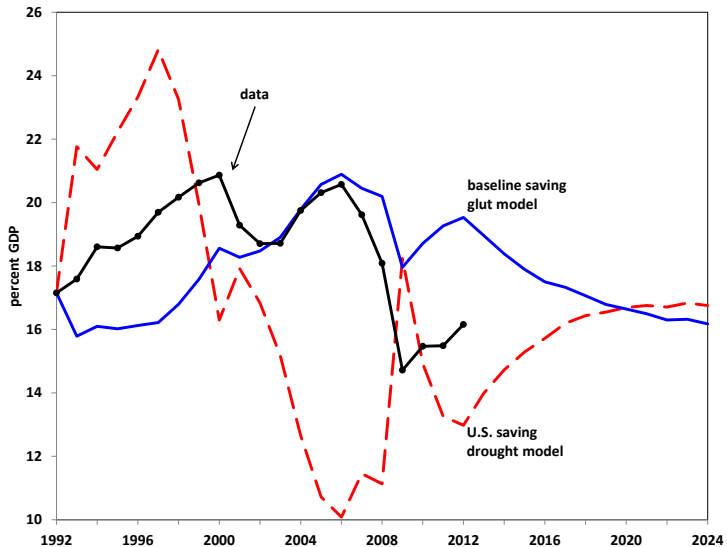
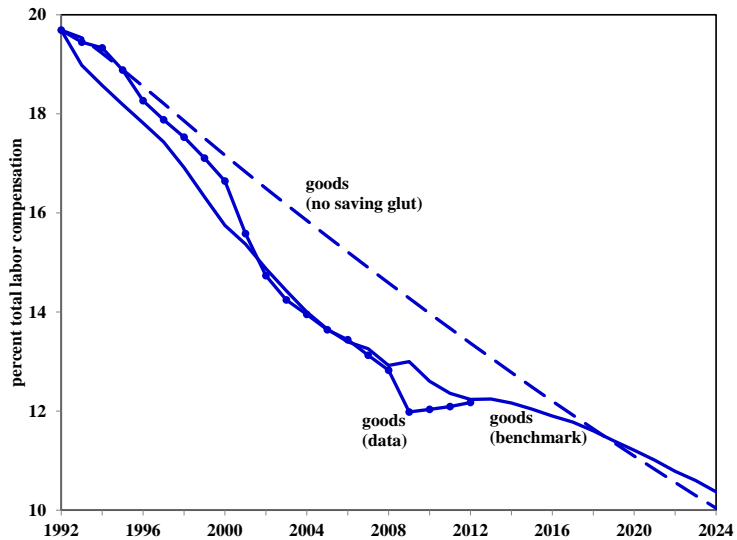Fact 1: U.S. real exchange rate appreciates, then depreciates
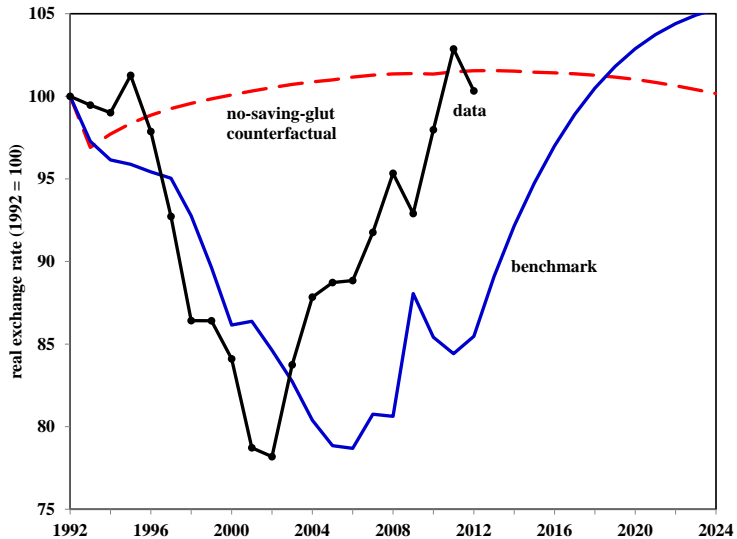
Fact 2: Trade balance dynamics driven by goods trade

Fact 3: Good-sector employment falls, construction grows

Goods-sector employment

(figure labels: "percent total labor compensation" on y-axis; "goods (no saving glut)"; "goods (data)"; "goods (benchmark)")

Summary: The saving glut

- ▶ Key facts during 1992–2012:
  - ▶ Increase in borrowing drives up trade deficit (by construction)
  - ▶ Relative increase in imported goods: RER appreciation
  - ▶ Low services import share: Goods imports drive trade balance
  - ▶ Labor shifts out of goods into construction and services; most of this shift would have occurred even in absence of saving glut

- ▶ Post–2012 rebalancing:
  - ▶ Bond repayment associated with trade balance and RER reversal
  - ▶ Trade balance dynamics again driven by goods
  - ▶ Goods employment continues to decline

Contributions to structural change

► Turn off structural change forces

► Measure their contributions to structural change, 1992–2012

  ► Saving glut 15%

  ► Nonhomothetic preferences 6%

  ► Differential productivity growth

Saving glut in the long run

- By 2024 employment effects of saving glut are finished
  - Not a driver of long-run structural change
  - Hastened structural change 1992–2012

Saving glut in the long run

▶ By 2024 employment effects of saving glut are finished

  ▶ Not a driver of long-run structural change

  ▶ Hastened structural change 1992–2012

▶ Long-run effects are in international markets

  ▶ U.S. real exchange rate depreciated by 6%

  ▶ U.S. trade surplus 1% GDP larger

Robustness

▶ The saving glut's modest contribution to structural change is robust

    ▶ Fixed investment and labor supply

    ▶ Saving glut perfectly foreseen in 1992

    ▶ Long-run interest rate assumptions

    ▶ Various assumptions about government policy

    ▶ Correcting the RER timing (mechanically)

▶ Estimates of the saving glut's contribution rate between 11% and 20%

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5. Two puzzles

Puzzle: U.S. real interest rates

Why is the United States, with the world's largest economy, borrowing heavily on international capital markets – rather than lending, as would seem more natural?. . . [O]ver the past decade a combination of diverse forces has created a significant increase in the global supply of saving — a global saving glut — which helps to explain both the increase in the U.S. current account deficit **and the relatively low level of long-term real interest rates** *in the world today.*
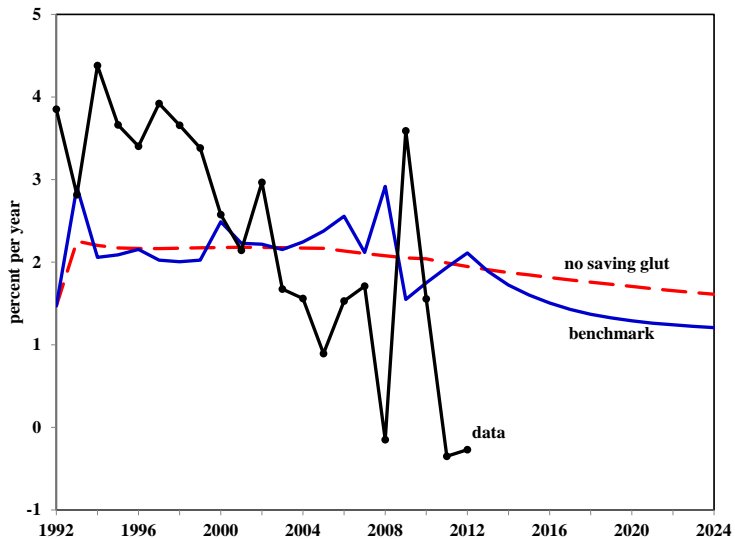   *(Ben S. Bernanke, 2005)*

▶ Model: saving glut has little impact on interest rates

$$1 + r_{t+1}^{us} = \left(1 + r_{t+1}^{rw}\right) \frac{rer_{t+1}}{rer_t}$$

▶ Results consistent with some empirical estimates of foreign lending's impact on U.S. real interest rates, e.g. Warnock and Warnock (2008)

# U.S. real interest rates in the model vs. data

▶ Real exchange rate and trade balance out of sync in data

▶ Peak real exchange rate appreciation occurs in 2002, but peak trade deficit does not occur until 2006

▶ Why do U.S. imports continue to rise after 2002, even though imports are becoming more expensive?

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real exchange rate (1992 = 100)

no-saving-glut counterfactual

data

benchmark
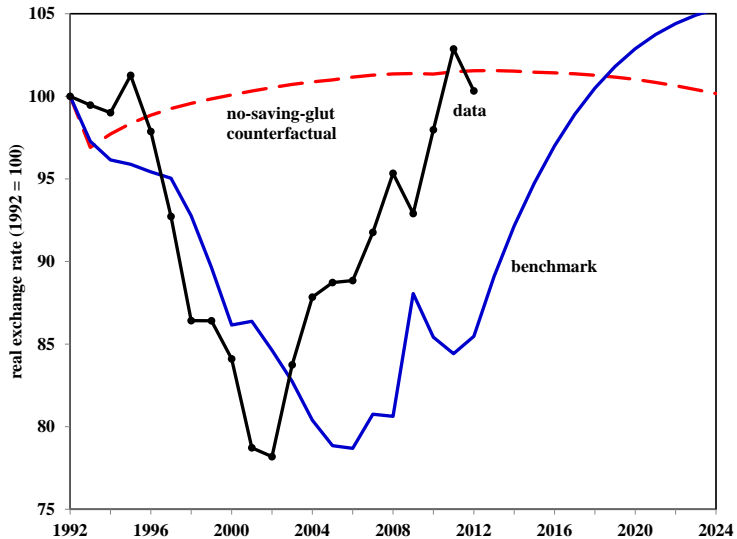
U.S. real exchange rates with China and other trade partners
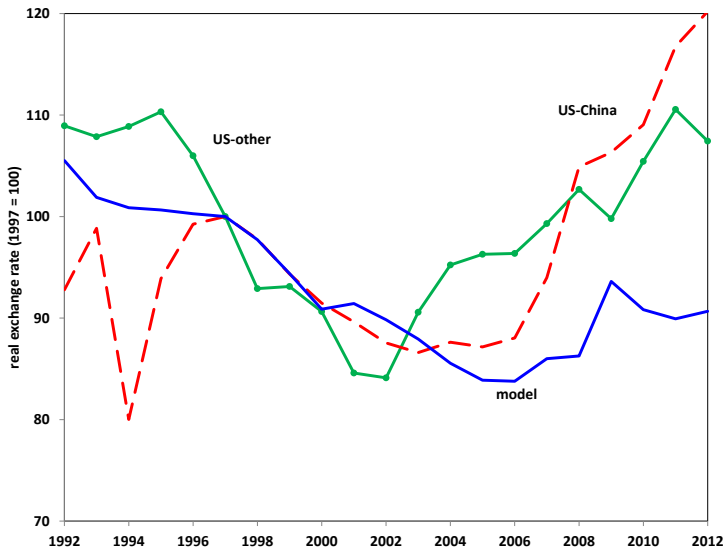
Conclusion

▶ Increased foreign demand for U.S. assets important driver of U.S. trade balance and real exchange rate

▶ Responsible for 15% of the decline in goods-sector employment

▶ Goods-sector employment decline due primarily to fast productivity growth compared to other sectors

▶ Decline will continue after saving glut ends