Global Imbalances
and Structural Change in the United States

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University of Toronto

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Traded sector employment and trade deficit

- Labor compensation in goods production
- Trade balance

Graph showing trends from 1992 to 2012.
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

- By borrowing, receive tradable goods from ROW
- Shift from domestic goods production to nontradables/services
- End borrowing, increase goods-sector employment

Provide the first measure of trade-deficit induced structural change
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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
What we do

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  - 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
What we find

- 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

- Goods employment will continue to fall as U.S. repays debt
- Services trade surplus reduces need to export goods
- Long-run U.S. trade balance about 1% of GDP larger
- Long-run U.S. real exchange rate 6% depreciated
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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
Model

- 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
Timing and expectations

- 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)

<table>
<thead>
<tr>
<th>USA</th>
<th>Intermediate inputs</th>
<th>Final demand</th>
<th>Gross output</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Goods</td>
<td>Services</td>
<td>Construction</td>
</tr>
<tr>
<td>USA</td>
<td>21.52</td>
<td>9.96</td>
<td>3.14</td>
</tr>
<tr>
<td>USA</td>
<td>11.74</td>
<td>39.23</td>
<td>2.99</td>
</tr>
<tr>
<td>ROW</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>ROW</td>
<td>3.17</td>
<td>1.11</td>
<td>0.33</td>
</tr>
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<td>0.44</td>
<td>1.08</td>
<td>0.10</td>
</tr>
<tr>
<td>ROW</td>
<td>19.55</td>
<td>76.96</td>
<td>3.50</td>
</tr>
<tr>
<td>Gross</td>
<td><strong>56.41</strong></td>
<td><strong>128.33</strong></td>
<td><strong>10.05</strong></td>
</tr>
</tbody>
</table>

- 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 \((\nu)\) and intermediate-good bundle \((m)\)
U.S. production: gross output and value added

- Perfect competition, representative firm

- Gross output in goods, services, and construction \((i = g, s, c)\)

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\]

- Combine value added \((\nu)\) and intermediate-good bundle \((m)\)

- Value added

\[

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

- Labor productivity \(\bar{\gamma}_{it}^{us}\) grows at different rates across sectors
U.S. production: intermediate goods

Intermediate-good bundle

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

- \( \mu_{ij}^{us} \) govern share of domestic vs. foreign input of \( j \)
- \( \pi_{ij}^{us} \) govern share of goods vs. services
U.S. production: intermediate goods

- Intermediate-good bundle

\[
m^{us}_{it} = \Pi^{us}_{i} \left\{ \sum_{j=g,s} \pi^{us}_{ij} \left[ \mu^{us}_{ij} (m^{us,us}_{ijt}) \zeta_j + (1 - \mu^{us}_{ij}) (m^{us,ru}_{ijt}) \zeta_j \right] \frac{\xi}{\zeta_j} \right\}
\]

- \( \mu^{us}_{ij} \) govern share of domestic vs. foreign input of \( j \)

- \( \pi^{us}_{ij} \) govern share of goods vs. services

- 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)

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<tr>
<td>USA Goods</td>
<td>21.52 9.96 3.14</td>
<td>3.10 1.14</td>
<td>7.66 1.91</td>
</tr>
<tr>
<td>USA Services</td>
<td>11.74 39.23 2.99</td>
<td>0.90 1.35</td>
<td>54.97 13.68</td>
</tr>
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<td>0.00 0.00 0.00</td>
<td>0.00 0.00</td>
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<td>3.17 1.11 0.33</td>
<td>89.56 41.13</td>
<td>1.64 0.41</td>
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<tr>
<td>ROW Services</td>
<td>0.44 1.08 0.10</td>
<td>42.59 88.67</td>
<td>0.19 0.05</td>
</tr>
<tr>
<td>Value added</td>
<td>19.55 76.96 3.50</td>
<td>85.18 206.22</td>
<td>0.00 0.00</td>
</tr>
<tr>
<td>Gross output</td>
<td>56.41 128.33 10.05</td>
<td>221.33 338.51</td>
<td>64.47 16.05</td>
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- Goods and services use domestic and foreign intermediates
- Construction: nontraded, used only in investment
Final demand in U.S. (R.W. only consumption)

- Household consumption, \( i = g, s \)

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

- Government consumption, \( i = g, s \)

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

- Investment, \( i = g, s \)

\[
x_{usx} = \Theta_i \left( \theta_i \left( x_{usx,us} \right)^{\sigma_i} + (1 - \theta_i) \left( x_{usx,rw} \right)^{\sigma_i} \right)^{1/\sigma_i}
\]
U.S. final demand: investment

- Aggregate of goods, services and all of construction

\[ x_{ts}^{usx} = E^{usx} (\epsilon_{g}^{usx} (x^{usx}_{gt})^\nu + \epsilon_{s}^{usx} (x^{usx}_{st})^\nu + \epsilon_{c}^{usx} (y^{us}_{ct})^\nu)^{1/\nu} \]

- 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

$$1 + r_{t+1} = \frac{P_t^{us}}{Q_t}$$
U.S. final demand: households

- Stone-Geary preferences generate income effects

\[ u = \left( \epsilon_{ush} \left( \frac{c_{ush} - \bar{c}_{ush}}{\bar{n}_{us}} \right)^\rho + \epsilon_{ush} \left( \frac{c_{ush} + \bar{c}_{ush}}{\bar{n}_{us}} \right)^\rho \right) \frac{\phi_{us}}{\rho} \left[ \frac{\bar{l}_{us} - \bar{l}_{ush}}{\bar{l}_{ush}} \right]^{1-\phi_{us}} \]

- Subsistence requirement for goods $\bar{c}_{ush}$, endowment for services $\bar{c}_{ush}$

- Adult-equivalent $\bar{n}_{us}$ and working-age population $\bar{l}_{us}$
Households choose consumption of goods and services, labor, investment, and bonds to maximize

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

subject to

$$p_{gt} c_{gt} + p_{st} c_{st} + p_{usx} x_{usx} + Q_t b_{t+1}$$

$$= w_t \ell_{t} + P_t b_t + (1 - \tau^u) r_{kt} k_{ts} - T_{us}$$

$$k_{ts} = (1 - \delta) k_{ts} + x_{usx}$$
U.S final demand: government

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

- Goods and services consumption maximize

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

subject to:

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

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

$$p_{gt}^{usg} c_{gt}^{usg} + p_{st}^{usg} c_{st}^{usg} = r^{us} k_t^{us} + T^{us}_t + P^{us}_t b_t^{usg} - Q_t b_{t+1}^{usg}$$

- 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

\[ rer_t = \frac{P_{rw}^t}{P_{us}^t} \]
Rest of the world

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

\[
\sum_{t=0}^{\infty} \bar{\omega}_t^{rw} \beta^t u_\psi(c_{gt}^{rw}, c_{st}^{rw}, \ell_t^{rw})
\]

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 \(\{\bar{b}^{usg}_t, \bar{c}^{usg}_t, \bar{\omega}^{rw}_t\}_{t=t_0}^{\infty}\)

... 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 \( \{b_t, c_t, \bar{c}_t, \bar{r}_t, n_t, \ell_t\}_{t=t_0}^\infty \) are constant
- \( \gamma_{it}/\gamma_{i,t-1} = g_\gamma, \ i = g, s, c \)
- \( \bar{c}_{i,u}^{sh}, \bar{c}_{i}^{rw} \) are zero
Balanced growth path

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- \( \gamma_{it}/\gamma_{i,t-1} = g_{\gamma}, i = g, s, c \)
- \( \bar{c}_{ush}, \bar{c}_{rw} \) are zero
- The model converges to a balanced growth path
  - Quantities grow at \( g_{\gamma} \) (except labor supply)
  - All relative prices are constant
Balanced growth path

- When \( \{\bar{b}_t^{usg}, \bar{c}_t^{usg}, \bar{\omega}_t^{rw}, \bar{n}_t, \bar{l}_t\}_{t=t_0}^\infty \) are constant
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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 $\omega_t^{rw}$ to match 1992 IO matrix
Overview of quantitative strategy

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  - Choose elasticities from literature
  - Calibrate all parameters except $\omega^{rw}_t$ to match 1992 IO matrix

- Calibrate $\omega^{rw}_t$ to match trade balance during 1992–2012
Calibration: production parameters

- Scaling factors \((\Lambda_i, A_i, \Pi_i)\) 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 \(\tilde{\gamma}_i^{us}\): 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 ($\Theta_i$) 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 $1/(1 - \nu) = 0.65$

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

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

- Stone-Geary parameters ($\bar{c}_{ush}^i, \bar{c}_{rw}^i$): 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
Model fit: elasticities

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<table>
<thead>
<tr>
<th>Change in share, 1995–2012</th>
<th>Data</th>
<th>Model</th>
</tr>
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<tbody>
<tr>
<td>Intermediate share of gross output</td>
<td>−1.04</td>
<td>−1.50</td>
</tr>
<tr>
<td>Goods share of intermediate use</td>
<td>−6.81</td>
<td>−5.40</td>
</tr>
<tr>
<td>Goods share of final consumption</td>
<td>−1.66</td>
<td>−2.68</td>
</tr>
<tr>
<td>Goods share of investment</td>
<td>−0.19</td>
<td>−0.00</td>
</tr>
<tr>
<td>Std. dev. goods trade balance</td>
<td>1.54</td>
<td>1.45</td>
</tr>
<tr>
<td>Std. dev. services trade balance</td>
<td>0.24</td>
<td>0.20</td>
</tr>
</tbody>
</table>
R.W.’s savings behavior calibrated to generate saving glut
Model fit: Global saving glut vs. U.S. saving drought

► 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
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
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

- Long-run effects are in international markets
  - U.S. real exchange rate depreciated by 6%
  - U.S. trade surplus 1% GDP larger
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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%
Game plan

1. Key facts

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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

\[ 1 + r_{us}^{t+1} = (1 + r_{rw}^{t+1}) \frac{rer_{t+1}}{rer_{t}} \]

► 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

-1 0 1 2 3 4 5
percent per year
no saving glut
benchmark
data
Puzzle: timing of real exchange rate vs. trade balance

- 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?
Fact 1: U.S. real exchange rate appreciates, then depreciates.
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