The Greek Depression

- In 2007, Greek GDP per capita was around $35,000 and the unemployment rate was 8.4%.

- In 2014, Greek GDP per capita was around $25,000 and the unemployment rate was 26.6%

- What happened?
An ‘Interim Report’

• Empirical investigation: Was Greece really that bad?
  • Yes!
  • Much worse than emerging market sudden stops
  • Even for ‘strict peggers’

• Model-Based investigation: Why?
  • Because Greece caught an EM disease with AE leverage ratios
  • What would have helped?
    • Less leverage
    • Banking union
    • Fiscal discipline
    • More flexible prices
Three Interlinked Crises (at least)

- A sovereign debt crisis
  - Rapidly deteriorating fiscal accounts
  - Greek sovereign debt appears increasingly unsustainable
  - Default in 2012.

- A banking crisis
  - Boom in credit to the private non financial sector peaks in 2008-09
  - Increasing projected losses on their assets
  - Investors question Greek banks solvency.
  - Multiple rounds of resolution & recapitalization

- A sudden stop
  - Large & persistent current account deficits
  - After the GFC, foreign investors unwilling to lend to government, banks, firms
  - Startling development for a currency union (Ingram (1973))

- All three crises linked (doom loops)
Literature

- Empirical literature on Crises

- DSGE literature and estimation
  - Galì and Monacelli (2008), Iacovello (2015), Mendoza (2010)...
  - An & Schorfheide (2007)...

- Analysis of the Eurozone & Greek crises
  - de Grauwe (2013), Martin & Philippon (2016), Shambaugh (2012)...

Benchmarking: the Comparison Group

- **Sudden Stops**
  - Combination of capital flow reversal & large drop in domestic output
  - 49 sudden stops

- **Sovereign Defaults**
  - from Gourinchas & Obstfeld (2012) based on literature
  - default on domestic or external debt
  - 65 default episodes

- **Lending booms/busts**
  - defined as in Gourinchas et al (2001)
  - deviation of credit/output from trend
  - 114 boom/busts
The Incidence of Crises

<table>
<thead>
<tr>
<th></th>
<th>Sudden Stop</th>
<th>Defaults</th>
<th>Credit Booms</th>
<th>‘Trifecta’</th>
<th>#</th>
</tr>
</thead>
<tbody>
<tr>
<td>AE</td>
<td>13</td>
<td>Greece</td>
<td>18</td>
<td>Greece</td>
<td>22</td>
</tr>
<tr>
<td>EM</td>
<td>36</td>
<td>64</td>
<td>96</td>
<td>9</td>
<td>57</td>
</tr>
<tr>
<td>Total</td>
<td>49</td>
<td>65</td>
<td>114</td>
<td>10</td>
<td>79</td>
</tr>
</tbody>
</table>
Benchmarking Ia: GDP Relative to All Sudden Stops

Collapse of 25%

Real Output per capita relative to t-2 (100-log points)

Sudden Stop

Greece (2010)
Benchmarking Ia: Aggregate Domestic Investment/Output

Collapse of 50%

Investment/Output relative to t-2 (100-log points)

Sudden Stop Greece (2010)
Benchmarking Ib: Other Crises

Output per capita relative to t-2 (log points)

- Default
- Lending Boom
- Trifecta
- IIPS (2010)
- Greece (2010)
Sovereign Default? Credit Bust?... Trifecta

Output per capita, relative to t-2 (log points), Trifecta crises

- Greece, 2010
- Argentina, 2001
- Uruguay, 1983
- Mexico, 1982
- Chile, 1983
- Indonesia, 1998
Benchmarking Ic: Compared to EM Floaters & Peggers

Output per capita relative to t-2, EME sudden stops (log points)

- float
- de-peggers
- strict peggers
- IIPS (2010)
- Greece (2010)
Output per capita relative to t-2, EME sudden stops (log points)

-40
-30
-20
-10
0
10
20

t-2
t-1
Trough (t)
t+1
T+2
T+3
T+4

-40
-30
-20
-10
0
10
20

strict peggers
Estonia (2009)
Latvia (2009)
Greece (2010)

Benchmarks Id: Endogenous Peg?
External Adjustment

Trade Balance/GDP, deviation from country mean, % of GDP

Real Exchange Rate, percent deviation from country mean

- Sudden Stop
- Default
- Lending Boom
- Trifecta
- Greece (2010)
Empirical Lessons

1. Greek crisis significantly more severe persistent and backloaded than typical sudden stop
2. Greek crisis significantly more severe persistent and backloaded than ‘Trifecta’ episodes
3. Greek crisis more severe than for peggers (even Estonia or Latvia)
4. Collapse in aggregate investment unprecedented in its persistence and magnitude
5. Adjustment in external balances was very gradual, despite any significant movement in RER
Model

- Small Open Economy in a currency union \((r, \pi^F)\) exogenous
- Standard NK DSGE à la Galì (2011) with financial frictions
  - Government \((B^g, T, G, r^g)\)
  - Banks \((V, r^d)\)
  - Households \((B^h, C, r^h)\)
  - Firms \((I, K, r^k)\)
- Various shocks
\[
\zeta_t^\# = \rho^\# \zeta_{t-1}^\# + \sigma^\# \varepsilon_t^\#
\]
Government

- Budget constraint

\[ \frac{B^g_t}{R^g_t} + \tau_t Y_t = G_t + T_t + \frac{B^g_{t-1}}{\Pi^H_t} \]

- Fiscal rule (spending and social transfers)

\[ g_t = F_l g_{t-1} - F_n n_t - F_r r^g_t - F_b b^g_t + \zeta^{\text{spend}}_t \]

- Tax rate

\[ \tau_t = \bar{\tau} + \zeta^{\text{tax}}_t \]

- Government funding cost \((x \equiv \ln(x/x_{ss}), \; d^g_t \equiv \text{expected losses})\)

\[ r^g_t = r_t + d^g_t \]

\[ d^g_t = \bar{d}_g \frac{B^g_t}{Y} \left( b^g_t - \mathbb{E}_t [y_{t+1}] - \mathbb{E}_t \left[ \pi^h_{t+1} \right] + \zeta^{dg}_t \right) \]
Households

\[ U^i = \mathbb{E}_0 \sum_{t=0}^{\infty} \beta_t^i \left( \frac{(C_t)^{1-\gamma}}{1-\gamma} - \frac{(N_t)^{1+\phi}}{1+\phi} \right) ; \quad C_t^i \equiv \left( (1-\omega) \frac{1}{\epsilon_h} C_{H,t}^{i,\epsilon_h^{-1}} + C_{F,t}^{i,\epsilon_h^{-1}} \right)^{\epsilon_h^{-1}} \]

- **Borrowers**, \( \beta_b \) (mass \( \chi \)), \( d^p \equiv {\text{realized loss rate,}} \ B_t^h \leq \bar{B}_t^h \),

\[ P_t C_t^b = (1 - \tau_t) W_t N_t^b + \frac{P_{H,t} B_t^h}{R_t^h} - (1 - d^p_t) P_{H,t-1} B_{t-1}^h + P_{H,t} T_t^b \]

\[ d_t^p = -\bar{d}_y y_t + \bar{d}_b b_t^h + \xi_{t}^{\text{def}} \]

\[ \bar{b}_t^h = \psi_{bh} \bar{b}_{t-1}^h - \xi_{t}^{bh} r_t + \xi_{t}^{bh} \]

- **Savers**, \( \beta > \beta_b \) (mass \( 1 - \chi \)),

\[ P_t C_t^s = (1 - \tau_t) W_t N_t^s + \tilde{R}_t P_{H,t-1} S_{t-1} - P_{H,t} S_t + P_{H,t} T_t^s \]
Non-Financial Firms

- Break down into capital- and goods-producing firms.
- Capital-producing firms:
  - Convert consumption goods into capital, and rent to goods-producing firms.
  - Q rule for investment.
- Goods-producing firms:
  - Convert capital and labor into goods.
  - Cobb-Douglas with constant TFP.
  - Financing friction: pay part of wage bill in advance. Intraperiod loan with funding cost $r^k$. 
Price and Wage Rigidity

- Wage-calvo process yields a Phillips curve for wages

\[ \pi_t^w = \beta \mathbb{E}_t \pi_{t+1}^w - \lambda_w (w_t - \gamma c_t - \phi n_t) + \zeta_t^w \]

- Price-calvo process yields a Phillips curve for domestic prices

\[ \pi_t^h = \beta \mathbb{E}_t \pi_{t+1}^h + \lambda_p mc_t + \zeta_t^{\pi h}, \]

where \( mc_t \) is log real marginal cost in terms of domestic goods.

- \( \zeta_t^w \): wage markup shock, \( \zeta_t^{\pi h} \): domestic price markup shock
Banks

- Domestic deposits and foreign loans
- Lend to households, firms and government
- Subject to capital requirement

\[ V_t \geq \kappa \left( \frac{B_t^k}{R_t^k} + \frac{B_t^h}{R_t^h} \right) \]

where \( V_t \) is franchise value.

- No capital requirement for sovereign exposure
- Bank funding costs

\[ r_t^d = r_t + \zeta_t + \xi^d L^E_t \{ d_{t+1}^p \} \]
Summary of Funding Costs

- Key equations
  - Banks fund households and firms
    \[ r_t^k = r_t^d \]
  - Banks: sudden stop and capital loss
    \[
    \begin{align*}
    r_t^d &= r_t + \zeta^r_t + \xi^d L \mathbb{E}_t \left[ d_{t+1}^p \right] \\
    d_t^p &= -\bar{d}_y y_t - \bar{d}_b b_{t-1} + \zeta_t^{def}
    \end{align*}
    \]
  - Government
    \[
    \begin{align*}
    r_t^g &= r_t + d_t^g \\
    d_t^g &= \bar{d}_g \frac{B^g}{Y} \left( b_t^g - \mathbb{E}_t [y_{t+1}] - \mathbb{E}_t \left[ \pi_{t+1}^h \right] + \zeta_t^{dg} \right)
    \end{align*}
    \]
  - Households
    \[ r_t^h = r_t^d + \mathbb{E}_t \left[ d_{t+1}^p \right] \]
Doom Loops

No direct doom loop, but indirect GE feedback loops:

- **Sovereign risk shock** $\zeta_{tg}$:
  - Government funding costs increase $\rightarrow$ Government raises taxes and reduces expenditure $\rightarrow$ Output declines $\rightarrow$ Expected costs of default on private-sector loans increase $\rightarrow$ Funding costs for private sector increase and investment drops.

- **Sudden stop** $\zeta_{tr}$:
  - Funding costs for private sector increase $\rightarrow$ Output and investment drop $\rightarrow$ Fiscal revenues drop $\rightarrow$ Expected costs of default on sovereign loans increase $\rightarrow$ Government funding costs increase.
Impulse Response: Sovereign Risk Shock

Output

Consumption

Investment

Employment

Funding Cost

Sovereign Yield

NPL/Total Loans

Inflation

Govt Finance

Govt Debt

Household Debt

Current Account/GDP
Impulse Response: Fiscal Shock

Spending

Output

Consumption

Investment

Employment

Funding Cost

Sovereign Yield

NPL/Total Loans

Inflation

Govt Finance

Govt Debt

Household Debt

Current Account/GDP

Years

Output

Consumption

Investment

Employment

Funding Cost

Sovereign Yield

NPL/Total Loans

Inflation

Govt Finance

Govt Debt

Household Debt

Current Account/GDP

Years
Bayesian Estimation of the Model

- Standard techniques (Herbst & Schorfheide (2015))
- Period: 1999 to 2015
- Calibrate steady state parameters
- Estimate dynamic parameters

<table>
<thead>
<tr>
<th>Observable</th>
<th>Description</th>
<th>Shock</th>
<th>Shock Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>$G_t + T_t$</td>
<td>Government spending</td>
<td>$\zeta_t^{\text{spend}}$</td>
<td>Govt. spending shock</td>
</tr>
<tr>
<td>$\tau_t \gamma_t$</td>
<td>Government revenues</td>
<td>$\zeta_t^{\text{tax}}$</td>
<td>Tax rate shock</td>
</tr>
<tr>
<td>$R_t^\varepsilon$</td>
<td>Greek government spread over EZ average</td>
<td>$\zeta_t^{\text{dg}}$</td>
<td>Sovereign risk shock</td>
</tr>
<tr>
<td>$R_t^k$</td>
<td>SME spread over EZ average</td>
<td>$\zeta_t^{r}$</td>
<td>Funding cost shock</td>
</tr>
<tr>
<td>$\exp(d_t^P)$</td>
<td>Non-performing loans/total loans, $\text{def} = \text{npl}$</td>
<td>$\zeta_t^{\text{def}}$</td>
<td>Private default shock</td>
</tr>
<tr>
<td>$\Pi_t$</td>
<td>Greece CPI - EZ CPI</td>
<td>$\zeta_t^{\pi h}$</td>
<td>PPI cost push shock</td>
</tr>
<tr>
<td>$B_t^h$</td>
<td>Household debt</td>
<td>$\zeta_t^{bh}$</td>
<td>Household credit shock</td>
</tr>
<tr>
<td>$\Pi_t^w$</td>
<td>Greek Wage Inflation - EZ Wage Inflation</td>
<td>$\zeta_t^{w}$</td>
<td>Wage inflation shock</td>
</tr>
</tbody>
</table>

Table: Observables and Shocks
### Calibrated Parameters-I

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Description</th>
<th>Value</th>
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</thead>
<tbody>
<tr>
<td>$\beta$</td>
<td>Discount Factor</td>
<td>0.97</td>
</tr>
<tr>
<td>$\alpha$</td>
<td>Capital Share</td>
<td>1/3</td>
</tr>
<tr>
<td>$\varepsilon_h$</td>
<td>Elasticity between H and F</td>
<td>1</td>
</tr>
<tr>
<td>$\varepsilon_f$</td>
<td>Elasticity between exports</td>
<td>1</td>
</tr>
<tr>
<td>$\phi$</td>
<td>Inverse labor supply elasticity</td>
<td>1</td>
</tr>
<tr>
<td>$\gamma$</td>
<td>Risk Aversion</td>
<td>1</td>
</tr>
<tr>
<td>$\vartheta$</td>
<td>Price Stickiness</td>
<td>0.5</td>
</tr>
<tr>
<td>$\varepsilon$</td>
<td>Elasticity of Substitution Goods</td>
<td>6</td>
</tr>
<tr>
<td>$\vartheta_w$</td>
<td>Wage Stickiness</td>
<td>0.5</td>
</tr>
<tr>
<td>$\varepsilon_w$</td>
<td>Elasticity of Substitution Labor</td>
<td>6</td>
</tr>
<tr>
<td>$\varepsilon_r$</td>
<td>Elasticity of $R$ to $NFA$</td>
<td>0.0001</td>
</tr>
<tr>
<td>$\phi_k$</td>
<td>Adjustment Cost</td>
<td>1</td>
</tr>
<tr>
<td>$\delta$</td>
<td>Depreciation</td>
<td>0.07</td>
</tr>
<tr>
<td>$FC$</td>
<td>Fixed cost of production, 10% of $Y$</td>
<td>0.0955</td>
</tr>
</tbody>
</table>
## Calibrated Parameters-II

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Description</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\varpi$</td>
<td>Openness (??)</td>
<td>0.3</td>
</tr>
<tr>
<td>$\chi$</td>
<td>Fraction of Impatient (??)</td>
<td>0.65</td>
</tr>
<tr>
<td>$\Delta$</td>
<td>Annual lending spread of 2%</td>
<td>1.02</td>
</tr>
<tr>
<td>$\bar{B}_h^h$</td>
<td>Households debt to GDP of 50%</td>
<td>0.5</td>
</tr>
<tr>
<td>$\bar{B}_g^g$</td>
<td>Government debt to GDP of 120%</td>
<td>1.2</td>
</tr>
<tr>
<td>$\frac{G}{Y}$</td>
<td>Government consumption to GDP of 20%</td>
<td>0.2</td>
</tr>
<tr>
<td>$\frac{T}{Y}$</td>
<td>Public social expenditure to GDP of 20%</td>
<td>0.2</td>
</tr>
<tr>
<td>$\bar{d}_h$</td>
<td>Steady state default rate for Households</td>
<td>5.4%</td>
</tr>
<tr>
<td>$\bar{d}_k$</td>
<td>Steady state default rate for Corporates</td>
<td>5.4%</td>
</tr>
<tr>
<td>$\frac{B_k}{Y}$</td>
<td>Corporate debt to GDP of 50%</td>
<td>0.5</td>
</tr>
<tr>
<td>$\Psi_{sk}$</td>
<td>Working Capital Constraint</td>
<td>1</td>
</tr>
<tr>
<td>$\tau$</td>
<td>Tax rate, budget balance in SS</td>
<td>0.436</td>
</tr>
<tr>
<td>$L$</td>
<td>Leverage scaling</td>
<td>1</td>
</tr>
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</table>
## Calibrated Parameters-III

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Description</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>$F_b$</td>
<td>Elasticity of govt. spending to public debt</td>
<td>0.05</td>
</tr>
<tr>
<td>$F_n$</td>
<td>Elasticity of govt. spending to employment</td>
<td>0.025</td>
</tr>
<tr>
<td>$F_r$</td>
<td>Elasticity of govt. spending to the int. rate</td>
<td>0.5</td>
</tr>
<tr>
<td>$F_l$</td>
<td>Persistence of govt. spending</td>
<td>0.75</td>
</tr>
</tbody>
</table>
Data Inputs

Govt. Revenue

Govt. Spending

Govt. Yield

Private Funding Cost

NPL/Total Loans (Obs.)

dlog GDP Deflator (Obs.)

Household Debt

Wage Inflation (Obs.)
Estimated Shocks (posterior)
Fit of the Model

Output

Investment

PPI Inflation

Current Account/GDP

Wage Inflation

Data

Model
Decomposition of Output and Investment
Decomposition of Private Default and Funding Costs

Private Default

Private Funding Cost

- Spending
- Tax
- Credit Demand
- Sudden Stop
- Priv. Def.
- Sov. Risk
- Markup
- Wage Markup
Decomposition of Government Spending and Revenues

Govt. Spending

Govt. Revenue
Decomposition of Domestic Price and Wage Inflation

Domestic Price Infl.

Wage Infl.

Legend:
- Spending
- Tax
- Credit Demand
- Sudden Stop
- Priv. Def.
- Sov. Risk
- Markup
- Wage Markup
Key Lessons

‘Murder on the Orient Express’

- Fiscal trajectory prior to 2009 unsustainable. Stimulates output initially, but depresses it later on.
- First phase of the crisis (2009-2013)
  - Sovereign risk
  - Sudden stop
- Second phase of the crisis (2013-..)
  - Non-performing loans
  - Price markups.
4 Counterfactual Exercises

Compare $\hat{x}^T = \Gamma \left( \hat{\Theta}, \{ \hat{\varepsilon}_k^T \}_{k=1}^K \right)$ and $\tilde{x}^T = \Gamma \left( \tilde{\Theta}, \{ \tilde{\varepsilon}_k^T \}_{k=1}^K \right)$.

1. Low leverage (EME leverage)
2. Banking union
3. Fiscal discipline
4. Price flexibility (Latvia)
## Counterfactual I: EME Leverage

<table>
<thead>
<tr>
<th></th>
<th>Greece</th>
<th>Typical EME</th>
<th>Min</th>
<th>Max</th>
</tr>
</thead>
<tbody>
<tr>
<td>Credit / GDP</td>
<td>1.01</td>
<td>0.46</td>
<td>0.025</td>
<td>1.46</td>
</tr>
<tr>
<td>Sovereign Debt / GDP</td>
<td>1.38</td>
<td>0.343</td>
<td>0.063</td>
<td>0.68</td>
</tr>
<tr>
<td>Current Account / GDP</td>
<td>-0.083</td>
<td>-0.039</td>
<td>-0.10</td>
<td>+0.17</td>
</tr>
</tbody>
</table>

**Table:** Leverage and Imbalances Before Sudden Stop

**Notes:** Average from t-6 to t-2 where t is sudden stop.
Counterfactual I: EME Leverage

GDP

Investment

Current Account/GDP

Govt. Spending
Counterfactual II: Banking Union

GDP

Investment

Current Account/GDP

Govt. Spending

Data

CFact

Model
Counterfactual III: No Discretionary Spending
Counterfactual V: Low Price Stickiness

- GDP
- Investment
- Current Account/GDP
- Govt. Spending

Data, CFact, Model
Conclusion: What Would Have Helped?

- What we can say
  - Exposure Y+10%, I+15%
  - Banking union Y+10%, I+30%
  - Sound fiscal Y+15%, I+20%
  - More flexible prices Y+15%, I+20%

- Open issues
  - Uncertainty (political, EZ risk)?
  - Early sovereign default?
  - Devaluation?