Dissecting the Dynamics of the US Trade Balance in an Estimated Equilibrium Model

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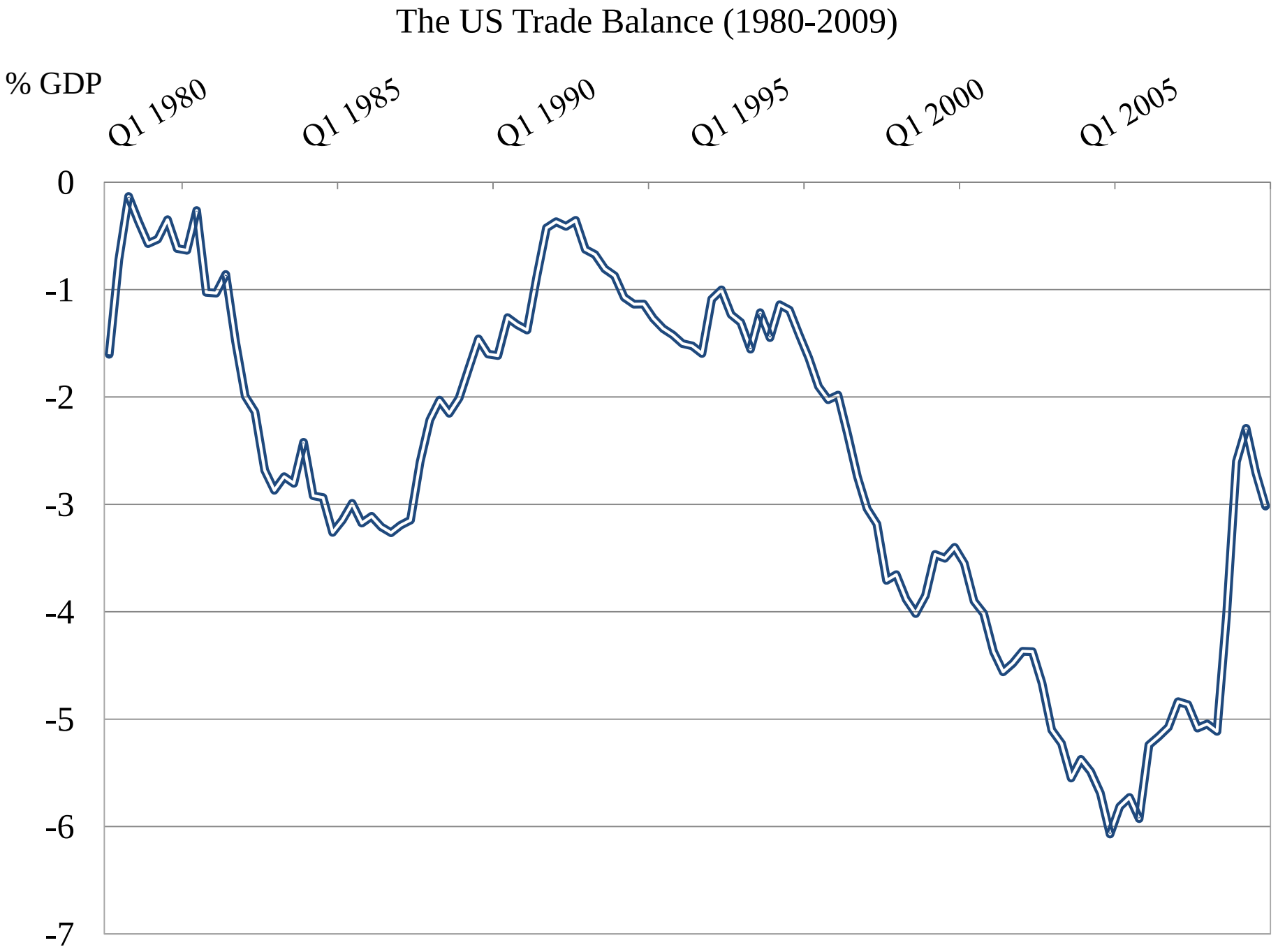
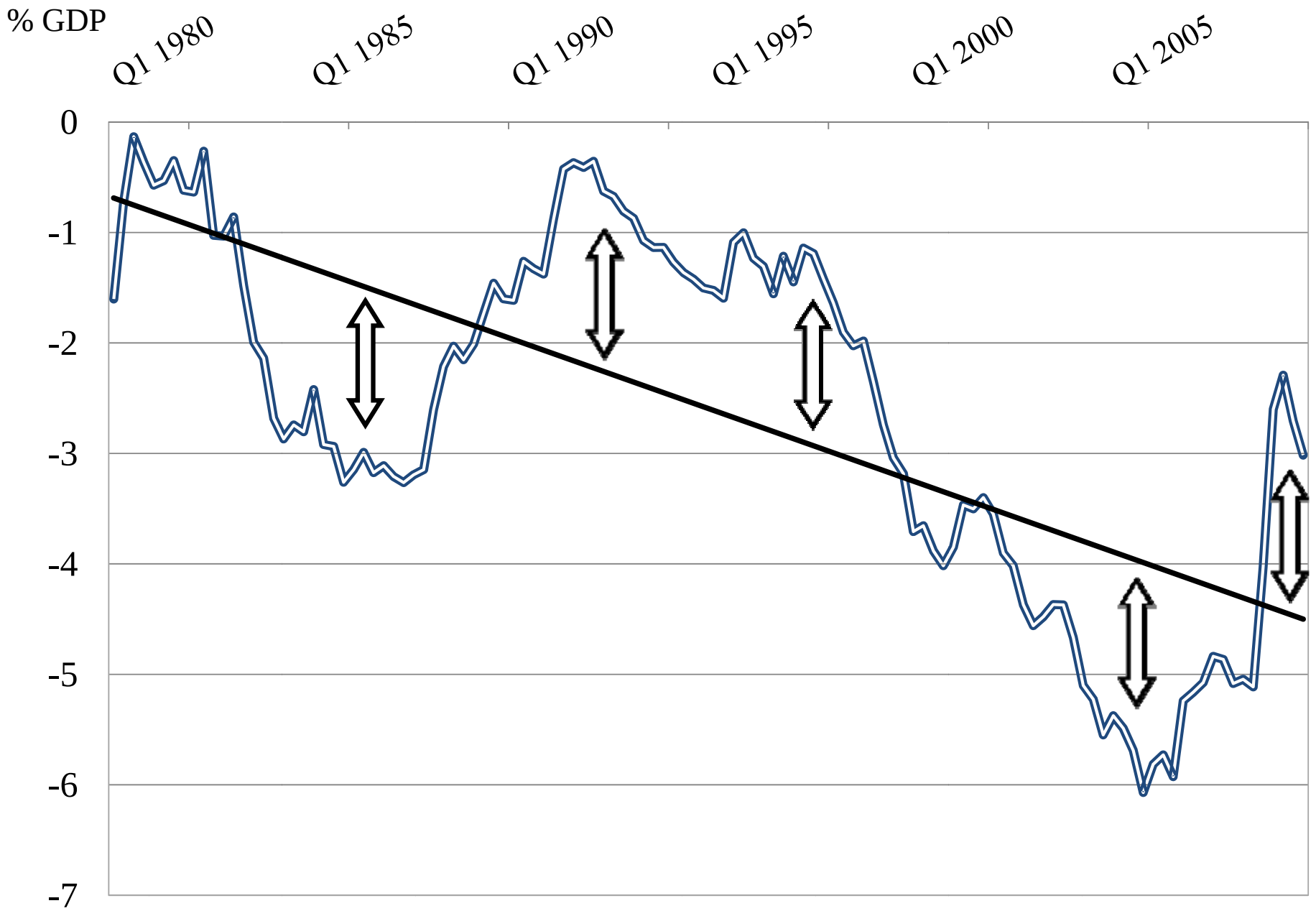
Motivation:

The richest country in the world is also the biggest debtor in economic history


The US Trade Balance (1980-2009)
% GDP
Q1 1980
Q1 1985
Q1 1990
Q1 1995
Q1 2000
Q1 2005
0
-1
-2
-3
-4
-5
-6
-7

- Very little empirical work attempting to understand the structural shocks that influence the US trade balance, especially within a general equilibrium framework.
- Precisely our purpose.

The Trend and the Cycle of the US Trade Balance (1980-2009)



Preview of Results:

- Shocks to the marginal efficiency of investment ('real' shocks) are the main drivers of the US trade balance fluctuations.
- Traditional technological shocks associated to a fall in prices and an expansion in output have little impact, be they neutral (TFP) shocks that decrease the general price level or investment-specific technological shocks that decrease the price of investment.
- TFP shocks even makes the trade balance counterfactually procyclical.

Structure of the Presentation:

- Extant Views and Results
- Model Sketch
- Estimation and Results
- Conclusions

Extant Views on the cyclical behavior of the US Trade Balance:

- Total Factor Productivity: favored by RBC proponents

→ Richer US residents raise consumption and investment
→ Imports rise more than exports
→ Trade balance worsens

- The Twin Deficits Hypothesis

→ Government spends more than it receives
→ Lack of public saving reflects in the external position

Statistical Results:

- Single Equation:

Bussierre, Fratscher and Muller *ECB 2005* : TFP movements matter while the fiscal position does not.

- Vector Autoregressions:

Bems, Dedola and Smets *JIMF 2007* : Investment-specific technology shocks and public spending shocks.
Corsetti and Konstantinou *CEPR 2008* : 'Technology' shocks.
→Focus on Shocks of US Origin

Inspiration:

- A Truism: It takes two parties to make a trade balance. The US deficit absorbs more than half of the trade surpluses in the world
- Inspired by Policy discussions

→ The Global Savings Glut thesis of Bernanke (2005) and Clarida (2005)
→ Taylor (2006) suggests a differential in investment behavior

- This paper explicitly allows for influences ('shocks') from the Rest of the World on the 'US' Imbalance.

Empirical Strategy:

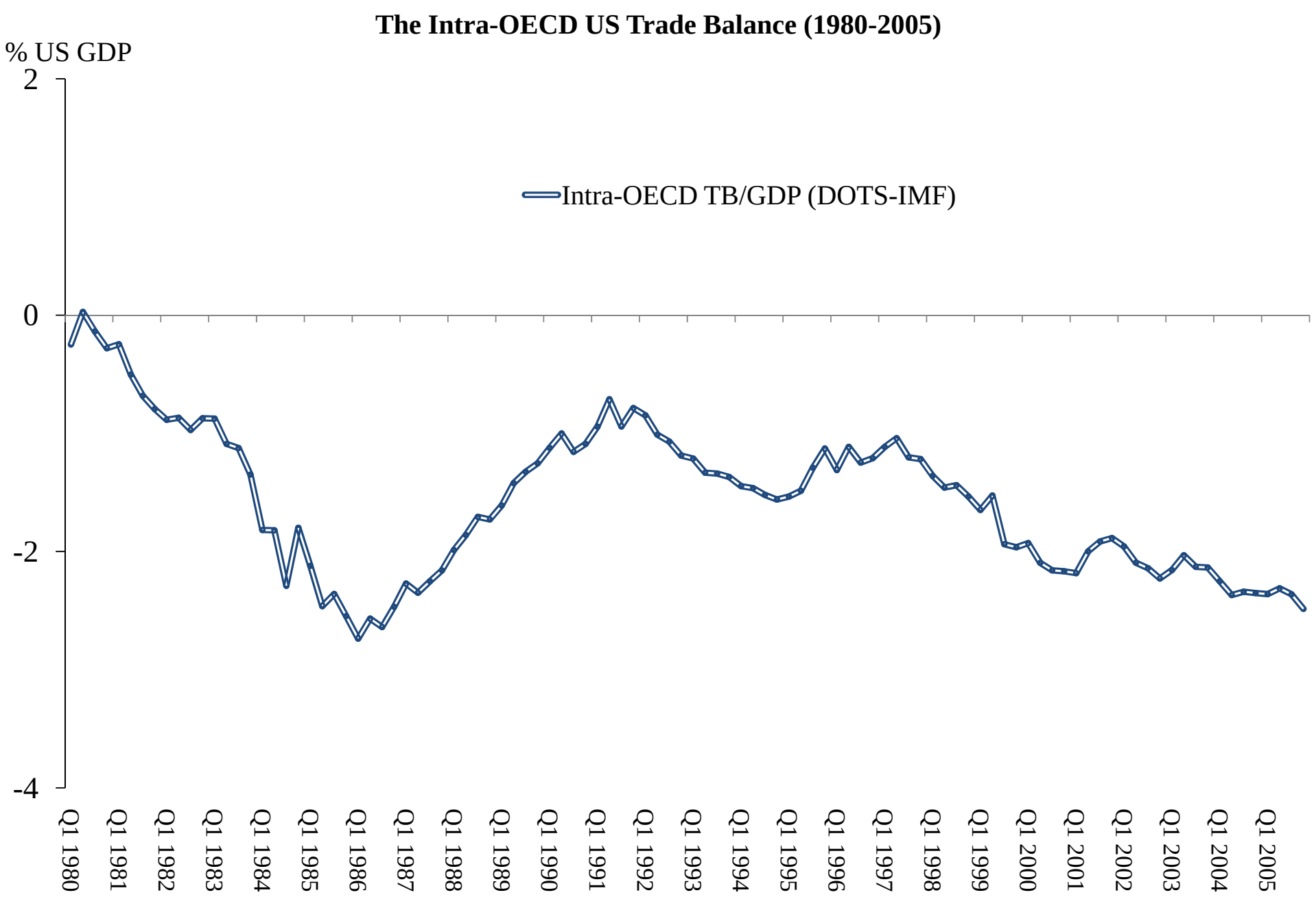
- Construct and estimate with Bayesian methods, a two-country dynamic stochastic general equilibrium (DSGE) model with Home Country (US) and the Foreign 'Country' (RoW)
- Allow structural shocks from both regions to influence fluctuations in the trade balance in the model
- Decompose the volatility of the trade balance viewed through the lens of the estimated model

Problem: Data!!

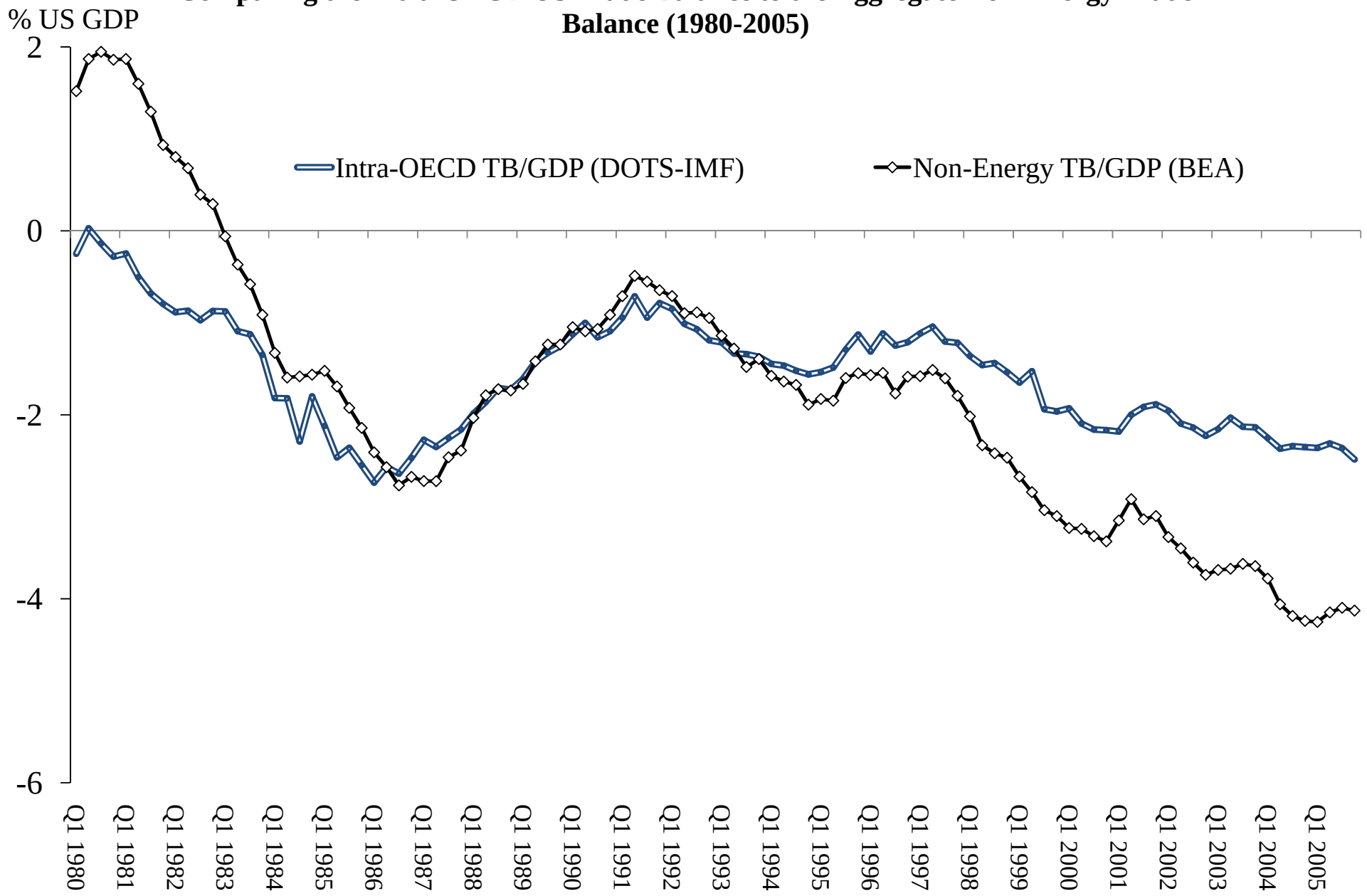
- Long quarterly series unavailable for emerging economies that hold large proportions of US financial assets and equivalently are net exporters to the US
- To position the 'Rest of the World' as the second country in our theoretical construct, we need to make sure the bilateral trade balance is indeed the 'correct' one
- Impossible task to reconcile the two goals given the lack of data

Attention: An OECD Imbalance

- A trade imbalance prevails even within the data-rich OECD


The Intra-OECD US Trade Balance (1980-2005)
% US GDP
2
0
-2
-4
Intra-OECD TB/GDP (DOTS-IMF)
Q1 1980
Q1 1981
Q1 1982
Q1 1983
Q1 1984
Q1 1985
Q1 1986
Q1 1987
Q1 1988
Q1 1989
Q1 1990
Q1 1991
Q1 1992
Q1 1993
Q1 1994
Q1 1995
Q1 1996
Q1 1997
Q1 1998
Q1 1999
Q1 2000
Q1 2001
Q1 2002
Q1 2003
Q1 2004
Q1 2005

Comparing the Intra-OECD US Trade Balance to the Aggregate Non-Energy Trade Balance (1980-2005)



An RoW made of 16 OECD economies:

- We use time-varying trade share weights to aggregate macroeconomic time series from these 16 economies to embody the RoW
- Note: We estimate with the actual balance also among many other checks !!

Economic Environment:

- Two-Country version of closed-economy sticky wage-sticky price models of Smets and Wouters (*JEEA 2003, AER 2007*) and Justiniano, Primiceri and Tambalotti (RED forthcoming)
- Two regions identical in structure but parameter values are allowed to vary
- Economic agents

→ Consumer-Investor
→ Monopolistic intermediate good producer
→ Perfectly competitive final good producer
→ Empirical monetary policy rule

Positioning the Structural Shocks

Preliminaries:

- Focus on Home Country (US) and log-linearized version of the model
- ^indicates a deviation of a variable from its long-run deterministic trend

Positioning the Structural Shocks (Contd):
Final Goods Sector

- CES aggregates of domestic output and imported output for consumption and investment.

$$C_t = \left[(1-\xi_C)^{\frac{1}{\mu}} C_{Ht}^{\frac{\mu-1}{\mu}} + \xi_C^{\frac{1}{\mu}} C_{Ft}^{\frac{\mu-1}{\mu}} \right]^{\frac{\mu}{\mu-1}}$$

$$I_t = \varepsilon_t^{RPI} \left[(1-\xi_I)^{\frac{1}{\mu}} I_{Ht}^{\frac{\mu-1}{\mu}} + \xi_I^{\frac{1}{\mu}} I_{Ft}^{\frac{\mu-1}{\mu}} \right]^{\frac{\mu}{\mu-1}}$$

C, I	Aggregate Consumption, Investment
C_H, I_H	Domestically Produced Components of C, I
C_F, I_F	Imported Components of C,I
μ	Price elasticity of Import Demand
ξ_C, ξ_I	Import-share of C,I

Positioning the Structural Shocks (Contd):
Final Goods Sector

- Relative Prices of Investment in terms of Output and Consumption

$$\begin{aligned}
\hat{P}_{It} - \hat{P}_{Ht} &= \xi_I \overbrace{\left(\hat{P}_{Ft} - \hat{P}_{Ht}\right)}^{\widehat{ToT}_t} - \hat{\varepsilon}_t^{RPI} \\
\hat{P}_{It} - \hat{P}_{Ct} &= (\xi_I - \xi_C)\,\widehat{ToT}_t - \hat{\varepsilon}_t^{RPI}
\end{aligned}$$

Basu and Thoenissen (2008): Unlike in Greenwood, Hercowitz and Krussel (1997), the terms of trade breaks equivalence between inverse of the technological shock and the relative price of investment.

Positioning the Structural Shocks (Contd):

- Consumption (Observed Data Series for US, RoW): Smoothing through 3 assets: Physical capital, Home and Foreign nominal bonds

$$\hat{C}_t = c_1 \mathbf{E}_t \hat{C}_{t+1} + c_2 \hat{C}_{t-1} - c_3 \left(\hat{R}_t - \mathbf{E}_t \hat{\pi}_{Ct+1} \right) + \hat{\varepsilon}_t^{TI}$$

$$\text{where } c_1 = \frac{1}{1+\vartheta},\ c_2 = 1 - c_1,\ c_3 = \frac{(1-\vartheta)c_1}{\sigma_C}$$

$\hat{C}$	Consumption	$\vartheta \in (0,1)$	External Habit
$\hat{R}$	Nominal Interest Rate	$\sigma_C > 0$	Utility Curvature
$\hat{\pi}_C$	CPI Inflation		
$\hat{\varepsilon}^{TI}$	Time Impatience Shock		

Positioning the Structural Shocks (Contd):

- Investment (Observed Data Series for US, RoW)

$$\hat{I}_t = i_1 \mathbf{E}_t \hat{I}_{t+1} + i_2 \hat{I}_{t-1} + i_3 \left(\widehat{TQ}_t - \left\{ \xi_I \widehat{ToT}_t - \hat{\varepsilon}_t^{RPI} \right\} \right) + \hat{\varepsilon}_t^{MEI}$$

$$\text{where } i_1 = \frac{\beta}{1+\beta},\ i_2 = 1 - i_1,\ i_3 = \frac{i_2}{\psi}$$

$\hat{I}$	Investment	$\psi > 0$	Adjustment Cost
$\widehat{TQ}$	Tobin's Q	$\beta \in (0,1)$	Discount Factor
$\widehat{ToT}$	Terms of Trade		
$\hat{\varepsilon}^{RPI}$	$\hat{I}$ Price Shock	$\hat{\varepsilon}^{MEI}$	Marginal Efficiency of $\hat{I}$ Shock

Positioning the Structural Shocks (Contd)

- Physical Capital Accumulation

$$\widehat{\bar{K}}_t - (1-\delta)\,\widehat{\bar{K}}_{t-1} = \delta \hat{I}_t + \delta\psi\,(1+\beta)\,\hat{\varepsilon}_t^{MEI}$$

$\widehat{\bar{K}}$	Physical Capital Stock	$\psi > 0$	$\hat{I}$ Adjustment Cost
$\hat{I}$	Investment	$\beta \in (0,1)$	Discount Factor
$\hat{\varepsilon}^{MEI}$	Marginal Efficiency Shock	$\delta \in (0,1)$	Depreciation Rate

Positioning the Structural Shocks (Contd):
Interpreting the MEI Shock

- Justiniano, Primiceri and Tambalotti (forthcoming) suggest that the MEI shock may proxy the efficiency of the financial sector to convert household saving into productive capital.
- Their estimate of the shock is highly correlated to data-based measures of the external finance premium
- In periods when the external finance premium is high, the MEI innovation is negative.

Positioning the Structural Shocks (Contd):

- Uncovered Interest Parity
  No arbitrage condition between Home and Foreign nominal bonds

$$\mathbf{E}_t \Delta \widehat{NER}_{t+1} = \hat{R}_t - \left(\hat{R}^*_t - \kappa \widehat{NFA}_t + \hat{\varepsilon}^{UIP}_t \right)$$

$\widehat{NER}$	Nominal Ex. Rate \$/RoW	$\kappa > 0$	$\widehat{NFA}$ Adjustment Cost
$\hat{R}$	US Nominal Interest Rate	$\hat{\varepsilon}^{UIP}$	'Int. Risk Prem.' Shock
$\hat{R}^*$	RoW Nominal Interest Rate		
$\widehat{NFA}$	Net Foreign Assets/GDP		

Positioning the Structural Shocks (Contd)

- Output (Supply-side):
  Intermediate monopolist sells part of production at home, exports the remaining abroad

$$\hat{Y}_{Ht} = fc\left[(1-\alpha)\,\hat{N}_t + \alpha\hat{K}_t^S + \hat{\varepsilon}_t^{TFP}\right]$$

$\hat{Y}_H$	Output	α	Share of Capital
$\hat{N}$	Hours	fc	Fixed Cost
$\hat{K}^S$	Capital Services		
$\hat{\varepsilon}^{TFP}$	TFP Shock		

The Trade Balance to GDP Ratio:

$$\widehat{RTB}_t = \overbrace{\Xi_C \xi_C \left(\hat{C}_t^* - \hat{C}_t\right)}^{\text{Relative C Absorption}} + \overbrace{\Xi_I \xi_I \left(\hat{I}_t^* - \hat{I}_t\right)}^{\text{Relative I Absorption}}$$

$$+ \overbrace{\begin{array}{c} \Xi_C \xi_C \widehat{RER_t}^{C} + \Xi_I \xi_I \widehat{RER_t}^{I} \\ + (\mu - 1)\left[\Xi_C \xi_C (1 - \xi_C) + \Xi_I \xi_I (1 - \xi_I)\right]\left(\widehat{ToT}_t - \widehat{ToT}^*\right) \end{array}}^{\text{International Relative Prices}}$$

$\widehat{RTB}$	Net Exports/GDP	$\widehat{RER}^{(C,I)}$	Real Ex Rates (C,I based)
$\hat{C}^*, \hat{I}^*$	RoW C and I	μ	Price Elasticity of Imports
$\hat{C}, \hat{I}$	US C and I		
$\Xi_{(C,I)}$	Long-run shares of C and I in GDP		
$\xi_{(C,I)}$	Import-Shares		

Connecting the Model to the Data

16 Series, 16 Shocks, 1980 Q1 - 2005 Q4:

Data Series	Filter
Real Consumption Growth (US, RoW)	Demeaned
Real Investment Growth (US, RoW)	Demeaned
Real GDP Growth (US, RoW)	Demeaned
GDP Deflator Inflation (US, RoW)	Demeaned
Real Wage Inflation (US, RoW)	Demeaned
Investment Deflator Inflation (US,RoW)	Demeaned
Nominal Interest Rate (US, RoW)	Demeaned
Real Depreciation of USD	Demeaned
Trade balance to GDP	Linearly detrended

Connecting the Model to the Data (Contd):

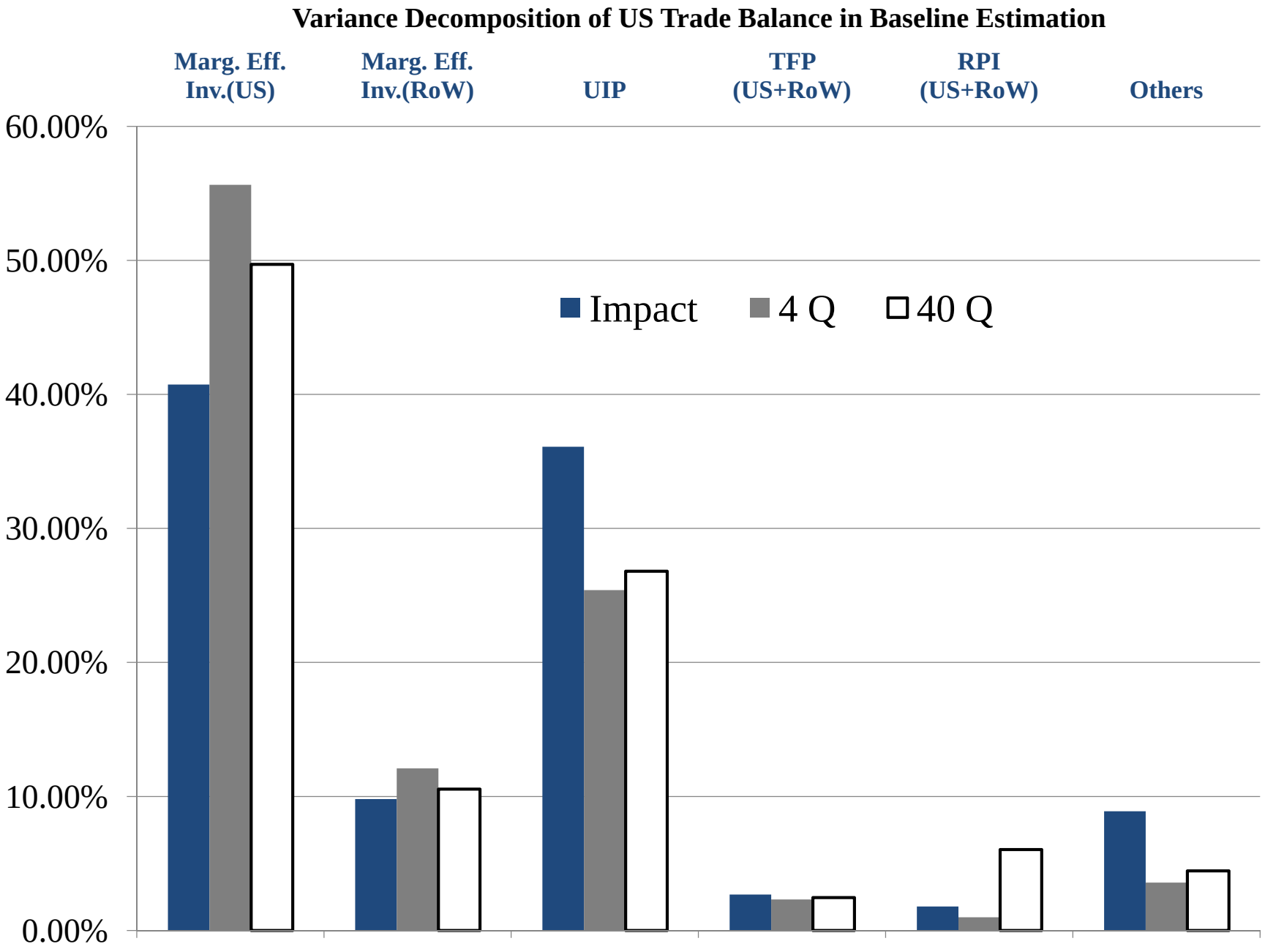
- US: As in the recent literature, expenditures on **consumer durables and changes in inventories** added to US Investment. Durables deducted from US consumption
- RoW: No similar adjustment due to lack of data, especially for the Euro-Area.

Key Calibrated Values:

- Share of Imports in Consumption: 2.3 %, Share of Imports in Investment: 39.94 %
- Sample Means from Bureau of Economic Analysis data as in Erceg, Guerrieri and Gust (*JEDC 2008*)
- Since consumption is the most important component of absorption, the contribution in the *trade balance/GDP* ratio is not as disparate: 1.4% vs 8.5% for investment

Results

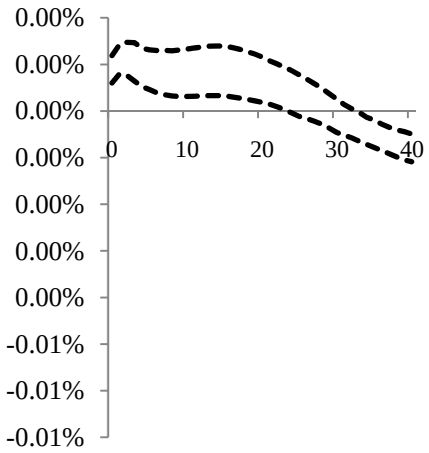
- Variance Decomposition
- Selected Impulse Responses


Variance Decomposition of US Trade Balance in Baseline Estimation
Marg. Eff. Inv.(US)
Marg. Eff. Inv.(RoW)
UIP
TFP (US+RoW)
RPI (US+RoW)
Others
60.00%
50.00%
40.00%
30.00%
20.00%
10.00%
0.00%
Impact
4 Q
40 Q

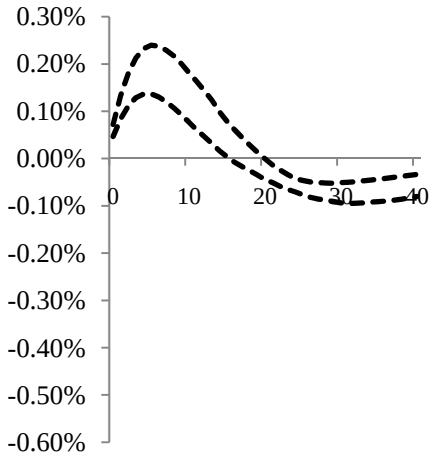
5th and 95th Percentiles of Posterior Impulse Responses of the Components of the Trade Balance to Selected 1 St Dev Shocks

(a) **– – Uncovered Interest Rate Parity Shocks**

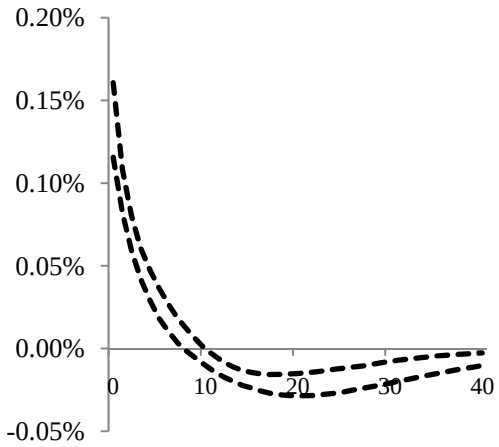
Consumption (Foreign-US)



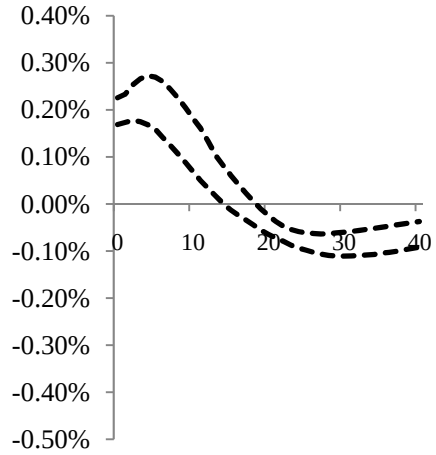
Investment (Foreign-US)



Real Ex. Rates +Terms of Trade



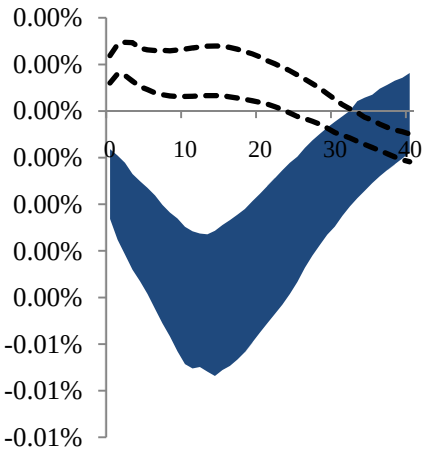
Aggregate US Net Exports/GDP



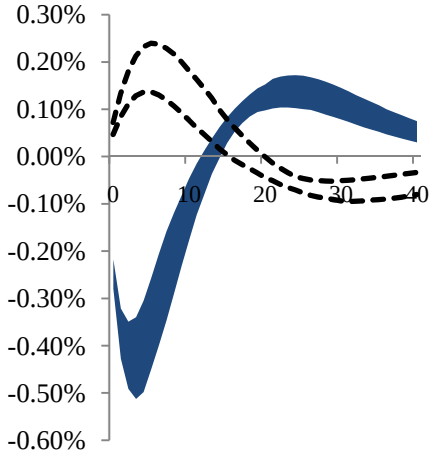
5th and 95th Percentiles of Posterior Impulse Responses of the Components of the Trade Balance to Selected 1 St Dev Shocks

(a) **Uncovered Interest Rate Parity Shocks** **Marginal Efficiency of Investment Shocks**

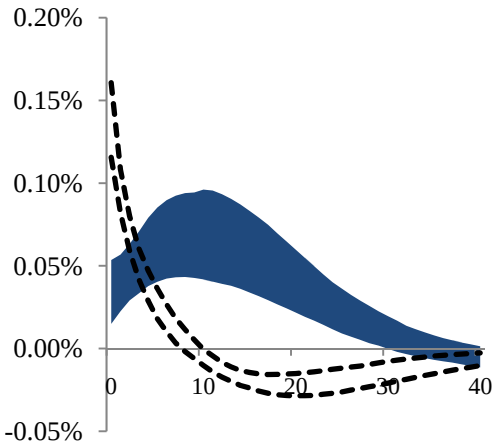
Consumption (Foreign-US)



Investment (Foreign-US)



Real Ex. Rates +Terms of Trade



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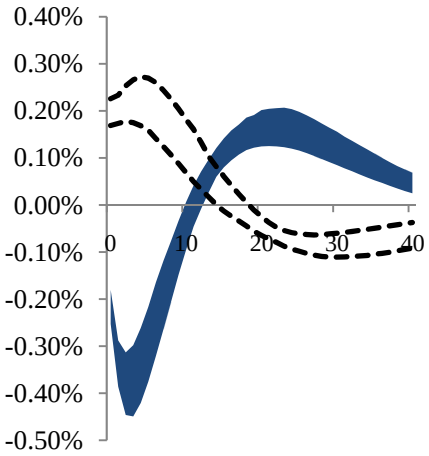
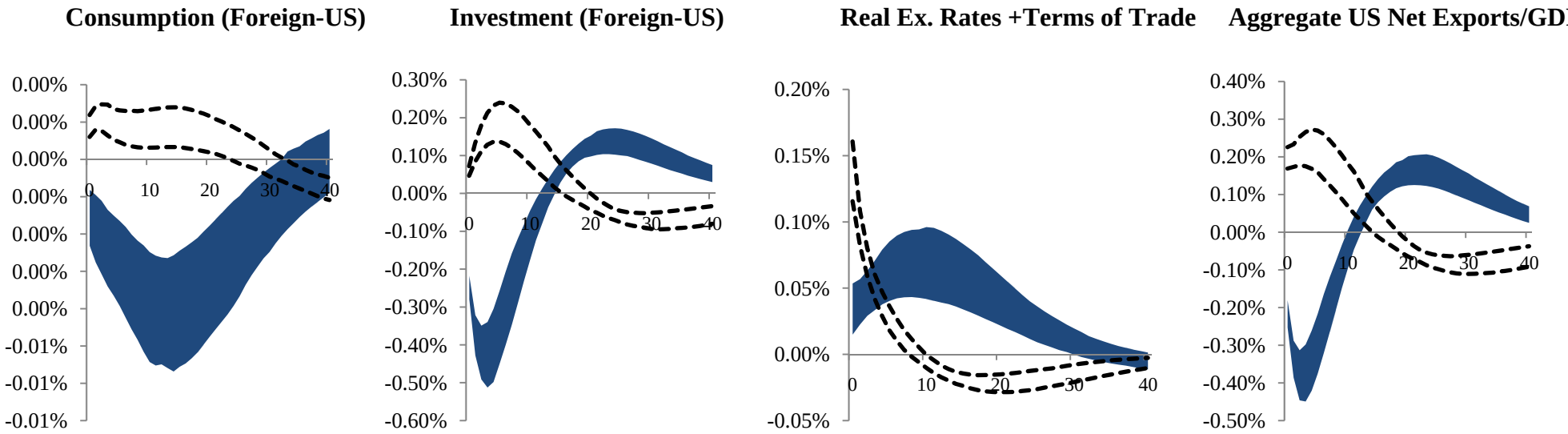
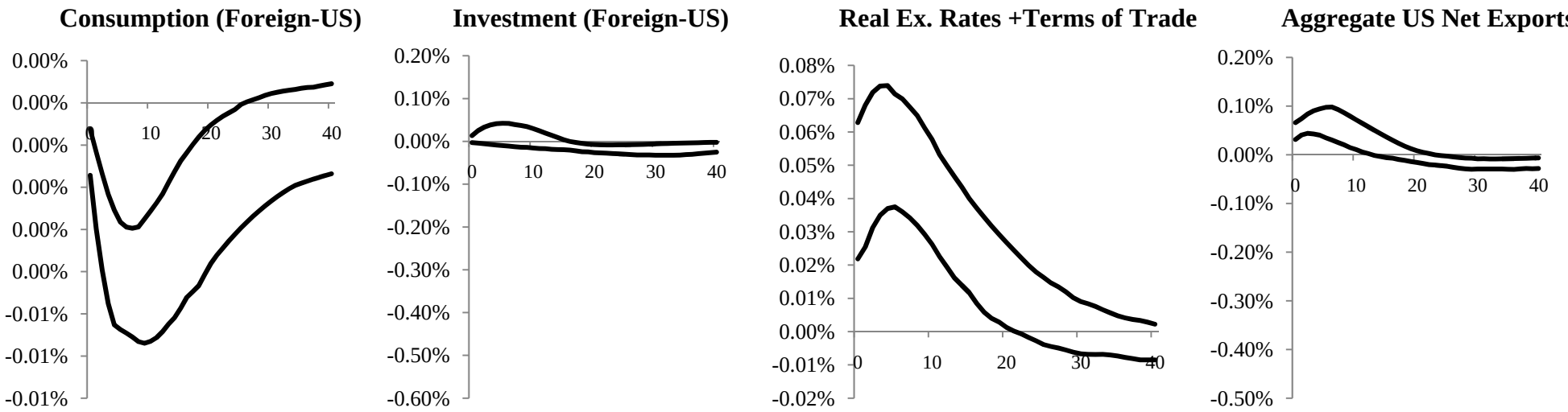


5th and 95th Percentiles of Posterior Impulse Responses of the Components of the Trade Balance to Selected 1 St Dev Shocks

(a) Uncovered Interest Rate Parity Shocks Marginal Efficiency of Investment Shocks

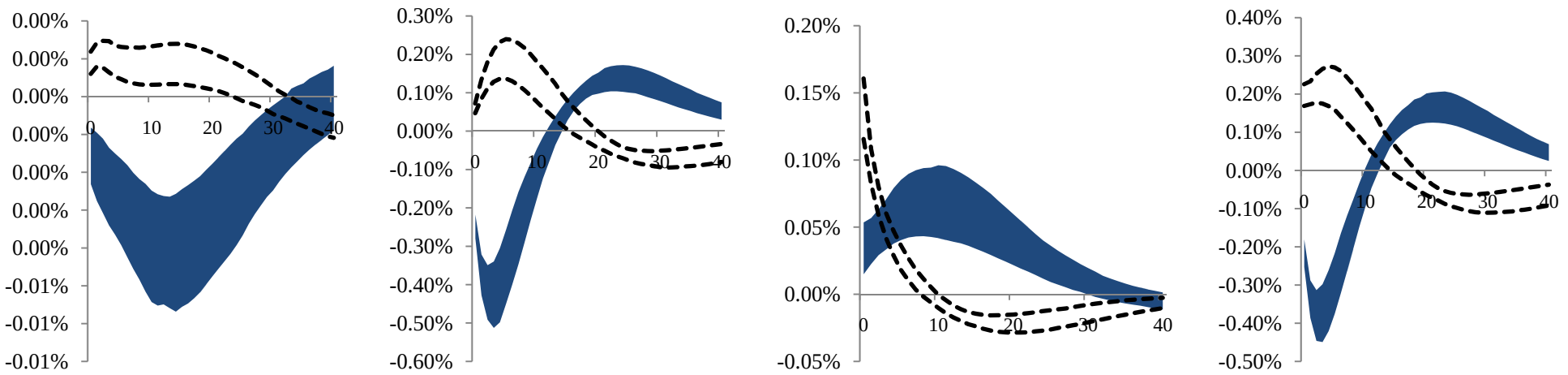


(b) Total Factor Productivity Shocks

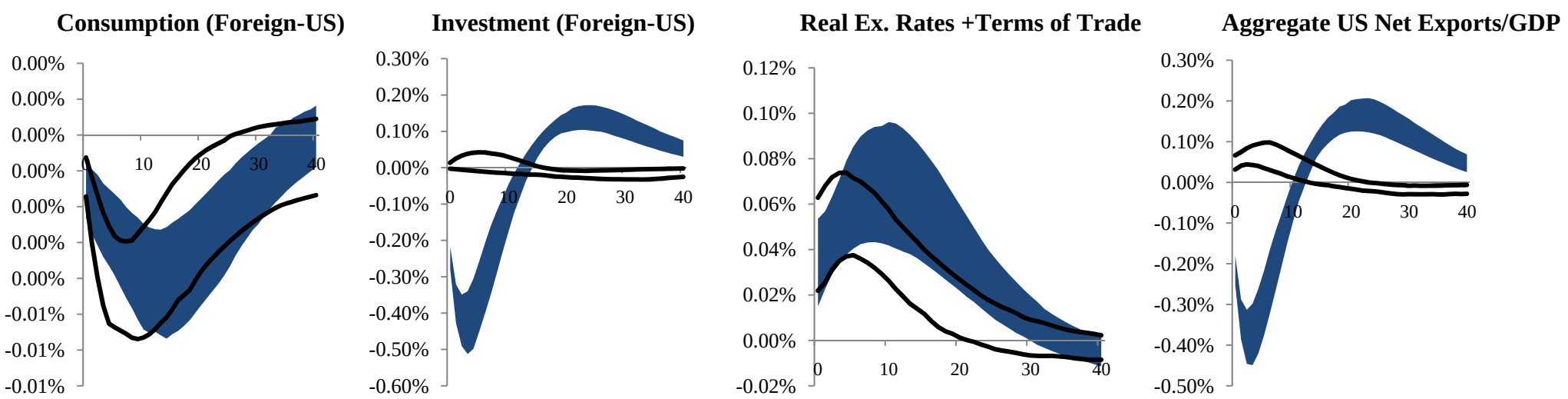


5th and 95th Percentiles of Posterior Impulse Responses of the Components of the Trade Balance to Selected 1 St Dev Shocks

(a) Uncovered Interest Rate Parity Shocks — Marginal Efficiency of Investment Shocks



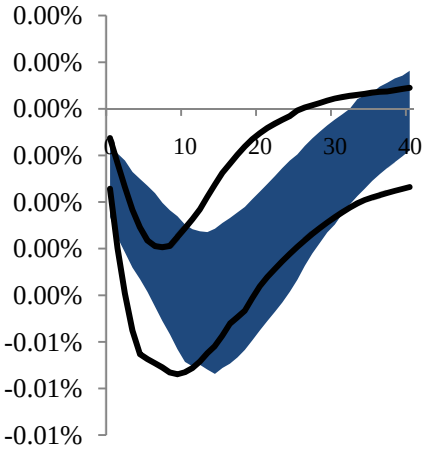
(b) Total Factor Productivity Shocks — Marginal Efficiency of Investment Shocks



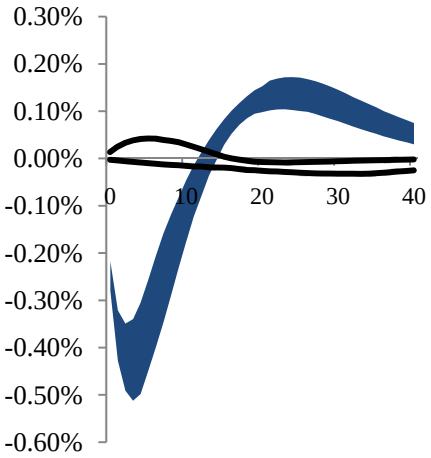
IRF (Contd): Comparing the Neutral and Investment-Specific Technology Shock Dynamics

(b) **Total Factor Productivity Shocks** **Marginal Efficiency of Investment Shocks**

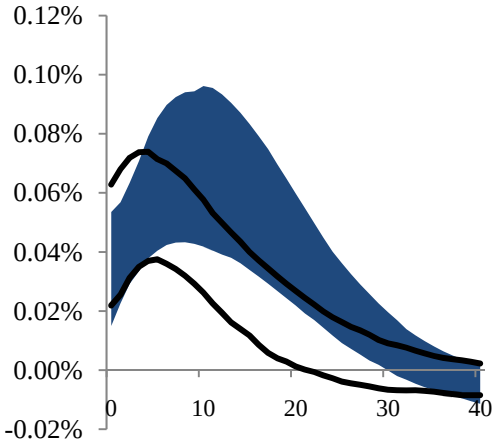
Consumption (Foreign-US)



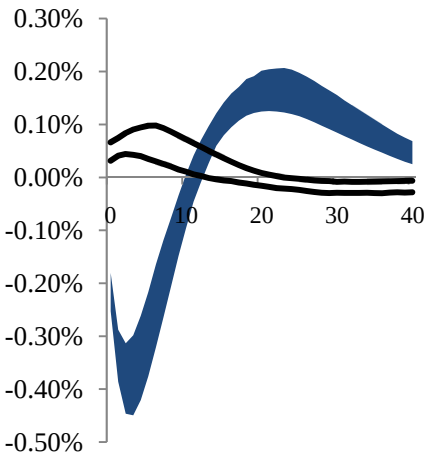
Investment (Foreign-US)



Real Ex. Rates +Terms of Trade

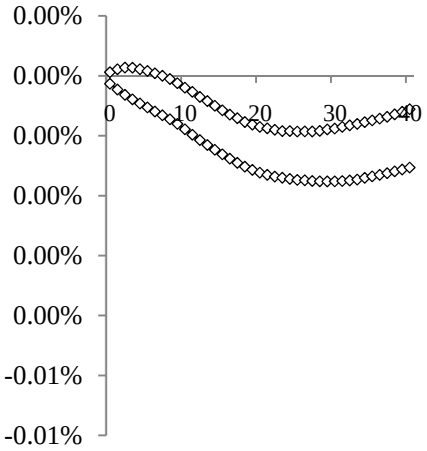


Aggregate US Net Exports/GDP

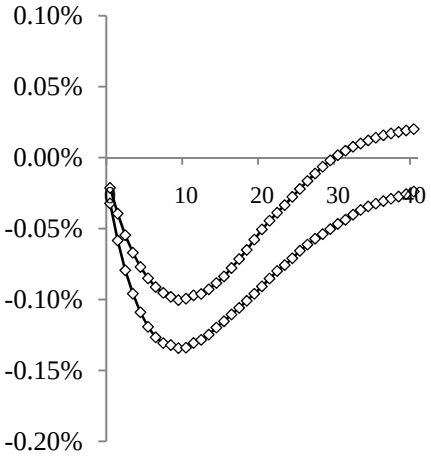


(c) **Relative Price of Investment Shocks**

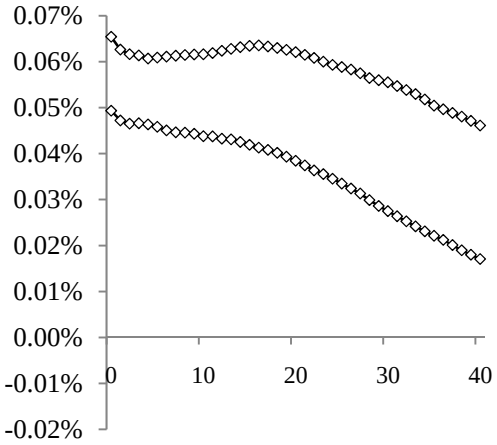
Consumption (Foreign-US)



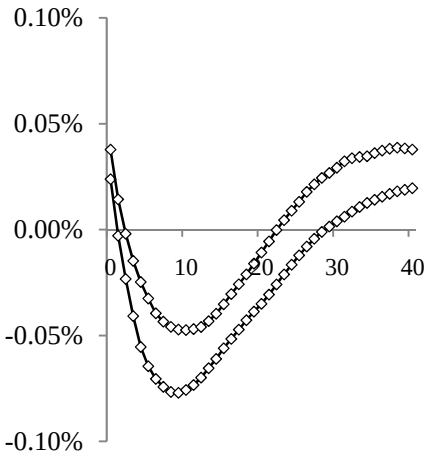
Investment (Foreign-US)



Real Ex. Rates +Terms of Trade



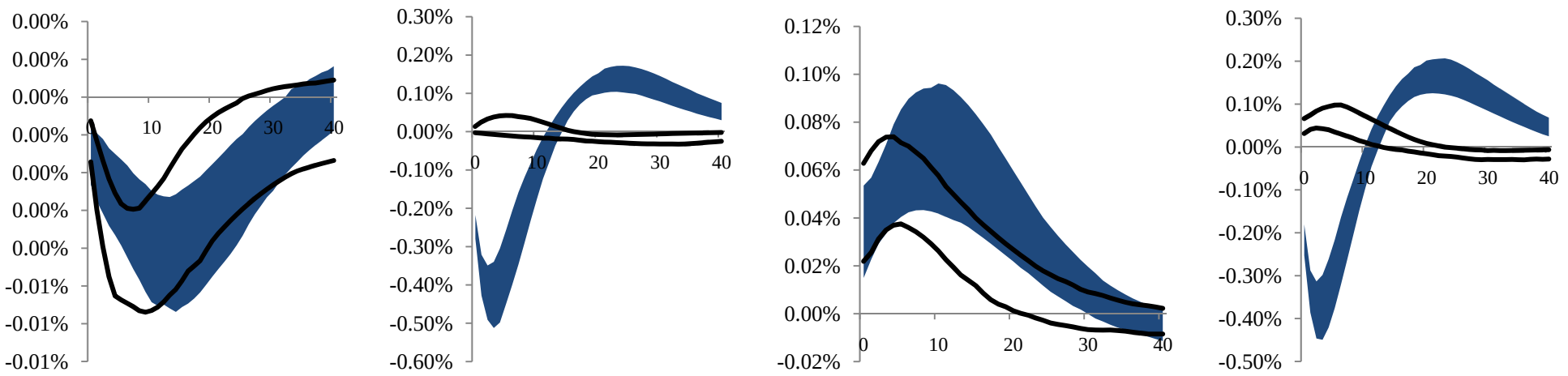
Aggregate US Net Exports/GDP



IRF (Contd): Comparing the Neutral and Investment-Specific Technology Shock Dynamics

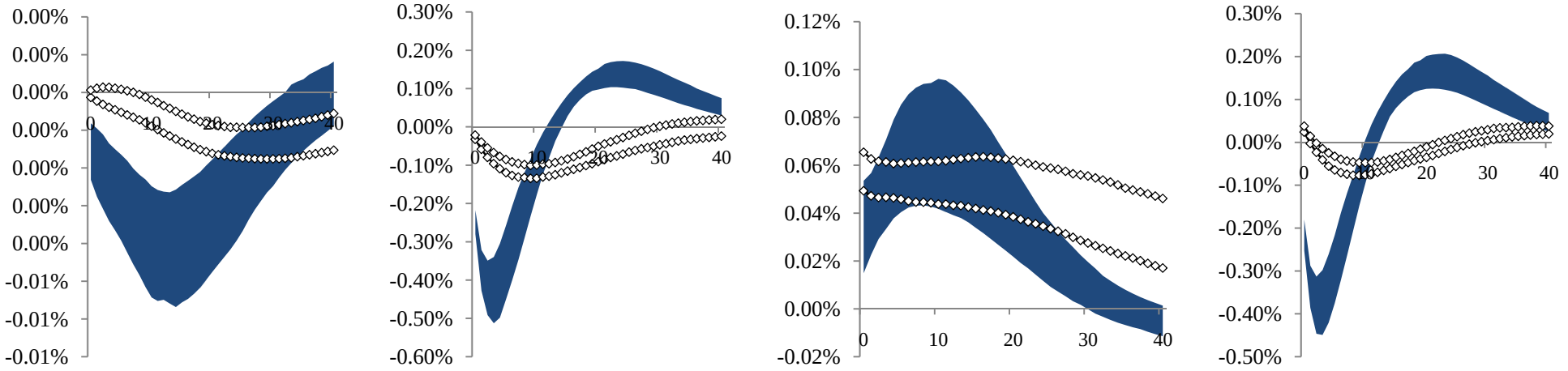
(b) **Total Factor Productivity Shocks** **Marginal Efficiency of Investment Shocks**

Consumption (Foreign-US) **Investment (Foreign-US)** **Real Ex. Rates +Terms of Trade** **Aggregate US Net Exports/GDP**



(c) **Relative Price of Investment Shocks** **Marginal Efficiency of Investment Shocks**

Consumption (Foreign-US) **Investment (Foreign-US)** **Real Ex. Rates +Terms of Trade** **Aggregate US Net Exports/GDP**

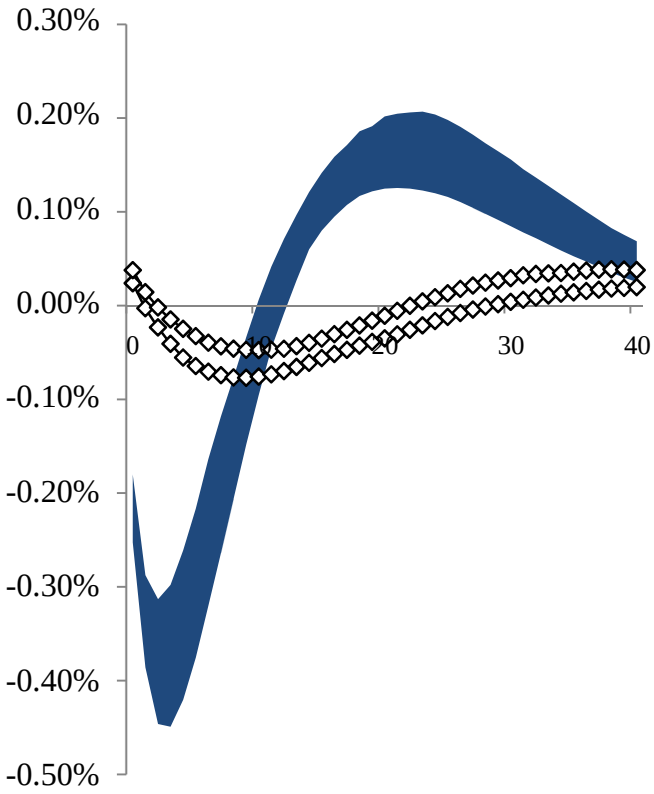


IRF (Contd): Comparing Relative Price of Investment Shocks to Marginal Efficiency of Investment Shocks

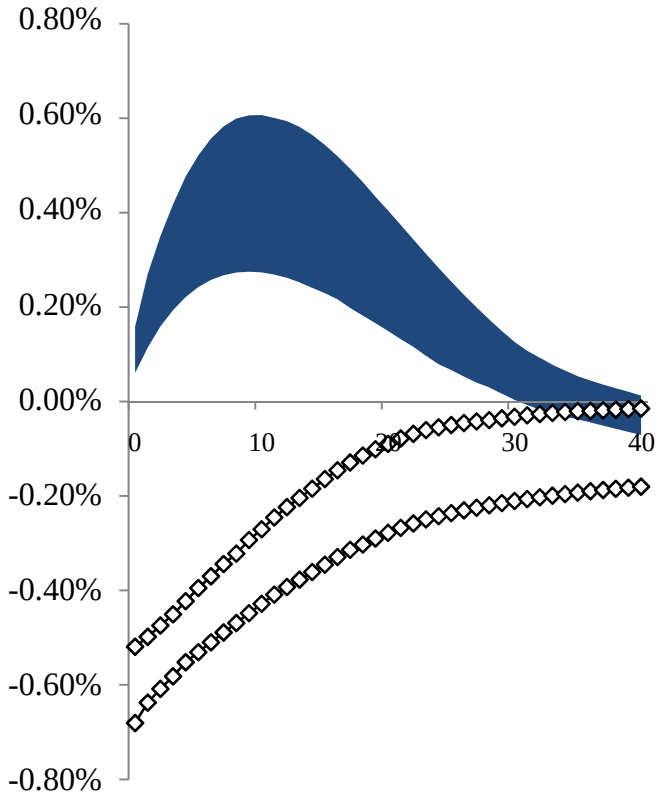
Relative Price of Investment Shocks **Marginal Efficiency of Investment Shocks**

$$\hat{P}_{It} - \hat{P}_{Ht} = \xi_I \widehat{TOT}_t - \varepsilon_t^{RPI}$$

Aggregate US Net Exports/GDP



Relative Price of Investment in terms of Output



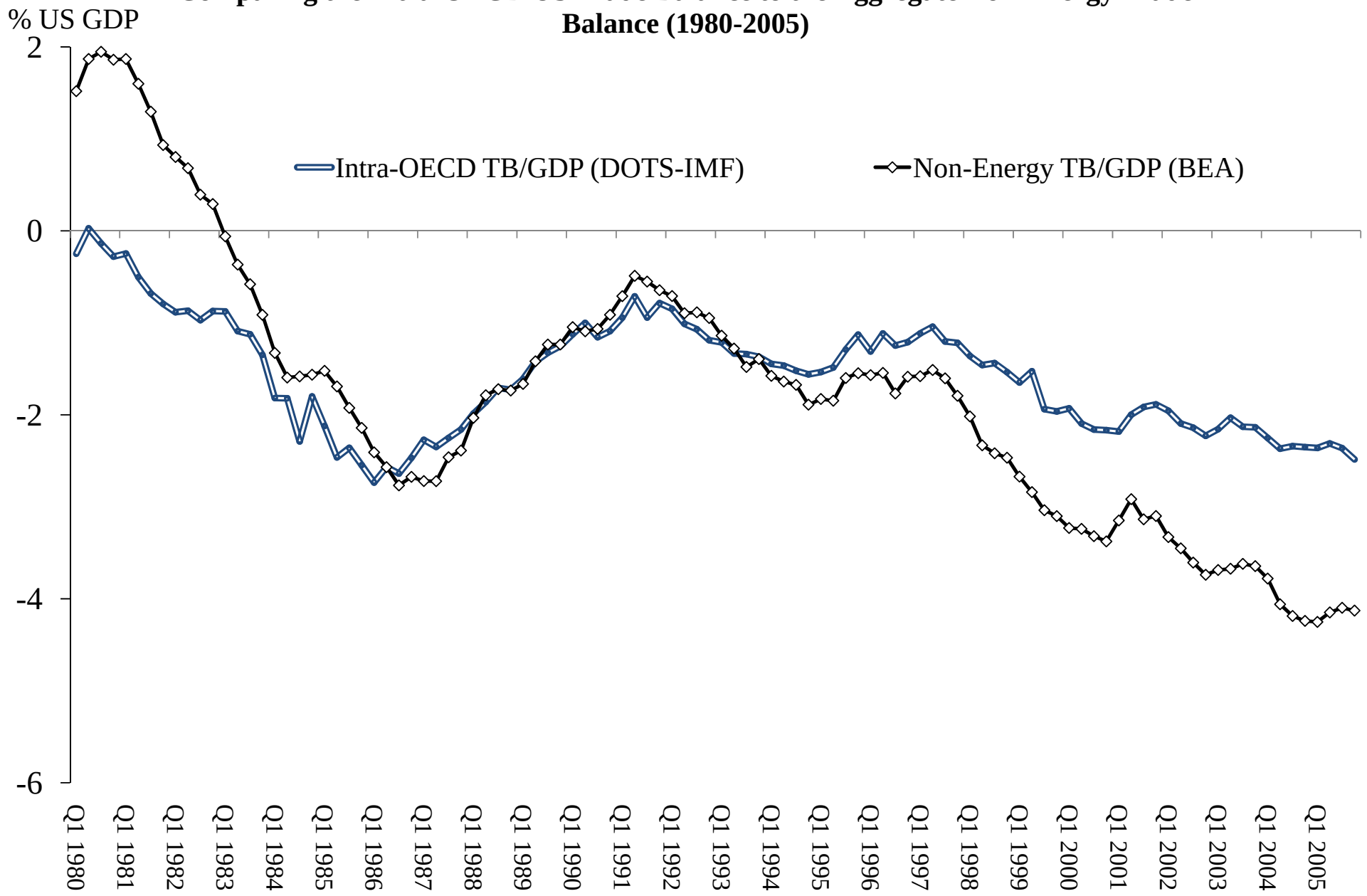
MEI Shocks and the Counter-cyclicality of the Trade Balance:

- Neutral (TFP) shocks makes the trade balance respond *pro*-cyclically
- A large literature in international economics emphasizing *counter-cyclicality* of trade balance: Backus *et al.* (*AER 1994*), Kollmann (*JIMF 1998*), Raffo (*JIE 2008*) and Coeurdacier, Kollmann and Martin (*JIE 2010*)
- MEI shocks gets us counter-cyclicality: Absorption effect dominating the Price effect
- More likely candidate driving trade deficits in prosperous economies

Robustness Checks:

- Using the actual non-energy US trade balance

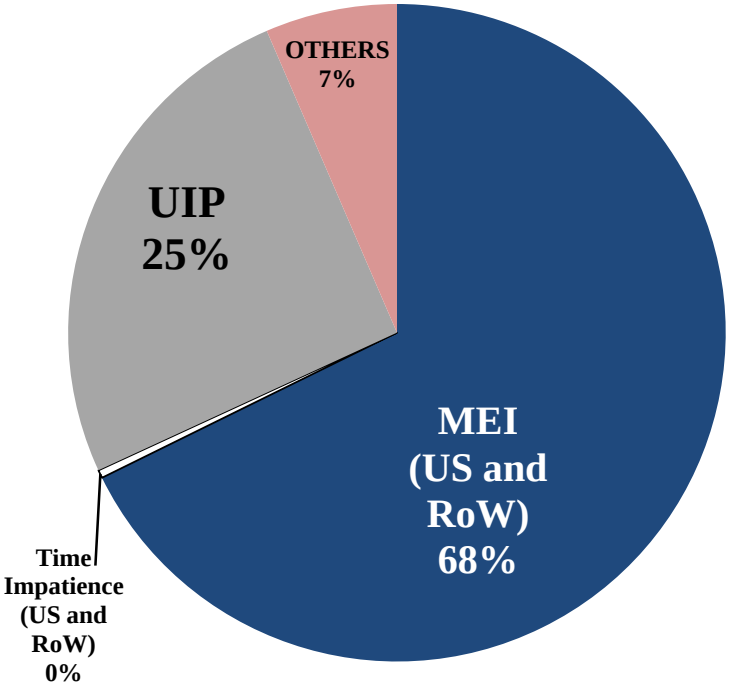
Comparing the Intra-OECD US Trade Balance to the Aggregate Non-Energy Trade Balance (1980-2005)



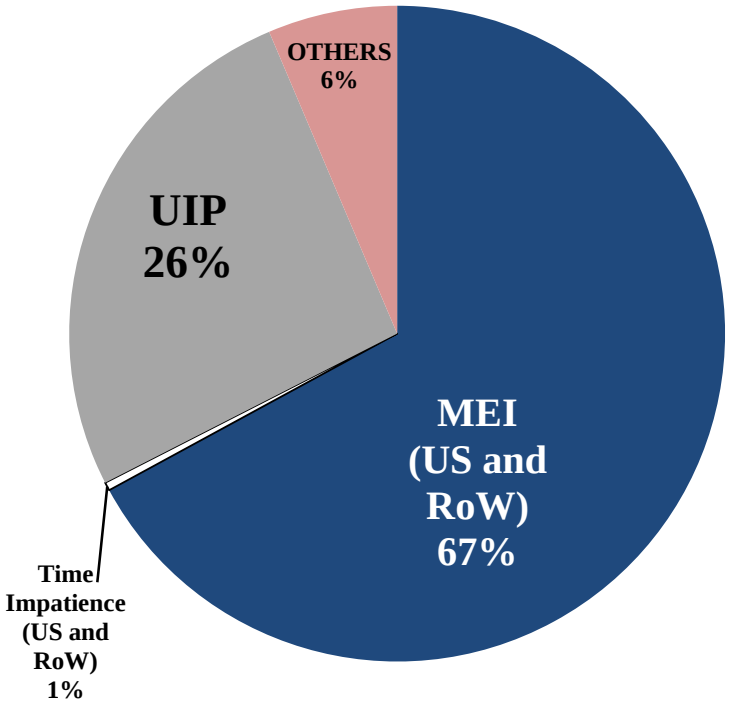
Variance Decomposition of US Trade Balance at the 4 quarter horizon

Robustness Check 1

Baseline: Intra-OECD Trade Balance



Use Actual Non-Energy Trade Balance



Robustness Checks (Contd):

- Assume a non-linear trend in the trade balance by using a Hodrick-Prescott filter with a smoothing parameter of 1600
- Use complete markets instead of incomplete markets as in the baseline model
- Use import-adjustment costs as in Erceg *et al.* (2008) in order to decrease the short-run price-elasticity of import-demand

Robustness Checks (Contd):
Risk Premium Shocks (Smets and Wouters *AER 2007*):
An interest-rate wedge

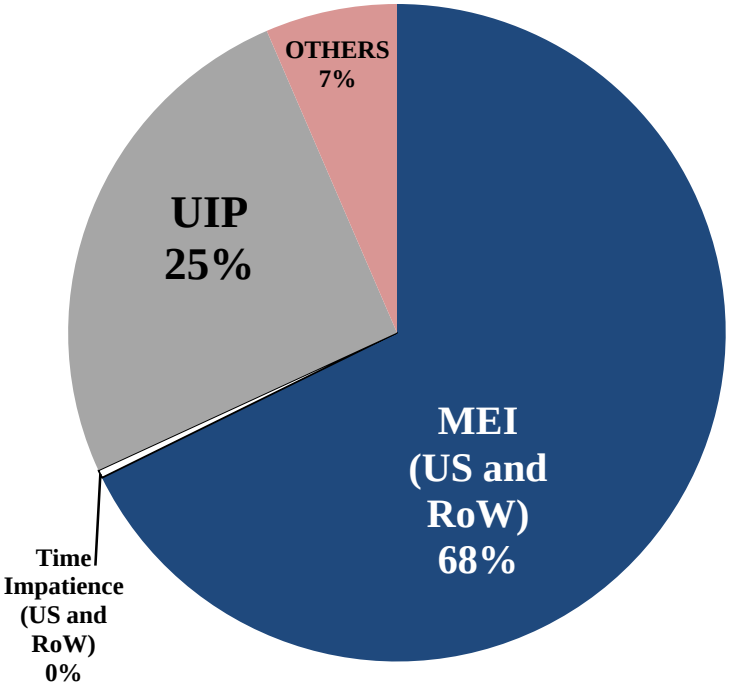
$$\hat{C}_t = c_1 \mathbf{E}_t \hat{C}_{t+1} + c_2 \hat{C}_{t-1} - c_3 \left(\hat{R}_t - \mathbf{E}_t \hat{\pi}_{Ct+1} - \varepsilon_t^{RP} \right)$$

$$\widehat{TQ}_t = t_1 \mathbf{E}_t \widehat{TQ}_{t+1} + (1 - t_1) \mathbf{E}_t \hat{r}_{t+1}^k - \left(\hat{R}_t - \mathbf{E}_t \hat{\pi}_{Ct+1} - \varepsilon_t^{RP} \right)$$

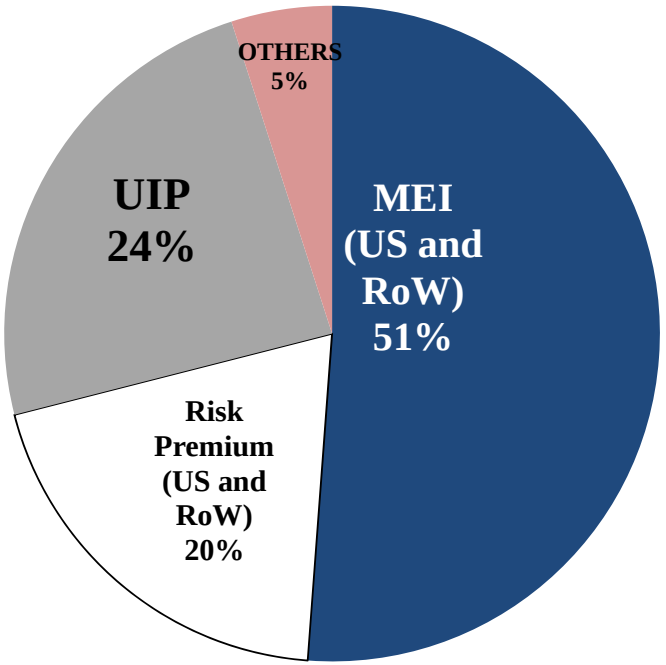
Variance Decomposition of US Trade Balance at the 4 quarter horizon

Robustness Check 4

Baseline using Time Impatience Shocks to C Euler



Use Risk Premium Shocks that stimulates C& K Eulers



Conclusions:

- In a sequence of estimated two-country models, we find that shocks to the marginal efficiency of investment contribute more than half of the conditional forecast variance of the trade balance.
- Traditional technological shocks, either neutral (TFP) shocks or investment-specific, that lead to a fall in the price of output or that of investment alone, do not matter much.
- TFP shocks even makes the trade balance behave counterfactually procyclically.
- Future work: Introduce shocks with a sharper financial interpretation into the two country set-up.

Additional Slides

Latest results: Accomodating the trend in the trade balance

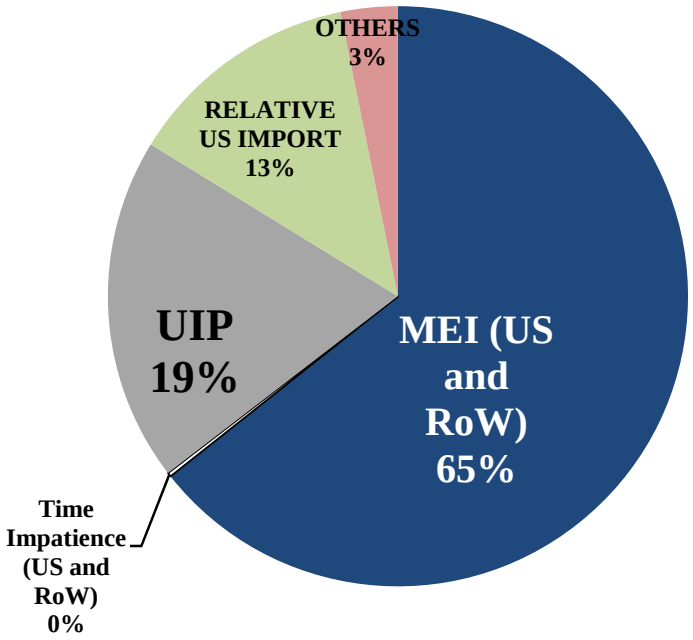
- Baseline model linearly detrends variables as it is difficult to accomodate a downwardly trending trade balance in a model-consistent manner.
- Perhaps unrealistic to think of a trade balance that will grow forever in the sense of 'balanced growth'.
  In this experiment, the model is connected to the data as follows

$$\log x_t^{DATA} - \log x_{t-1}^{DATA} = \bar{x} + \hat{x}_t^{MODEL} - \hat{x}_{t-1}^{MODEL}$$

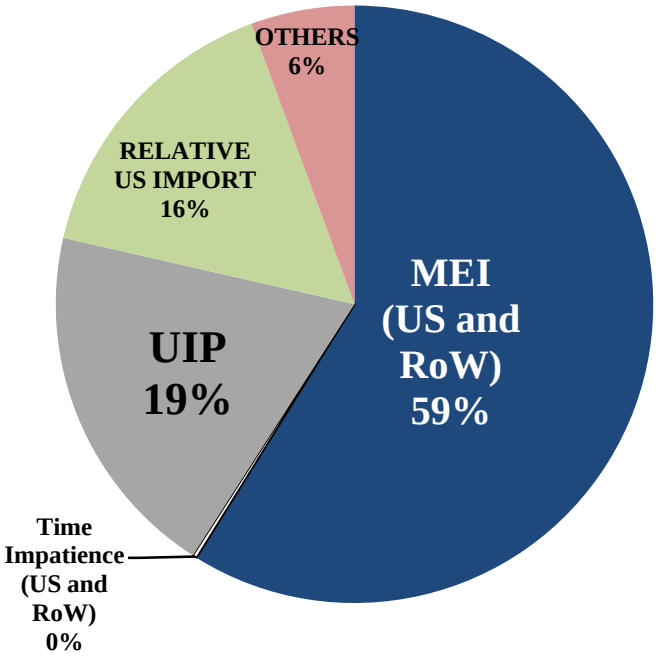
Variance Decomposition of US Trade Balance at the 4 quarter horizon

Robustness Check

Use US Import Shock and Filtered Data



Unfiltered Data



Additional Slides

Estimation Particulars

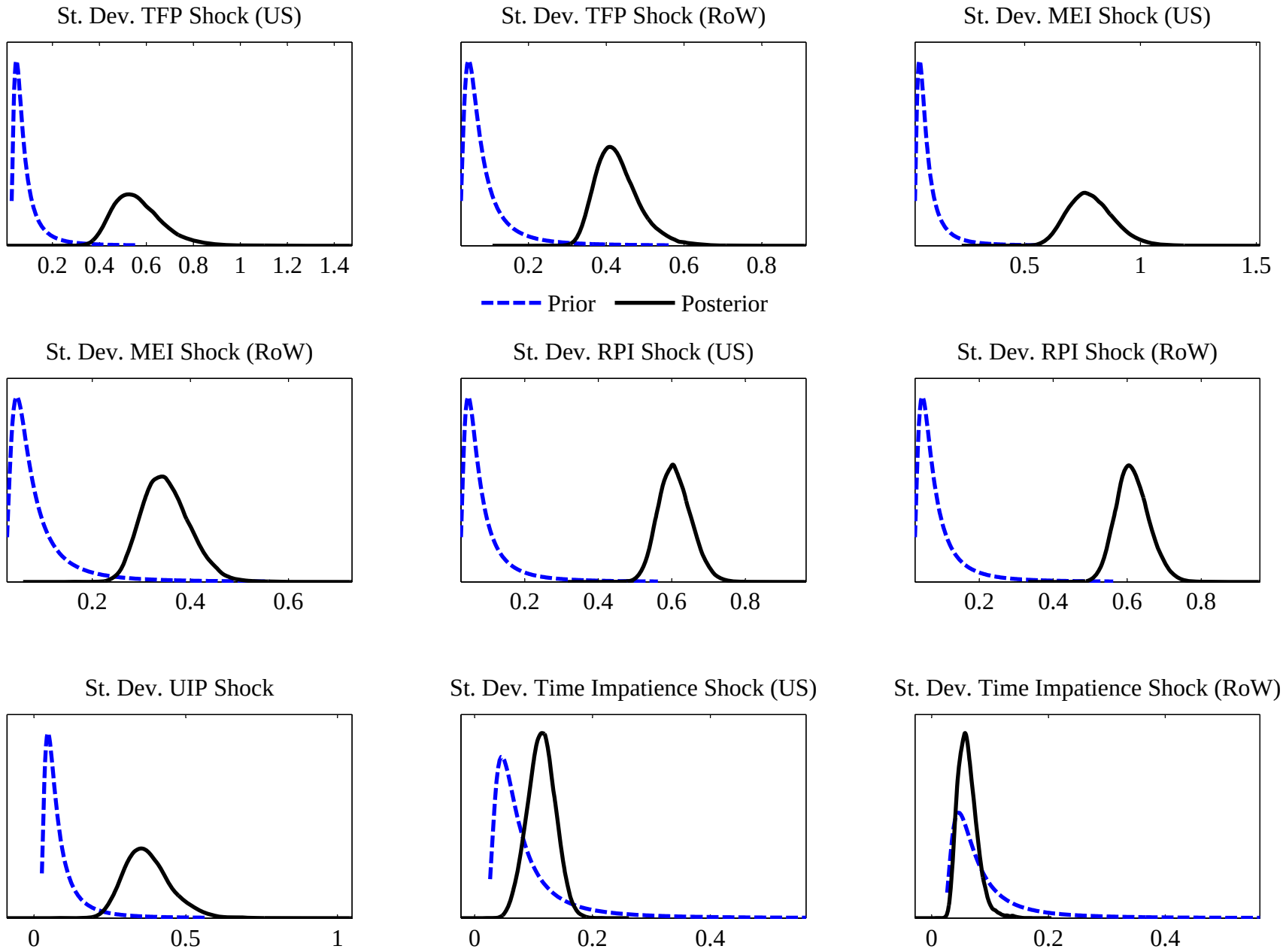
- Posterior simulated using 525,000 draws using Random-walk Metropolis Hastings. First, 25,000 draws discarded before moments are computed.
- IRFs and variance decompositions computed from 150 random draws from the posterior.

Additional Slides

Results

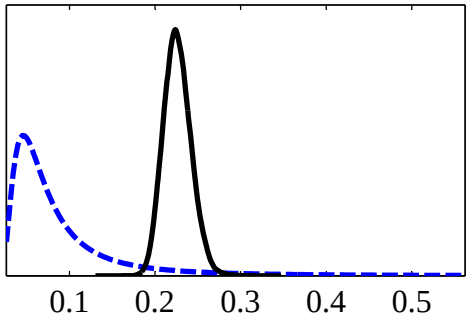
- Priors and Posteriors

PRIOR AND POSTERIOR DISTRIBUTIONS OF STRUCTURAL PARAMETERS

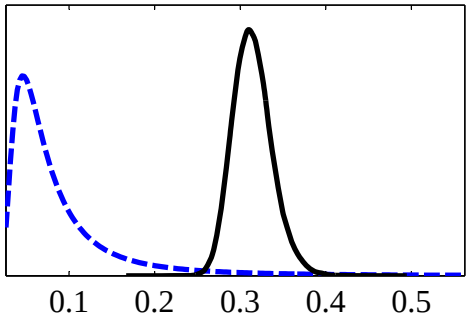


PRIOR AND POSTERIOR DISTRIBUTIONS OF STRUCTURAL PARAMETERS

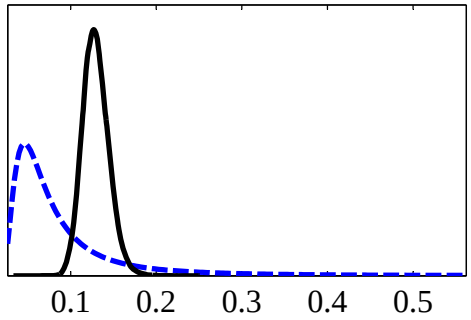
St. Dev. Govt Sp. Shock (US)



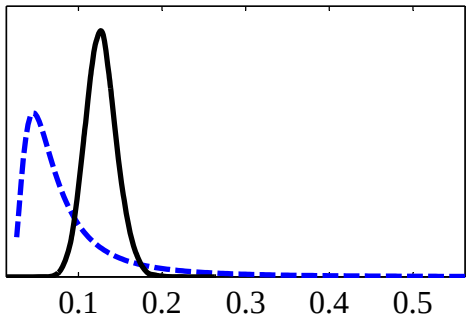
St. Dev. Govt. Sp. Shock (RoW)



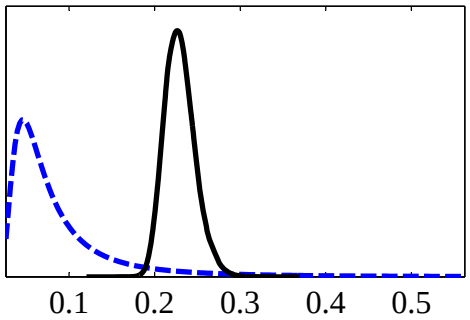
St. Dev. Wage MkUp Shock (US)



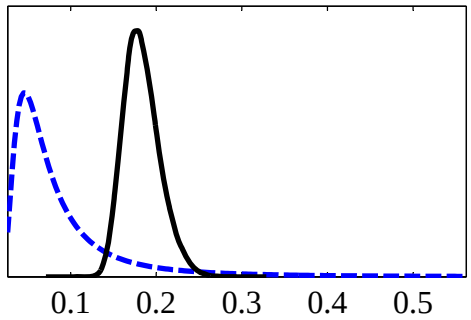
St. Dev. Wage MkUp Shock (RoW)



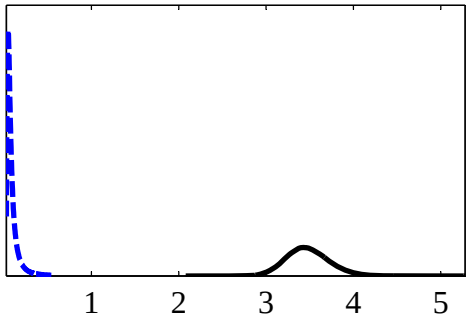
St. Dev. Monetary Policy Shock (US)



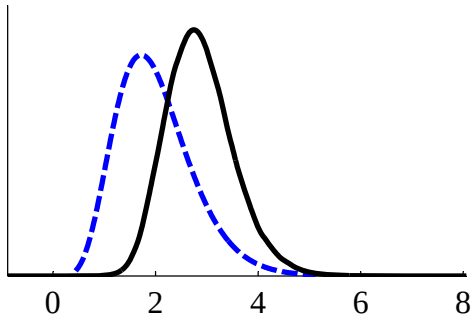
St. Dev. Monetary Policy Shock (RoW)



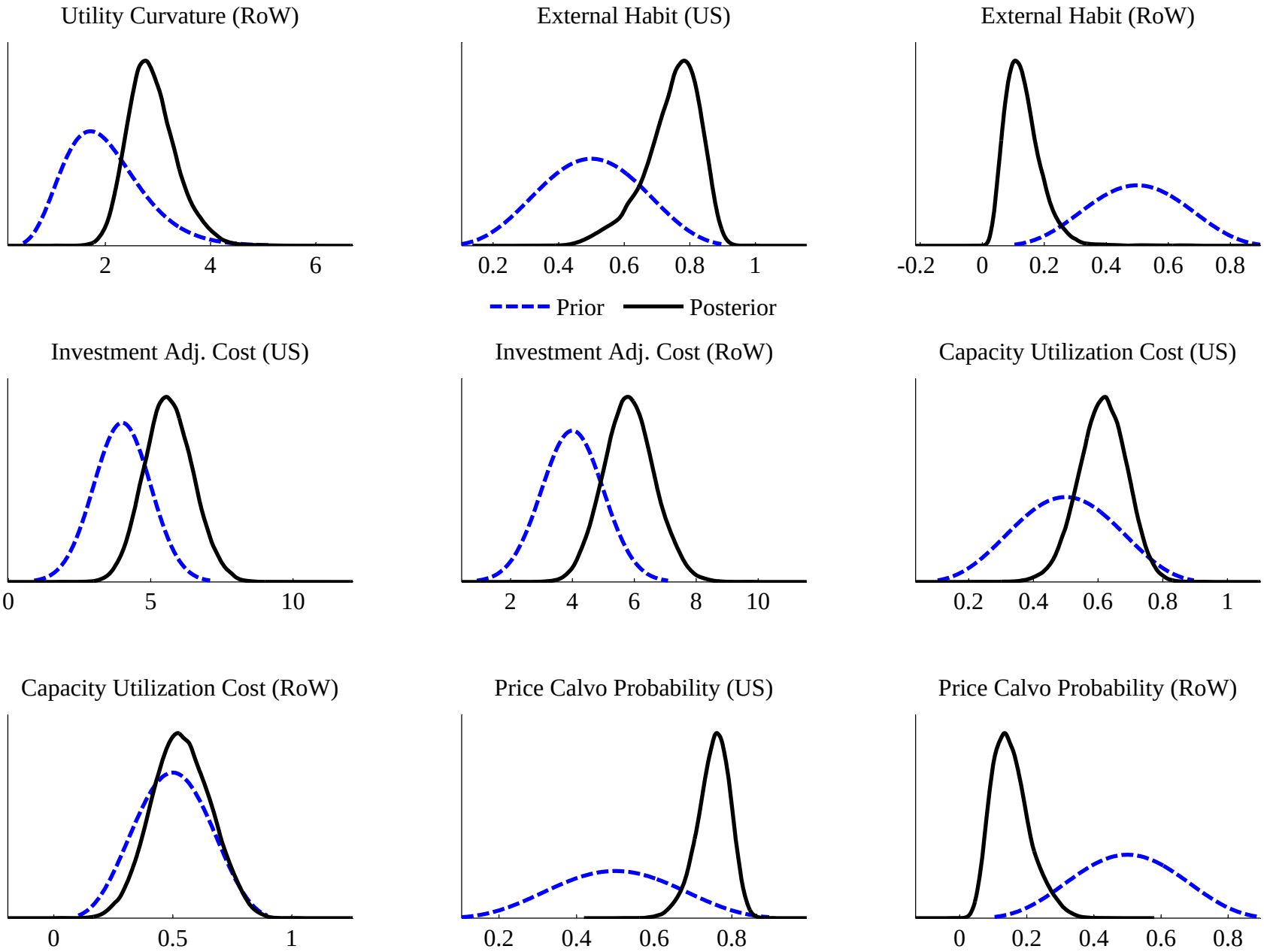
St. Dev. PPP Shock



Utility Curvature (US)



PRIOR AND POSTERIOR DISTRIBUTIONS OF STRUCTURAL PARAMETERS



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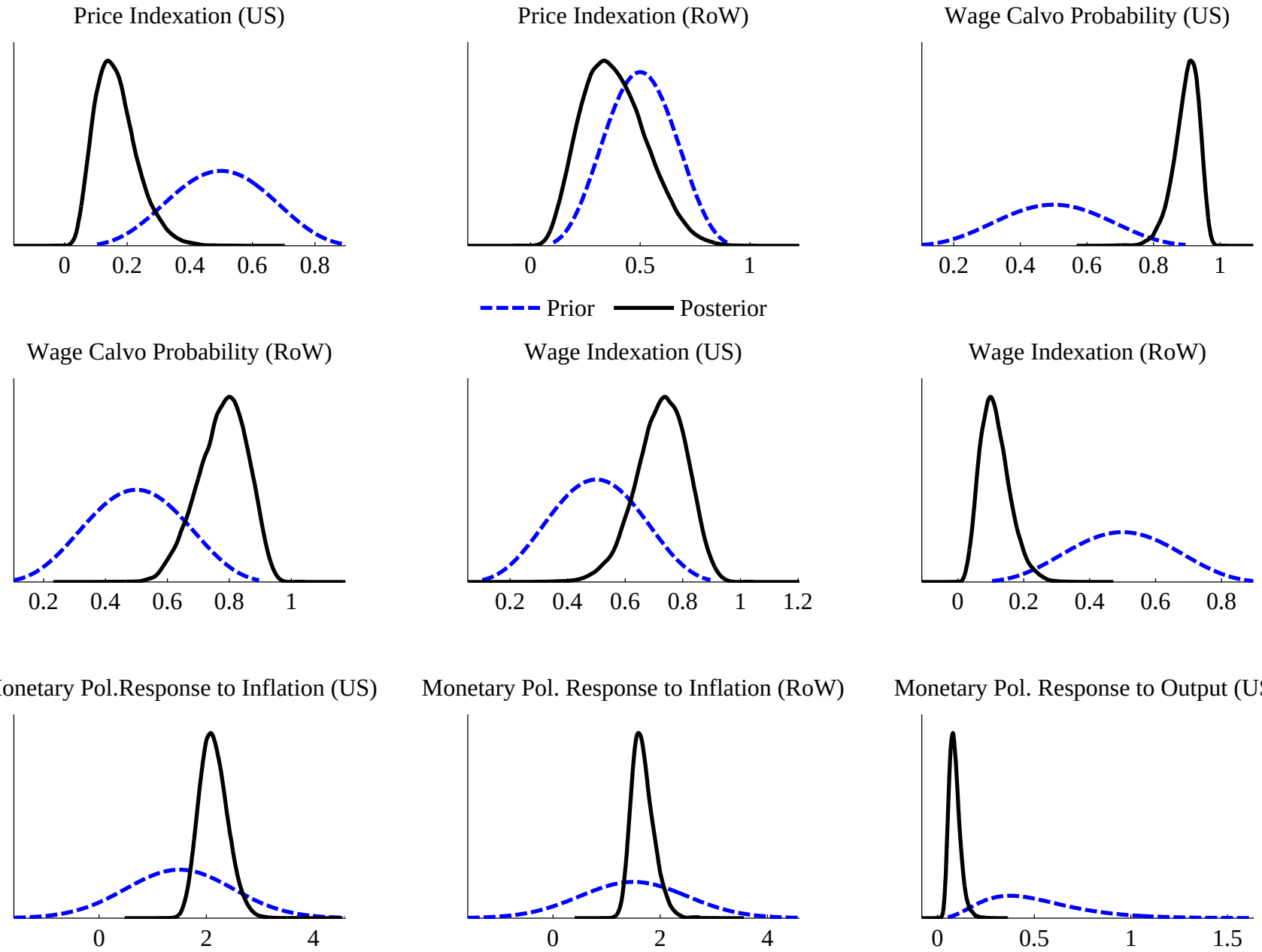

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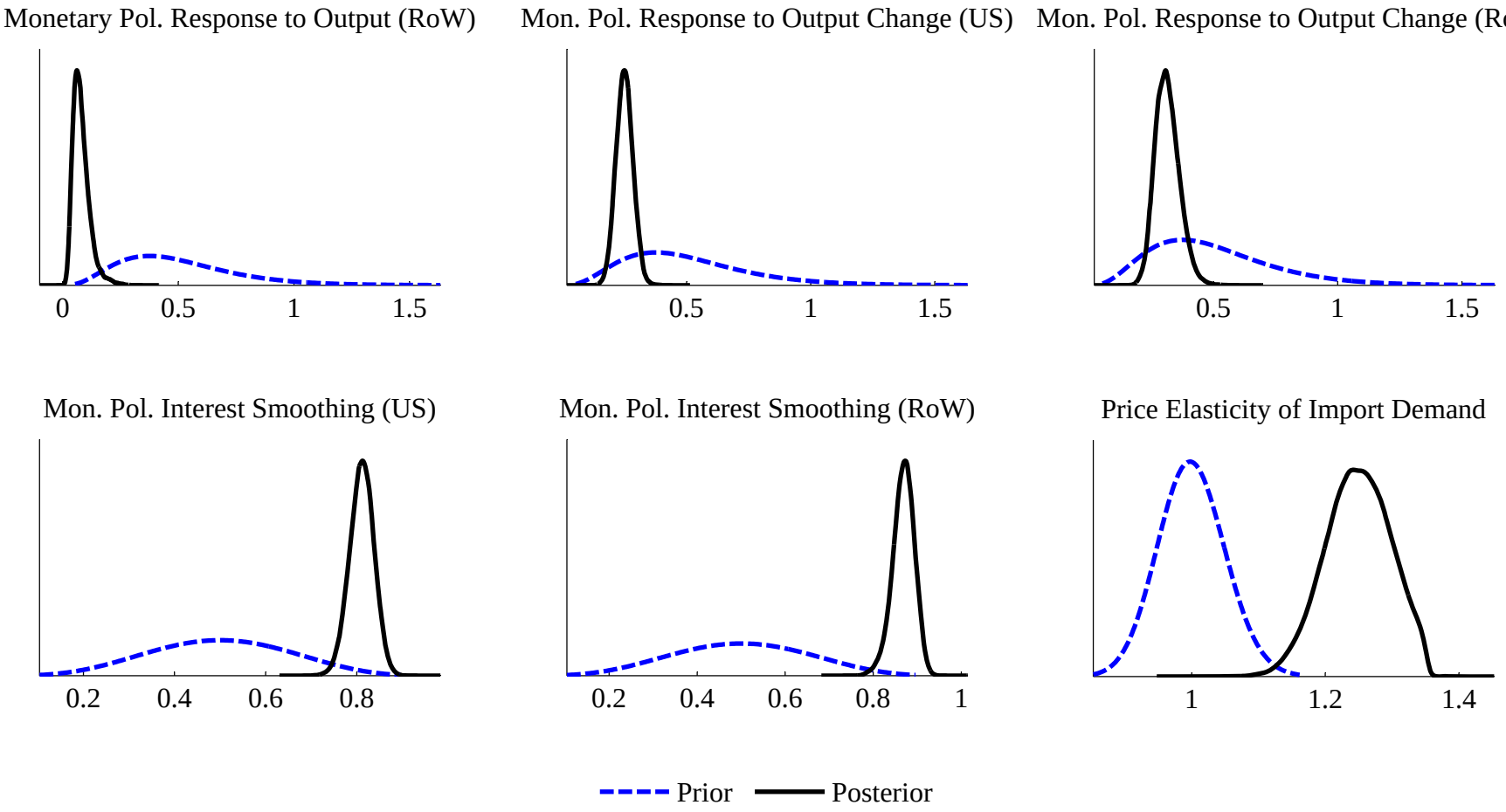

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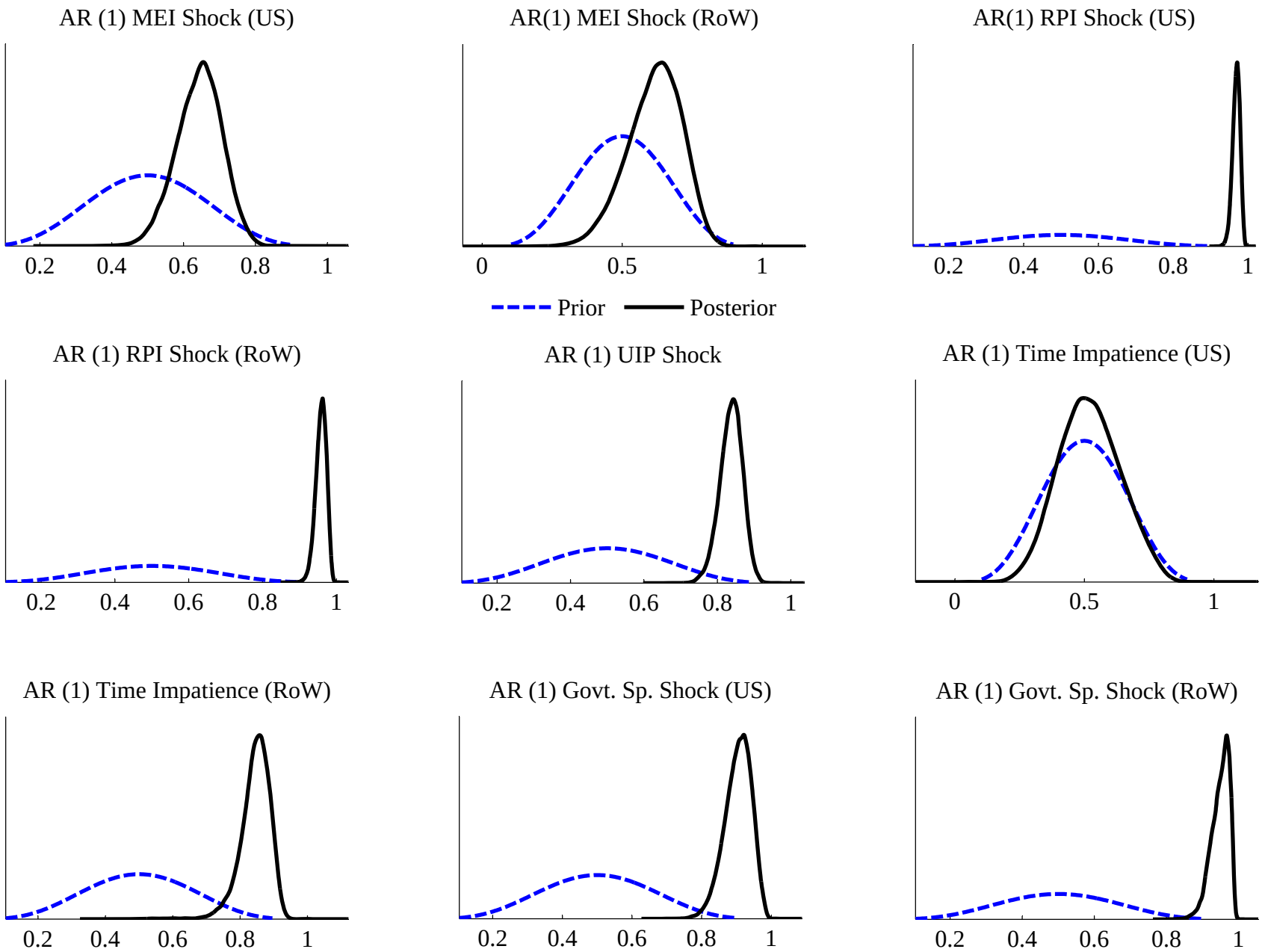


Robustness Checks (Contd):

- Aggregated Specification of Trade: Backus *et al.* (*AER 1994*), Kollmann (*JIMF 1998*), Raffo (*JIE 2008*)

Final Goods Sector makes CES aggregates of domestic output and imported output to be absorbed

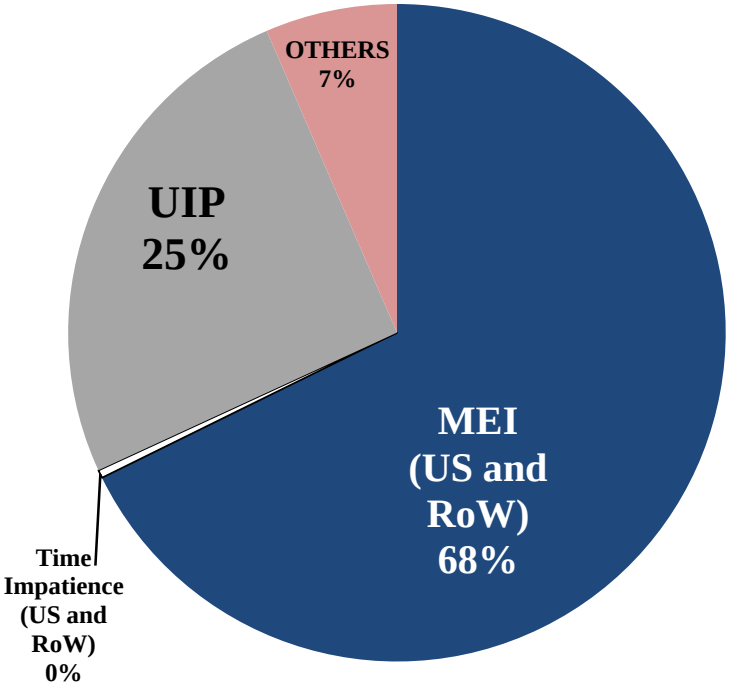
$$Ab_t = \left[(1-\xi)^{\frac{1}{\mu}} Ab_{Ht}^{\frac{\mu-1}{\mu}} + \xi^{\frac{1}{\mu}} Ab_{Ft}^{\frac{\mu-1}{\mu}} \right]^{\frac{\mu}{\mu-1}} \text{ where } Ab_t = C_t + I_t$$

- Does **not** allow differential import shares for consumption and investment

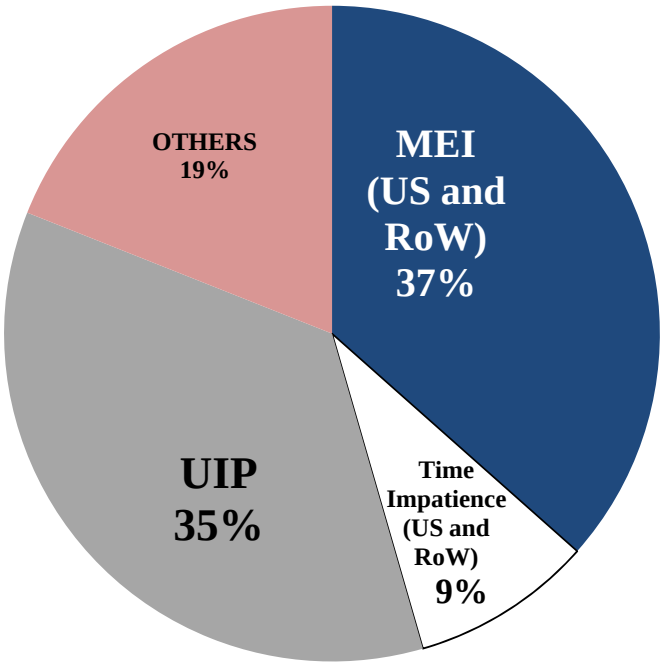
Variance Decomposition of US Trade Balance at the 4 quarter horizon

Robustness Check 3

Baseline: C and I have different import shares



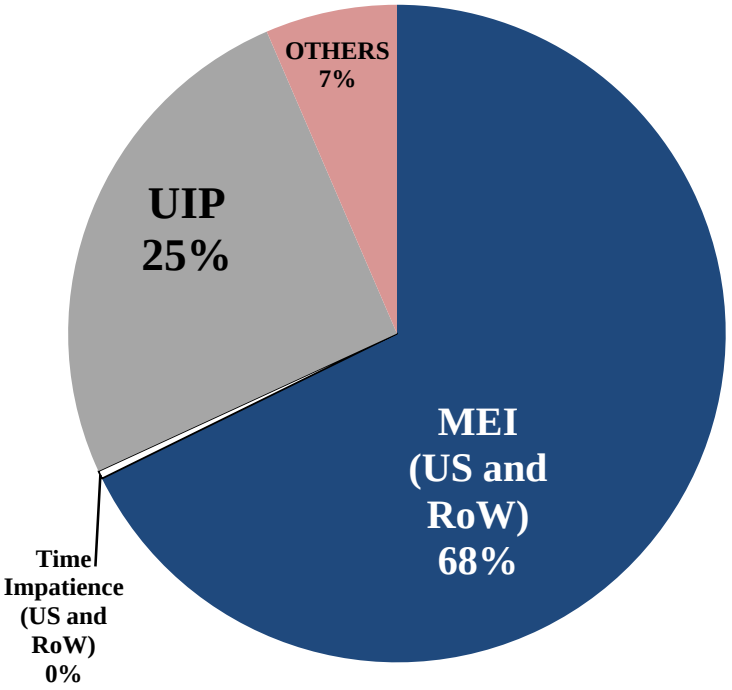
Backus et al. (1994) trade spec. with imports = Fn(C+I)



Variance Decomposition of US Trade Balance at the 4 quarter horizon

Robustness Check 2

Baseline: PPP Shock that enters RExRate Definition



Use US Import Shock in place of PPP Shock