Economics 442
Macroeconomic Policy

(Spring 2016)

3/9-14/2016

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UW Madison

Countercyclical Fiscal Policy

- Complicating the basic IS-LM model
- Analyzing the ARRA, using our tools
- CEA, CBO estimates
- Interpreting the multiplier debate in AD-AS

Solving for Multipliers, in general

$$(21) \qquad Y_0 = \hat{\gamma}\left[\Lambda_0 + \frac{b_2}{h}\left(\frac{M_0}{P}\right) - \frac{b_2\mu_0}{h}\right]$$ <equilibrium income>

$$(22) \qquad \Delta Y = \hat{\gamma}\left[\Delta\Lambda + \frac{b_2}{h}\Delta\left(\frac{M}{P}\right) - \frac{b_2}{h}\Delta\mu\right]$$

For Fiscal Policy

$$\Delta Y = \hat{\gamma}\Delta GO \Rightarrow \frac{\Delta Y}{\Delta GO} = \hat{\gamma}$$

If it is lump sum taxes:

$$\Delta Y = -\hat{\gamma}c_1\Delta t_0 \Rightarrow \frac{\Delta Y}{\Delta t_0} = -\hat{\gamma}c_1$$

The “Multiplier”

$$\hat{\gamma} \equiv \frac{1}{1 - c_1(1 - t_1) - b_1 + \frac{b_2}{h}}$$

This could fall during financial distress

Interest semi-elasticity, goes to infinity in liquidity trap

Endogenous Monetary Supply

Suppose money supply is increased with the interest rate.

$$\frac{M^s}{P} = \omega_0 + \theta i$$

Then:

$$\hat{\gamma}' \equiv \frac{1}{1 - c_1(1 - t_1) - b_1 + \dfrac{b_2}{h + \theta}}$$

As θ goes to infinity, then multiplier goes to γ

Non-partisan and Partisan Analyses

- The CBO is the Congress's nonpartisan economic/budget analytical arm
- Other agencies include General Accountability Office (GAO) and Congressional Research Service (CRS)
- Mirrors the Executive Branch's Office of Management and Budget (OMB) and Council of Economic Advisers (CEA) in White House
- Always think about who's writing what you read

Did the Stimulus “Work”

- What does “work” mean?
- We’ll interpret “work” to mean increase aggregate demand, output, employment
- One has to be careful about over what period one talks about “working”
- Uncertainty pervades all these analyses (real world vs. textbook)

Estimates of the Impact of ARRA

Table 8. Estimates of the Effects of the ARRA on the Level of GDP

	2009:Q2	2009:Q3	2009:Q4	2010:Q1	2010:Q2	2010:Q3
			Percent			
CEA: Model Approach	+0.8	+1.7	+2.1	+2.5	+2.7	+2.7
CEA: Projection Approach	+0.7	+1.1	+2.1	+2.7	+2.7	+2.7
CBO: Low	+0.8	+1.2	+1.4	+1.7	+1.7	+1.5
CBO: High	+1.3	+2.4	+3.3	+4.1	+4.5	+4.2
Goldman Sachs	+0.5	+1.4	+1.9	+2.3	+2.6	+2.4
IHS/Global Insight	+0.5	+1.2	+1.7	+2.0	+2.2	+2.3
James Glassman, J.P.Morgan Chase	+1.3	+1.8	+2.6	+3.2	+3.7	+3.5
Macroeconomic Advisers	+0.5	+1.0	+1.4	+1.7	+2.1	+2.1
Mark Zandi, Moody's Economy.com	+0.8	+1.6	+2.2	+2.5	+2.7	+2.7

Sources: See text for details.

Table 9. Estimates of the Effects of the ARRA on the Level of Employment

	2009:Q2	2009:Q3	2009:Q4	2010:Q1	2010:Q2	2010:Q3
CEA: Model Approach	+399,000	+1,120,000	+1,747,000	+2,223,000	+2,547,000	+2,673,000
CEA: Projection Approach[a]	+318,000	+1,010,000	+1,844,000	+2,701,000	+3,376,000	+3,668,000
CBO: Low	+300,000	+700,000	+1,000,000	+1,200,000	+1,400,000	+1,400,000
CBO: High	+500,000	+1,300,000	+2,100,000	+2,800,000	+3,400,000	+3,700,000
IHS/Global Insight	+228,000	+689,000	+1,245,000	+1,696,000	+2,107,000	+2,342,000
Macroeconomic Advisers	+248,000	+623,000	+1,057,000	+1,462,000	+1,847,000	+2,119,000
Mark Zandi, Moody's Economy.com	+500,000	+1,008,000	+1,486,000	+1,893,000	+2,249,000	+2,522,000

Sources: See text for details.

Notes: a. Estimates are for the middle month of the quarter.

Source: CEA, *Fifth Quarterly Report on the Economic Impact of ARRA* (Nov. 18, 2010)
http://www.whitehouse.gov/sites/default/files/cea_5th_arra_report.pdf

How Did They Estimate This Effect?

- Use the multiplier model we have learned
- Figure out how much tax payments have been reduced, how much transfers have increased
- Figure out how much government spending on goods and services
- Apply multipliers, then add up effects, compare to GDP
- Annualize to get growth rates
- Caveat: Have to account for time dimension (impact takes time)

Quantities (Cumulative)

Table 2. Fiscal Stimulus by Functional Category

	Through the end of[a]						
	2009:Q1 (March)	2009:Q2 (June)	2009:Q3 (September)	2009:Q4 (December)	2010:Q1 (March)	2010:Q2 (June)	2010:Q3 (September)
	Billions of Dollars						
Individual Tax Cuts	2.3	28.4	42.1	55.0	98.6	120.7	130.9
AMT Relief	0.0	7.0	12.4	15.5	25.7	68.0	74.5
Business Tax Incentives	0.1	10.9	20.0	28.0	34.1	38.5	36.2
State Fiscal Relief	8.5	28.2	43.8	59.3	75.5	92.1	107.1
Aid to Directly Impacted Individuals	0.1	9.8	32.2	56.2	72.8	78.3	83.3
Public Investment Outlays	0.0	7.4	24.9	41.5	59.2	86.3	119.3
Total[b]	**11.0**	**91.7**	**175.4**	**255.6**	**365.9**	**484.0**	**551.2**
Change in Total (from End of Previous Quarter)	**11.0**	**80.7**	**83.7**	**80.2**	**110.2**	**118.1**	**67.3**

Sources: Agency Financial and Activity Reports to the Office of Management and Budget; simulations from the Department of the Treasury (Office of Tax Analysis) based on the FY2011 Mid-Session Review .

Notes: a. Data on outlays and obligations are for the last day of each calendar quarter.

b. Items may not add to total due to rounding.

Source: CEA, *Fifth Quarterly Report on the Economic Impact of ARRA* (Nov. 18, 2010)
http://www.whitehouse.gov/sites/default/files/cea_5th_arra_report.pdf

Apply Multipliers (for '09Q2)

IMPACT MULTIPLIERS (within the quarter)

- Tax cuts: \$28.4 bn × 0
- AMT relief: \$7.0 bn × 0
- Bus. Tax incentives: \$10.9 bn × 0
- State fiscal relief: \$28.2 bn × 0.5
- Aid to directly impacted: \$9.8 bn × 1
- Govt. investment outlays: \$7.4 bn × 1

= (28.4 ×0)+(7.2×0)+(10.9×0)+(28.2×0.5)+(9.8×1)+(7.4×1)

= \$31.3 bn

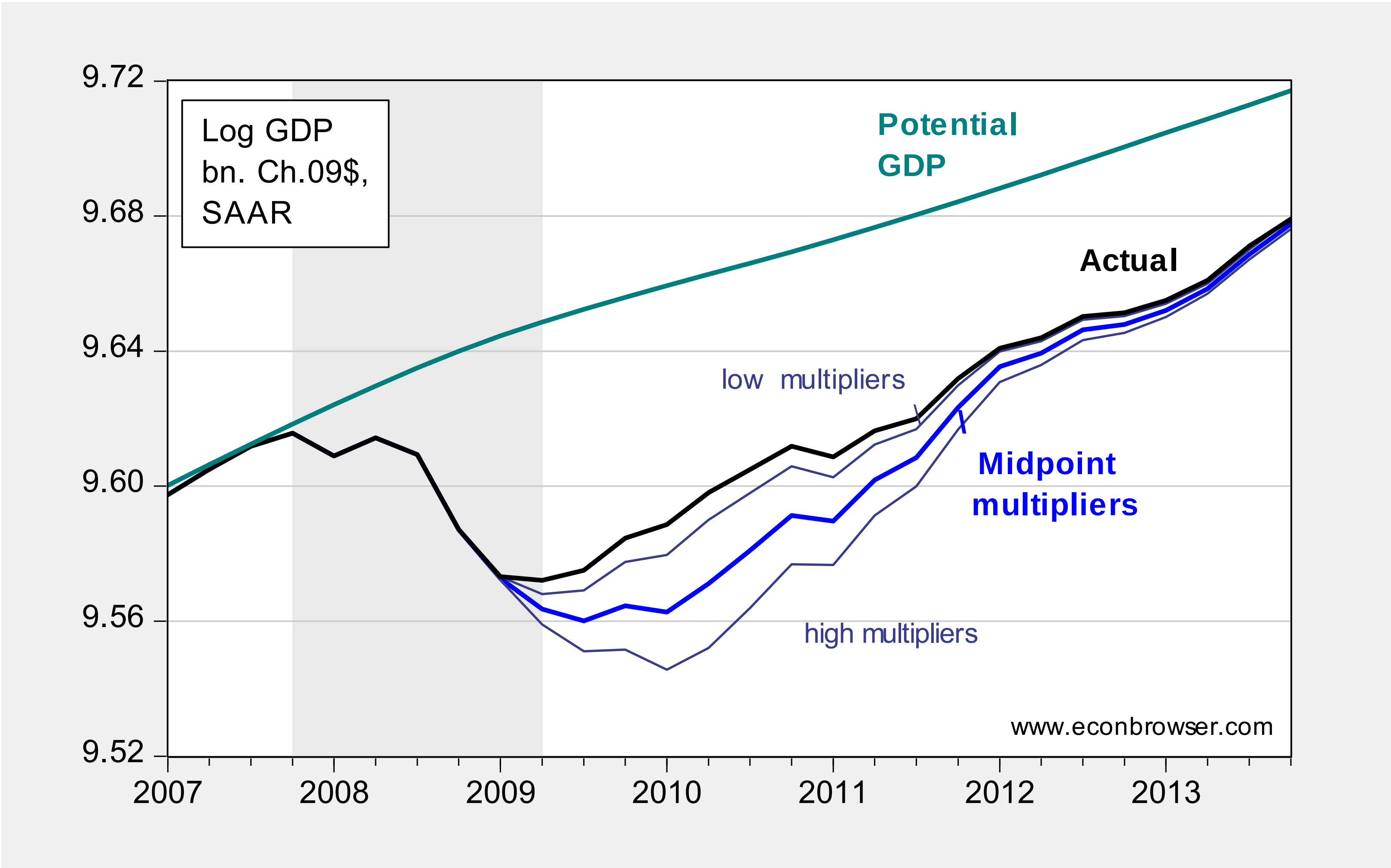
Deflate, calculate q/q impact

- GDP deflator in 2009Q2: 109.555 ≈ 110
- $31.3 bn/1.10 = 28.57 Ch.2005$
- ‘09Q2 real GDP SAAR: 12810.45-28.57=12781.88
- ‘09Q2 real GDP: 12781.88/4 = 3195.47
- Impact 2009Q2: 28.57/3195.47 = 0.00894
- Annualize impact: $(1.00894)^4$ = 1.0362
- Impact on growth: (1.0362-1)×100%= 3.6 ppts (q/q, annualized)

Comparisons, Complications

- Impact of 3.6 ppts vs. CEA 2.8 ppts.
- Impact vs. dynamic multipliers
- In our math, we assume everything happens with “a period”
- In reality, impact is different from cumulative long run
- In 2009Q3, some of the tax cuts in 2009Q2 will have an impact: how much?

ARRA and What Could Have Been

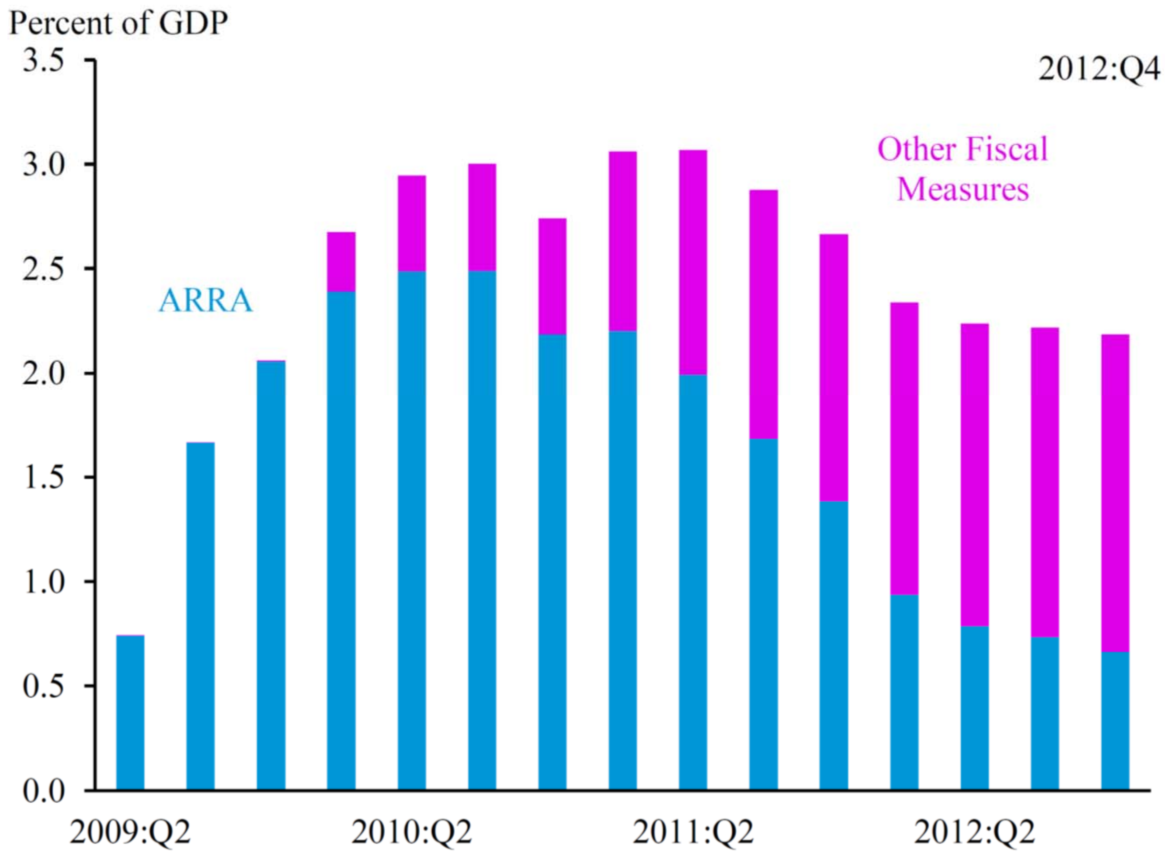


CEA, The Economic Impact of the American Recovery and Reinvestment Act Five Years Later (Feb. 2014)

ARRA and Other Fiscal

Figure 7

Quarterly Effect of the Recovery Act and Subsequent Fiscal Measures on GDP, 2009–2012



Source: Bureau of Economic Analysis, National Income and Product Accounts; Congressional Budget Office; CEA calculations.

CEA, The Economic Impact of the American Recovery and Reinvestment Act Five Years Later (Feb. 2014)

Where Do the Multiplier Estimates Come From?

- Macroeconometric models (essentially IS-LM, AD-AS with estimated equations)
- Vector AutoRegressions (VARs)
- Dynamic Stochastic General Equilibrium (DSGE) models

Large Scale Macroeconometric Models

- Examples: Global Insight (subsumes Wharton Econometrics), Standard and Poors (subsumes Data Resources, Inc.), Macroeconomic Advisers, MiniMOD, FRB/US
- Most of these models developed in 1960s-1970s.
- In the 1980s and 1990s, implemented model consistent expectations, as opposed to adaptive expectations.

FRB/US Model

- Used at the Federal Reserve
- Typical of macroeconometric models
- But US focused
- All described here:

http://www.federalreserve.gov/econresdata/frbus/us-models-about.htm

- Will describe in terms of AD, AS

Table 3: Aggregate Consumption Equation (c)

equilibrium relationship:	$c^* = 1.0v + .62s_{trans} - .15s_{prop} + .52s_{stock} + 1.28s_o + .013\tilde{x}.$
dynamic adjustment:	$\Delta c_t = -.12(c_{t-1} - c^*_{t-1}) + .17 \text{ lags}_1(\Delta c_{t-i}) + .75 \text{ leads}_\infty(\Delta c^{*e}_{t+i}) + .09\Delta y_t.$
	span: 63q1-95q4 $\quad$ R^2: .54 $\quad$ SEE: .0032 $\quad$ MRL [a]: 7.9 quarters
definitions:	c - log consumption (including service flow of stock of durables). Y - income (labor + transfer + property). y - log Y. V - wealth = $\text{leads}_\infty(Y^e)$. v - log V. s_{trans} - transfer wealth / V. s_{prop} - property wealth / V. s_{stock} - value of corp. equity / V. s_o - other net financial and tangible assets / V. $\tilde{x}$ - aggregate output gap.

[a] Mean response lag to a surprise.

http://www.federalreserve.gov/pubs/feds/1996/199642/199642pap.pdf

Table 5: Business Investment Equations (i_{pd} and k_i)

equilibrium relationships:	$i^*_{pd} = 1.0x_b - 1.0r_{pd} + 1.0z_{pd} + 19.5\Delta x_b.$ $k^*_i = 1.0x_b.$
dynamic adjustment:	$\Delta i_{pd,t} = -.07(i_{pd,t-2} - i^*_{pd,t-2}) + .26 \text{ lags}_2(\Delta i_{pd,t-i}) + .47 \text{ leads}_\infty(\Delta i^{*e}_{pd,t+i-1}) + .22 \text{ lags}_2(\Delta cf_{t-i}).$ span: 64q1-94q4 R^2: .40 SEE: .0022 MRL [a]: 7.0 quarters $\Delta k_{i,t} = -.23(k_{i,t-1} - k^*_{i,t-1}) + .47 \text{ lags}_3(\Delta k_{i,t-i}) + .53 \text{ leads}_\infty(\Delta k^{*e}_{i,t+i}).$ span: 62q3-94q4 R^2: .42 SEE: .0065 MRL [a]: 1.3 quarters
remarks:	• dynamic equation for i_{pd} is a weighted average of adjustment model (.78) and cash flow model (.22). • adjustment model component for i_{pd} includes 1-quarter delivery lag.
definitions:	i_{pd} - log investment in producers' durable equipment (constant dollars). k_i - log stock of manufacturing and trade inventories (constant dollars). x_b - log output, business sector (constant dollars). r_{pd} - log user cost of capital, producer durables. z_{pd} - log(depreciation rate + mean of Δx_b). cf - log corporate cash flow (constant dollars).

[a] Mean response lag to a surprise.

Table 2: Aggregate Price Equation (p)

equilibrium relationship:	$p^* = .98(w - \rho) + .02p_e - .003u.$	
remarks:	• equilibrium condition includes also effects of farm and import prices.	
dynamic adjustment:	$\Delta p_t = -.10(p_{t-1} - p^*_{t-1}) + .57\text{lags}_2(\Delta p_{t-i}) + .43\text{leads}_\infty(\Delta p^{*e}_{t+i}).$	R^2 .88 SEE .0025
properties:	mean response lag to surprise = 3.3 quarters.	span: 63q1-94q4
remarks:	• dynamic equation includes an accelerated response to energy price inflation.	
definitions:	p - log price of final sales plus imports less gov't labor and indirect business taxes. w - log compensation per hour (ECI). ρ - log trend labor productivity. p_e - log crude energy price. u - demographically-weighted unemployment rate.	

Table 6: Aggregate Labor Hours, Wages, and Prices (h, w, and p)

equilibrium relationship:

$$h^* = 1.0x_g - .0069t_{47} + .0042t_{73}.$$

$$w^* = 1.0\rho + 1.02p_g - .02p_e - .01u.$$

$$p^* = .98(w - \rho) + .02p_e - .003u.$$

remark: • equilibrium condition for p also includes effects of farm and import prices.

dynamic adjustment:

$$\Delta h_t = -.15(h_{t-1} - h^*_{t-1}) + .38 \text{ lags}_1(\Delta h_{t-i}) + .41 \text{ leads}_\infty(\Delta h^{*e}_{t+i}).$$
$$+ .31\ \Delta h^*_t - .12 \text{ lags}_1(\Delta h^*_{t-i}).$$

span: 63q1-94q4 R^2: .76 SEE: .0046 MRL [a]: 0.7 quarters

$$\Delta w_t = -.03(w_{t-1} - w^*_{t-1}) + .71 \text{ lags}_3(\Delta w_{t-i}) + .29 \text{ leads}_\infty(\Delta w^{*e}_{t+i}).$$

span: 63q1-94q4 R^2: .82 SEE: .0028 MRL [a]: 8.7 quarters

$$\Delta p_t = -.10(p_{t-1} - p^*_{t-1}) + .57 \text{ lags}_2(\Delta p_{t-i}) + .43 \text{ leads}_\infty(\Delta p^{*e}_{t+i}).$$

span: 63q1-94q4 R^2: .88 SEE: .0025 MRL [a]: 3.3 quarters

remarks:
- dynamic equation for h is a weighted average of standard adjustment model (.69) and immediate response model (.31)
- dynamic equation for w also includes variables for wage and price controls, employer social insurance contributions, and the minimum wage.
- dynamic equation for p also includes an accelerated response to energy price inflation.

definitions:
- h - log hours, nonfarm business sector (employees and self-employed).
- w - log compensation per hour (ECI).
- p - log price of final sales plus imports less gov't labor and indirect business taxes.
- x_g - log output, nonfarm business sector plus oil imports less housing product (constant dollars).
- t_{47} and t_{73}- quarterly time trends starting 47q1 and 73q1.
- ρ - log trend labor productivity.
- p_g - log price of x_g less indirect business taxes.
- p_e - log crude energy price.
- u - demographically-weighted unemployment rate.

[a] Mean response lag to a surprise.

Table 7: Financial Sector Equations (r_5, r_{10}, r_{cb}, and v_s)

5-year gov't bond rate [a]:	$r_{5,t} = .34 + 1.0 \text{ leads}_{20}(r^e_{t+i}) - .62 \text{ leads}_{20}(\tilde{x}^e_{t+i}) + .83 \text{ lag}_1(\tilde{\mu}_{5,t-i})$
	span: 63q1-94q4 R^2: .97 SEE: .47 MRL [b]: 0 quarters
10-year gov't bond rate [a]:	$r_{10,t} = .46 + 1.0 \text{ leads}_{40}(r^e_{t+i}) - .79 \text{ leads}_{40}(\tilde{x}^e_{t+i}) + .85 \text{ lag}_1(\tilde{\mu}_{10,t-i})$
	span: 63q1-94q4 R^2: .99 SEE: .32 MRL [b]: 0 quarters
corporate bond rate [a]:	$r_{cb,t} = 1.21 + 1.0 \text{ leads}_{120}(r^e_{t+i}) - 1.21 \text{ leads}_{120}(\tilde{x}^e_{t+i}) + .87 \text{ lag}_1(\tilde{\mu}_{30,t})$
	span: 63q1-94q4 R^2: .99 SEE: .27 MRL [b]: 0 quarters
stock market wealth:	$v_{s,t} - p_{g,t} = 4.7 + d_t + 50 \text{ leads}_{\infty}(\Delta d^e_{t+i}) - 50(\ (r_{cb,t}/400) - \text{leads}_{120}(\Delta p^e_{c,t+i})\ )$
	span: 65q1-95q4 R^2: .97 SEE: .20 MRL [b]: 0 quarters
definitions:	r - federal funds rate. $\tilde{x}$ - output gap. $\tilde{\mu}_5$, $\tilde{\mu}_{10}$, and $\tilde{\mu}_{30}$ - term premium residuals for r_5, r_{10}, and r_{cb}. v_s - log stock market wealth (current dollars, flow of funds accounts). d - log national income dividends (constant dollars, deflated by p_g). p_g - log price, business sector output.[c] Δp_c - inflation rate, household consumption price.[c]

[a] For the three bond equations, the reported SEE and R^2 are computed after adjustment for first-order serial correlation of the term-premium residuals.

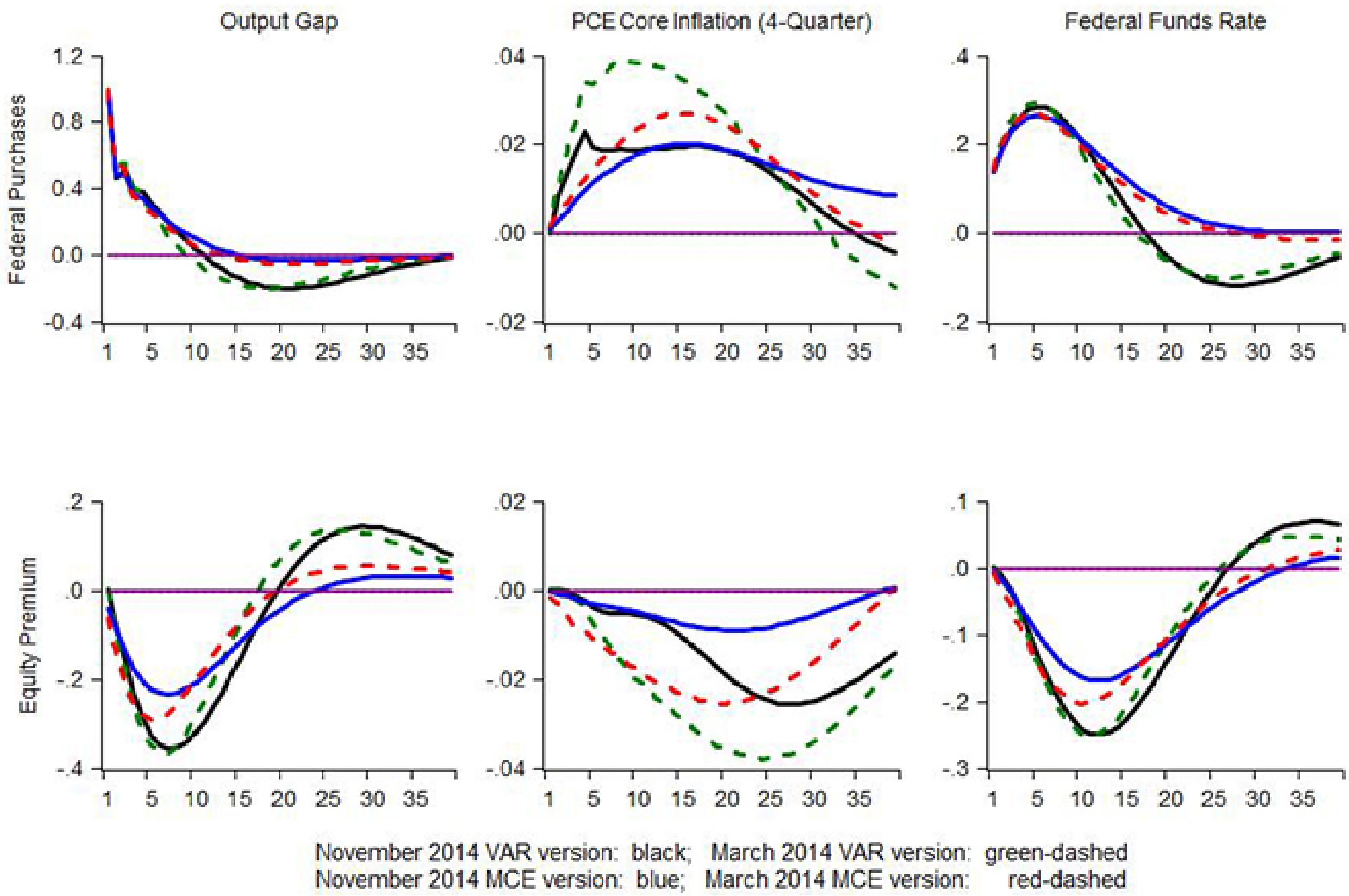
[b] Mean response lag to a surprise.

[c] Price indexes divided by 100 before taking logarithms.

Expectations

- Model consistent expectations (the closest that one can come to rational expectations)
- Learning is built in
- Or, use a VAR

Impulse Response Function



http://www.federalreserve.gov/econresdata/notes/feds-notes/2014/november-2014-update-of-the-frbus-model-20141121.html

VARs

- The various equations are estimated using OLS, etc.
- Obtaining unbiased or consistent estimates of the coefficients requires correct identification so error term is uncorrelated the RHS variables
- But in principle all equations should have same RHS variables, so omitted variables bias
- Sims: “Incredible identification”

VARs

The mathematical representation of a VAR is:

$$y_t = A_1 y_{t-1} + \cdots + A_p y_{t-p} + B x_t + \epsilon_t \qquad (18.1)$$

where y_t is a k vector of endogenous variables, x_t is a d vector of exogenous variables, $A_1, \ldots, A_p$ and B are matrices of coefficients to be estimated, and ϵ_t is a vector of innovations that may be contemporaneously correlated but are uncorrelated with their own lagged values and uncorrelated with all of the right-hand side variables.

Example of bivariate VAR, using industrial production, money, with 2 lags

$$\begin{aligned} IP_t &= a_{11} IP_{t-1} + a_{12} M1_{t-1} + b_{11} IP_{t-2} + b_{12} M1_{t-2} + c_1 + \epsilon_{1t} \\ M1_t &= a_{21} IP_{t-1} + a_{22} M1_{t-1} + b_{21} IP_{t-2} + b_{22} M1_{t-2} + c_2 + \epsilon_{2t} \end{aligned} \qquad (18.2)$$

where a_{ij}, b_{ij}, c_i are the parameters to be estimated.

VARs

- Standard approach: recursive, via Cholesky decomposition of the residual covariance matrix
- Can identify shocks using theory (long run/short run, e.g., Blanchard-Quah)
- No instantaneous impact (Blanchard-Perrotti)
- Can identify shocks using narrative approach (Romer-Romer)

Multipliers in Advanced Economies (panel)

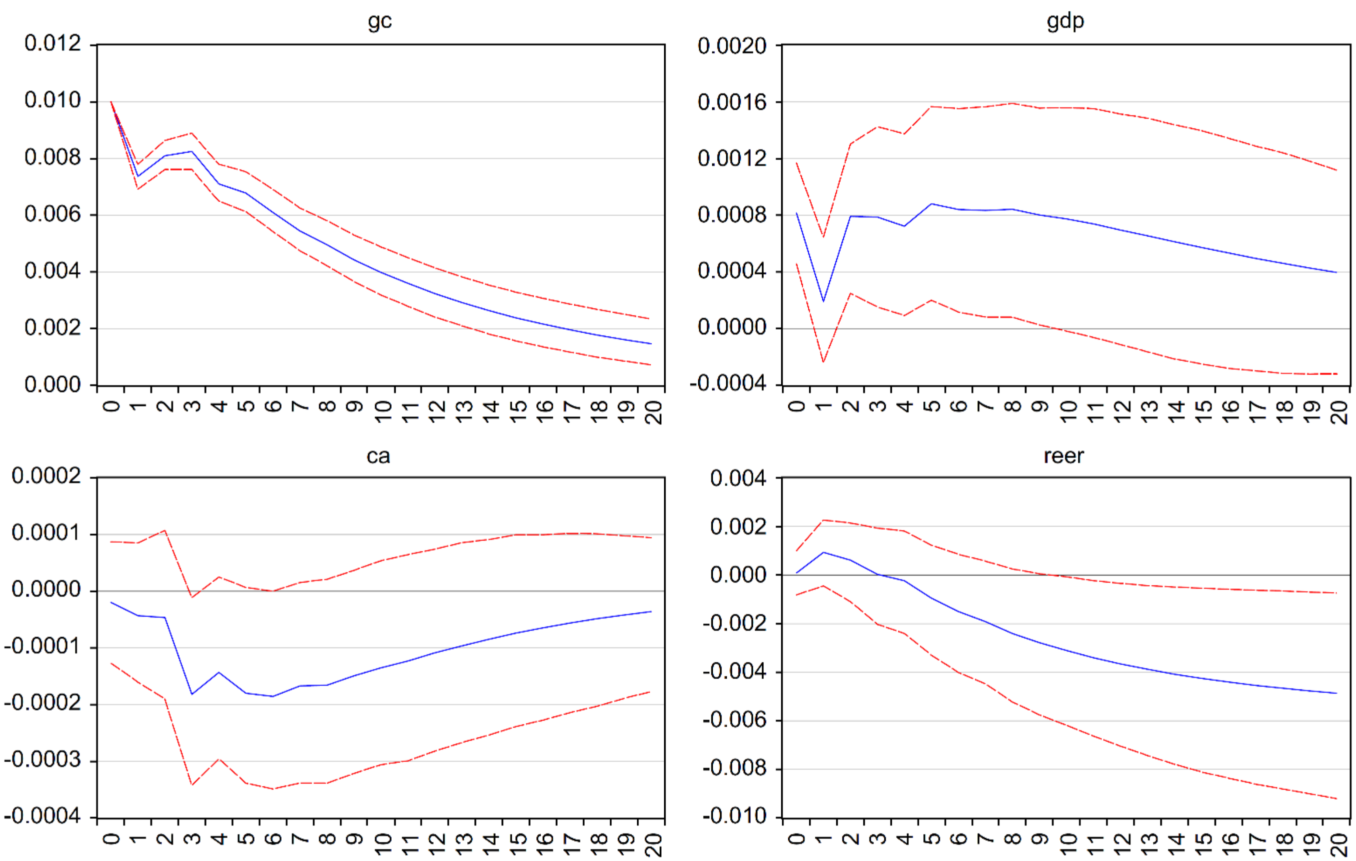


Fig. 1. Impulse responses to a 1% shock to government consumption in high-income countries. Responses are: gc, government consumption; gdp, real gross domestic product; ca, the current account as a percentage of GDP; reer, the real effective exchange rate. Dotted lines represent 90% confidence intervals based on Monte Carlo simulations.

Ilzetzki, et al. (2012)

Cumulative Multipliers

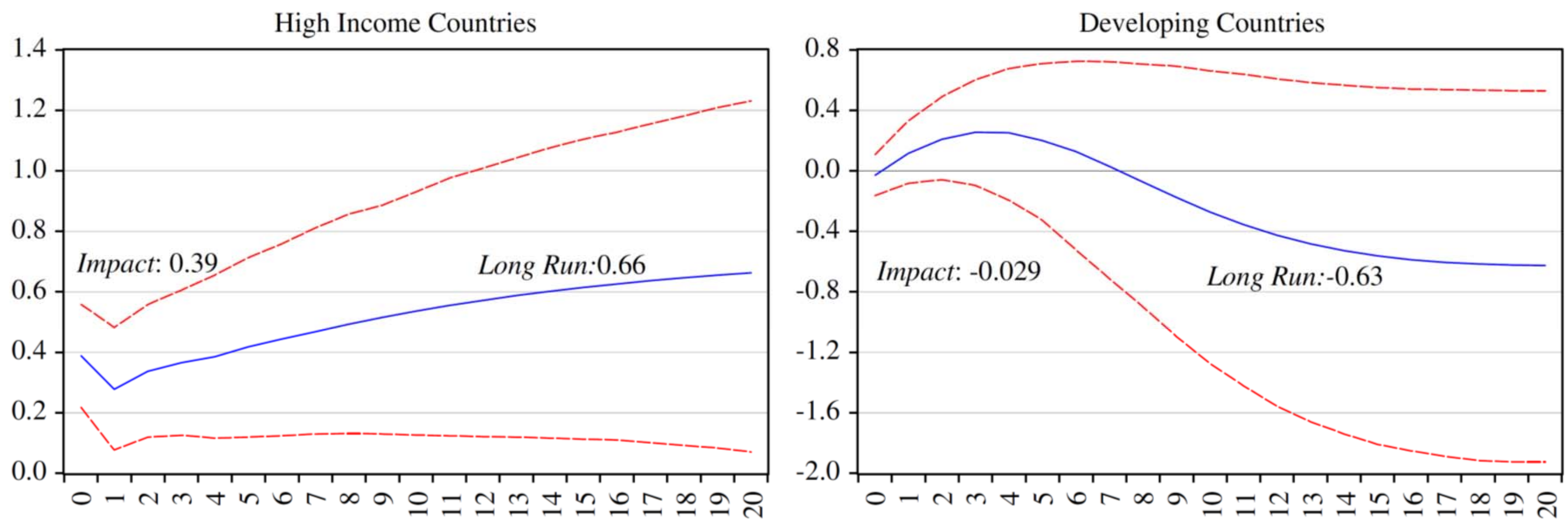


Fig. 3. Cumulative multiplier: high-income and developing countries. Ratio of the cumulative increase in the net present value of GDP and the cumulative increase in the net present value of government consumption, triggered by a shock to government consumption. Dotted lines represent 90% confidence intervals based on Monte Carlo simulations.

$$\text{impact multiplier} = \frac{\Delta y_0}{\Delta g_0} \qquad \text{cumulative multiplier}(T) = \frac{\sum_{t=0}^{T}(1+i)^{-t}\Delta y_t}{\sum_{t=0}^{T}(1+i)^{-t}\Delta g_t}$$

Ilzetzki, et al. (2012)

Cumulative Multipliers: Govt Investment

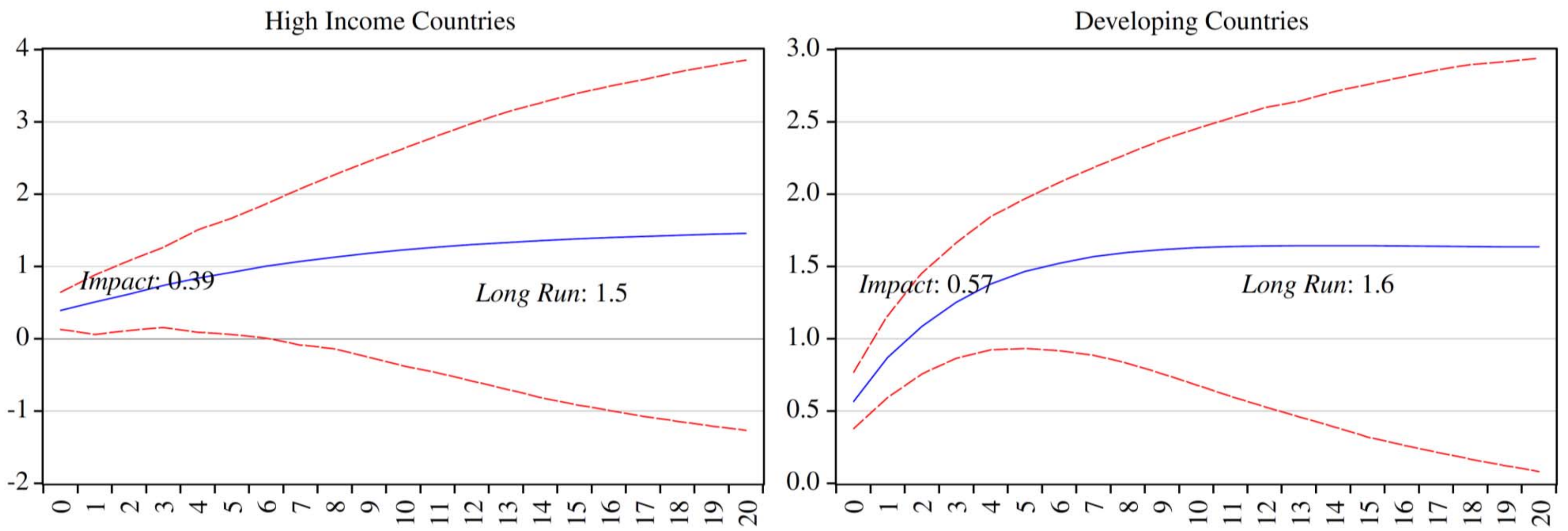
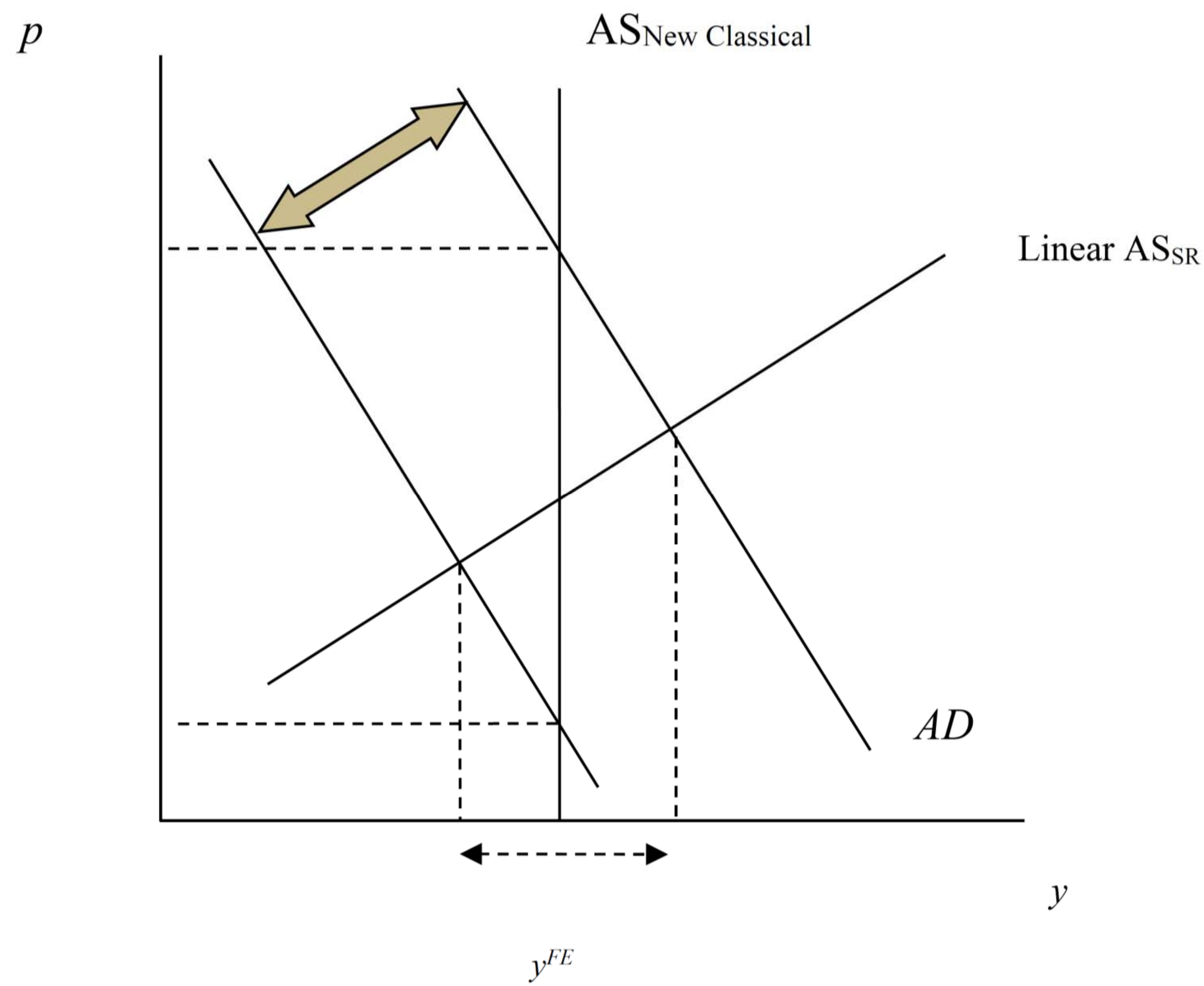


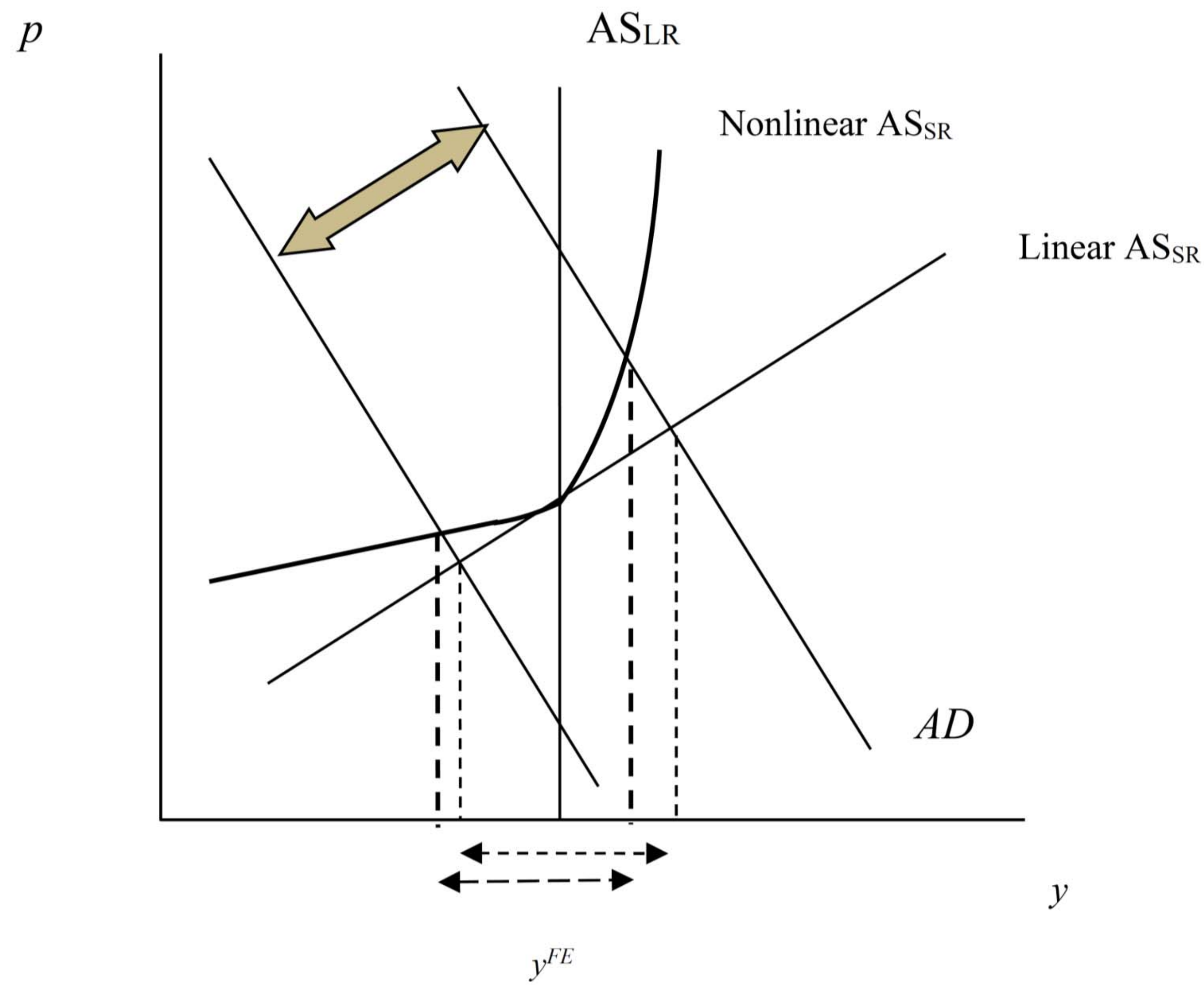
Fig. 9. Cumulative multiplier to a "pure" public investment shock: high-income and developing countries. Ratio of the cumulative increase in the net present value of GDP and the cumulative increase in the net present value of government investment, triggered by a shock to government investment. This response controls for public consumption, but does not allow for endogenous responses of GDP or public investment to government consumption. Dotted lines represent 90% confidence intervals based on Monte Carlo simulations.

Ilzetzki, et al. (2012)

Keynesian vs. New Classical



Kinked AS



Asymmetry

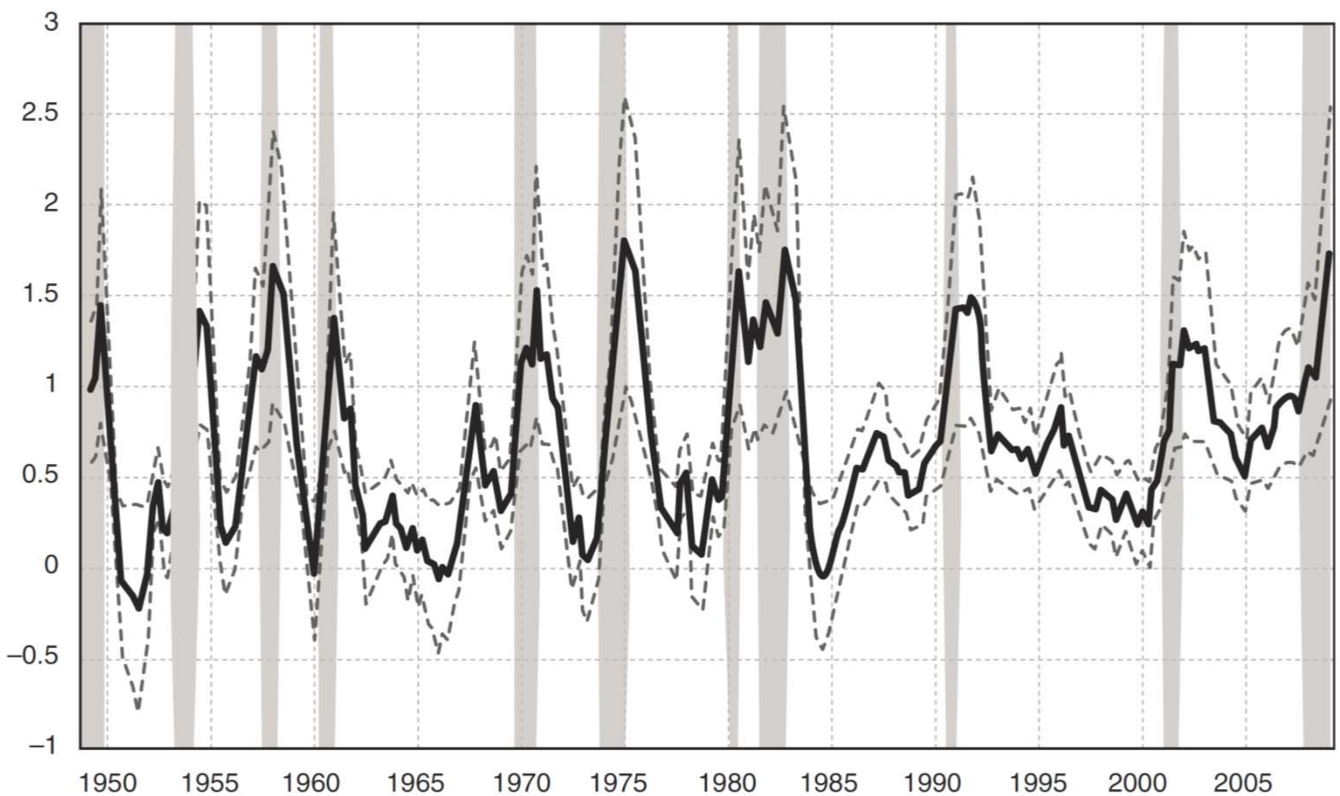


Figure 1 Historical multiplier for total government spending (Source: Auerbach and Gorodnichenko (2012b)).