Economics 210c/236a
Fall 2018

Christina Romer
David Romer

# LECTURE 5

# The Effects of Fiscal Changes: Aggregate Evidence

September 19, 2018

# I. Introduction

# Theoretical Considerations (I)

A traditional Keynesian model (sticky prices and demand-determined output in the short run; consumption determined largely by current income; small supply-side effects; etc.)

- Increases in G (or decreases in T) cause Y, C, and r to rise; I falls.
- The response of monetary policy is very important.

# Theoretical Considerations (II)

## A neoclassical model with lump-sum taxation (flexible prices; permanent-income consumers; …)

- Changes in T have no effects (Ricardian equivalence).
- The effects of changes in G work through wealth and substitution effects. For example, an increase in G means lifetime private resources are lower (wealth effect), leading to a fall in leisure (and so an increase in labor supply) and a fall in consumption. It also leads to changes in interest rates (substitution effect), further changing behavior.

# Theoretical Considerations (III)

## News of a future rise in G in a neoclassical model with lump-sum taxation

- Wealth effects cause immediate falls in consumption in leisure.
- Since output is higher and C is lower (and G hasn't yet changed), I is higher.
- When the change in G occurs, C and L don't change discontinuously. So I falls sharply.
- …

# Theoretical Considerations (IV)

Examples of possible additional complications:

- Adding “GHH preferences.” When these are added to a neoclassical model with lump-sum taxation, a rise in G has opposing effects on C: the fall in wealth acts to push it down, but the rise in L acts to push it up.
- Adding distortionary taxes. Now taxes matter in a neoclassical model.
- Adding more complicated “Keynesian” features, such as gradual price adjustment.

…

# II. Hall, "By How Much Does GDP Rise If the Government Buys More Output?"

# Hall's Regression

$$\frac{Y_t - Y_{t-1}}{Y_{t-1}} = a + b\frac{G_t - G_{t-1}}{Y_{t-1}} + e_t,$$

where Y is real GDP and G is real government military purchases (and the data are annual).

# What Question Are We Trying to Answer?

# Are There Possible Sources of Omitted Variable Bias in Hall's Regression? How Does Hall Interpret His Regression?

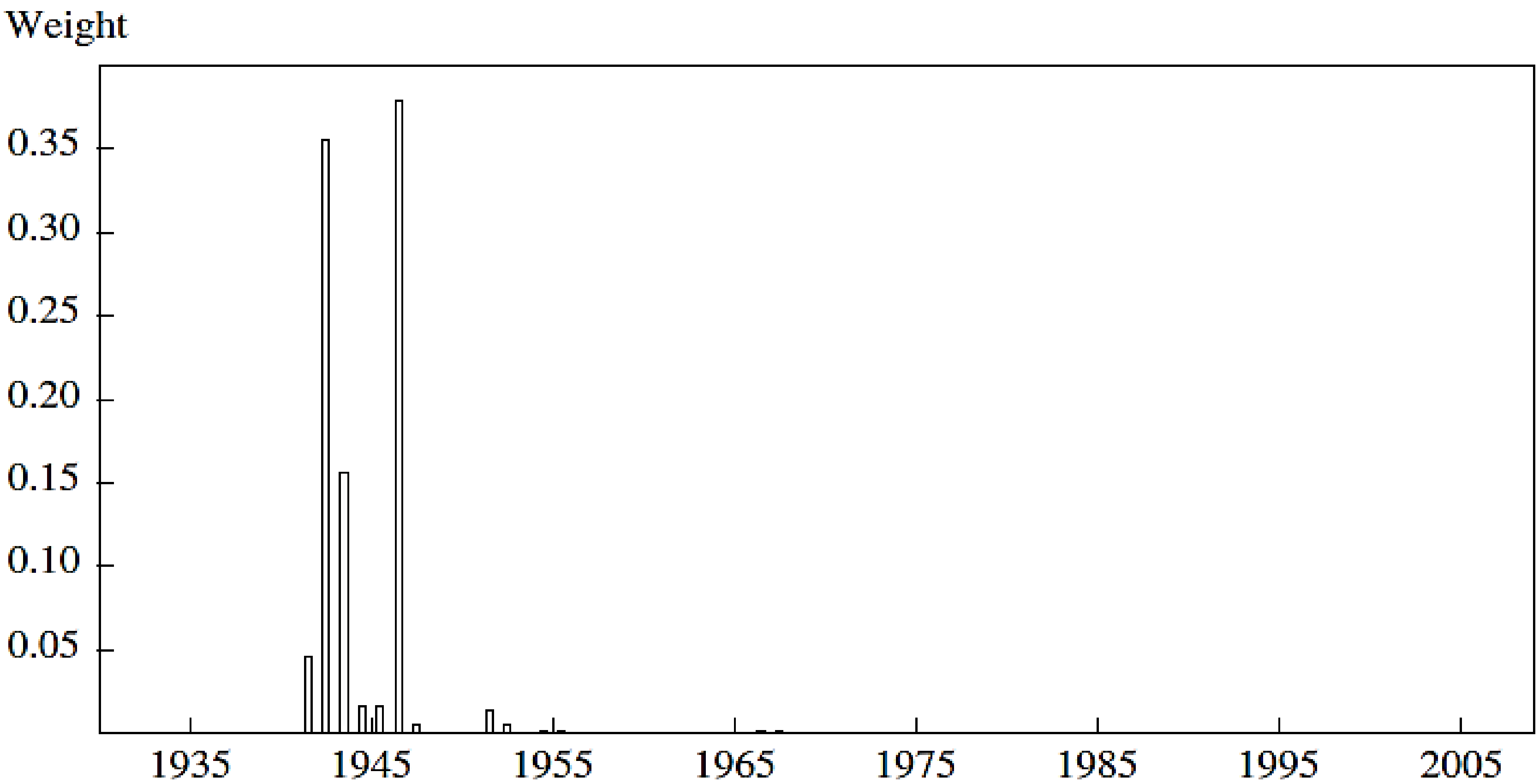
**Table 1. Ordinary Least Squares Estimates of Government Purchases Multipliers for Military Spending**[a]

| *Period* | *GDP multiplier* | *Consumption multiplier* |
|---|---|---|
| 1930–2008 | 0.55 | −0.05 |
| | (0.08) | (0.03) |
| 1948–2008 | 0.47 | −0.12 |
| | (0.28) | (0.10) |
| 1960–2008 | 0.13 | −0.09 |
| | (0.65) | (0.29) |
| 1939–48 | 0.53 | −0.05 |
| | (0.07) | (0.02) |
| 1949–55 | 0.48 | −0.18 |
| | (0.56) | (0.05) |
| 1939–44 | 0.36 | −0.11 |
| | (0.10) | (0.03) |
| 1945–49 | 0.39 | −0.04 |
| | (0.08) | (0.05) |

Source: Author's calculations.
a. Numbers in parentheses are standard errors.

From: Hall, "By How Much Does GDP Rise If the Government Buys More Output?"

**Figure 1. Annual Weights Implicit in OLS Estimates of Output and Consumption Multipliers[a]**




Source: Authorís calculations.

a. Each weight derives from the square of military spending in that year.

From: Hall, “By How Much Does GDP Rise If the Government Buys More Output?”

# III. Ramey, "Identifying Government Spending Shocks: It's All in the Timing"

# Themes

- Particularly interested in the effects of government purchases on consumption and real wages.
  - Argues that sheds important light on neoclassical vs. Keynesian theories of consumption and on competing views of product markets.
- Particularly interested in correctly measuring the <u>timing</u> of shocks to government spending.

# Results from a Conventional VAR

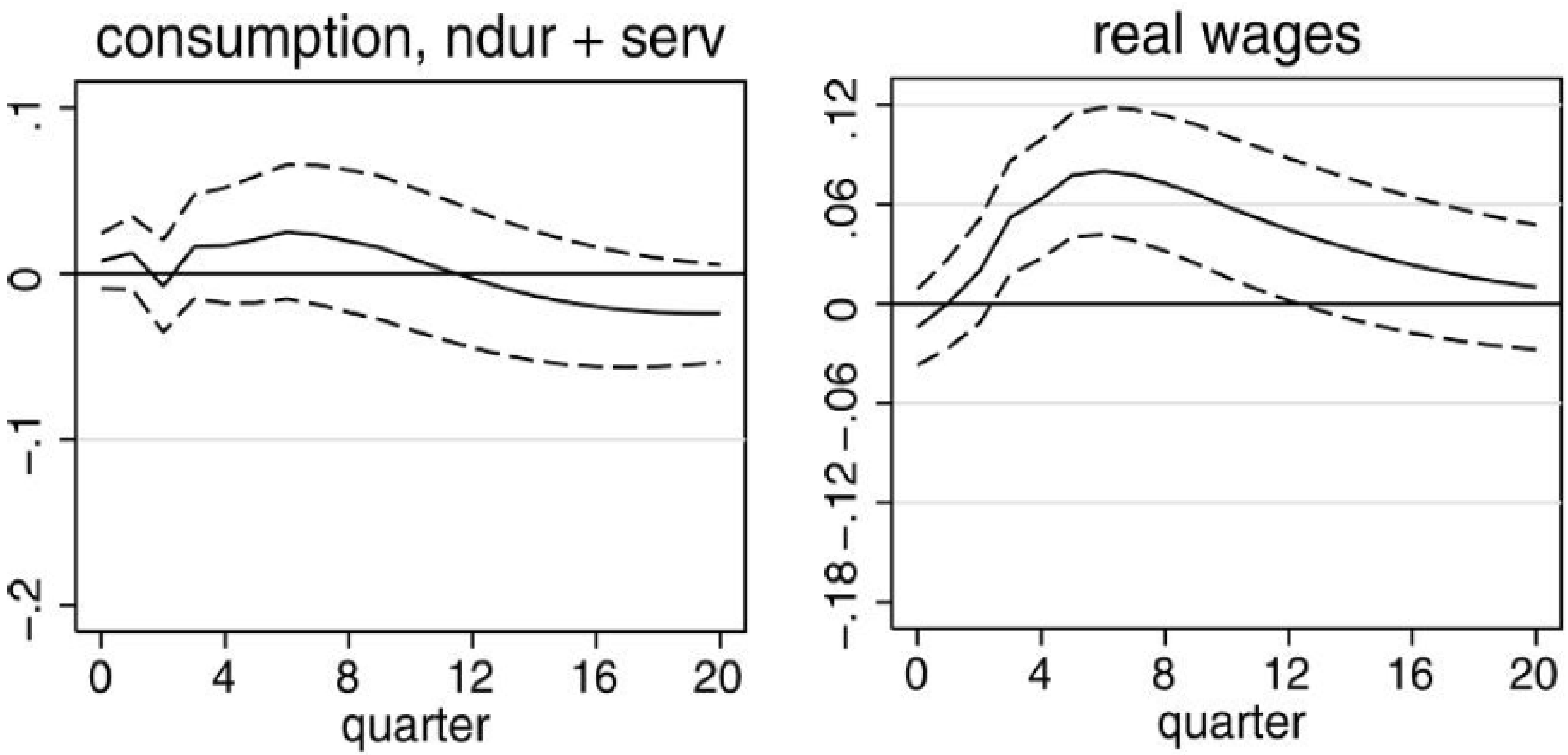



FIGURE IV

Comparison of Identification Methods: Response to a Government Spending Shock (Standard error bands are 68% confidence intervals)

From: Ramey, "Identifying Government Spending Shocks: It's All in the Timing"

# Themes

- Particularly interested in the effects of government purchases on consumption and real wages.
  - Argues that sheds important light on neoclassical vs. Keynesian theories of consumption and on competing views of product markets.
- Particularly interested in correctly measuring the <u>timing</u> of shocks to government spending.
  - Argues that if a variable jumps in response to news and then returns slowly to normal, a slight measurement error in timing can cause us to misestimate the <u>sign</u> of the effect.

TABLE I

GRANGER CAUSALITY TESTS

| Hypothesis tests | p-value in parenthesis |
|---|---|
| Do war dates Granger-cause VAR shocks? 1948:1–2008:4 | Yes (0.012) |
| Do one-quarter ahead professional forecasts Granger-cause VAR shocks? 1981:3–2008:4 | Yes (0.032) |
| Do four-quarter ahead professional forecasts Granger-cause VAR shocks? 1981:3–2008:4 | Yes (0.016) |
| Do VAR shocks Granger-cause war dates? 1948:1–2008:4 | No (0.115) |

*Notes.* VAR shocks were estimated by regressing the log of real per capita government spending on 4 lags of itself, the Barro–Redlick tax rate, log real per capita GDP, log real per capita nondurable plus services consumption, log real per capita private fixed investment, log real per capita total hours worked, and log compensation in private business divided by the deflator for private business. Except for the professional forecasts, 4 lags were also used in the Granger-causality tests. For the professional forecaster test, the VAR shock in period t is regressed on either the forecast made in period t-1 of the growth rate of real federal spending from t-1 to t for the forecast made in period t-4 of the growth from t-4 to t. The professional forecast regressions were estimated from 1981:3 to 2008:4 because this forecast was only available for that period. The war dates are a variable that takes a value of unity at 1950:3, 1965:1, 1980:1, and 2001:3.

From: Ramey, “Identifying Government Spending Shocks: It’s All in the Timing”

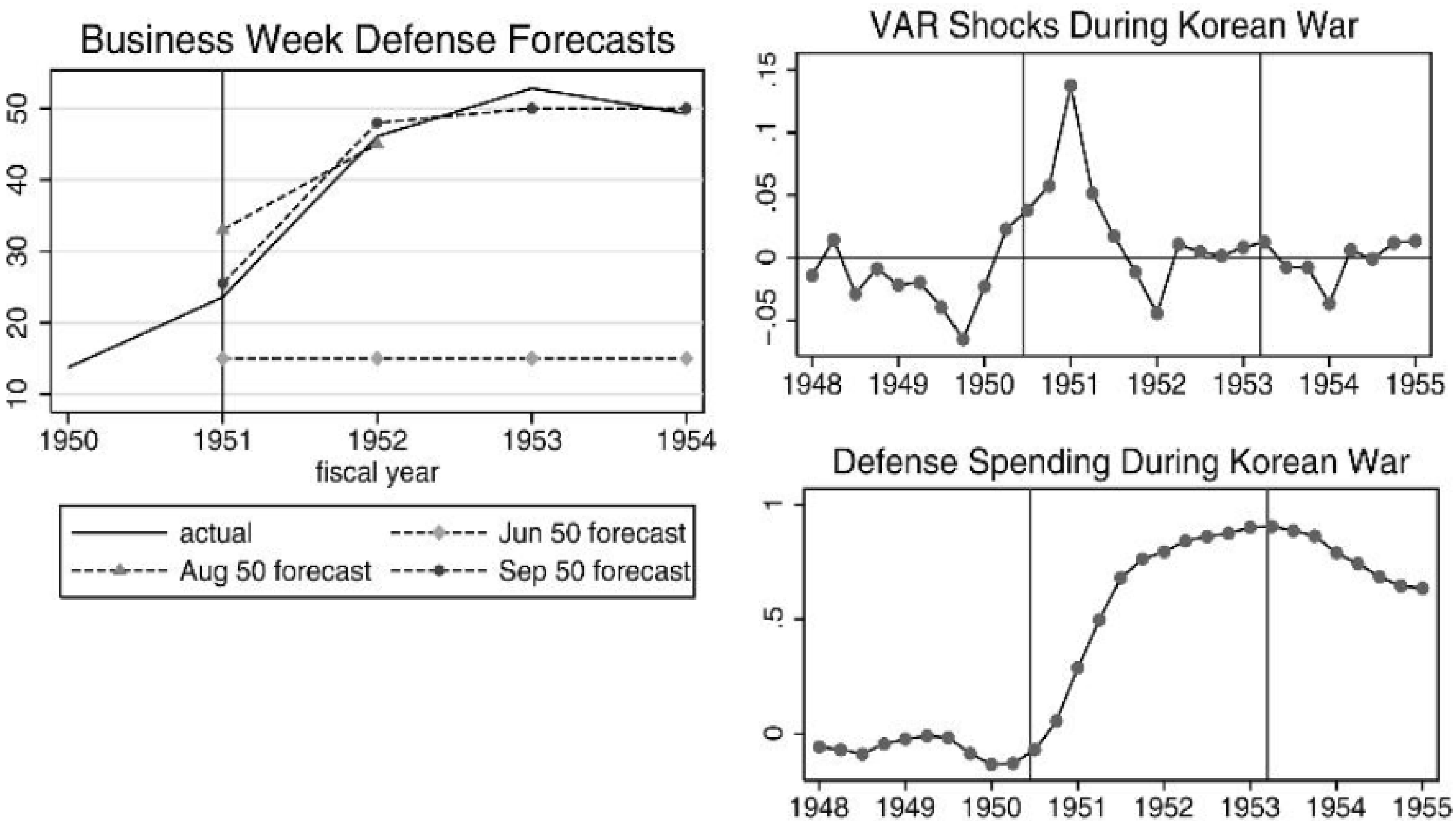



FIGURE V

Comparison of VAR Defense Shocks to Forecasts: Korea and Vietnam

From: Ramey, "Identifying Government Spending Shocks: It's All in the Timing"

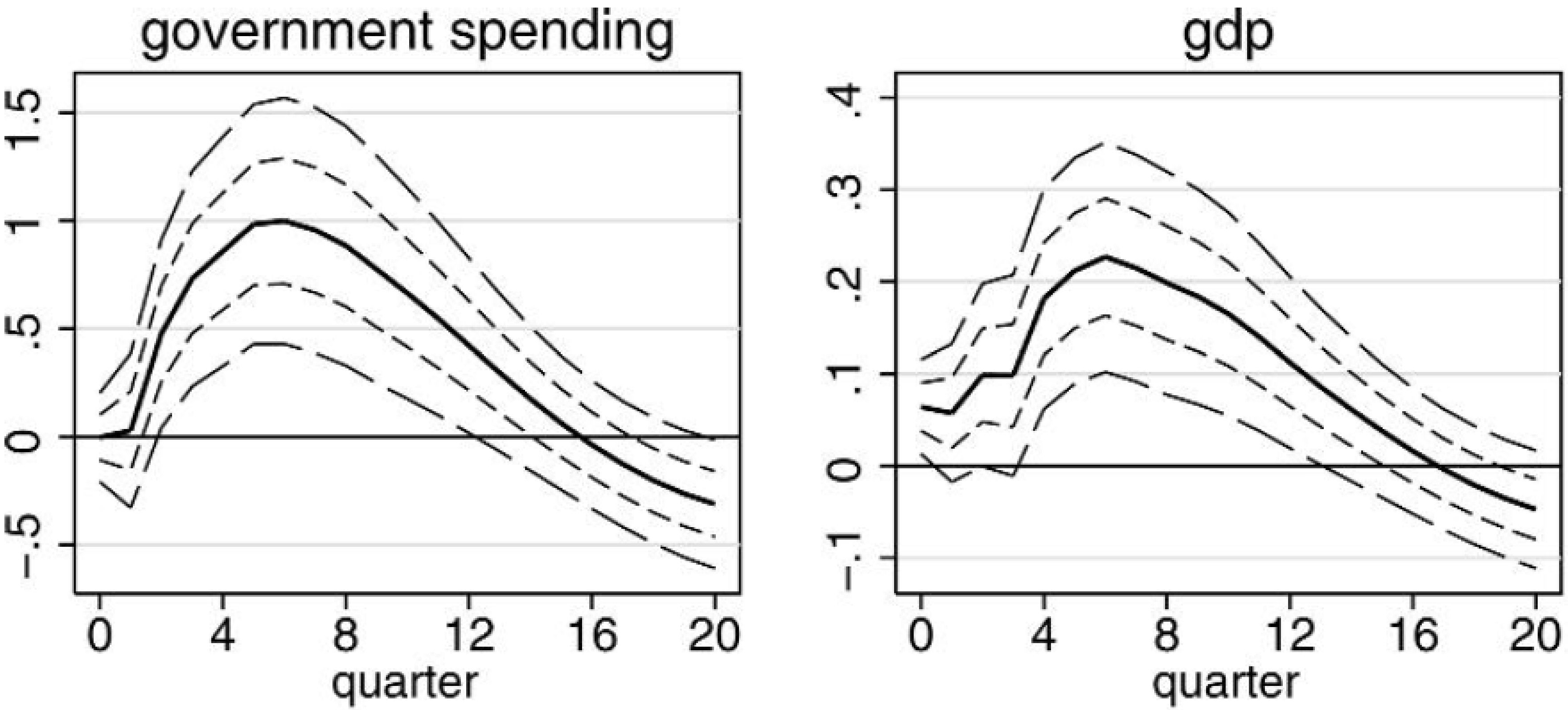



FIGURE X

The Effect of an Expected Change in Defense Spending, 1939–2008 (Both 68% and 95% standard error bands are shown)

From: Ramey, "Identifying Government Spending Shocks: It's All in the Timing"

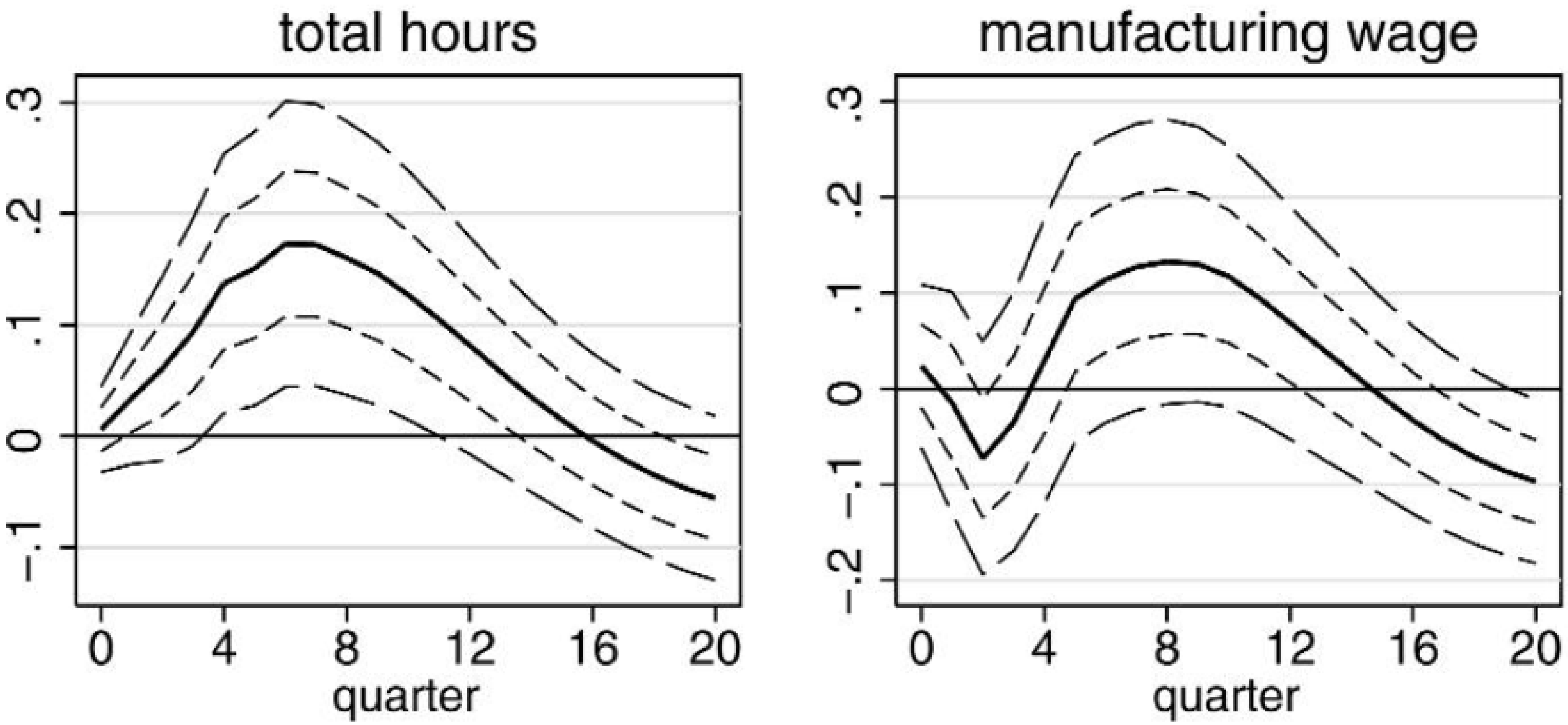



FIGURE X
The Effect of an Expected Change in Defense Spending, 1939–2008 (Both 68% and 95% standard error bands are shown)

From: Ramey, "Identifying Government Spending Shocks: It's All in the Timing"

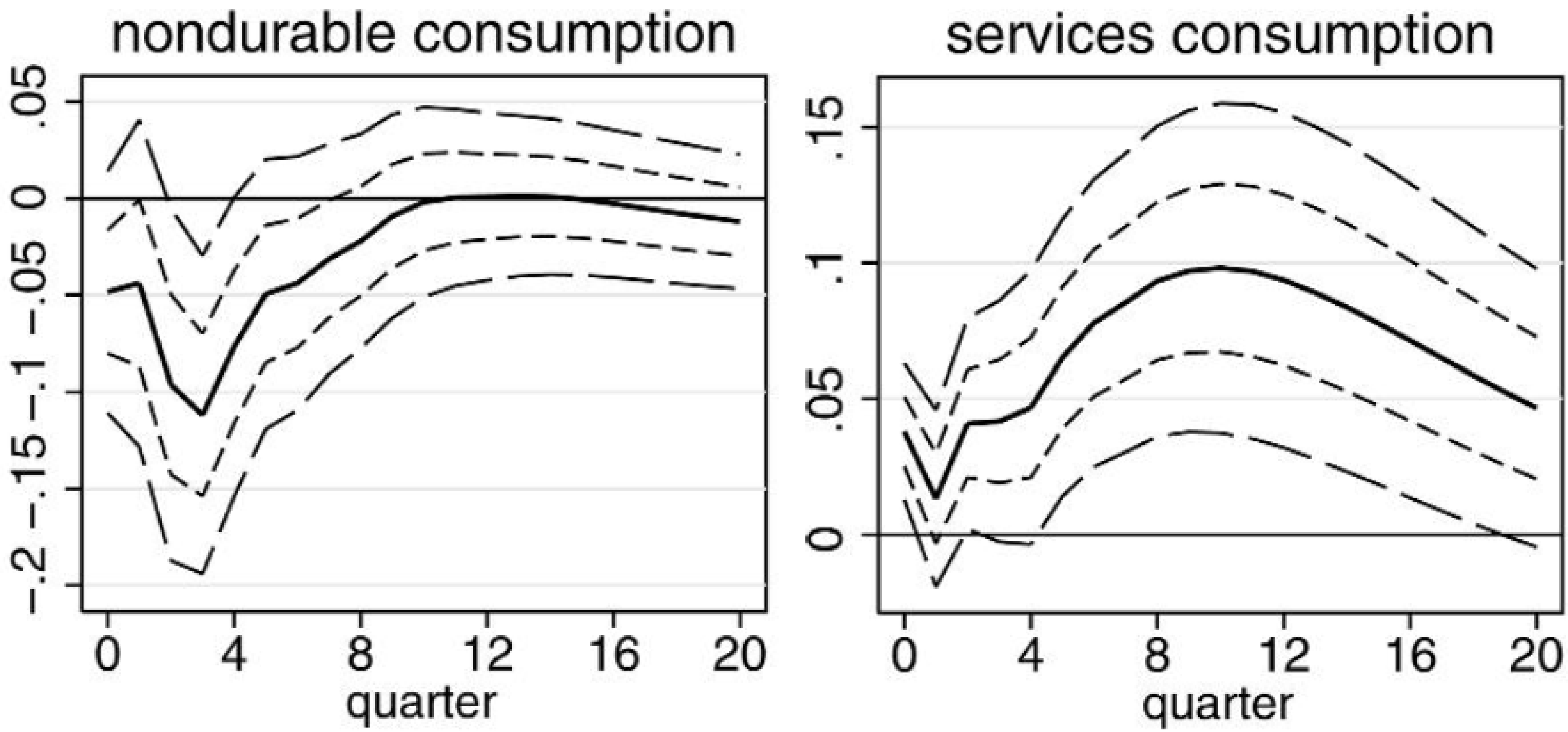



FIGURE X

The Effect of an Expected Change in Defense Spending, 1939–2008 (Both 68% and 95% standard error bands are shown)

From: Ramey, “Identifying Government Spending Shocks: It’s All in the Timing”

| Quarter | PDV of expected change in spending, billions of nominal $ | % of previous quarter GDP |
|---|---|---|
| 1939q1 | 0.5 | 0.56 |
| 1939q3 | 0.7 | 0.78 |
| 1940q2 | 31.6 | 32.17 |
| 1940q4 | 4.9 | 4.78 |
| 1941q1 | 7 | 6.63 |
| 1941q2 | 44.3 | 39.15 |
| 1941q4 | 97 | 74.50 |
| 1942q2 | 29 | 20.22 |
| 1942q3 | 66.2 | 42.45 |
| 1943q1 | 23 | 12.67 |
| 1944q2 | −34 | −15.93 |
| 1944q4 | 19.4 | 8.71 |
| 1945q3 | −41 | −17.60 |
| 1946q3 | 3.7 | 1.70 |
| 1947q2 | 7.8 | 3.29 |
| 1948q1 | 1.8 | 0.71 |
| 1948q2 | 3.5 | 1.34 |
| 1949q4 | −2 | −0.75 |
| 1950q2 | 7.7 | 2.80 |
| 1950q3 | 179.4 | 63.06 |
| 1950q4 | 124 | 41.07 |
| 1951q1 | 4.1 | 1.31 |

From: Ramey, “Identifying Government Spending Shocks: It’s All in the Timing”

# IV. Romer and Romer, "The Macroeconomic Effects of Tax Changes: Estimates Based on a New Measure of Fiscal Shocks"

# Background: Blanchard and Perotti

- A VAR with Y, G, cyclically-adjusted T.
- G and cyclically-adjusted T assumed not to respond to Y within the quarter.
- More precisely: Shocks to G and cyclically-adjusted T assumed uncorrelated with present and future shocks to Y.

# Discussion of Romer and Romer’s Approach

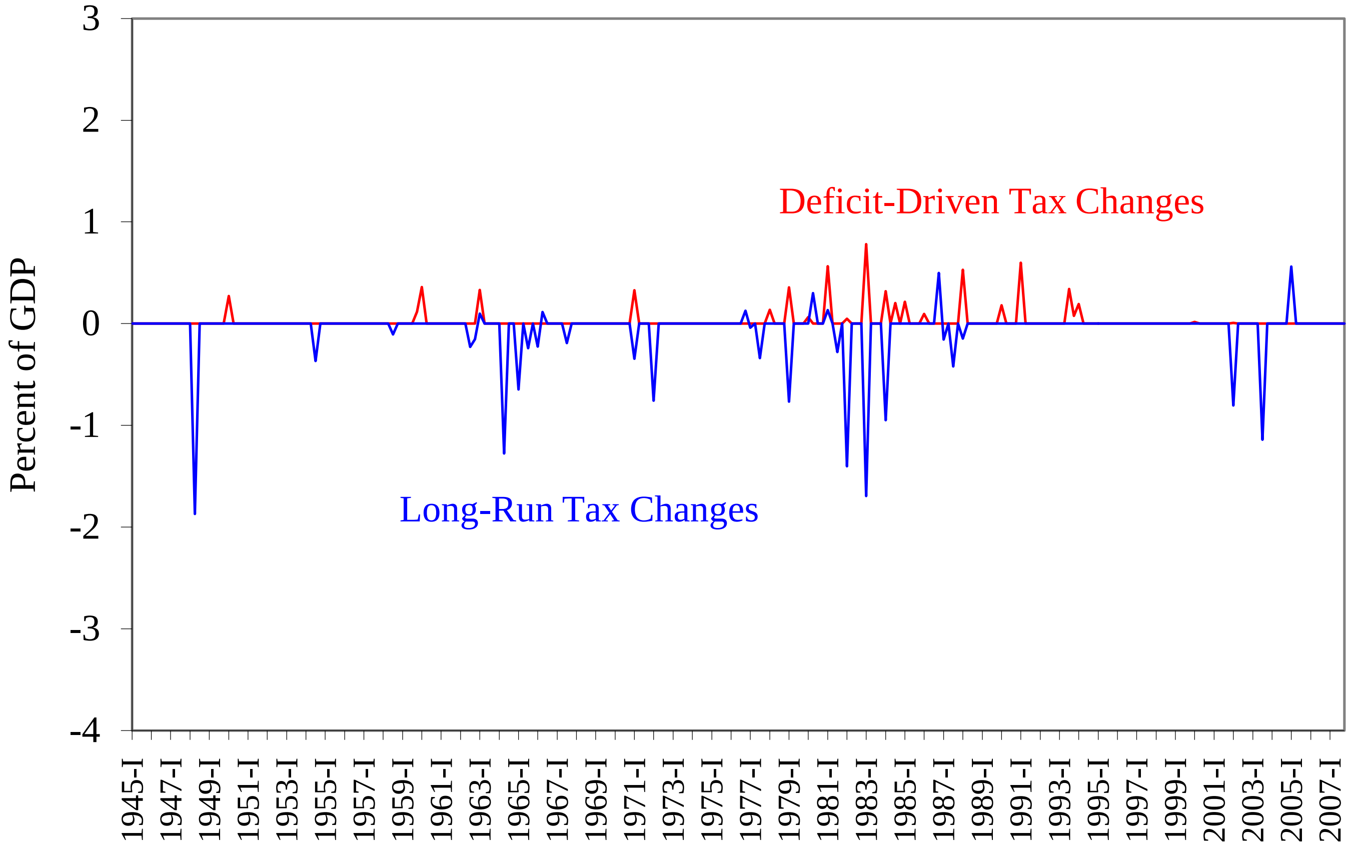
# Classifying Motivation

- Endogenous
  - Countercyclical
  - Spending-driven
- Exogenous
  - Deficit-driven
  - For long-run growth

# Figure 1

## New Measure of Fiscal Shocks

### b. Long-Run and Deficit-Driven Tax Changes

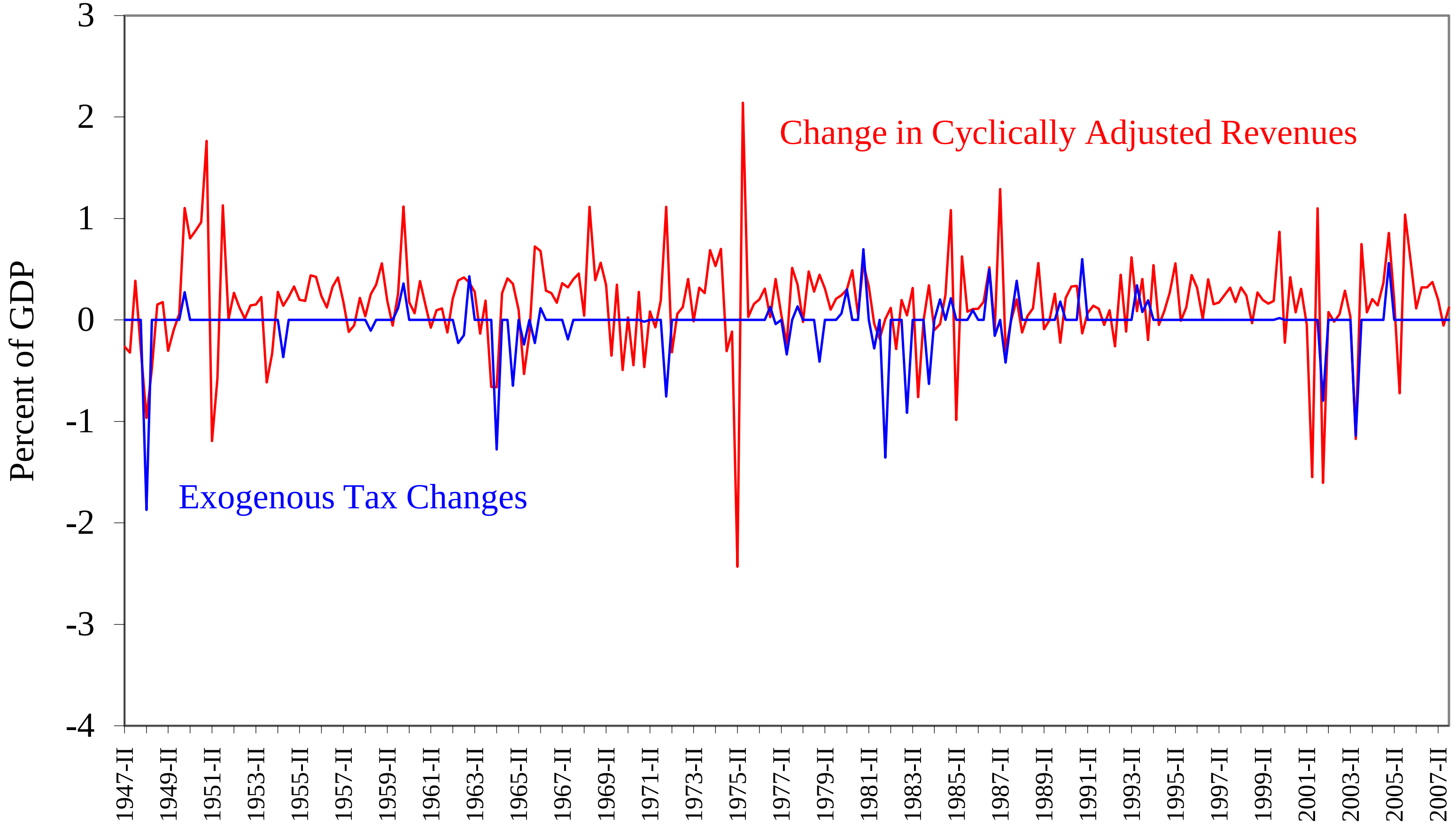



From: Romer and Romer, “The Macroeconomic Effects of Tax Changes”

# Figure 3

## Comparing New Measure of Tax Changes and Cyclically Adjusted Revenues

### a. Exogenous Tax Changes and the Change in Cyclically Adjusted Revenues




From: Romer and Romer, “The Macroeconomic Effects of Tax Changes”

# Specifications

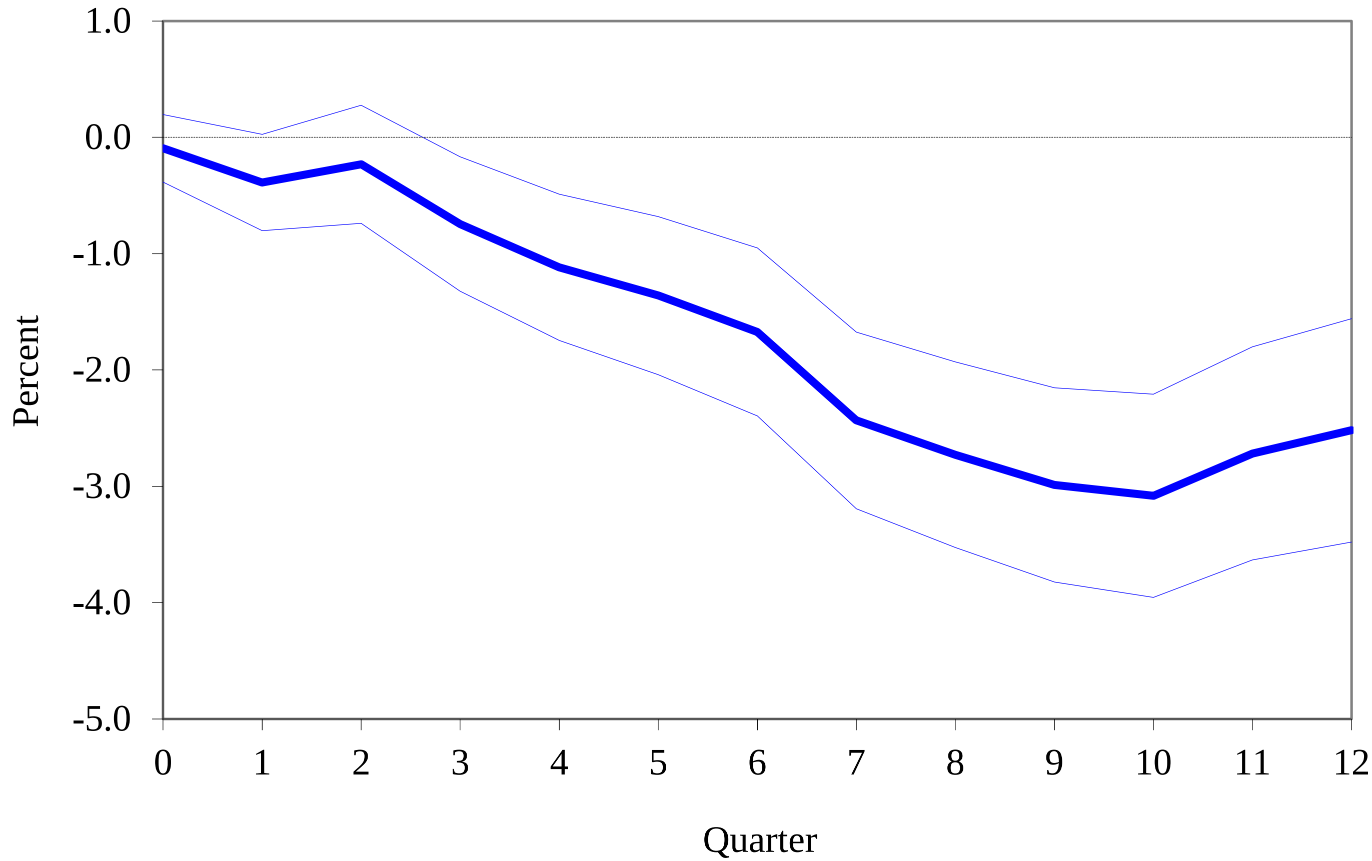
1. $$\Delta Y_t = a + \sum_{i=0}^{M} b_i \Delta T_{t-i} + e_t.$$

2. $$\Delta Y_t = a + \sum_{i=0}^{M} b_i \Delta T_{t-i} + \sum_{j=1}^{N} c_j \Delta Y_{t-j} + e_t.$$

3. A two-variable VAR with tax changes and GDP, 12 lags, tax variable ordered first.

# Figure 4

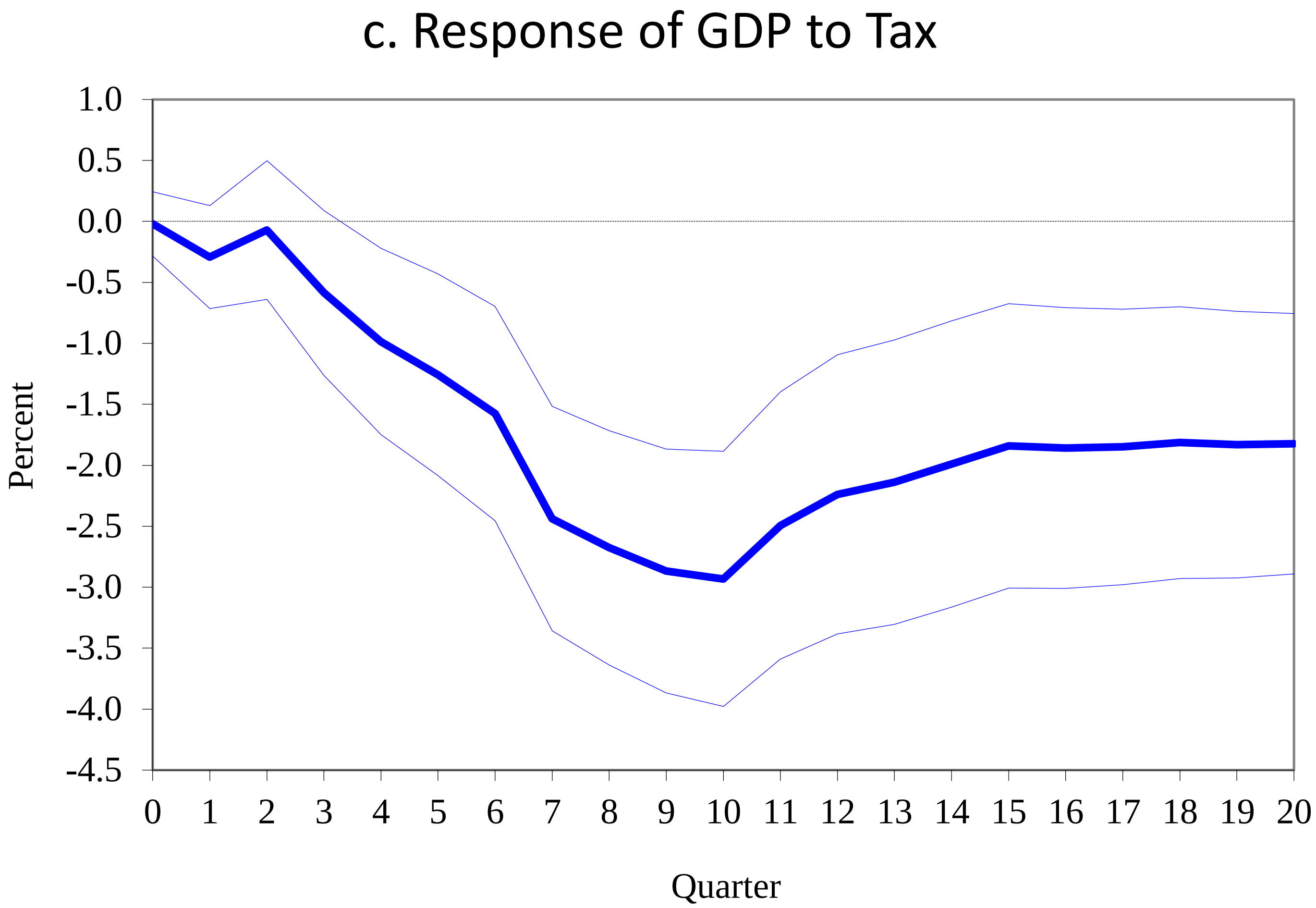
Estimated Impact of an Exogenous Tax Increase of 1% of GDP on GDP
(Single Equation, No Controls)




From: Romer and Romer, “The Macroeconomic Effects of Tax Changes”

# Figure 6

## Results of a Two-Variable VAR for Exogenous Tax Changes and Real GDP

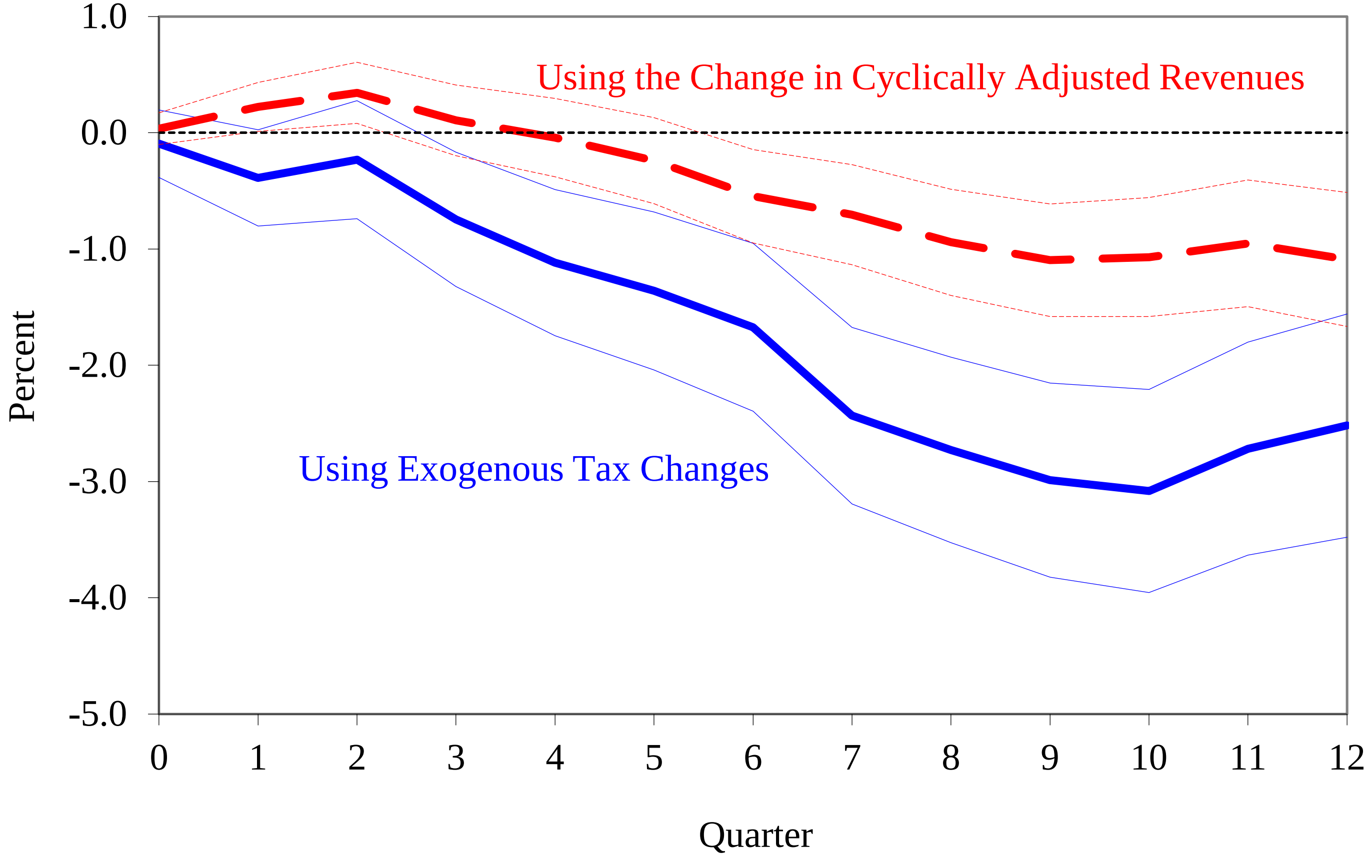



From: Romer and Romer, “The Macroeconomic Effects of Tax Changes”

# Figure 7

## Estimated Impact of a Tax Increase of 1% of GDP on GDP (Single Equation, No Controls)

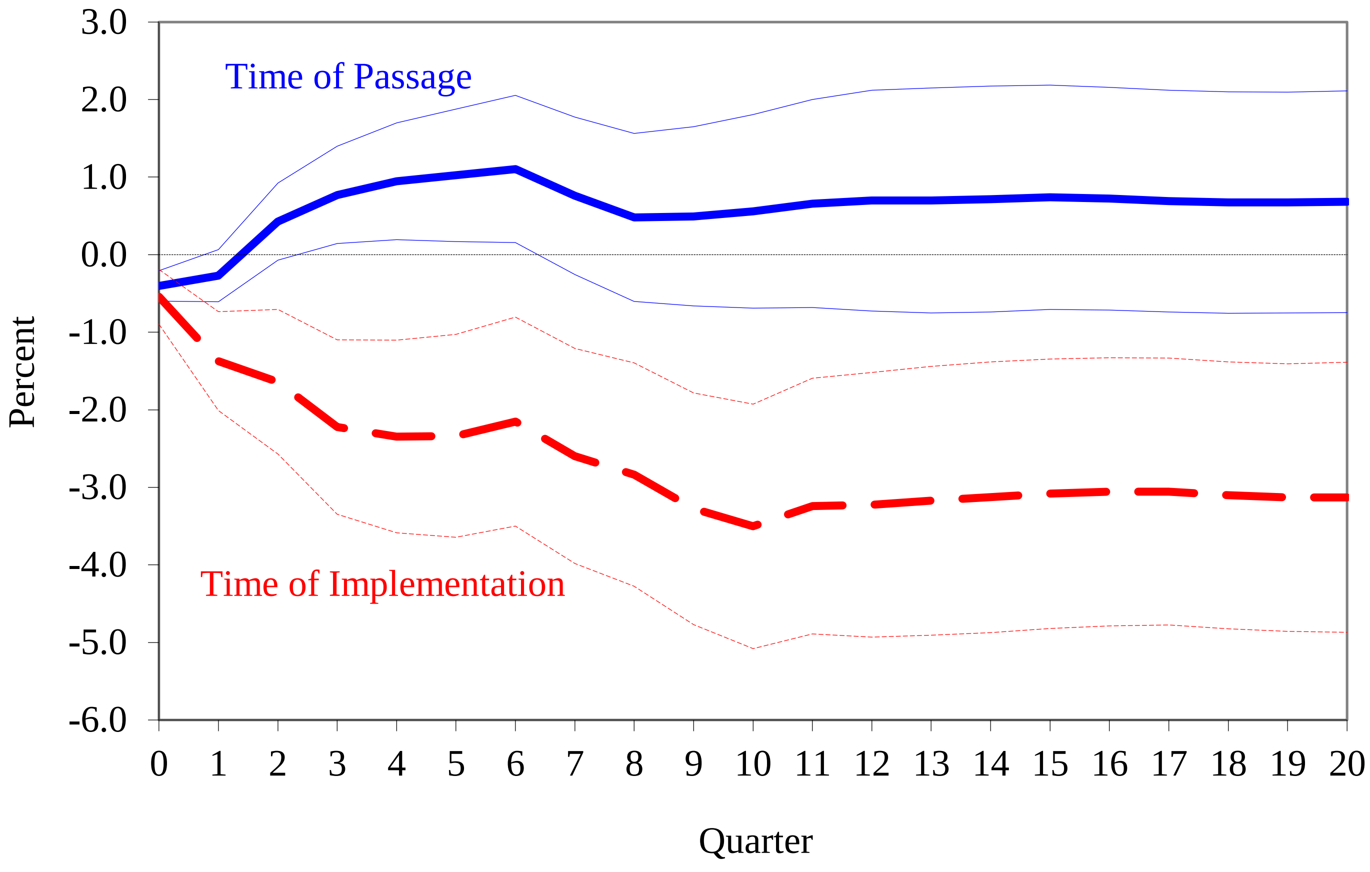
### a. Using the Change in Cyclically Adjusted Revenues




From: Romer and Romer, “The Macroeconomic Effects of Tax Changes”

## Figure 12

Estimated Impact of a Tax Increase of 1% of GDP on GDP
Including Tax Changes Dated Both at Time of Implementation and at Time of Passage
(Single Equation, Controlling for Lagged GDP Growth)




From: Romer and Romer, "The Macroeconomic Effects of Tax Changes"

# Discussion

# V. Auerbach and Gorodnichenko, “Measuring the Output Responses to Fiscal Policy”

# Auerbach and Gorodnichenko's Question

- Does the size of the fiscal multiplier vary with the state of the economy?

# Auerbach and Gorodnichenko's Method

$$(1) \quad \mathbf{X}_t = (1 - F(z_{t-1}))\Pi_E(L)\mathbf{X}_{t-1} + F(z_{t-1})\Pi_R(L)\mathbf{X}_{t-1} + \mathbf{u}_t,$$

$$(2) \quad \mathbf{u}_t \sim N(0, \Omega_t),$$

$$(3) \quad \Omega_t = \Omega_E(1 - F(z_{t-1})) + \Omega_R F(z_{t-1}),$$

$$(4) \quad F(z_t) = \frac{\exp(-\gamma z_t)}{1 + \exp(-\gamma z_t)}, \quad \gamma > 0,$$

$$(5) \quad \operatorname{var}(z_t) = 1, \; E(z_t) = 0.$$

The variables in **X** are log real government purchases, log real government receipts net of transfers, and real GDP. The baseline sample period is 1947:Q1–2008:Q4.

# Auerbach and Gorodnichenko's Method (continued)

- *G* is allowed to affect *Y* (and *T*) within the period, but is assumed to not be affected by *Y* (or by *T*).

# Digression: The Jordà Local Projections Approach

- Consider A-G's approach without the assumption that the multiplier may vary with the state of the economy (and without *T* for simplicity).
- Suppose that our assumption is again that *G* can affect *Y* within the period but is not affected by *Y*.
- To see how *G* affects *Y* at different horizons, we can estimate a **series** of regressions for h = 0, 1, 2, …:

$$Y_{t+h} = \alpha^h + \beta^h G_t + \sum_{i=1}^{N} \gamma_i^h Y_{t-i} + \sum_{i=1}^{N} \phi_i^h G_{t-i} + e_t^h.$$

- The estimated impulse response function is just the sequence of $\hat{\beta}^h$'s.

# The Jordà Local Projections Approach (continued)

- Note: As always, this presumes that the identifying assumptions are correct!
- In general, one strength of local projections is that it easily allows for nonlinearities, interaction effects, etc.
- It also makes it easy to calculate standard errors under different assumptions.
- See Section III of the handout for Lecture 3 for more. (Among other things, the handout shows that if the truth is a VAR with the analogous timing assumption, the local projections approach gives us an unbiased estimate of the VAR impulse response function.)

# The Local Projections Variant of Auerbach and Gorodnichenko's STVAR Approach

$$Y_{i,t+h} = \alpha_{i,h} + F(z_{i,t-1})\Pi_{R,h}(L)\,Y_{i,t-1} + (1 - F(z_{i,t-1}))\Pi_{E,h}(L)\,Y_{i,t-1}$$
$$+ F(z_{i,t-1})\Psi_{R,h}(L)G_{i,t-1} + (1 - F(z_{i,t-1}))\Psi_{E,h}(L)G_{i,t-1}$$
$$+ F(z_{i,t-1})\Phi_{R,h}FE^{G}_{it} + (1 - F(z_{i,t-1}))\Phi_{E,h}FE^{G}_{it} + u_{it},$$
$$\text{with } F(z_{i,t-1}) = \frac{\exp(-\gamma z_{i,t-1})}{1+\exp(-\gamma z_{i,t-1})},\ \gamma > 0,$$

From: Auerbach & Gorodnichenko, "Fiscal Multipliers in Recession and Expansion"

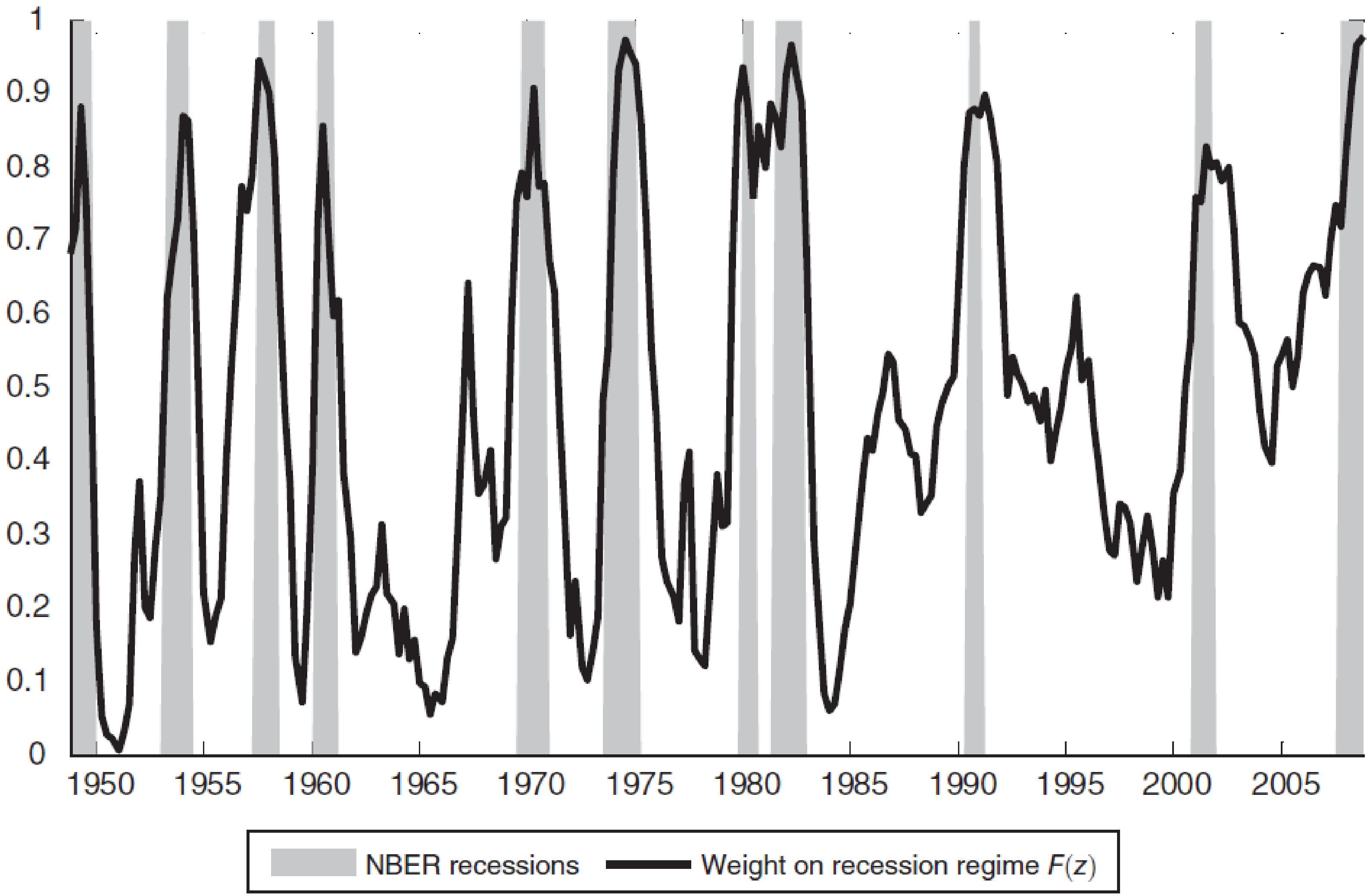
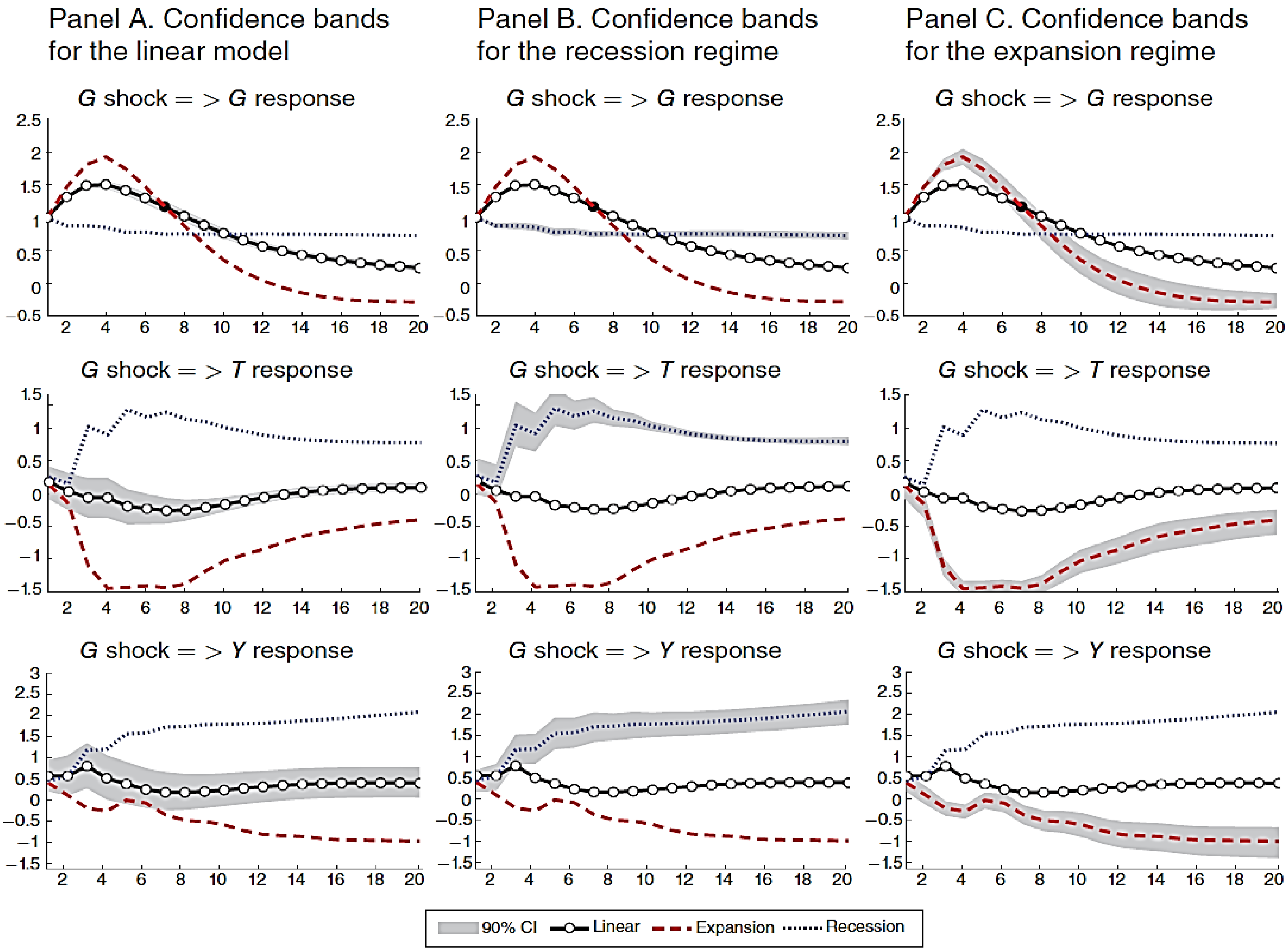



FIGURE 1. NBER DATES AND WEIGHT ON RECESSION REGIME $F(z)$

From: Auerbach & Gorodnichenko, "Output Responses to Fiscal Policy"



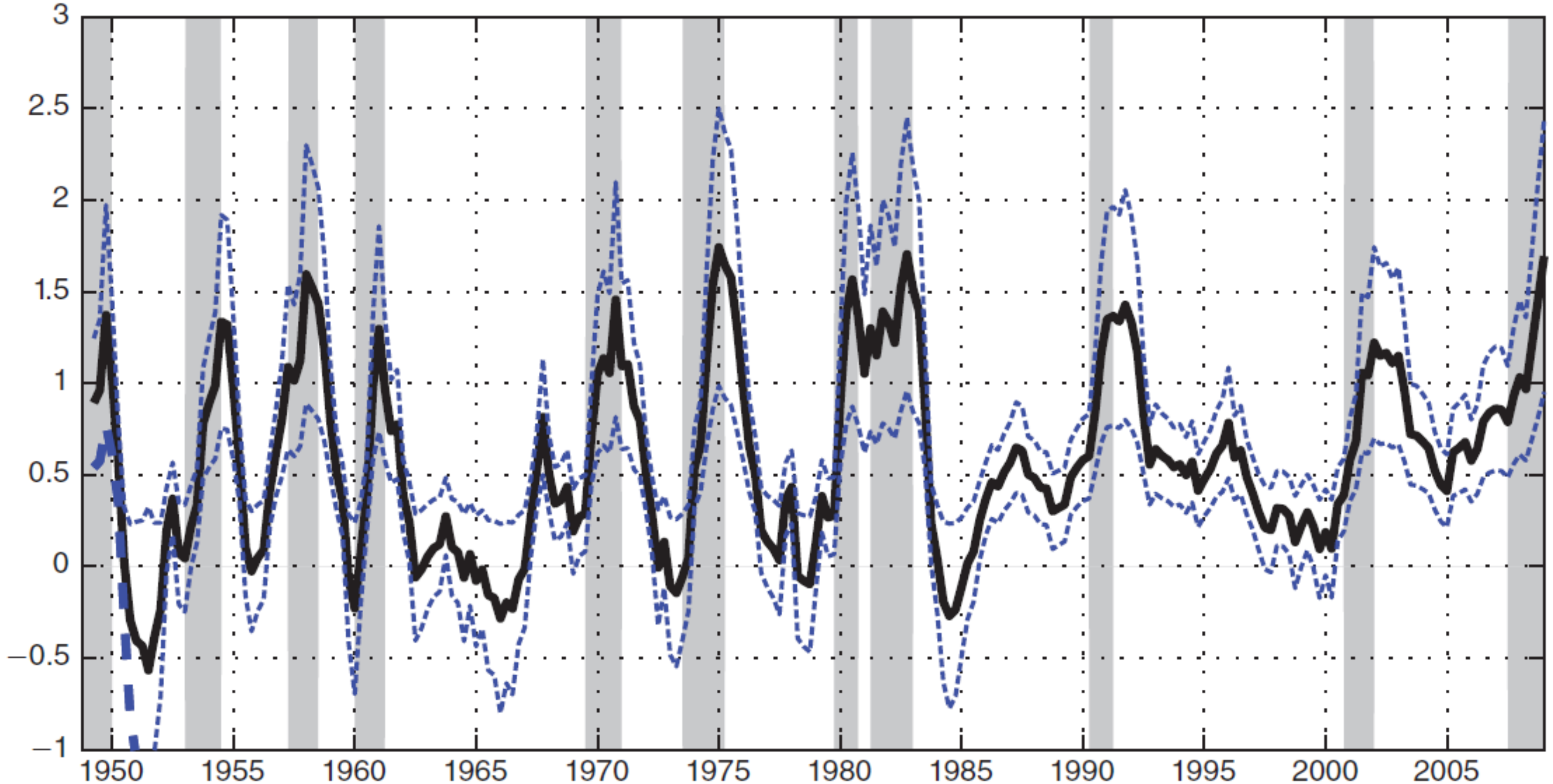

UPDATED FIGURE 2. IMPULSE RESPONSES IN THE LINEAR MODEL, EXPANSIONS, AND RECESSIONS

From: Auerbach & Gorodnichenko, "Corrigendum"

UPDATED TABLE 1—MULTIPLIERS

| | $\max_{h=1,\ldots,20}\{Y_h\}$ | | $\sum_{h=1}^{20} Y_h / \sum_{h=1}^{20} G_h$ | |
|---|---|---|---|---|
| | Point estimate | Standard error | Point estimate | Standard error |
| Total spending | | | | |
| Linear | 0.87 | 0.29 | 0.58 | 0.23 |
| Expansion | 0.49 | 0.13 | −0.80 | 0.16 |
| Recession | 2.12 | 0.18 | 2.17 | 0.19 |

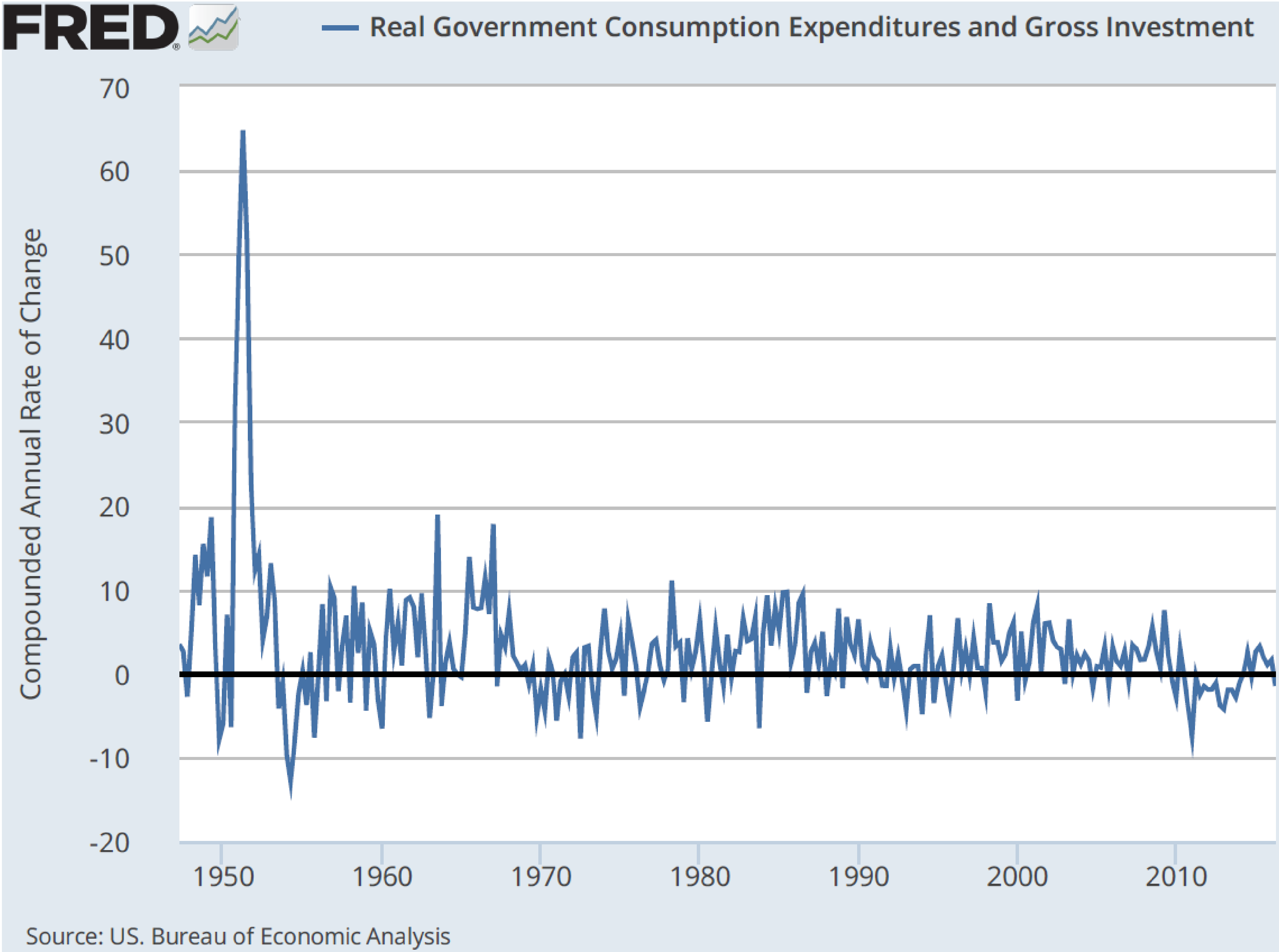
From: Auerbach & Gorodnichenko, "Corrigendum"




Updated Figure 3. Historical Multiplier for Total Government Spending

*Notes:* Shaded regions are recessions defined by the NBER. The solid black line is the cumulative multiplier computed as $\sum_{h=1}^{20} Y_h / \sum_{h=1}^{20} G_h$, where time index $h$ is in quarters. Dashed lines are 90 percent confidence interval. The multiplier incorporates the feedback from $G$ shock to the business cycle indicator $z$. In each instance, the shock is a 1 percent increase in government spending.

From: Auerbach & Gorodnichenko, "Corrigendum"


FRED
Real Government Consumption Expenditures and Gross Investment
Compounded Annual Rate of Change
70
60
50
40
30
20
10
0
-10
-20
1950
1960
1970
1980
1990
2000
2010
Source: US. Bureau of Economic Analysis

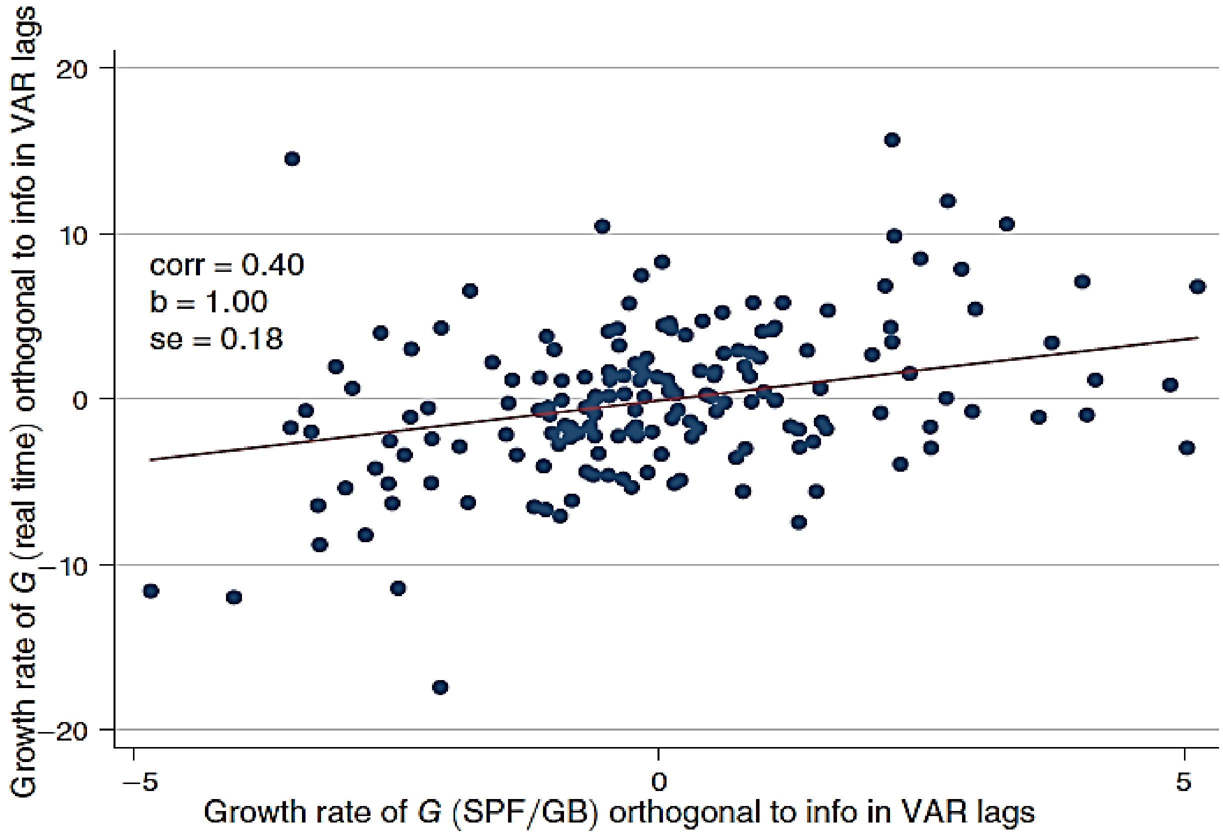


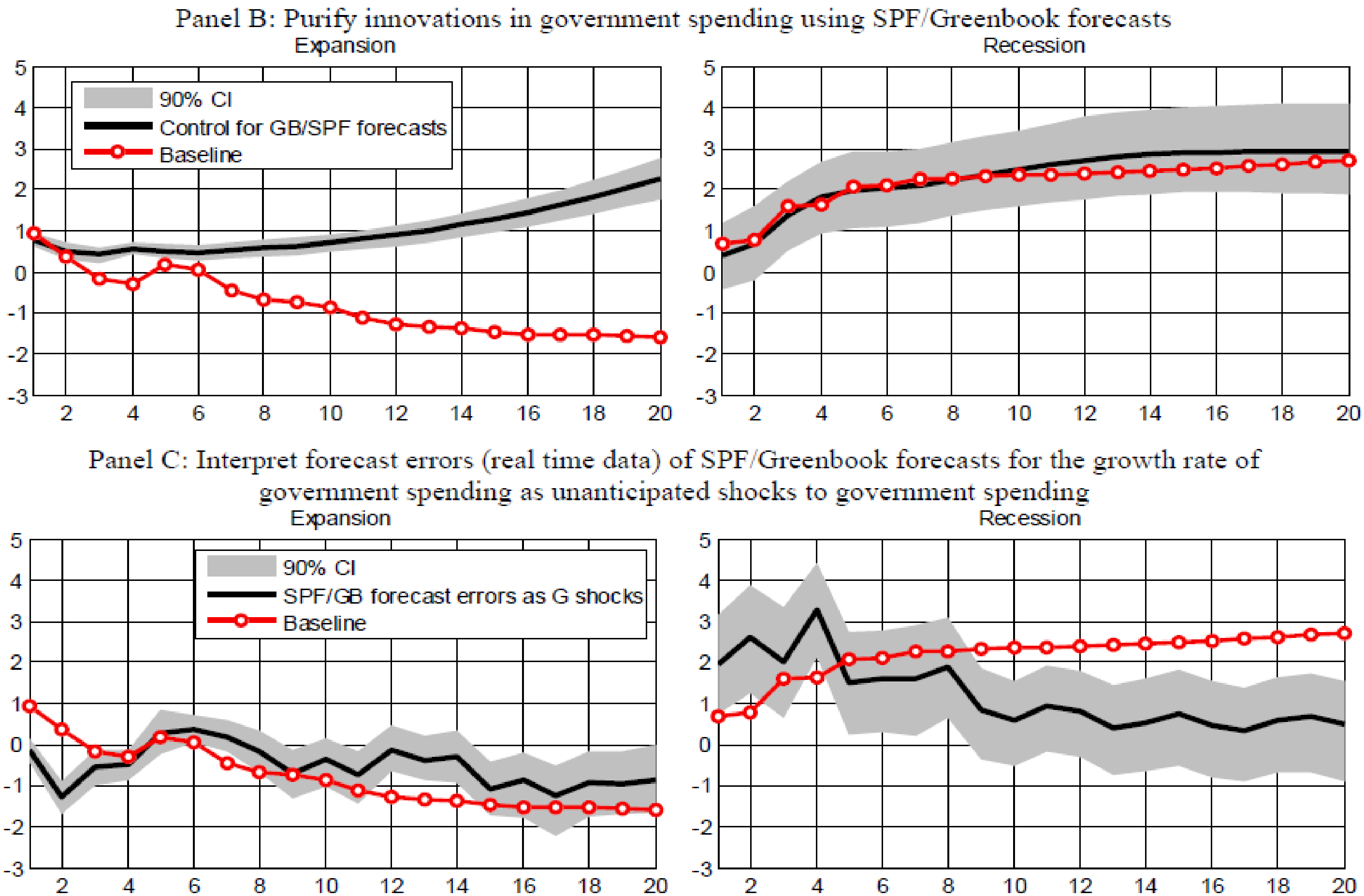

FIGURE 6. FORECASTABILITY OF VAR SHOCKS TO GOVERNMENT SPENDING

*Notes:* The figure plots residuals from projections of the growth rate of government spending predicted in SPF/Greenbook [horizontal axis] and actual growth rate of government spending (final vintage of data = top panel; real-time/first-release data = bottom panel) [vertical axis] on the information contained in the lags of the our baseline VAR. corr stands for the correlation between series. b and se show the estimated slope and associated standard error from regressing the residual for the actual growth rate of government spending on the residual for the predicted growth rate of government spending.

From: Auerbach & Gorodnichenko, “Output Responses to Fiscal Policy”

# Accounting for Expectations

- Auerbach and Gorodnichenko try several approaches.
- One is to add either the forecast or the forecast error to the VAR.




**Updated Figure 7 in AG (2012). Government spending multipliers for purified unanticipated shocks.**

**Notes:** Note: The figure plots impulse response of output to an unanticipated government spending shock which is normalized to have the sum of government spending over 20 quarters equal to one. The red lines with circles correspond to the responses in the baseline VAR specification. The shaded region is the 90% confidence interval.

From: Auerbach & Gorodnichenko, “Corrigendum”

Updated Table 1—Multipliers

| | $\max_{h=1,...,20}\{Y_h\}$ | | $\sum_{h=1}^{20} Y_h / \sum_{h=1}^{20} G_h$ | |
|---|---|---|---|---|
| | Point estimate | Standard error | Point estimate | Standard error |
| Nondefense spending | | | | |
| Linear | 1.69 | 0.08 | 2.08 | 0.15 |
| Expansion | 1.21 | 0.16 | 1.17 | 0.15 |
| Recession | 1.22 | 0.29 | 1.34 | 0.31 |
| Consumption spending | | | | |
| Linear | 0.82 | 0.28 | 0.89 | 0.29 |
| Expansion | 0.12 | 0.13 | −0.16 | 0.11 |
| Recession | 2.28 | 0.64 | 1.37 | 0.35 |
| Investment spending | | | | |
| Linear | 2.07 | 0.60 | 2.75 | 0.60 |
| Expansion | 2.82 | 0.26 | 1.94 | 0.17 |
| Recession | 2.79 | 0.52 | 4.26 | 0.46 |

From: Auerbach & Gorodnichenko, “Corrigendum”