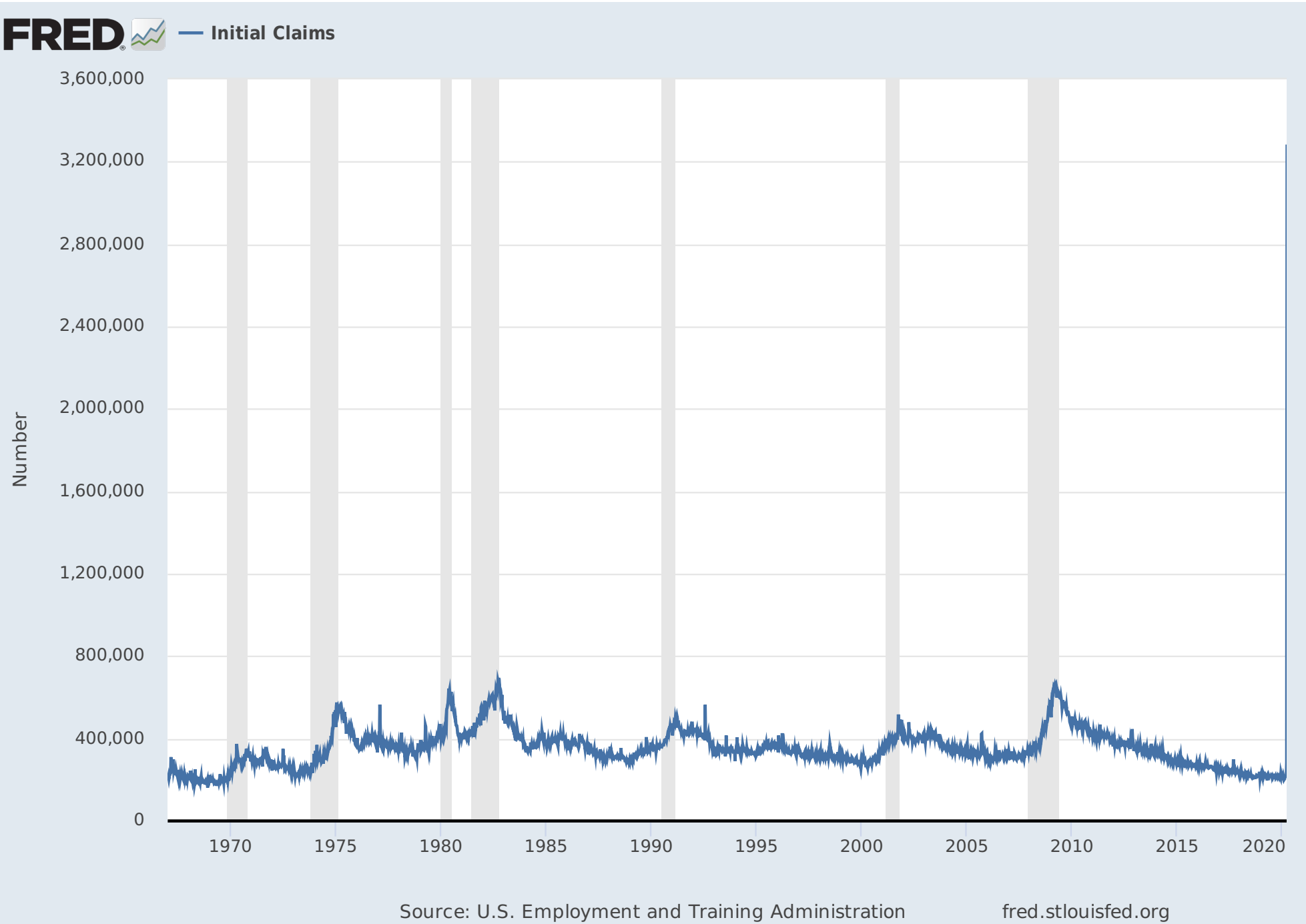
FRED
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3,200,000
2,800,000
2,400,000
2,000,000
1,600,000
1,200,000
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400,000
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Number
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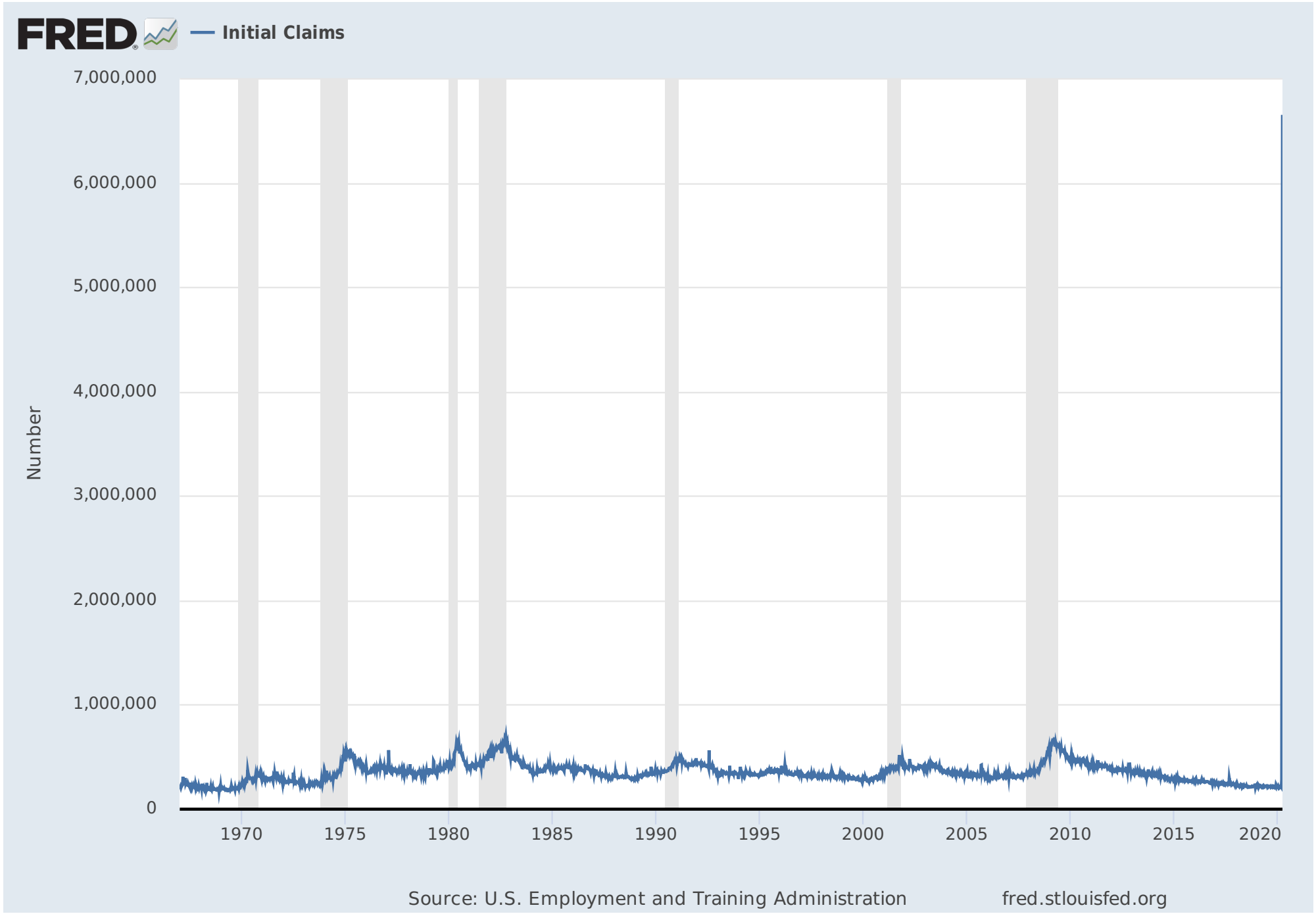
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020
Source: U.S. Employment and Training Administration
fred.stlouisfed.org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IS-MP

Harvard Economics 1011B
Professor Gabriel Chodorow-Reich
Spring 2020

Outline

Outline

Aggregate demand

- So far we have studied the behavior of individual consumers and firms taking the path of interest rates and aggregate income as given.
- In *general equilibrium*, consumption, investment, aggregate income Y, and the interest rate r are all co-determined.
- Now we'll combine the various elements together.

Big picture road map

- We started by thinking about *microfoundations*: how do individual agents make decisions?

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    1. Consumption/savings: Euler equation, borrowing constraints, behavioral/high discounting. Predictions of permanent income hypothesis versus high MPC if borrowing constrained.

Consumption microfoundation summary

	MPC out of:			Response to:	
Type	y_0	$y_h,\ h>0$	$y_t,\ \forall t$	$r\uparrow$	Uncertainty $\uparrow$
Intertemporal optimizer:					
Patient	$\frac{r}{1+r}$	$\frac{1}{(1+r)^h}\frac{r}{1+r}$	1	$\downarrow$ if $\sigma>1$	$\downarrow$
Impatient	1	$\frac{1}{(1+r)^h}$	$\sum_{t=0}^{T}\frac{1}{(1+r)^t}$	$\downarrow$ if $\sigma>1$	$\downarrow$
Constrained	1	0	1	0	0
Rule-of-thumb	α	0	α	b_0	0

- Many types of consumption behavior possible.
- Different predictions.

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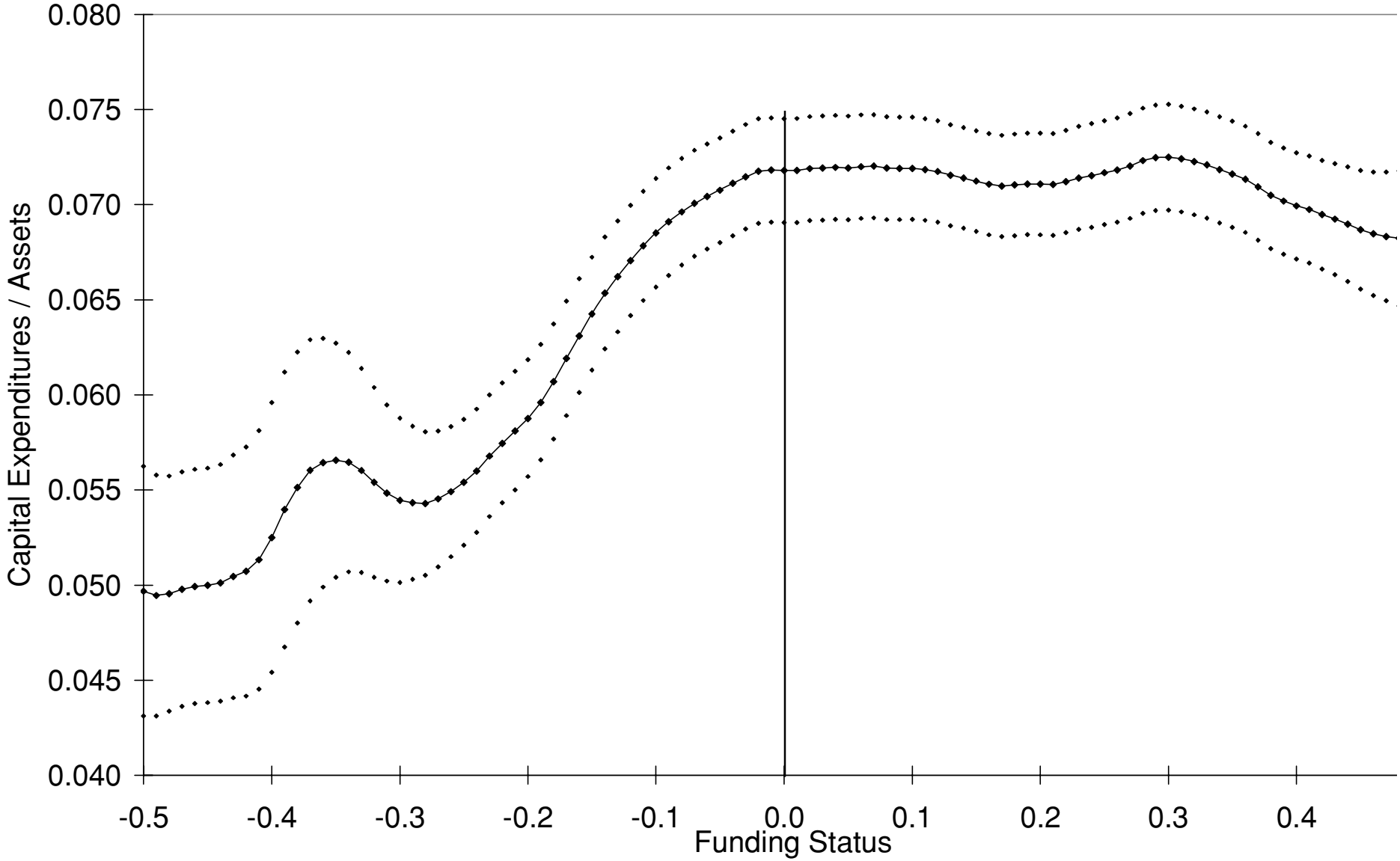
  2. Investment: Tobin's q as sufficient statistic versus cash flow sensitivity.

Tobin's Q summary

$$q_t = \frac{1}{p_t^K} \frac{1}{1+r} \sum_{s=t}^{\infty} \left(\frac{1-\delta}{1+r} \right)^{s-t} (F_{K_s} - \Phi_{K_s}).$$

- Investment increasing in profitability F_K.
- Investment declining in cost of capital p_t^K.
- Investment declining in interest rate r.
- Investment declining in depreciation rate δ.
- Investment declining in dividend taxes.
- Investment increasing in investment tax credits.

Rauh (JF 2006) Investment and Financing Constraints



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    3. Price setting.

Firm price setting problem, sticky prices

- Now suppose firm chooses one price to last for $T+1$ periods.
- Firm has forecast of average price $P_{t+1}, P_{t+2}, \ldots$.
- Firm maximizes discounted real profits with discount factor β:

$$\max_{P_{i,t},\{Y_{i,t+h}\}_{h=0}^{T}} \sum_{h=0}^{T} \beta^h \left[\frac{P_{i,t}}{P_{t+h}} Y_{i,t+h} - C\left(Y_{i,t+h}\right) \right] \text{ s.t. } \textbf{??}$$

$$= \max_{P_{i,t}} \sum_{h=0}^{T} \beta^h \left[\left(\frac{P_{i,t}}{P_{t+h}} \right)^{1-\varepsilon} - C\left(\left(\frac{P_{i,t}}{P_{t+h}} \right)^{-\varepsilon} \right) \right].$$

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- FOC:

$$\sum_{h=0}^{T} \frac{\beta^h}{P_{t+h}} \left[(1-\varepsilon) \left(\frac{P_{i,t}}{P_{t+h}} \right)^{-\varepsilon} + \varepsilon \left(\frac{P_{i,t}}{P_{t+h}} \right)^{-\varepsilon-1} C'\left(Y_{i,t+h}\right) \right] = 0$$

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$$\Rightarrow \sum_{h=0}^{T} \left(\beta^h \frac{P_t}{P_{t+h}} \right) Y_{i,t+h} \left[P_{i,t} - \frac{\varepsilon}{\varepsilon-1} P_{t+h} C'(Y_{i,t+h}) \right] = 0.$$

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Monetary policy feedback rule (Taylor rule)

$$i_{t,t+1} = r^*_{t,t+1} + \pi^*_{t,t+1} + \phi_Y(Y_t - Y^*_t) + \phi_\pi(\pi_{t,t+1} - \pi^*_{t,t+1}).$$

- Y^*_t: Fed's target for output; $\pi^*_{t,t+1}$: Fed's target for inflation (2%); $r^*_{t,t+1}$: real interest rate when $Y_t = Y^*_t$ and $\pi_{t,t+1} = \pi^*_{t,t+1}$.
- $\phi_Y > 0$: when output is below target, Fed lowers interest rates.
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- IS-MP/*Old Keynesian*: no explicit optimization.

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- IS-MP/*Old Keynesian*: no explicit optimization.
- *New Keynesian*: combine elements of this lecture with optimizing decisions by agents.

Big questions

- What tools do governments have to stabilize economic fluctuations?
- Fiscal policy: increase government spending or reduce taxes.
- Monetary policy: lower the policy interest rate.
- Why would these tools work? Why wouldn't they?

Outline

Closed economy, goods market

- Total expenditure:

$$Y = C + I + G. \tag{1}$$

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- G: government purchases of output. Exogenous.
- T: government taxes. Exogenous.

Terminology reminder

- Models consist of systems of equations.
- An equation contains **exogenous** variables, **endogenous** variables, and **parameters**.
- Variables: quantities, prices, etc.
  - Exogenous variables: determined outside system with no feedback. "Driving forces."
  - Endogenous variables: determined within the system by equilibrium.
- Parameters: constants of system.
- In reality, all variables are endogenous if you include enough equations. Art of model writing is choosing a parsimonious system and determining which variables can be taken as exogenous w.r.t that system.

KEYNESIAN CROSS

- (2)+(3)+G:

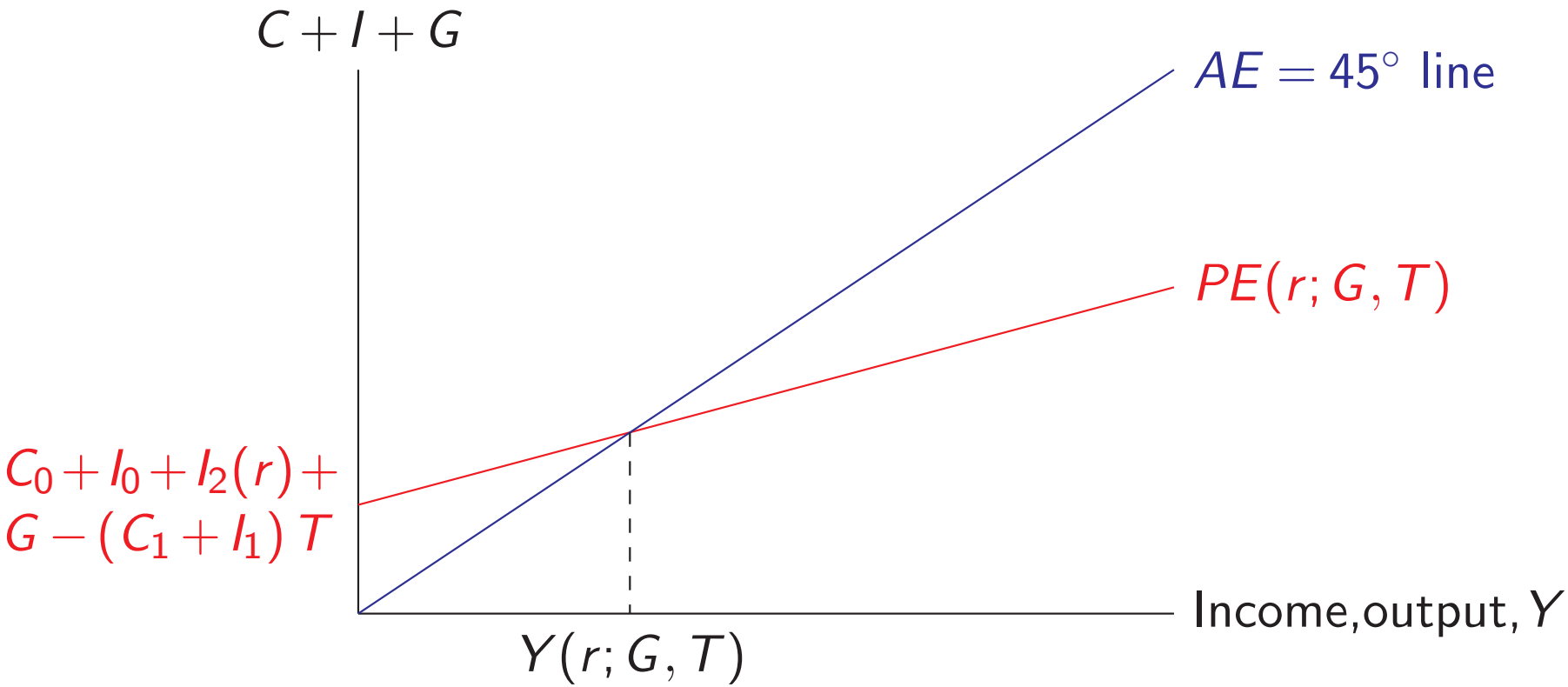
$$C + I + G = \underbrace{[C_0 + C_1 (Y - T)]}_{C} + \underbrace{[I_0 + I_1 (Y - T) + I_2(r)]}_{I} + G$$
$$= \underbrace{C_0 + I_0 + G - (C_1 + I_1) T + I_2(r) + (C_1 + I_1) Y}_{\text{Planned expenditure } (PE)}.$$

- Actual expenditure (AE):

$$C + I + G = Y.$$

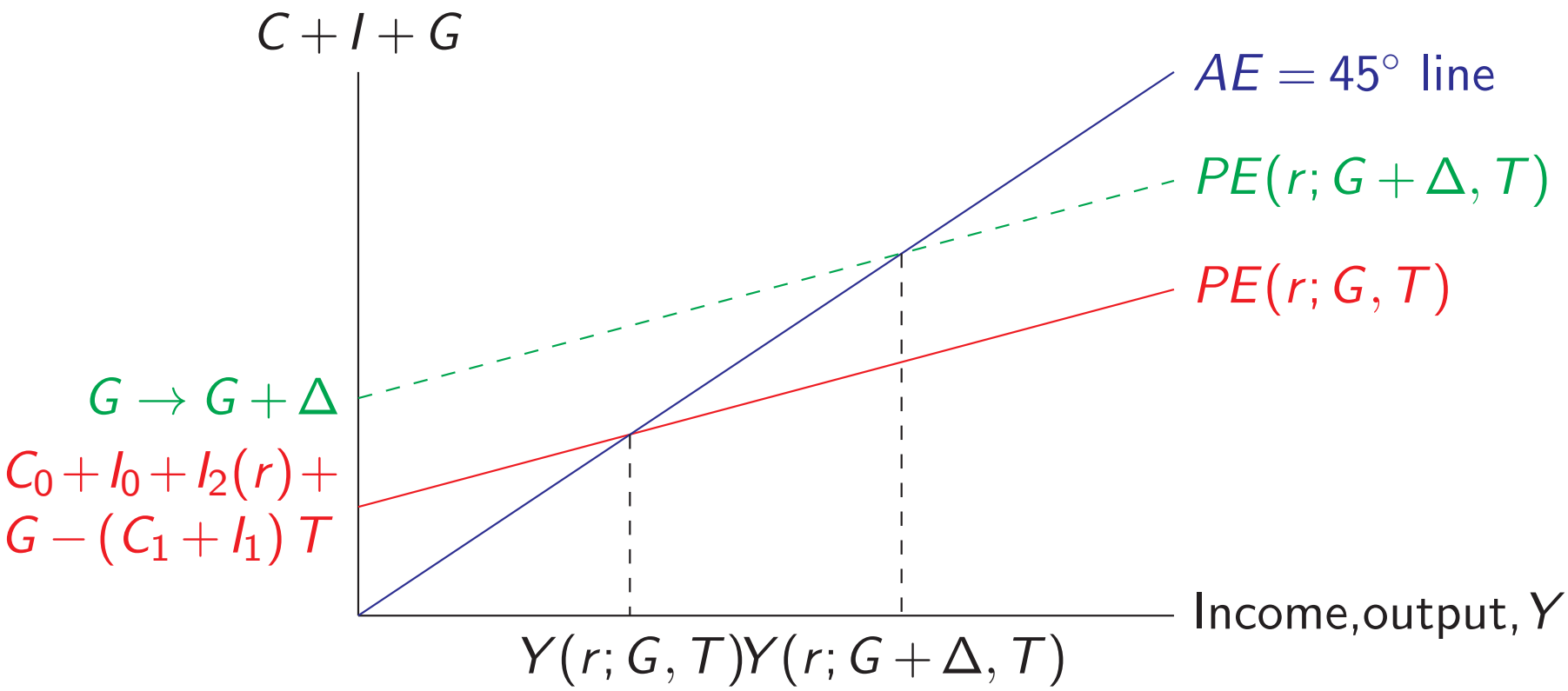
- Equilibrium: $PE = AE$.

Geometric equilibrium: Keynesian cross



- $PE = [C_0 + I_0 + I_2 r + G - (C_1 + I_1)\,T] + (C_1 + I_1)\,Y$. Total expenditure as function of Y, at given level of r, G, T.
- Slope of PE : $C_1 + I_1 < 1$: marginal propensity to spend.
- $Y(r; G, T)$: *equilibrium* output given r, G, T.

Government spending ↑, r fixed

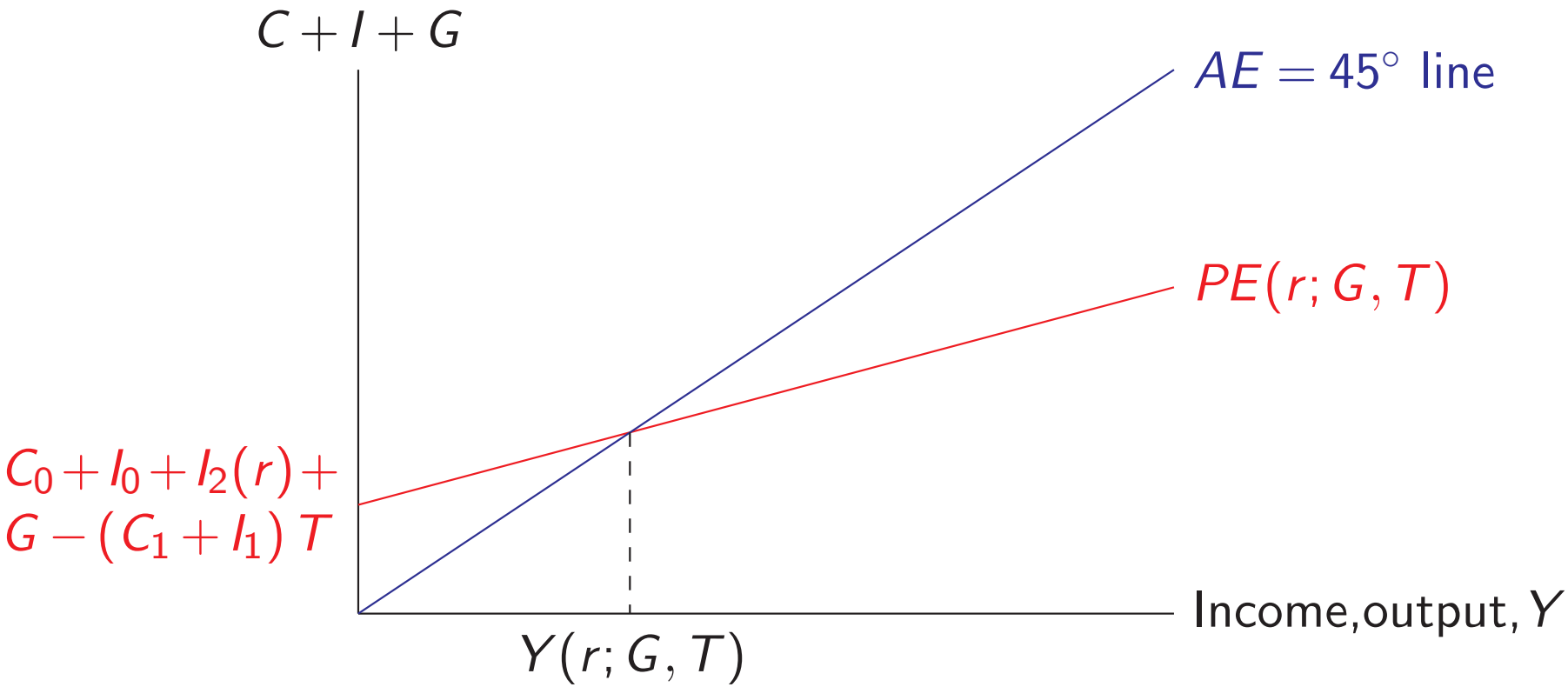


- Algebraic:

$$\left.\frac{\partial Y}{\partial G}\right|_{r \text{ fixed}} = \frac{1}{1 - C_1 - I_1} \geq 1.$$

- Result: if r fixed, $\lim_{C_1, I_1 \to 0} \frac{\partial Y}{\partial G} = 1$.

Geometric equilibrium: Keynesian cross



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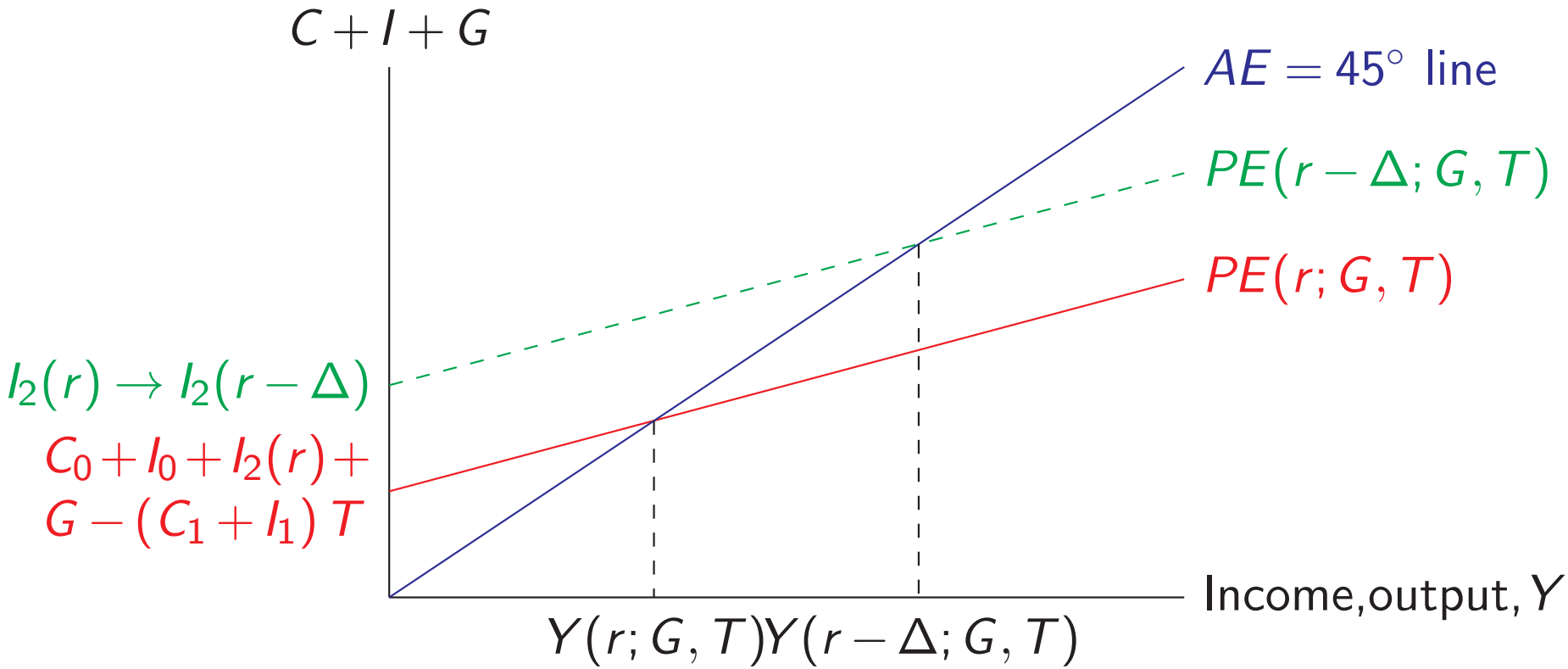
Changes in r



- $r \downarrow \Rightarrow I^{\uparrow} \Rightarrow Y^{\uparrow}$.
- Figure shows two possible equilibrium duples of Y, r.
- An infinite number of possible combinations of Y, r exist that would satisfy equilibrium.
- The *IS* curve is the set of points in Y, r space such that equilibrium obtains in the goods market.

IS CURVE ALGEBRAICALLY

- 3 equations in 4 unknowns Y, C, I, r:

$$\begin{aligned} Y &= C + I + G, \\ C &= C_0 + C_1 (Y - T), \\ I &= I_0 + I_1 (Y - T) + I_2(r). \end{aligned}$$

- Y, C, I, r are endogenous variables. G, T are exogenous variables. C_0, C_1, I_0, I_1, I_2 are parameters.

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- Substitute and solve:

$$\begin{aligned} Y &= \underbrace{[C_0 + C_1 (Y - T)]}_{C} + \underbrace{[I_0 + I_1 (Y - T) + I_2(r)]}_{I} + G \\ &= [C_0 + I_0 + I_2(r) + G - (C_1 + I_1) T] + (C_1 + I_1) Y, \\ \implies (1 - C_1 - I_1) Y &= [C_0 + I_0 + I_2(r) + G - (C_1 + I_1) T], \\ \implies Y &= \frac{C_0 + I_0 + G - (C_1 + I_1) T}{1 - C_1 - I_1} + \frac{I_2(r)}{1 - C_1 - I_1}. \end{aligned}$$

IS CURVE ALGEBRAICALLY

- From previous slide:

$$Y = \frac{C_0 + I_0 + G - (C_1 + I_1)\,T}{1 - C_1 - I_1} + \frac{I_2(r)}{1 - C_1 - I_1}.$$

- This is 1 equation in 2 unknowns Y, r. It desribes a curve in Y, r space.

- We call this curve the *IS* curve. *IS* stands for investment-saving.

- The *IS* curve describes the relationship between aggregate expenditure and the real interest rate.

Outline

Monetary policy feedback rule (Taylor rule)

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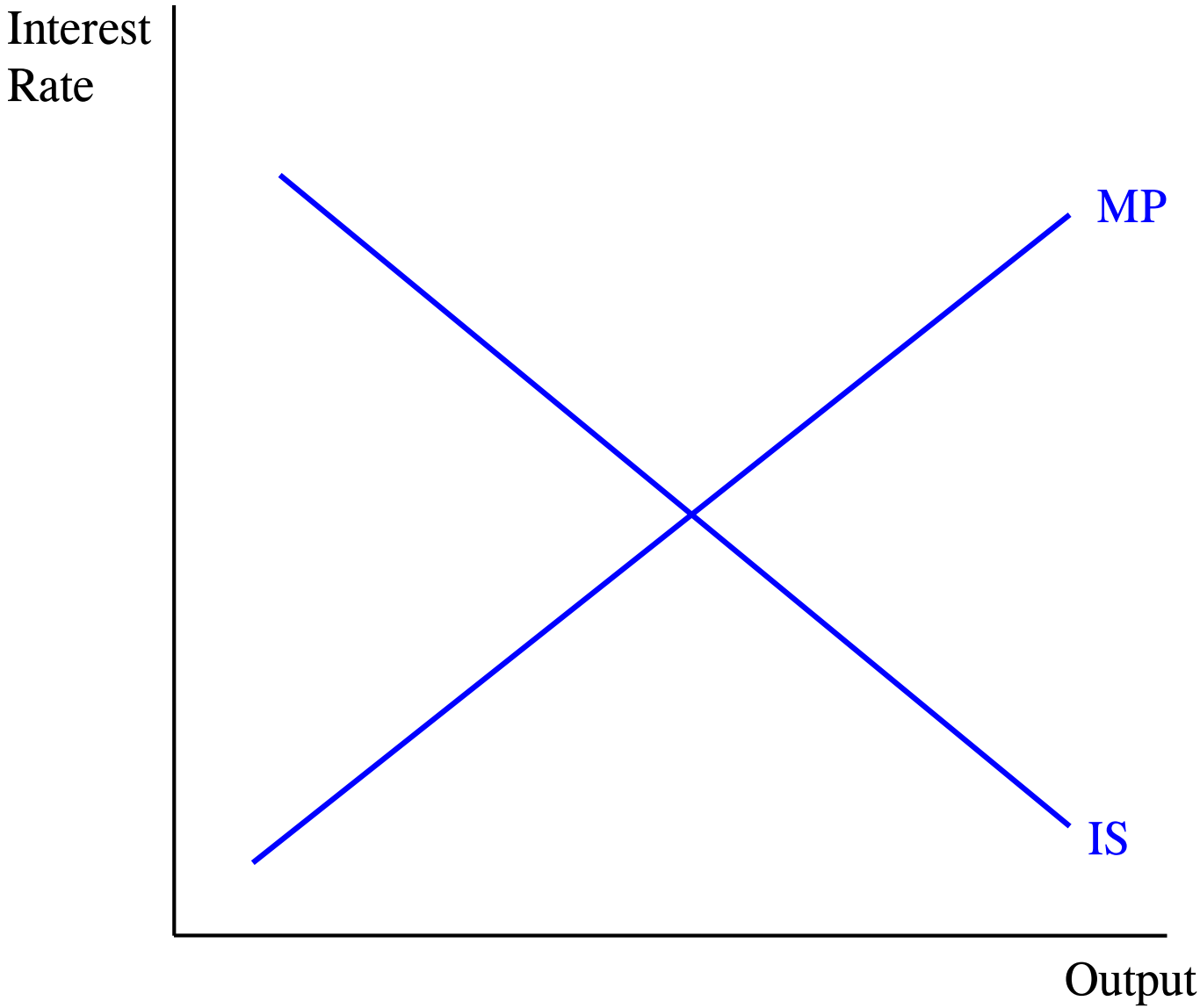
- $\phi_Y > 0$: when output is below target, Fed lowers interest rates.
- $\phi_\pi > 0$: when inflation is above target, Fed raises interest rates.
- Assumption: ϕ_Y, ϕ_π large enough, and inflation sluggish enough, that Fed raises real interest rate. This is usually true.
- Simplifying assumption: Fed directly controls short term real interest rate:

$$r_{t,t+1} = r(Y_t; \pi_{t,t+1}), \quad r'(Y_t) > 0.$$

  - Treat $\pi_{t,t+1}$ as exogenous variable.

Outline

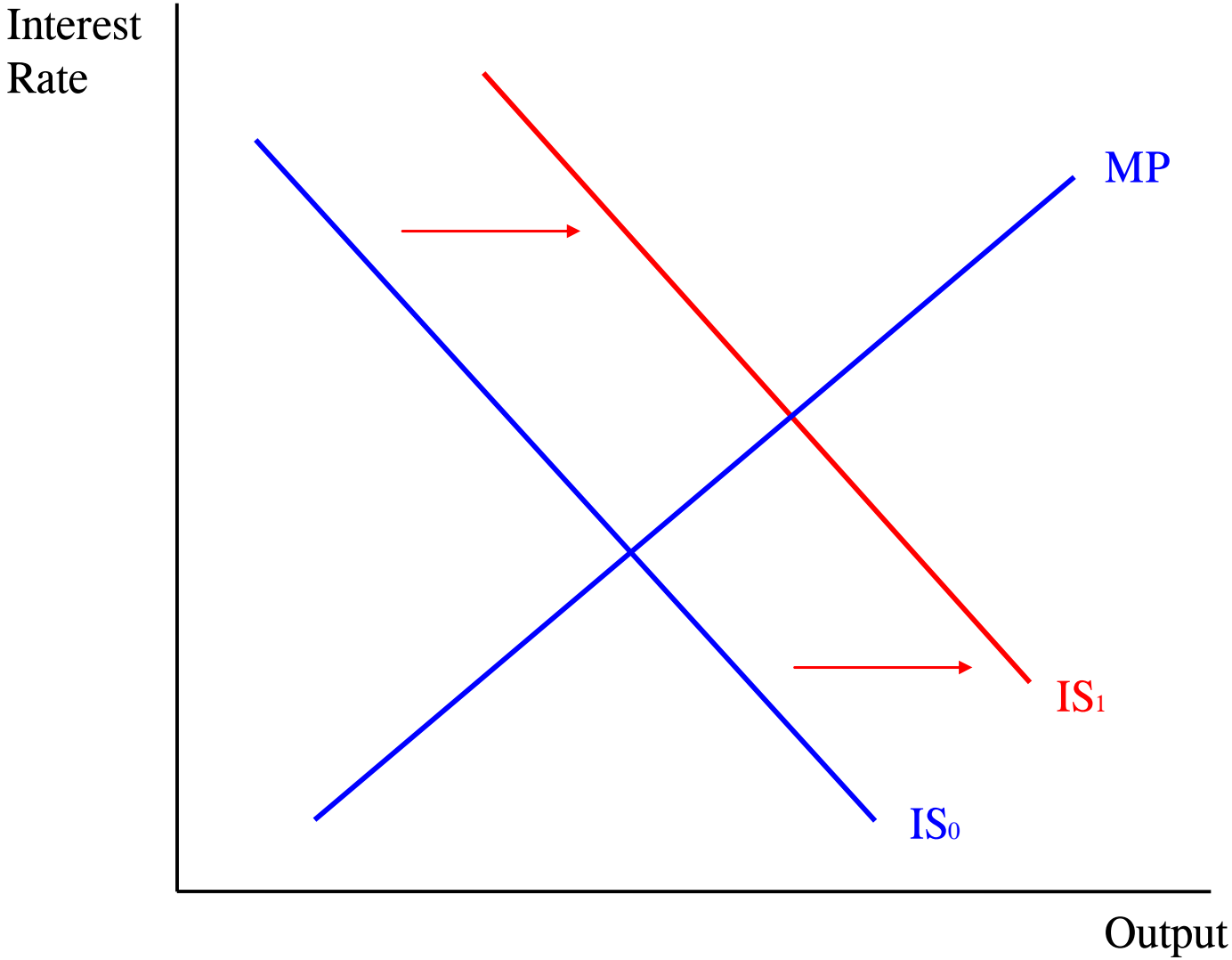
IS-MP DIAGRAM



Comments

1. IS-MP is modern version of IS-LM, which was introduced by John Hicks in 1937: "Mr. Keynes and the 'Classics'; A Suggested Interpretation", *Econometrica* 5 (2): 147-159.
2. It sometimes gets criticized as ad hoc or simplistic. Why?
   - We started by replacing consumption and investment demands we derived from agents' optimization problems with simple behavioral equations.
   - The behavioral equations do not have the forward-looking component of the optimization decisions.
   - The time horizon is funny. Assumption of sluggish or exogenous inflation okay in short run but not in long run.
   - The time horizon is funny. Short term interest rate versus long term interest rate.
3. But the model gives simple intuitions which survive in more complicated frameworks.

GOVERNMENT SPENDING ↑



- Output and interest rate both rise. Size of "multiplier" depends on slope of MP curve. Compare to earlier.

Government spending ↑, algebraic

- IS curve and MP curve give two equations in two unknowns r, Y:

$$Y = \frac{C_0 + I_0 + G - (C_1 + I_1)\,T}{1 - C_1 - I_1} + \frac{I_2(r)}{1 - C_1 - I_1},$$

$$r = r(Y), \qquad r'(Y) > 0.$$

- Implicitly differentiate first equation with respect to G:

- Fed responds to expansionary fiscal policy by raising interest rate.
- Implication: fiscal multiplier larger if Fed does not respond by tightening policy. When might this be true?

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- Implicitly differentiate first equation with respect to G:

$$\begin{aligned}\frac{\partial Y}{\partial G} &= \frac{1}{1 - C_1 - I_1} + \left(\frac{1}{1 - C_1 - I_1}\right) \frac{\partial I_2}{\partial r} \frac{\partial r}{\partial Y} \frac{\partial Y}{\partial G} \\ &= \left[1 - \left(\frac{I_2'(r) r'(Y)}{1 - C_1 - I_1}\right)\right]^{-1} \frac{1}{1 - C_1 - I_1} \\ &< \frac{1}{1 - C_1 - I_1} = \left.\frac{\partial Y}{\partial G}\right|_{r \text{ fixed}}.\end{aligned}$$

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Tax increases, algebraic

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$$r = r(Y), \qquad r'(Y) > 0.$$

- Implicitly differentiate first equation with respect to T:

- Prediction: G multiplier larger than T multiplier.
- Implication: balanced budget multiplier $\frac{\partial Y}{\partial G} - \frac{\partial Y}{\partial T} > 0$.
- Static: T not a function of Y, not distortionary.

Tax increases, algebraic

- IS curve and MP curve give two equations in two unknowns r, Y:

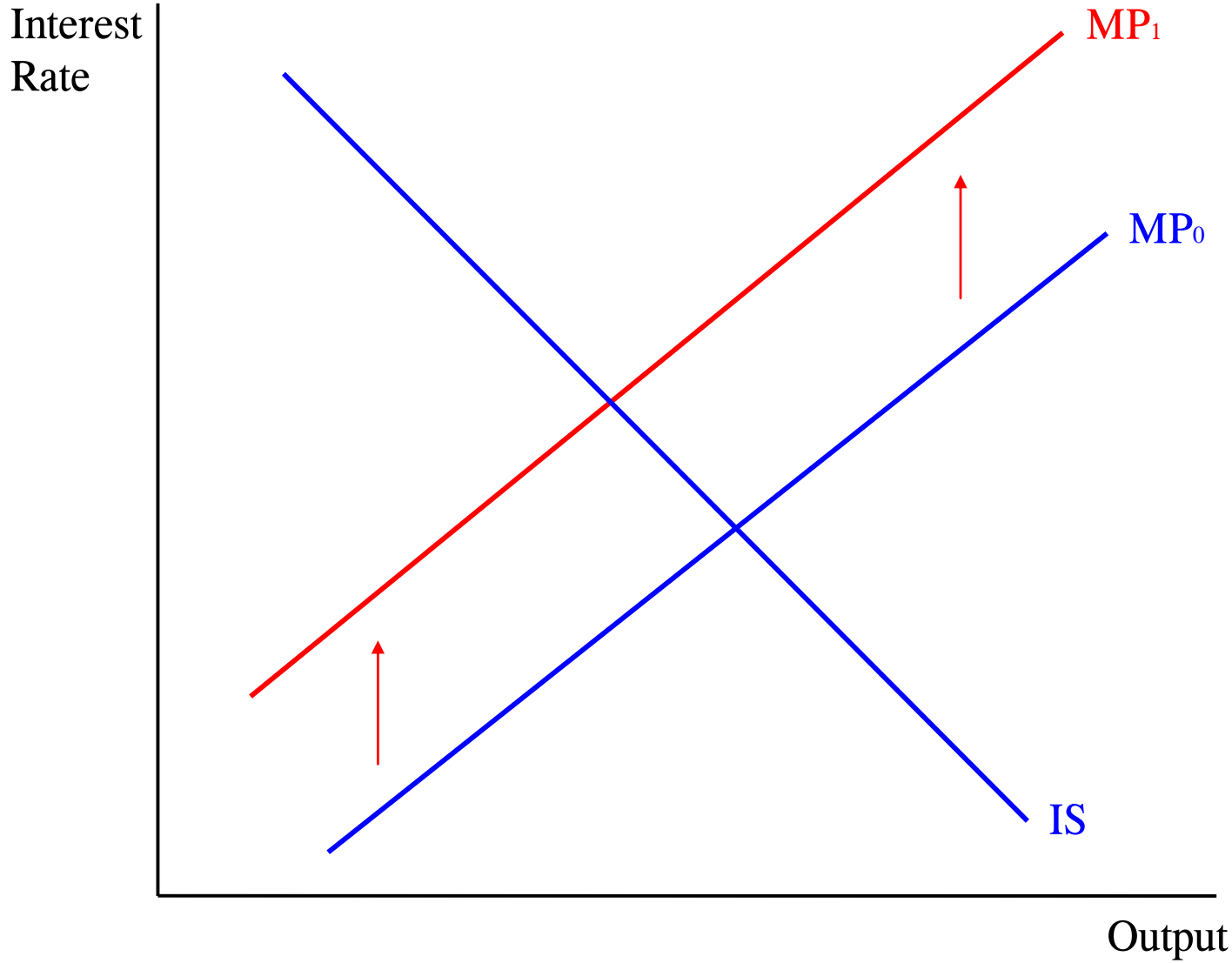
$$Y = \frac{C_0 + I_0 + G - (C_1 + I_1)\,T}{1 - C_1 - I_1} + \frac{I_2(r)}{1 - C_1 - I_1},$$
$$r = r(Y), \qquad r'(Y) > 0.$$

- Implicitly differentiate first equation with respect to T:

$$\begin{aligned}\frac{\partial Y}{\partial T} &= -\frac{C_1 + I_1}{1 - C_1 - I_1} + \left(\frac{1}{1 - C_1 - I_1}\right)\frac{\partial I_2}{\partial r}\frac{\partial r}{\partial Y}\frac{\partial Y}{\partial T} \\ &= -\left[1 - \left(\frac{I_2'(r)r'(Y)}{1 - C_1 - I_1}\right)\right]^{-1}\frac{C_1 + I_1}{1 - C_1 - I_1} \\ &= -(C_1 + I_1)\frac{\partial Y}{\partial G}.\end{aligned}$$

- Prediction: G multiplier larger than T multiplier.
- Implication: balanced budget multiplier $\frac{\partial Y}{\partial G} - \frac{\partial Y}{\partial T} > 0$.
- Static: T not a function of Y, not distortionary.

MONETARY POLICY TIGHTENS



- Example: $\pi_t > \pi_t^*$, so Fed raises real interest rate at given level of output. Output falls.

Outline

The St. Louis equation

- In the 1960s, economists at the St. Louis Federal reserve attempted to determine the impact of money on output by running a variant of the regression:

$$\Delta \ln Y_t = a + b i_t + e_t.$$

- Regression coefficient b is the "best fit" relationship between i_t and Y_t.
- Does not recover causal effect of i_t on Y_t if as in the IS-MP model both are endogenous variables.
- Counter-example: suppose the central bank chooses i_t perfectly to stabilize fluctuations in Y_t. Then $b = 0$ even though monetary policy is perfectly effective.

Romer and Romer (AER 2004) approach

- Christina Romer and David Romer, "A New Measure of Monetary Shocks: Derivation and Implications," *American Economic Review*, September 2004 (`https://eml.berkeley.edu/~dromer/papers/AER_September04.pdf`).
- Need some part of monetary policy which is exogenous – determined outside of the system.
- Idea is to estimate monetary policy feedback rule and use the part not explained by output or inflation:

$$i_{t,t+1} = r^*_{t,t+1} + \pi^*_{t,t+1} + \phi_Y(Y_t - Y^*_t) + \phi_\pi(\pi_{t,t+1} - \pi^*_{t,t+1}) + e_{t,t+1}.$$

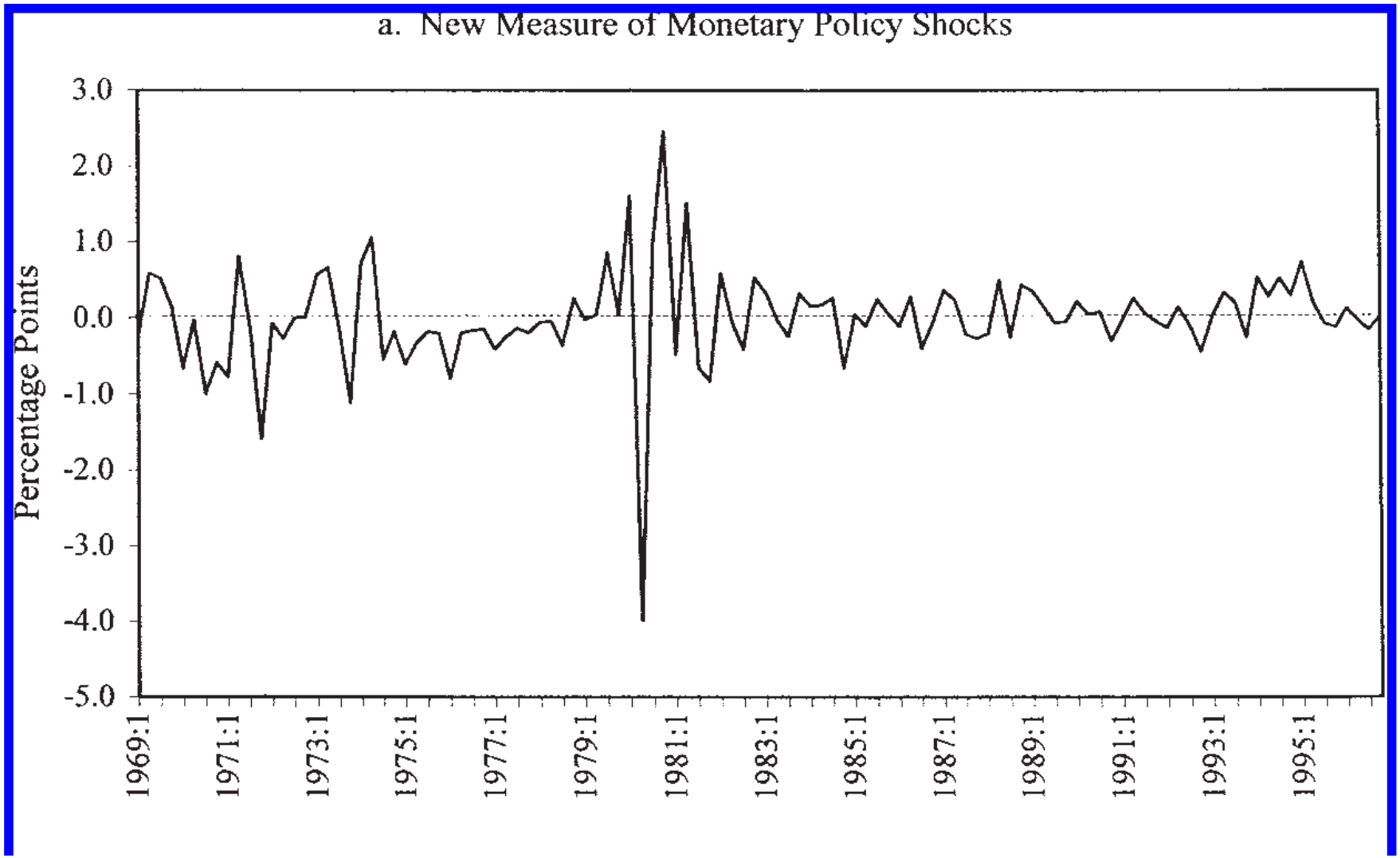
- $e_{t,t+1}$ is exogenous component of monetary policy rate.
- Romer and Romer use internal Federal Reserve forecasts of output and inflation in the monetary policy rule, so $e_{t,t+1}$ is the part of the interest rate not explained by the usual behavior of the Fed in response to expected output and inflation.

What are such monetary policy shocks?

- Change in operating procedure: target interest rate or money supply.
- Federal Reserve beliefs: how Fed reacts depends on whether it thinks monetary policy is effective.
- Tastes and goals: Fed gets "fed up" with inflation.
- Politics: sometimes Fed chair wants to please president to get reappointed.

Example: Richard Nixon and Arthur Burns

- In run-up to 1972 reelection campaign (of Watergate fame), President Nixon pressured Federal Reserve Chairman Arthur Burns to ease monetary policy to ensure a booming economy. Because of the Nixon tapes, we have recorded evidence.
- December 10, 1971. Burns: "I want more aggressive steps taken by that committee on next Tuesday." Nixon: "Great. Great. You can lead 'em. Just kick 'em in the rump a little." Burns: "Time is getting short. We want to get this economy going."
- December 24, 1971. Nixon to George Shultz: "Do you feel, as far as Arthur [Burns] and the money supply, we got that about as far as we can turn it right now, have we? I mean as far as my influence on him, that's what I'm really asking." Shultz: "Yeah. Well, you know he said that he, that they voted to increase it [the money supply]." Nixon: "I know. What was his view, his words?" Shultz: "'And I'm on the line on that.'" Nixon: "Well, you watch it and remind me. If I have to talk to him again, I'll do it. Next time I'll just bring him in."
- Etc.


a. New Measure of Monetary Policy Shocks
Percentage Points
3.0
2.0
1.0
0.0
-1.0
-2.0
-3.0
-4.0
-5.0
1969:1
1971:1
1973:1
1975:1
1977:1
1979:1
1981:1
1983:1
1985:1
1987:1
1989:1
1991:1
1993:1
1995:1

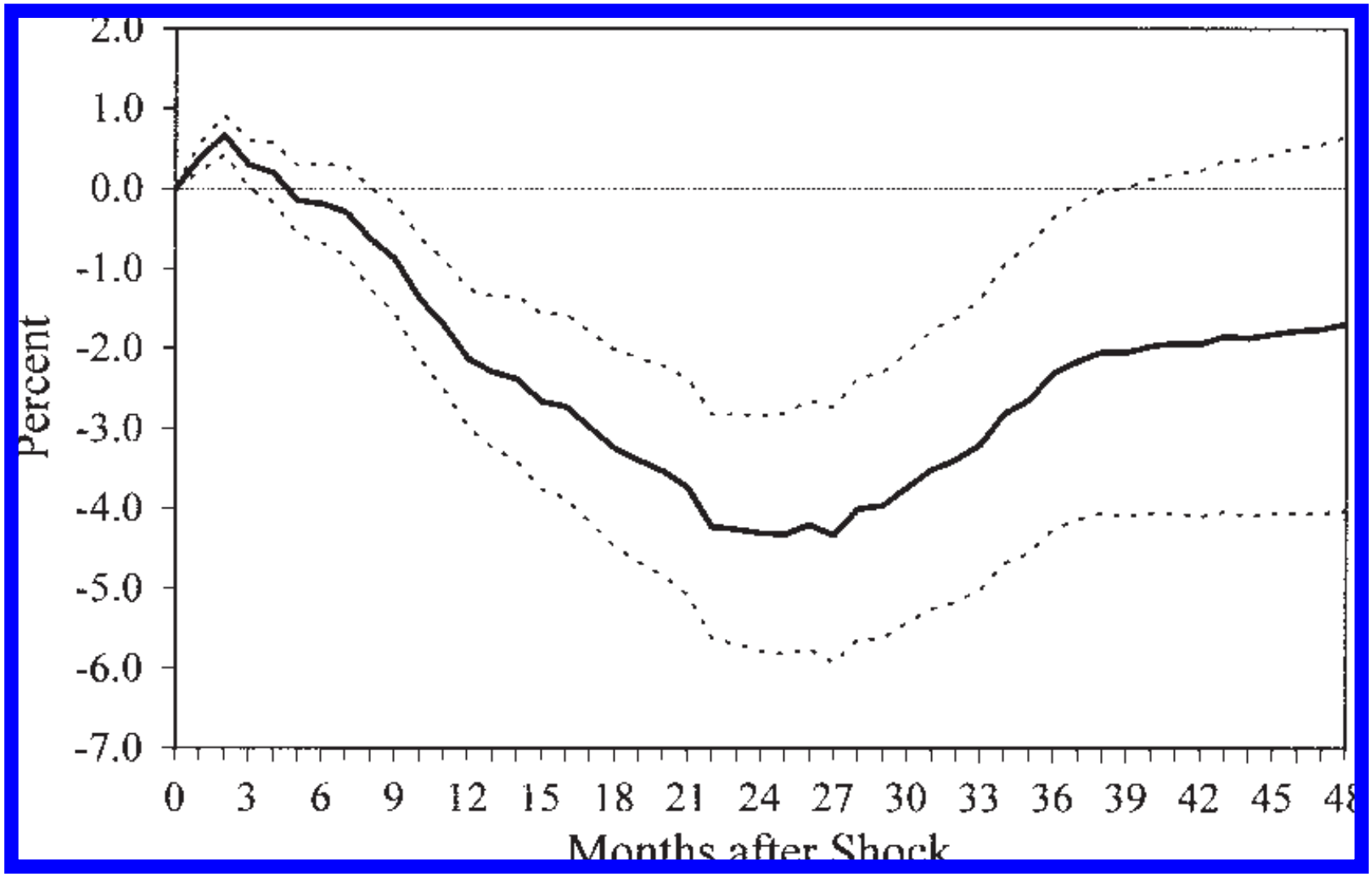


FIGURE 2. THE EFFECT OF MONETARY POLICY ON OUTPUT

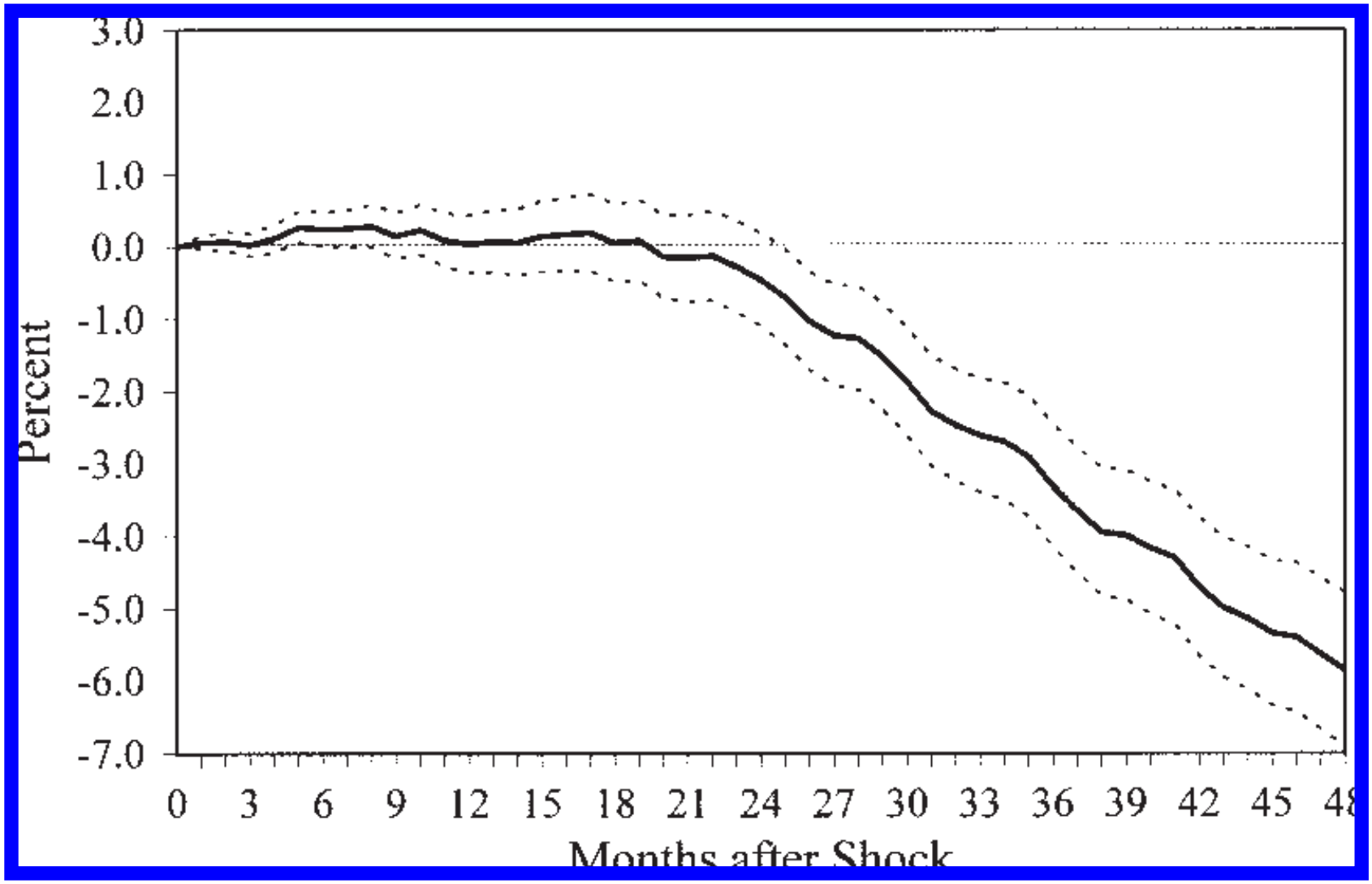


FIGURE 4. THE EFFECT OF MONETARY POLICY ON THE PRICE LEVEL

Outline