MONETARY THEORY AND POLICY

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INTRODUCTION

- We have looked into the central banking and monetary policy conducts.

- **Presumptions:** Monetary policy can affect real economic activities / macroeconomic targets.

- **Focus in this part:** various theoretical explanations on the real-effect of monetary policy
  - To build a prototype "monetary policy model"

AGENDA

- **Monetary policy and real economic activities?**
- Why does monetary policy affect output?
- Modern monetary policy models
  - Chapter 21 – 23 Mishkin (light version)
  - Note "IS-MP-PC model" By Karl Whelan (2015)

EVIDENCES ON MONETARY POLICY AND OUTPUT

- **Conventional wisdoms:**
  - **Long-run:** money does **NOT** affect output. Money affects only inflation
  - **Short-run:** money affects both output and inflation.

- **Evidences**
  - Some stylized-facts
  - Econometrics studies on monetary policy and real-economic activities.

LONG-RUN VIEW

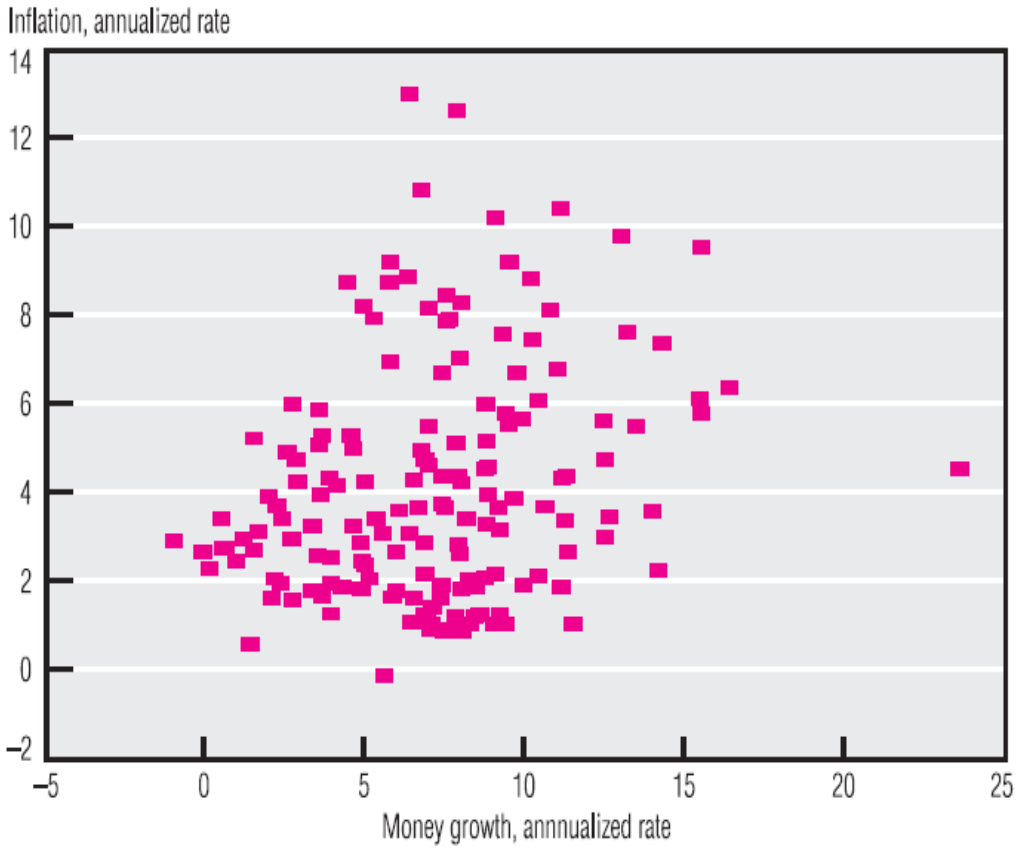
- Greatly influenced by the Quantity Theory of Money (QTM)

$$M * V = P * Q$$

M: Money / V: Velocity of money / P: Price / Q: real output

$$\%\Delta M + \%\Delta V = \%\Delta P + \%\Delta Q$$

MONEY AND INFLATION



SOURCES: U.S. Department of Labor, Bureau of Labor Statistics; Board of Governors of the Federal Reserve System; and DRI/McGraw–Hill.

Source: **Fitzgerald** (1999):

- Evidences?
- The pattern is not obvious!
  - Quarterly data!
  - Money growth v.s. inflation (YoY)
- **Question:** How long is long-run?

HOW LONG IS THE LONG-RUN?

ADJUSTED MONEY GROWTH AND INFLATION

$\%\Delta M - \%\Delta Q$ v.s. $\%\Delta P$

FIGURE 3a 2-YEAR AVERAGES

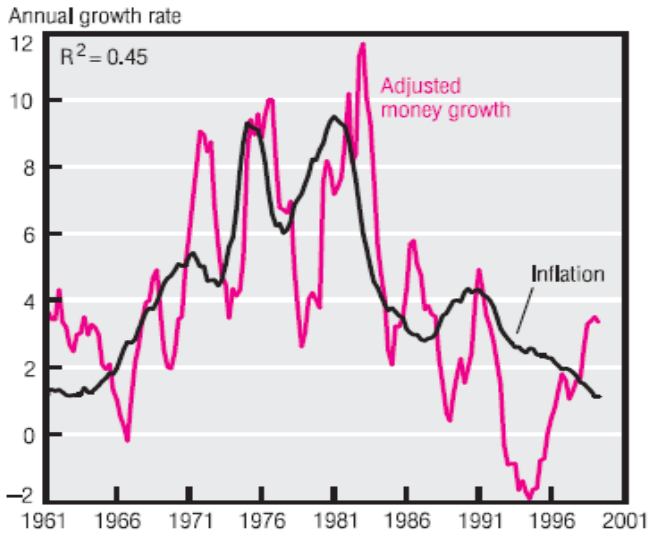


FIGURE 3b 4-YEAR AVERAGES

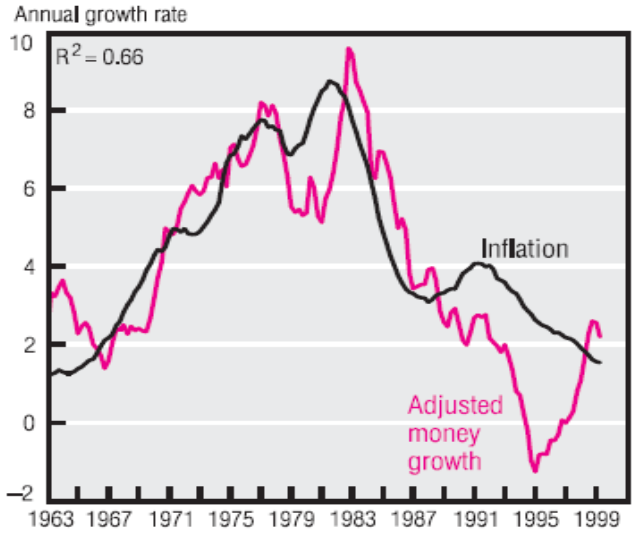


FIGURE 3c 8-YEAR AVERAGES

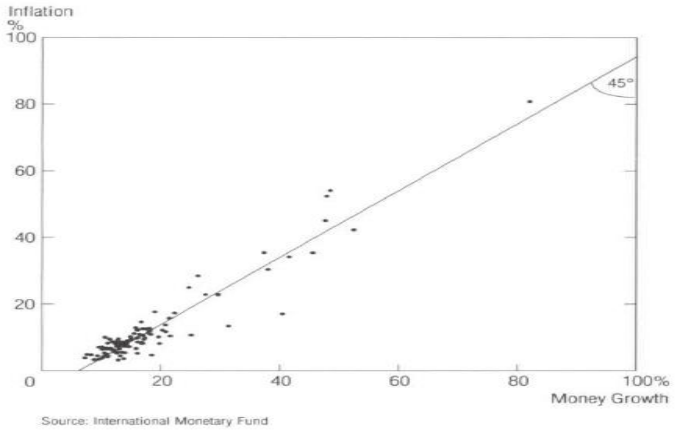
NOTE: Money is defined as M2. Inflation is defined using the implicit GDP price deflator (chained). Adjusted money growth is defined as money growth minus real GDP growth.

SOURCES: U.S. Department of Labor, Bureau of Labor Statistics; Board of Governors of the Federal Reserve System; and DRI/McGraw–Hill.

MONEY / INFLATION / OUTPUT: LONG-RUN VIEW

- International comparison study.
- Positive money growth and inflation is ***robust***!
  - Positive correlation (Strong) under selected subsample used.
- Plenty of previous studies have supported the conclusion as well.

Chart 1
Money Growth and Inflation: A High, Positive Correlation
Average Annual Rates of Growth in M2 and in Consumer Prices During 1960–90 in 110 Countries



Source: International Monetary Fund

Table 1
Correlation Coefficients for Money Growth and Inflation*
Based on Data From 1960 to 1990

Sample	Coefficient for Each Definition of Money M0	M1	M2
All 110 Countries	.925	.958	.950
Subsamples			
21 OECD Countries	.894	.940	.958
14 Latin American Countries	.973	.992	.993

*Inflation is defined as changes in a measure of consumer prices.
Source of basic data: International Monetary Fund

Table 2
Previous Studies of the Relationship Between Money Growth and Inflation

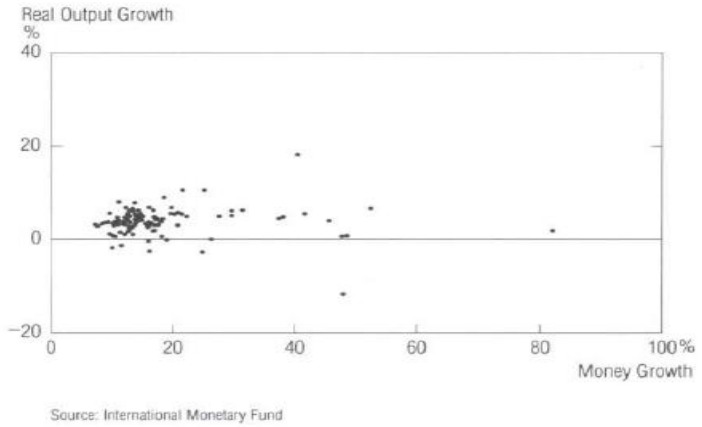
Author (and Year Published)	Study Characteristics: Time Series Money	Time Series Inflation	Countries	Time Period	Data Frequency	Finding
Vogel (1974)	Currency + Demand deposits	Consumer prices	16 Latin American countries	1950–69	Annual	Proportionate changes in inflation rate within two years of changes in money growth
Lucas (1980)	M1	Consumer prices	United States	1955–75	Annual	Strong positive correlation: Coefficient closer to one the more filter stresses low frequencies
Dwyer and Hafer (1988)	n.a.	GDP deflator	62 countries	1979–84	Five-year averages	Strong positive correlation
Barro (1990)	Hand-to-hand currency	Consumer prices	83 countries	1950–87	Full-period averages	Strong positive association
Pakko (1994)	Currency + Bank deposits	Consumer prices	13 former Soviet republics	1992 and 1993	Four-quarter averages	Positive relationship
Poole (1994)	Broad money	n.a.	All countries in World Bank tables	1970–80 and 1980–91	Annual averages	Strong positive correlation
Rolnick and Weber (1994)	Various	Various	9 countries	Various	Long-period averages	Strong positive correlation for fiat money regimes

MONEY / INFLATION / OUTPUT: LONG-RUN VIEW

Chart 2

Money and Real Output Growth:
No Correlation in the Full Sample . . .

Average Annual Rates of Growth in M2
and in Nominal Gross Domestic Product, Deflated by Consumer Prices
During 1960–90 in 110 Countries

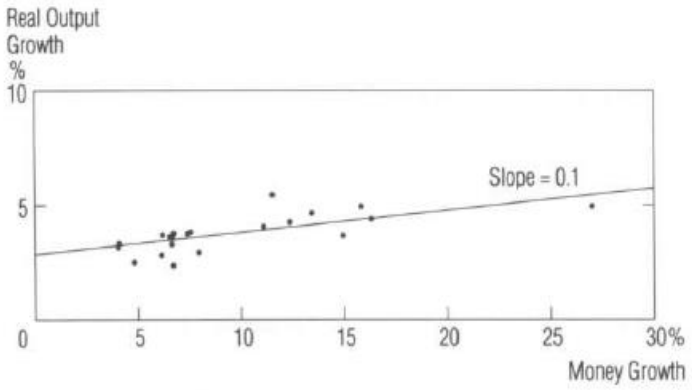


Source: International Monetary Fund

Chart 3

. . . But a Positive Correlation in the OECD Subsample

Average Annual Rates of Growth in M0
and in Nominal Gross Domestic Product, Deflated by Consumer Prices
During 1960–90 in 21 Countries



Source: International Monetary Fund

Table 3

Correlation Coefficients for Money Growth and Real Output Growth*

Based on Data From 1960 to 1990

Sample	Coefficient for Each Definition of Money		
	M0	M1	M2
All 110 Countries	−.027	−.050	−.014
Subsamples			
21 OECD Countries	.707	.511	.518
14 Latin American Countries	−.171	−.239	−.243

*Real output growth is calculated by subtracting changes in a measure of consumer prices from changes in nominal gross domestic product.

Source of basic data: International Monetary Fund

- Money growth and output growth has no correlation under full-sample.
  - Among OECD countries, the growth relationship is positive!
  - Negative correlation among 14 Latin American countries.
- The relationship is **NOT** robust!
- **Interpretation?** Correlation v.s. Causation

CORRELATION V.S. CAUSATION

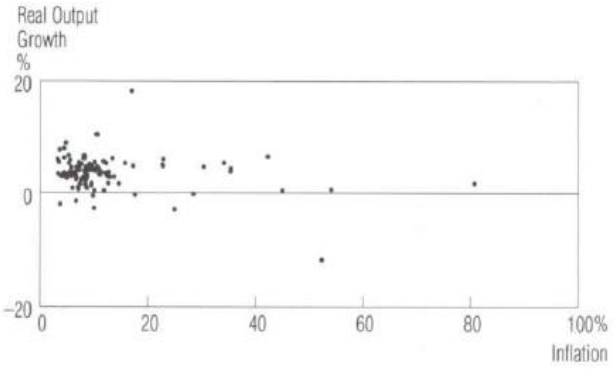
- Does money growth "cause" an increase in output growth?
- Money growth might be (negatively/positively) co-moved with output growth, due to **other factors**.
- **Example:** financial innovations / political instability (weak institution)

MONEY / INFLATION / OUTPUT: LONG-RUN VIEW

Chart 4

Inflation and Real Output Growth: No Correlation

Average Annual Rates of Growth in Consumer Prices and in Nominal Gross Domestic Product, Deflated by Consumer Prices During 1960–90 in 110 Countries



Source: International Monetary Fund

Table 5

Correlation Coefficients for Inflation and Real Output Growth*

Based on Data From 1960 to 1990

Sample	Coefficient With Outlier** Included	Excluded
All 110 Countries	–.243	–.101
Subsamples		
21 OECD Countries	.390	.390
14 Latin American Countries	—	–.342

*Inflation is defined as changes in a measure of consumer prices. Real output growth is calculated by subtracting those inflation rates from changes in nominal gross domestic product.

**The outlier is Nicaragua.

Source of basic data: International Monetary Fund.

Table 6

Previous Studies of the Relationship Between Inflation and Real Output Growth

Author (and Year Published)	Study Characteristics: Time Series: Inflation	Time Series: Output	Number of Countries	Time Period	Data Frequency	Finding
Fischer (1983)	n.a.	n.a.	53	1961–73, 1973–81	Annual	Negative contemporaneous relationship; positive correlation with one lag
Kormendi and Meguire (1985)	Consumer prices	Real GDP	47	1950–77	Period averages	Negative correlation
Fischer (1991)	GDP deflator	GDP	73	1970–85	Annual	Negative relationship
Altig and Bryan (1993)	GDP deflator	Per capita GDP	54 and 73	1960–88	Annual	Negative correlation
Ericsson, Irons, and Tryon (1993)	GDP deflator	GDP	102	1960–89	Annual	Weak negative correlation
Barro (1995)	Consumer prices	Per capita real GDP	78, 89, and 84	1965–90	Five- or ten-year averages	Negative correlation

n.a. = not available

- **Full-sample:** Weak negative correlation between inflation and output growth!
  - OECD: positive!
  - 14 Latin American: negative!
- Relationship might be **non-linear**!

CORRELATION V.S. REGRESSION ANALYSIS

- Regression model might be a better statistical framework
  - Correlation can NOT shed some light on causation!
  - Correlation is ONLY suitable for linear relationship

- Economists usually rely on regression model to fix the drawbacks of correlation analysis
  - Causal issue: Running regression, and introduce some controlled variables!
  - Flexibility: Regression can address "**non-linear**" relationship

CORRELATION V.S. REGRESSION ANALYSIS

- **Case studies:** inflation and output growth
  - Running regression
    - (average) Inflation
    - Other factors
    - Group-specific variable → Dummy variables
  - Most studies found that linear "regression" model does not explain the pattern well.
    - Better approach is the non-linear model!

Table 2. NLLS With Fixed Effects (Five-Year Average)

Dependent Variable: $d\log(gdp)$

Independent Variables	All	Industrial	Developing
$(1-d^{\pi^*})[\log(\pi)-\log(\pi^*)]$	0.00049	0.05991	0.00109
	(–0.66)	(2.53)a	(1.33)
$d^{\pi^*}[\log(\pi)-\log(\pi^*)]$	–0.00895	–0.00643	–0.00895
	(–4.70)a	(–4.23)a	(–4.42)a
ly_0	–0.02506	–0.03634	–0.02551
	(–13.20)a	(–15.58)a	(–11.08)a
igdp	0.15090	0.10640	0.15910
	(5.01)a	(3.47)a	(4.96)a
$d\log(pop)$	0.04947	–0.01557	0.05095
	(2.33)a	(–0.23)	(2.33)a
σ_{tot}	–0.00020	–0.00031	–0.00019
	(–2.56)a	(–1.17)	(–2.33)a
Threshold (%)	11	1	11
	(64.42)a	(9.10)a	(58.59)a
NxT	905	165	740
R^2	0.43	0.80	0.39

Note: The panel has 8 observations (T), that is five-year averages over 1960–98, for 140 countries (N). The variables are inflation,π; the log of initial income, ly_0; gross domestic investment over GDP, *igdp*; the growth rate of population, $d\log(pop)$; and the standard deviation of terms of trade, $\sigma(tot)$. The dummy variable d^{π^*} takes one for inflation rates greater than the threshold estimate (π^*) and zero otherwise. The *t*-statistics, given in parentheses, are computed from White heteroskedasticity-consistent standard errors. The letters "a", "b", "c", indicate statistical significance at 1, 5, and 10 percent, respectively. The growth rate of a variable x is approximated by the first difference of the log of x, $d\log(x)$. The estimated time dummies and country-specific effects are not reported.

MONEY / INFLATION / OUTPUT: LONG-RUN VIEW

- Hypothesis:
  - Low inflation might not matter.
  - But when it is high enough, things turn bad abruptly
- Econometric test: Panel data model, with Threshold effect
  - Threshold model (very much like Dummy variable)
- Why?

SHORT-RUN EVIDENCES

- Presenting some evidences related to "how money, monetary policy and macro aggregates (output, etc.) behave over the course of *business cycles*"

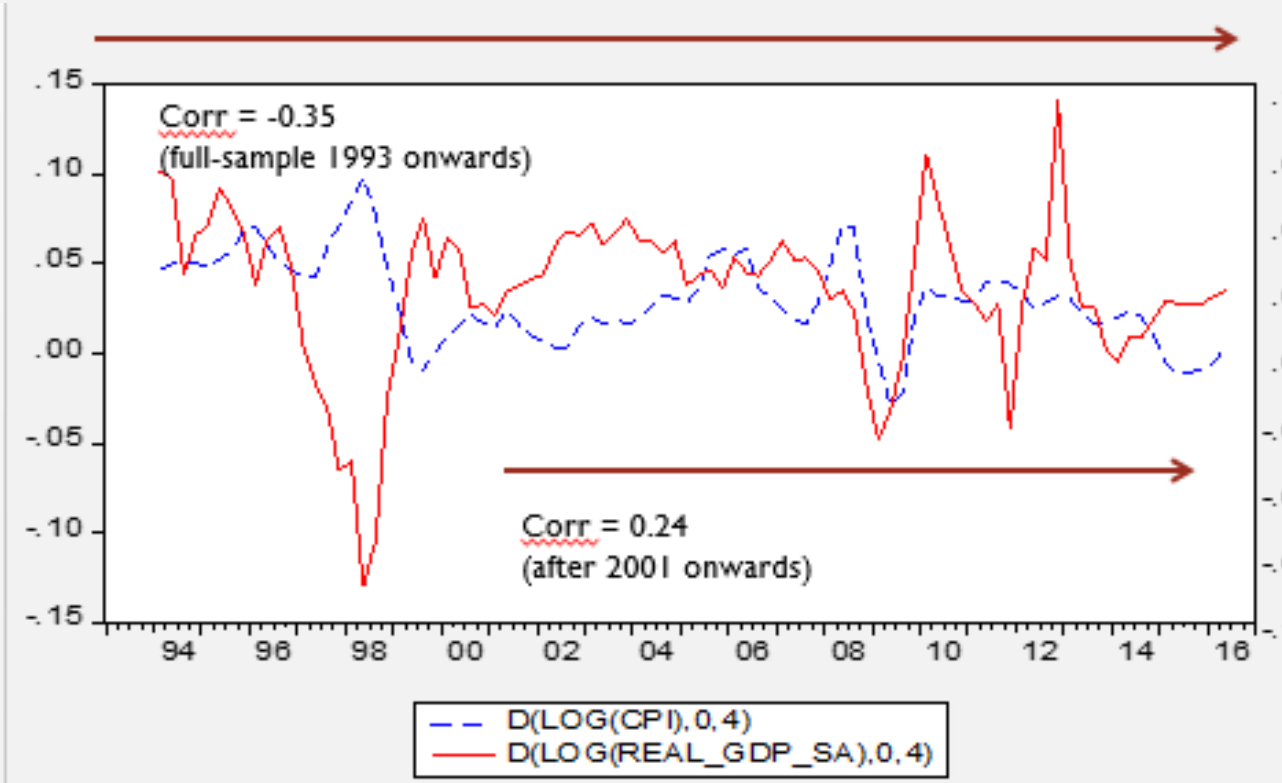
- What is business cycle?

DIGRESSION: WHAT IS BUSINESS CYCLE?

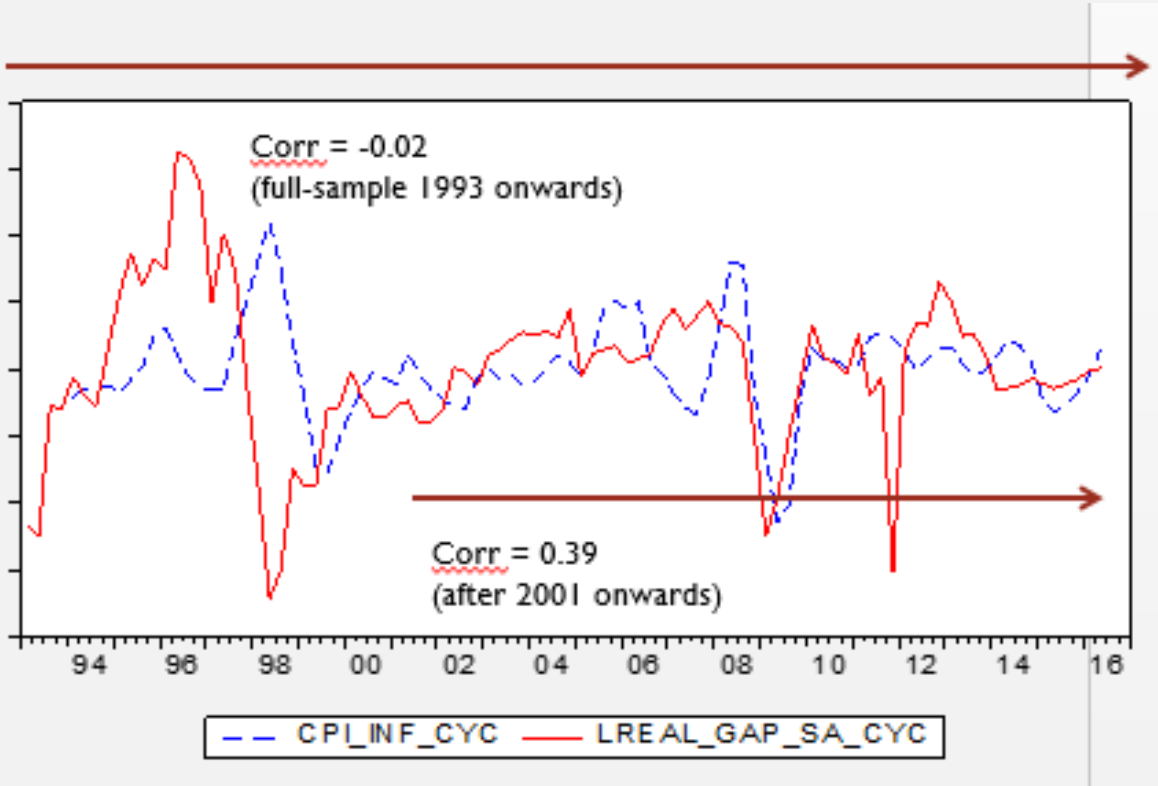
- Business cycles?
  - Quarterly frequency (for 2- 5 years)
  - Deviations from the actual from **trend**
  - Cycles are usually represented in terms of % deviation from trend. Why?

- Trend v.s. Cycle decomposition
  - Simple growth: Linear trend – e.g. $y(t) = y(0)*\exp(kt)$
  - Statistical trend decomposition: Non-linear trend – e.g. HP-Trend / Filtering

STYLIZED FACTS ON BUSINESS CYCLES: CYCLICAL PROPERTIES



Growth correlation



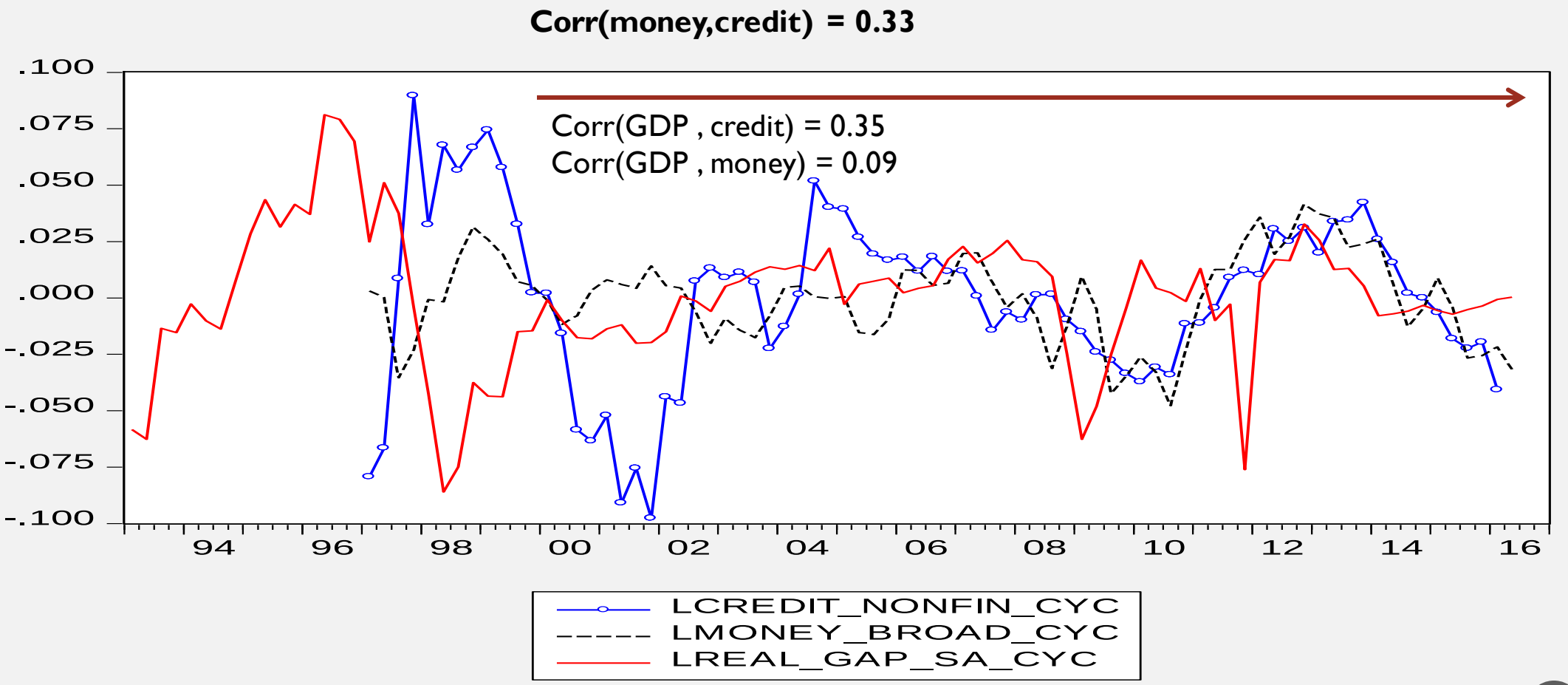
Detrending correlation

WHAT IS BUSINESS CYCLE STUDIES?

- Business cycle studies aim to
  - Identify the source of cycles: **Shocks**
  - How shocks transmit its effect and create the cycle: **Shock-propagation**
  - Normatively, aim to provide policy recommendations: **Shock-absorption**

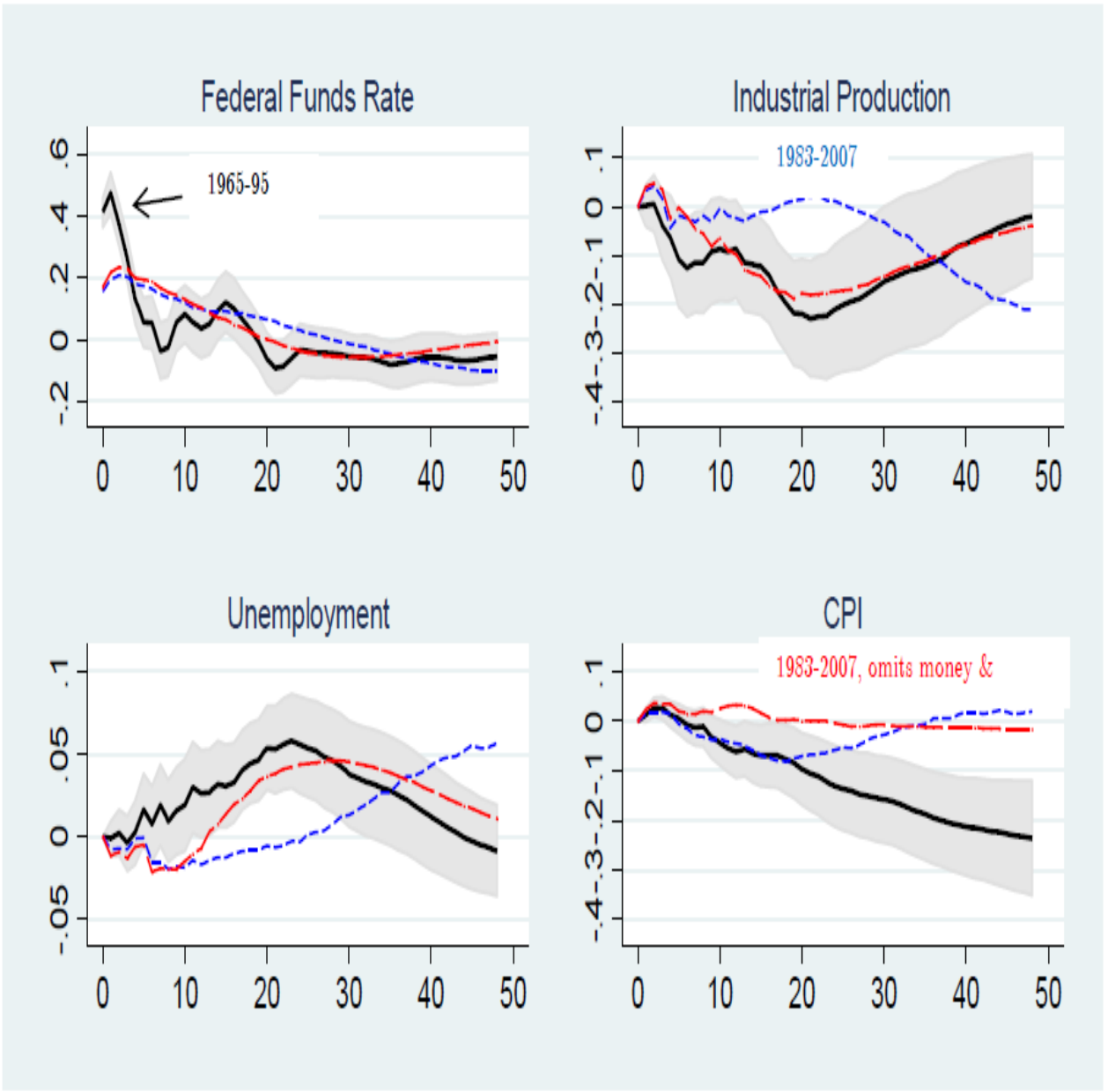
- Monetary business cycles
  - Extent to which the business cycle is driven by **monetary factors**.

DETRENDED OUTPUT / MONEY / CREDIT:FRIEDMAND AND SCHWARTZ (1987)



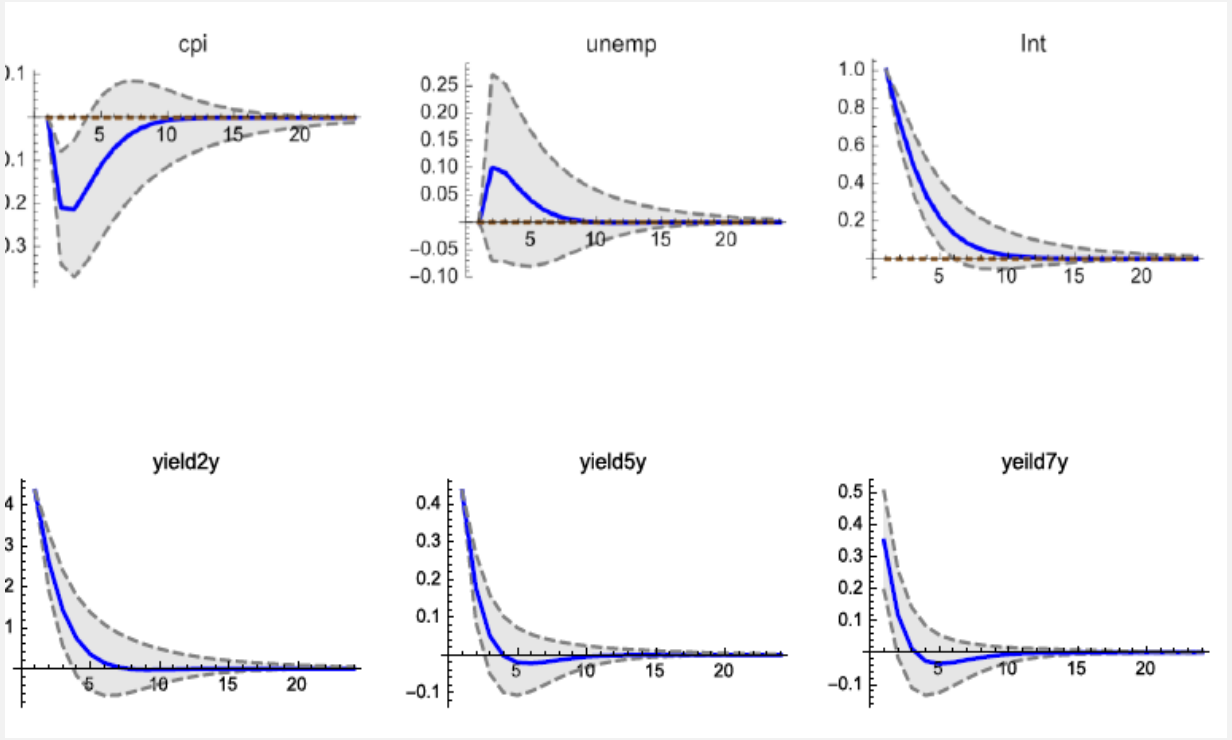
PROBLEMATIC

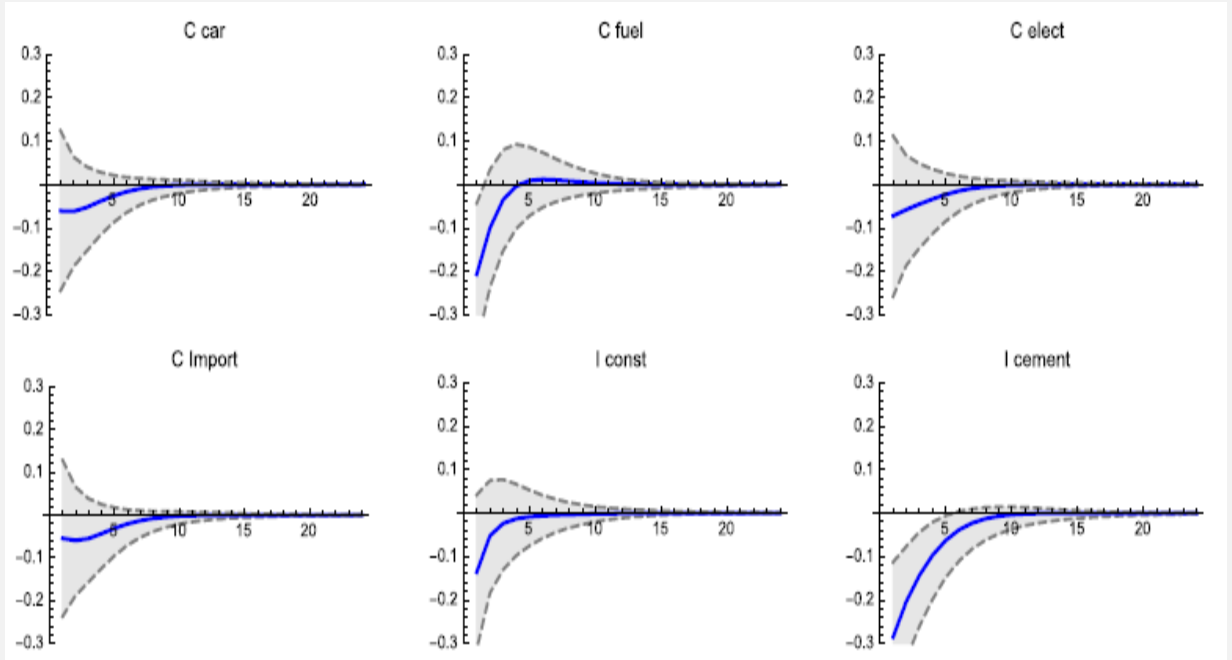
- How interpret the stylized-facts
- Of course, not a causal interpretation!
- Need econometrics inferences!
- Common tools: **VAR and FAVAR (study in EE435)**



VAR EVIDENCES: USA

- Common findings:
- A surprise increase in "FED fund rate" would causally led to
  - Higher unemployment rate
  - A decline in real economic activities
  - A falling in overall price.
- The effect lasts for a several years.





FVAR EVIDENCES: THAILAND

- Bernanke et.a.t (2005) "Measuring the effects of monetary policy: FAVAR approach"
- Sripinit (2017) for Thailand
- Offers similar findings!

AGENDA

- Money and real economic activities?
- **Why does money affect output?**
- Modern monetary policy model

WHY DOES MONEY AFFECT OUTPUT?

- Interpreting the evidences
  - Why money does not affect output in the long-term!
  - Why money affects out in the short-term!

- Classical v.s. Keynesian interpretation
  - Short-run v.s. Long-run aggregate supply

WHY DOES MONEY AFFECT OUTPUT?

- Idealistic → monetary neutrality!
  - Flexible price/wage
  - Perfect information

- Frictions → money generates real-effect!
  - Incomplete frictions: New classical interpretation
  - Nominal frictions: New Keynesian interpretation

NEW CLASSICAL INTERPRETATION

- New Classical interpretation / monetarist interpretation
  - Flexible price/wage

- Lucas's price misperception
  - The famous "Lucas Island model"

NEW CLASSICAL INTERPRETATION

- Agents have incomplete information.
  - Each firm does not know what others are doing!

- Firm can only observe its nominal price, but not the relative price.
  - Example: Price of its own product, but not other products

- Firm infer about its "relative price", using partial information.
  - Firm choose to produce using their perceived relative price.

NEW CLASSICAL INTERPRETATION

- Lucas' *individual* supply curve:

$$y_i = \bar{y}_i + \alpha(p_i - \bar{p}^e)$$

p_i	observe nominal price
$\bar{p}^e$	"expected" overall prices
$\bar{y}_i$	long-run level when information is complete

NEW CLASSICAL INTERPRETATION

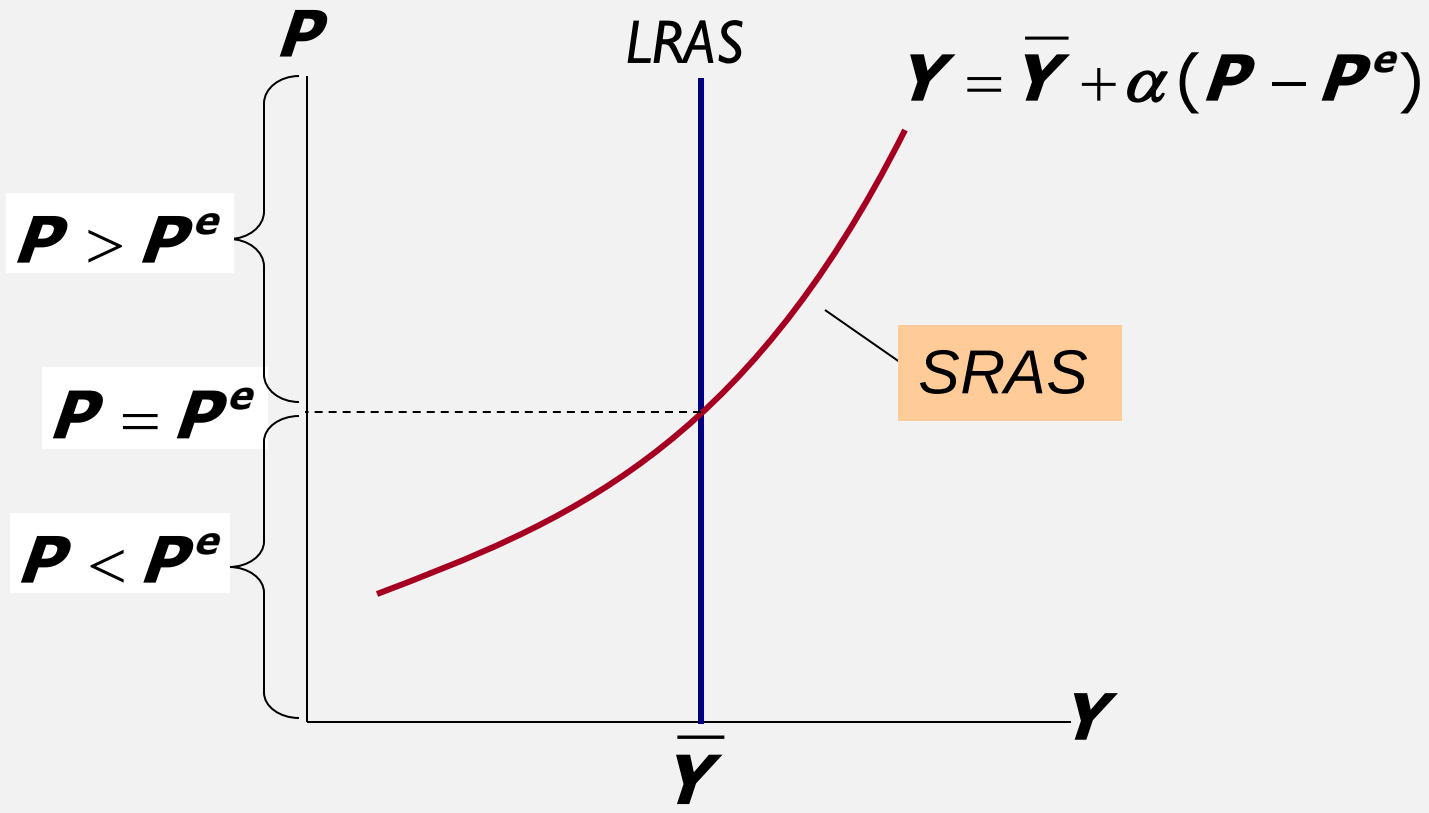
- Lucas' AGGREGATE supply curve:

$$y = \bar{y} + \alpha(p - \bar{p})$$

$\bar{y} = \sum_{i=1}^{N} \frac{\bar{y}_i}{N}$ (potential output)

$(p - \bar{p})$ Price surprises

GRAPHICAL VERSION OF LUCAS SUPPLY CURVE



LUCAS INTERPRETATION

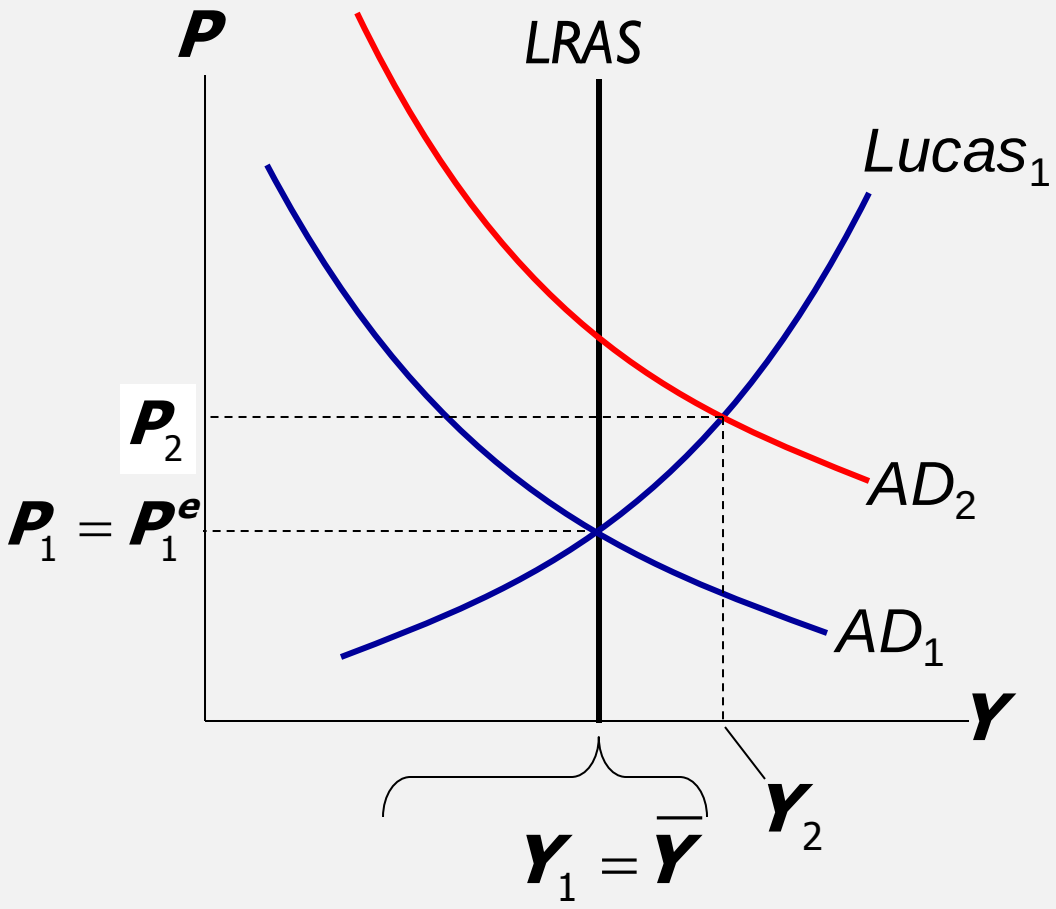
- Nominal increase in CPI can occur because of the surprise in monetary policy.

- Each firm "misinterprets" the rise in their nominal price as an increase in relative price, and voluntarily increases in the production at the same time.

LUCAS INTERPRETATION

SRAS equation: $Y = \overline{Y} + \alpha(P - P^e)$

Suppose a positive *AD* shock (increase in money supply) moves output above its natural rate and P above the level people had expected.



SHORTCOMINGS OF THE INTERPRETATION

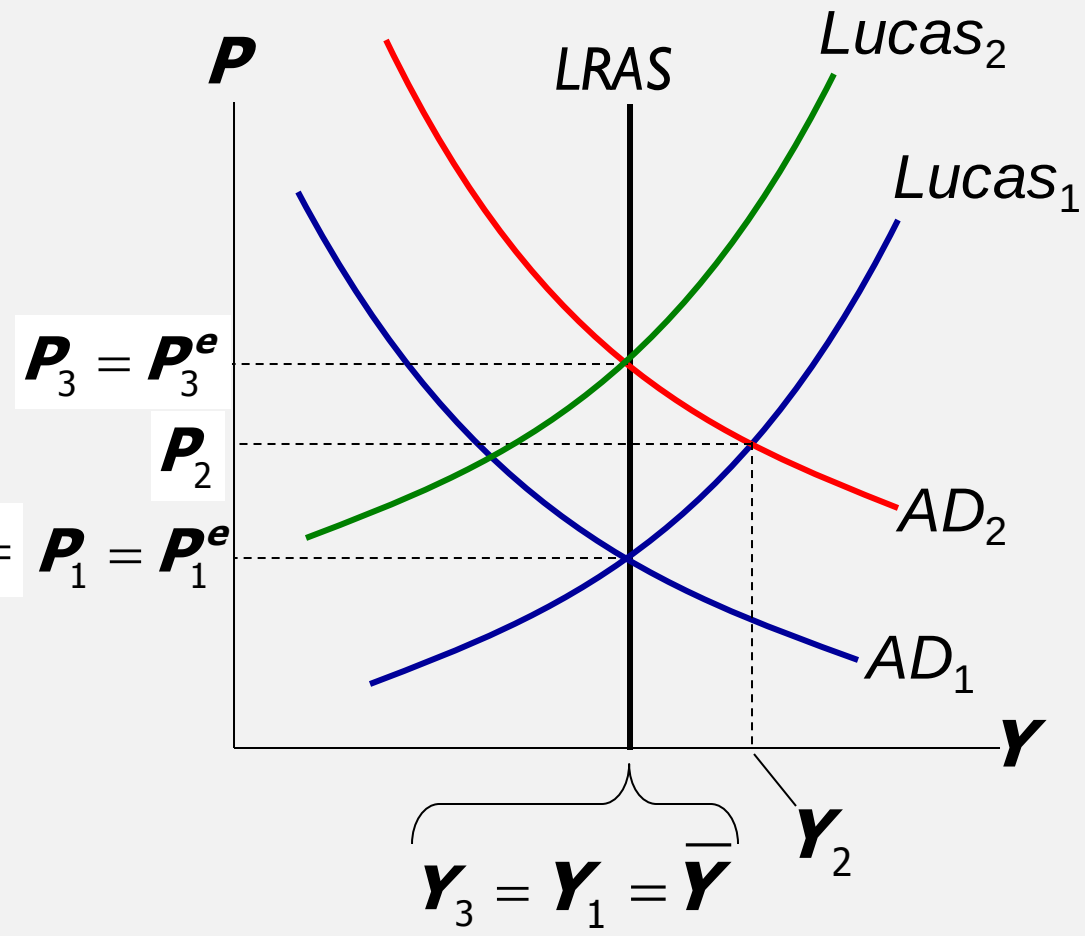
- Should the "misinterpretation" last long?
  - Information for money stock is continuously updated.
  - An unexpected increase in money supply should only temporary increase the real output.

- Under Lucas's framework, monetary policy generates short-lived/temporary effect.

SHORTCOMINGS OF THE INTERPRETATION

Suppose a positive *AD* shock (increase in money supply) moves output above its natural rate and ***P*** above the level people had expected.

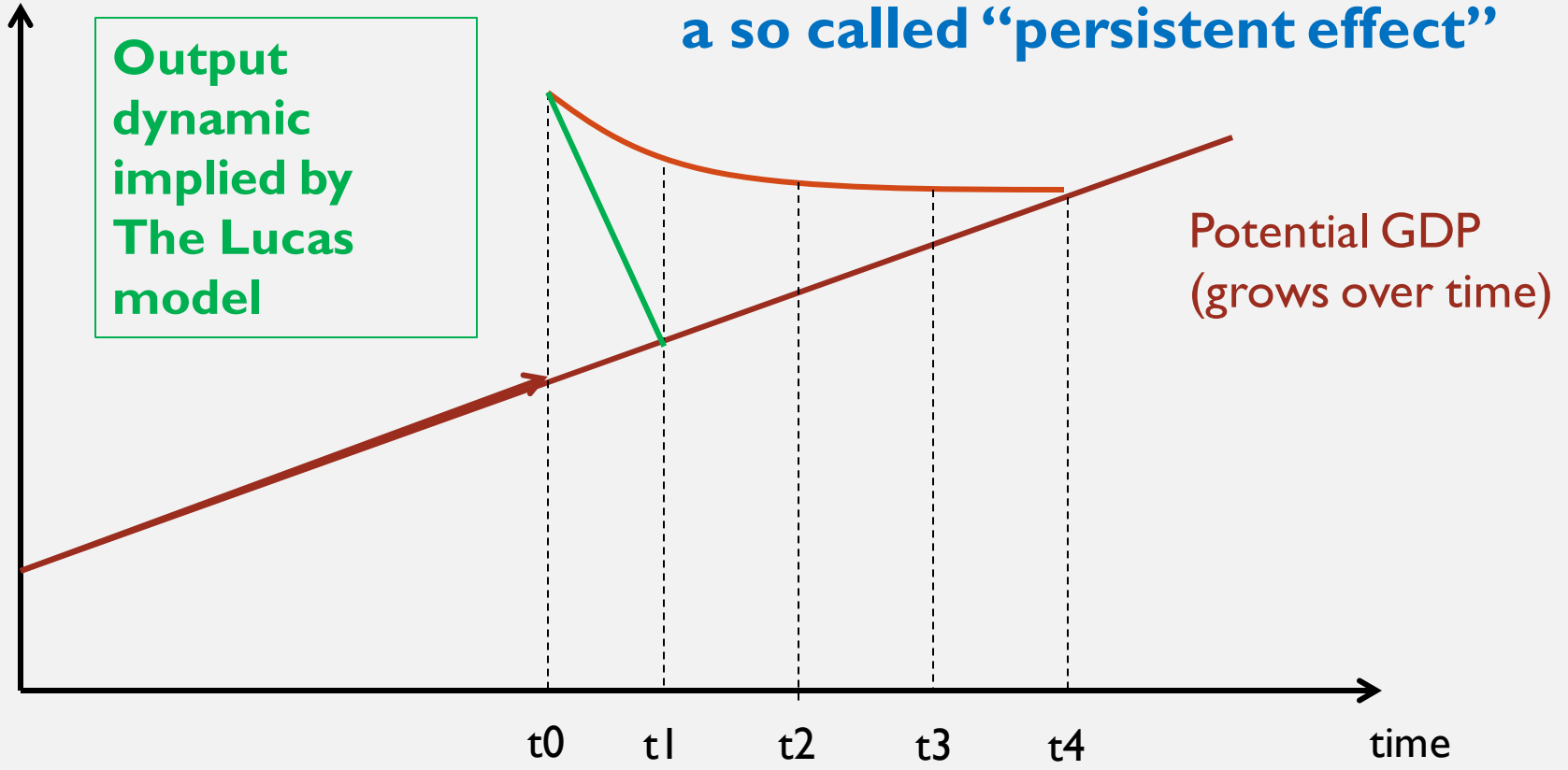
SRAS equation: $Y = \bar{Y} + \alpha(P - P^e)$



Over time, P^e rises, *SRAS* shifts up, and output returns to its natural rate.

VERY SHORT-LIVED EFFECT V.S. PERSISTENT EFFECT IN THE DATA

Empirically, money shock generates a so called "persistent effect"



NEW KEYNESIAN INTERPRETATION

- New Keynesian interpretation
  - Nominal rigidities in price/wage
  - Multi-period price settings
  - AS is then naturally non-vertical

NOMINAL RIGIDITIES

- Nominal rigidities ?
  - Commonly known in any standard macro textbook as price/wage stickiness.
  - Mostly confused with fixed price and flat supply curve.

- What does it mean in **the real world** for the **nominal price/wage rigidities?**

MICRO EVIDENCES ON PRICE SETTINGS KLENOW AND MALIN (2010)

Number of Price Changes per year (%) in Survey Data

Country	Paper	<1	1	2-3	≥4	Median	Mean (in months)
Austria	Kwapil *et al.* (2005)	24	51	15	11	1	12.7
Belgium	Aucremanne and Druant (2005)	18	55	18	8	1	11.9
Canada	Amirault *et al.* (2006)	8	27	23	44	2-3	6.8
Estonia	Dabusinskas and Randveer (2006)	14	43	25	18	1	10.0
Euro Area	Fabiani *et al.* (2005)	27	39	20	14	1	12.3
France	Loupias and Ricart (2004)	21	46	24	9	1	11.8
Germany	Stahl (2005)	44	14	21	21	1	13.5
Italy	Fabiani *et al.* (2007)	20	50	19	11	1	11.9
Japan	Nakagawa *et al.* (2000)	23	52	11	14	1	12.5
Luxembourg	Lunnemann and Matha (2006)	15	31	27	27	2-3	9.0
Mexico	Castanon *et al.* (2008)	-	-	-	-	-	5.7
Netherlands	Hoeberichts and Stokman (2006)	10	60	19	11	1	10.7
Portugal	Martins (2005)	24	51	14	12	1	12.7
Romania	Copaciu *et al.* (2007)	-	-	-	-	-	4.1
Spain	Álvarez and Hernando (2007a)	14	57	15	14	1	11.1
Sweden	Apel, Friberg and Hallsten (2005)	29	43	6	20	1	12.7
Turkey	Sahinoz and Saracoglu (2008)	-	-	-	-	-	3.0
United Kingdom	Hall, Walsh and Yates (2000)	6	37	44	14	2-3	8.2
United States	Blinder *et al.* (1998)	10	39	29	22	1	8.8

Note: Source: Álvarez (2008), Table 3. Mean implicit durations obtained from the interval-grouped data using the following assumptions: for firms declaring "at least four price changes per year", 8 price changes are considered (i.e. mean duration of 1.33 months); for those declaring "two or three price changes per year", 2.5 price changes are considered (i.e., 4.8 months); for those declaring "one change per year" a duration of 12 months, and for those declaring "less than one price change per year", a change every two years is considered (i.e., 24 months).

1. Survey data for price adjustment of some randomly selected firms/products

2. How many times does the firm change its price in a year?

3. Each firm have an **unequal frequency** of price change in a year.

4. What's shown in the last column on the table represents **"average" of the duration in month** that firms keep their price fixed.

MICRO EVIDENCES ON PRICE SETTINGS KLENOW AND MALIN (2010)

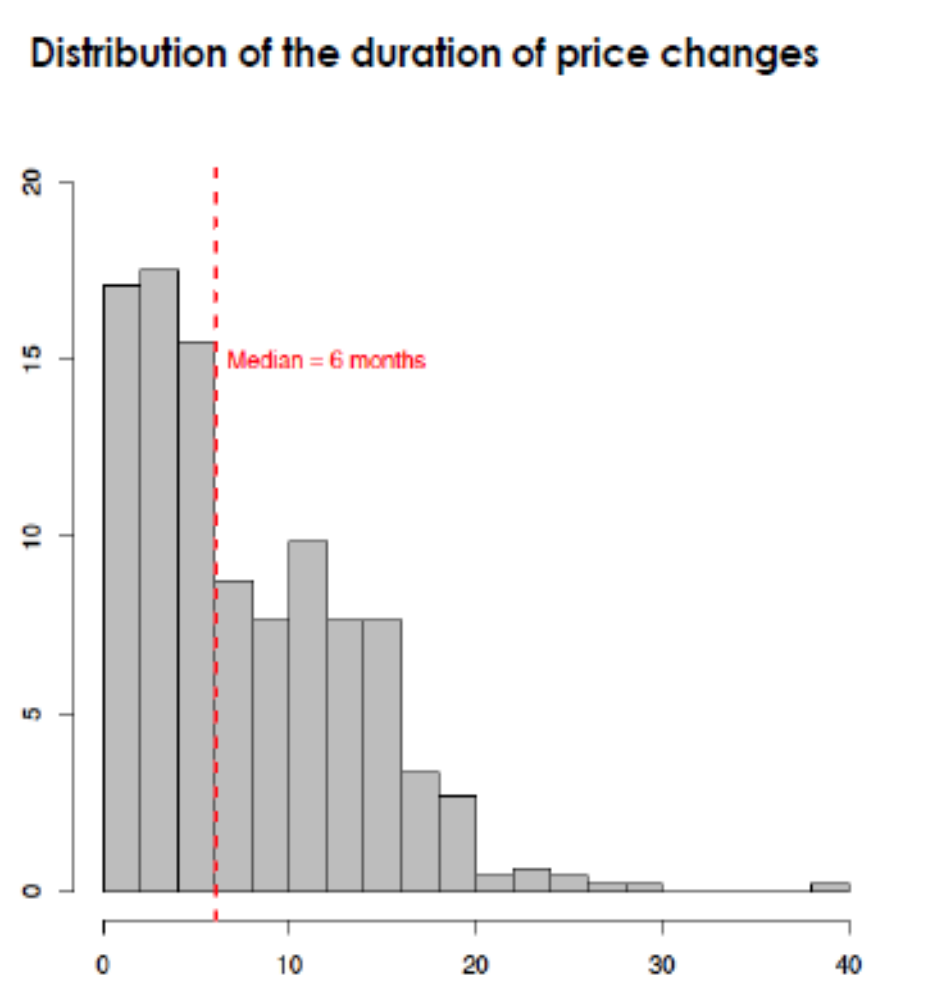
Price Durations by Category in the U.S. CPI

Durations in Months	*Posted*		*Regular*		% of CPI
	Median	Mean	Median	Mean	
All Items	3.4	6.2	6.9	8.0	100.0%
Durable Goods	1.8	3.0	1.8	5.0	21.7
Nondurable Goods	3.4	5.8	7.3	8.3	48.6
Services	7.6	9.4	7.6	9.6	29.7
Raw Goods	1.0	1.1	1.0	1.2	12.0
Processed Goods	4.4	6.9	7.7	8.9	88.0
Apparel	2.8	2.9	9.2	10.1	7.0
Education and Communication	5.4	6.2	6.7	6.3	7.3
Food	3.4	6.9	8.5	9.3	22.4
Home Furnishings	1.9	3.5	2.0	5.4	17.0
Medical Care	10.0	14.2	12.6	14.7	7.8
Recreation	6.3	7.5	9.4	9.8	8.5
Transportation	1.8	3.7	1.8	3.8	24.5
Other Goods and Services	8.6	14.7	12.1	16.7	5.5

Source: CPI-RDB. Data are for the top three cities (New York, Los Angeles, and Chicago) from February 1988 through October 2009. Durations are weighted medians or means of implied durations from weighted average frequencies within ELIs. Durables, Nondurables, and Services coincide with U.S. National Income and Product Account classifications. Raw goods include gasoline, motor oil and coolants, fuel oil and other fuels, electricity, natural gas, meats, fish, eggs, fresh fruits, fresh vegetables, and fresh milk and cream. Apparel, etc. are Major Groups in the CPI (1998-onward definition).

1. In each sector, each firm cannot adjust their price at the same time!
2. Duration of price stickiness varies across sectors. (finer disaggregate details)
3. Sectoral price rigidities is academically referred to "*unsynchronized* adjustment of products within and across sector"

MICRO EVIDENCES ON PRICE SETTINGS APHAITHAN AND PYM (2018)



Category	Mean Frequency	Implied Mean Duration (months)	Mean Duration (months)
Food & Non-Alcoholic Beverages	0.23	3.91	5.47
Apparel & Footware	0.03	29.37	13.85
Housing & Furnishing	0.13	7.37	6.57
Medical & Personal Care	0.07	13.03	10.10
Transportation & Communication	0.29	2.86	7.25
Recreation & Education	0.04	22.88	8.79
Tobacco & Alcoholic Beverages	0.11	8.70	7.17
Total CPI	**0.20**	**4.40**	**7.04**

Sector	Mean Frequency	Implied Mean Duration (months)	Mean Duration (months)
Core	0.06	15.13	9.16
Non-core	0.50	1.44	2.50
Control	0.34	2.45	5.28
Non-Control	0.12	7.60	8.10
Service	0.06	16.88	9.72
Non-Service	0.26	3.38	6.07
Durables	0.07	14.38	8.43
Non-Durables	0.22	4.03	6.87
Total CPI	**0.20**	**4.40**	**7.04**

RATIONALE FOR NOMINAL RIGIDITY / INFREQUENT ADJUSTMENT IN PRICE

- Why do we want to change price?
  - Shocks, e.g. unexpected increase in cost of production
- Why wouldn't firm change the price every single time when they confront with changing environments?
  - Menu cost / Information-processing cost / search cost
- What does the firm do under menu cost situation?
  - Optimal (S,s) policy: keep price (s) fixed as long as current price is not deviating too much from optimal new price (S).

IMPLICATIONS FOR INFREQUENT PRICE ADJUSTMENT TO AGGREGATE OUTPUT

- The implication of infrequent price adjustment is captured by the model so called "staggered price adjustment"
- Each firm sets their own price for N-period of time, and take turns in adjusting the price.
  - Staggered environment: overlapping period of price adjustment.
- One-time increase in money supply can generate lasting effects.
  - Output inertia
  - Inflation inertia