Identification in macroeconomics

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Some important questions in macroeconomics include

- Why do some countries grow faster than others?
- What causes business cycle fluctuations?
- How does monetary or fiscal policy affect the economy?

The answers to these questions are often

1. Unknown
2. Difficult to answer

A major complication - as in any empirical field - is identification.

What is identification?

- Necessary condition for the existence of consistent estimators
- i.e. when sample size increases, the estimator will converge, probabilistically, to parameters unknown value

Analytically, identification entails whether or not the unknown parameter value can be deduced from the observed data

- Consistent estimators may exist under number of assumptions, i.e. central limit theorem etc.

For a general definition of identification, let P be the true distribution of observed data X which can be modeled by

$$\mathbf{P} = \{P_\theta : \theta \in \Theta\} \tag{1}$$

Assuming that

$$P \in \mathbf{P} \tag{2}$$

or that there is a correctly specified model with parameters $\theta \in \Theta$ such that $P \in \mathbf{P}$. Of course we are interested in θ

Suppose that we know for a fact that $P \in \mathbf{P}$ which entails that $\theta \in \Theta$ for $P_\theta \in \mathbf{P}$

- Only problem is that we can't distinguish between $\theta \in \Theta$ from $\theta^* \in \Theta$

So from our knowledge about P alone we can only say that

$$\theta \in \Theta_0(P) = \{\theta \in \Theta : P_\theta = P\} \tag{3}$$

$\Theta_0(P)$ is the identified set

- θ is identified if $\Theta_0(P)$ is a singleton for all $P \in \mathbf{P}$

$\mathbf{P}$ should be interpreted as a structural model for the distribution of observed data X

Why should we care about a structural model? As we can calculate interesting statistics from P

- Predictors, conditional probabilities, etc.

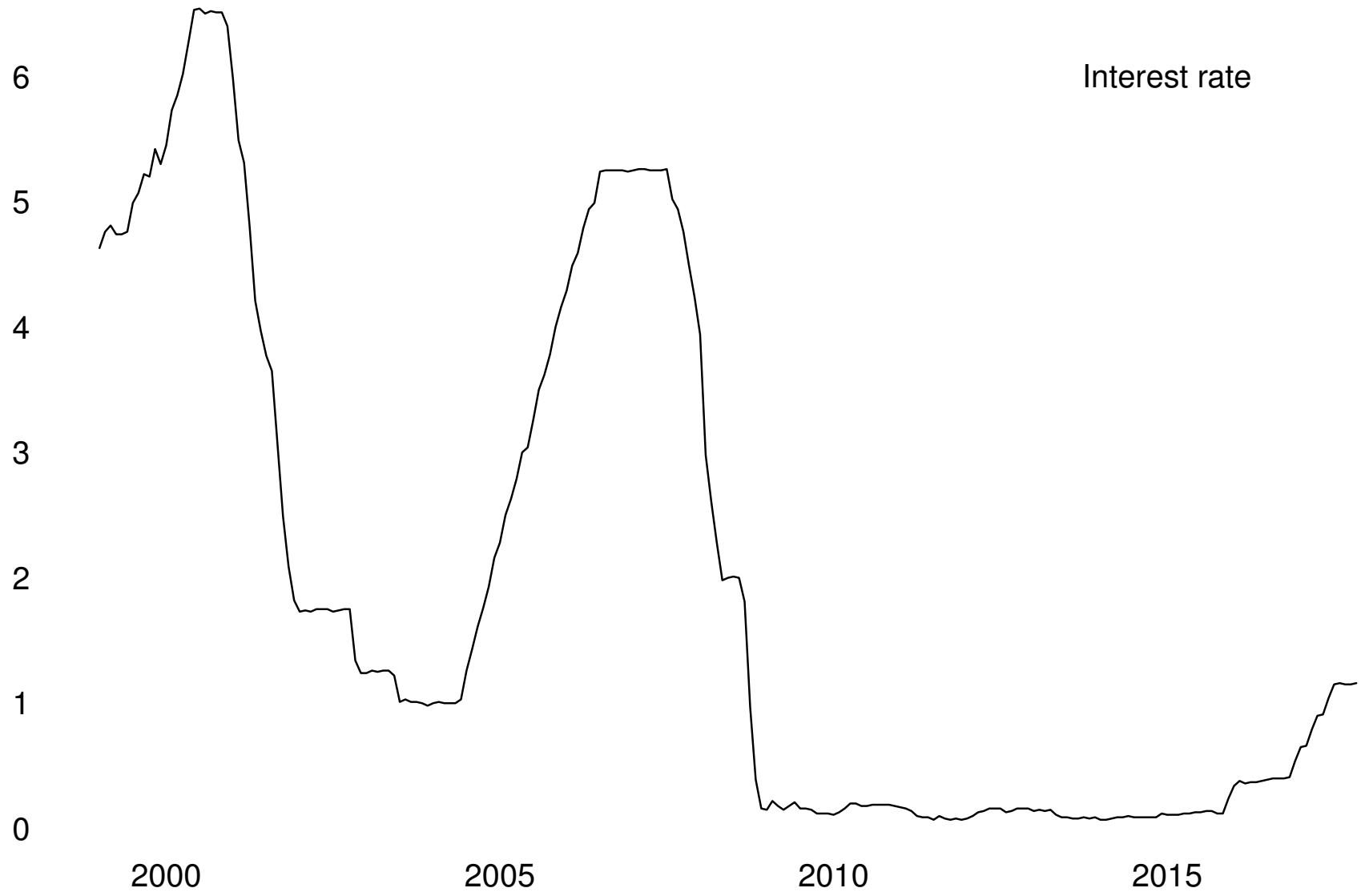
These statistics can provide useful insights about the data but not the mechanisms that generate the data. In the identified model the structure of the data $\mathbf{P}$ is given by unknown value $\theta \in \Theta$.

- A central question is what we can learn from θ, under certain conditions, from observed distribution P

Let's consider a more practical example looking at the FED interest rates: In 2008 the FED lowered the rates in a reaction to the crisis.

- Lowering interest rates should encourage spending; stimulate economic activity

Changes in interest rate are a source of variation in monetary policy which can be used in the model.


Interest rate
6
5
4
3
2
1
0
2000
2005
2010
2015

Can estimate effect of interest rate on economic output using following model:

$$\Delta GDP_t = \alpha + \beta \Delta i_t + \epsilon_t$$

Fit model to data using OLS; possible estimate $\beta > 0$

Simple OLS regression would lead to conclusion that reduction in interest rate correlates/causes decreases in output

- Lowering interest rate harms the economy

Policy implication would be to increase interest rates to stimulate economic activity.

- Sticking to evidence-based policy

FED does not change interest rates randomly, but change due to some factors affecting the economy

- Interest rates are endogenous
- Around 2008 think falling house prices and their effect on bank balance sheets

These other factors confound effect of change in monetary policy

- i.e. OLS regression does not capture isolated effect of interest rate

Paramount in macroeconomic research is the role of dynamics, and there are two important challenges:

1. Difficult to identify exogenous variation in macroeconomic policy
2. Natural experiment that can be identified are rarely those required to answer questions we're interested in.

As a result, there is an external validity problem.

There are some additional important issues :

1. Dynamic nature of monetary and fiscal policy make it high dimensional; can have effect on both short and long run
2. Effects of fiscal shocks depends on monetary policy (constrained by zero lower bound) and tax policy response
3. Effect of policy depends on the economy
4. Degree to which a policy is a surprise affects when and how strongly an economy reacts

This entails that macroeconomic research tends to be structural in nature

- Different from other empirical economic research which seeks to identify causal effects

As in any quantitative field macroeconomics relies on the use of statistical methods and thus on the use of moments

- Moments characterises the statistical distribution and are most commonly taken around the mean

In terms of econometrics we can distinguish between identified and unidentified moments

1. Unidentified: Simple statistics such as means, variances, and correlations
2. Identified: Statistics derived from empirical strategies or causal effect estimates

Identified moments are designed to help uncover causal effects (micro) or responses to structural shocks (macro).

1. Micro moments are constructed using microeconomic data on behaviour of individuals and firms
2. Macro moments use aggregated data to identify equilibrium outcomes; informative about what type of world we live in

Do identified moments correspond to structural parameters?

- They do in some cases: Labour supply elasticity in labour economics

In other cases they don't

1. Marginal propensity to consume following transitory fiscal rebate
2. Estimate of regional fiscal multiplier

In cases where they don't correspond you need a theoretical framework to go from the identified moments to the macroeconomic question of interest.

Finally there is the issue of data and the unit-of-analysis which means that identification can be done at

1. Aggregate level; focusing on single country
2. Cross-sectional level; e.g. across countries or within country

Cross-sectional identification is a fairly recent development

- Due to improvements in data collection
- Cross-sectional identification brings additional estimation challenges

Majority of studies are based on U.S. economy

- Largest economy in the world
- Technological leader
- Best data availability

Example of aggregate identification for fiscal stimulus

1. Evidence coming from wars
2. Evidence coming from VARs

NB - We will discuss VARs in more detail than you could wish for - or desire - later during the course.

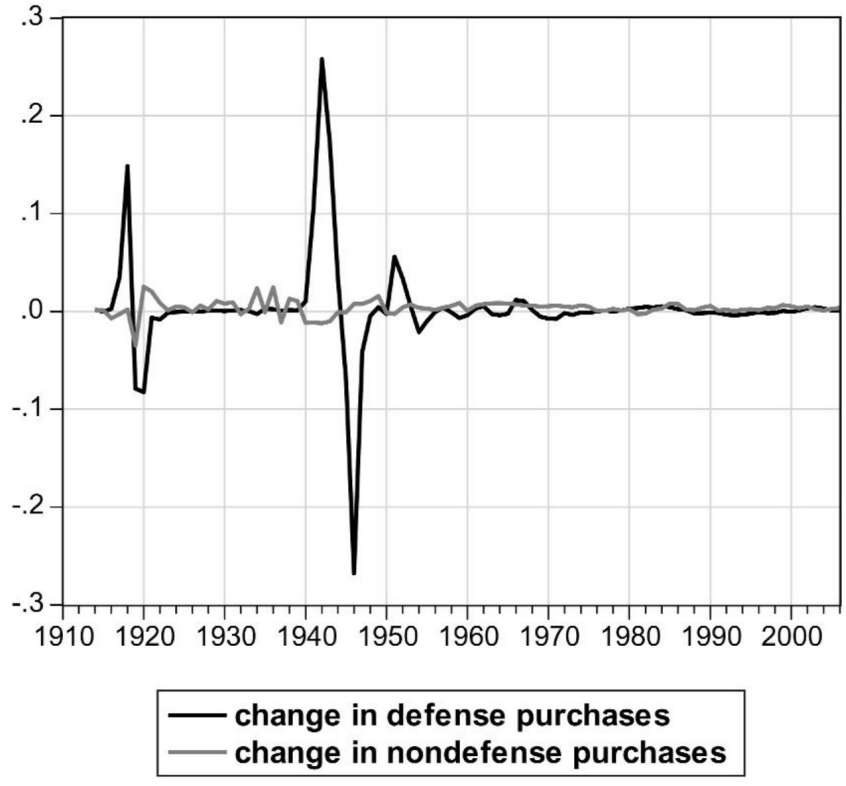


FIGURE I

Changes in Defense and Nondefense Government Purchases, 1914–2006
(expressed as ratios to the previous year's GDP)

The figure shows the change in per capita real government purchases (nominal purchases divided by the GDP deflator), expressed as a ratio to the prior year's per capita real GDP. The black graph is for defense purchases, and the gray graph is for nondefense purchases by all levels of government. The data on government purchases since 1929 are from Bureau of Economic Analysis and, before that, from Kendrick (1961). The GDP data are described in the online appendix.

Barro & Redlick, 2011

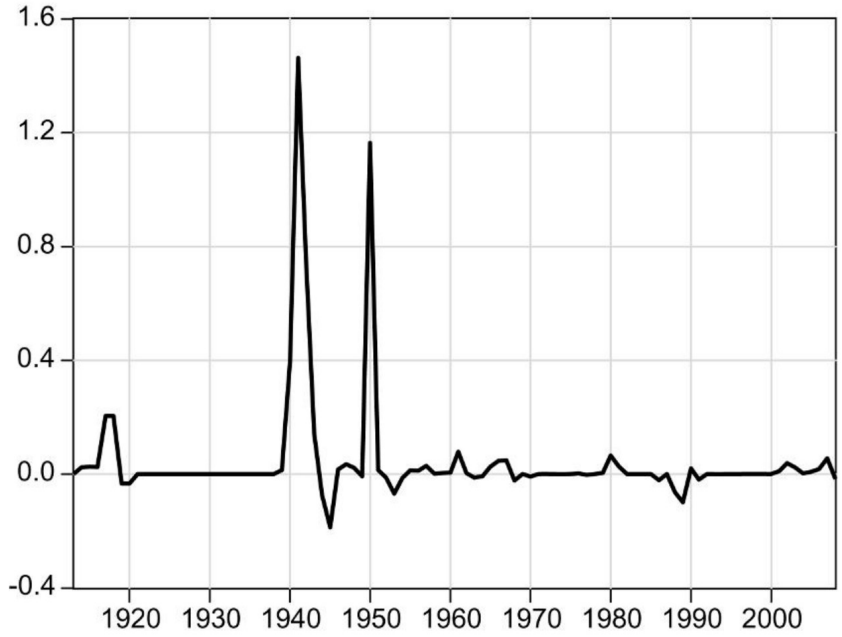


FIGURE II
Defense News Variable, 1913–2008

From 1939 to 2008, the variable is the annual counterpart of Ramey's (2011, Table II) measure of the present value of expected future nominal defense spending, expressed as a ratio to the prior year's nominal GDP. Values from 1913 to 1938 are rough estimates, described in Section III of the text. We use the defense news variable to measure $(g_t^* - g_{(t-1)}^*)/y_{t-1}$ in equation (1).

Barro & Redlick, 2011

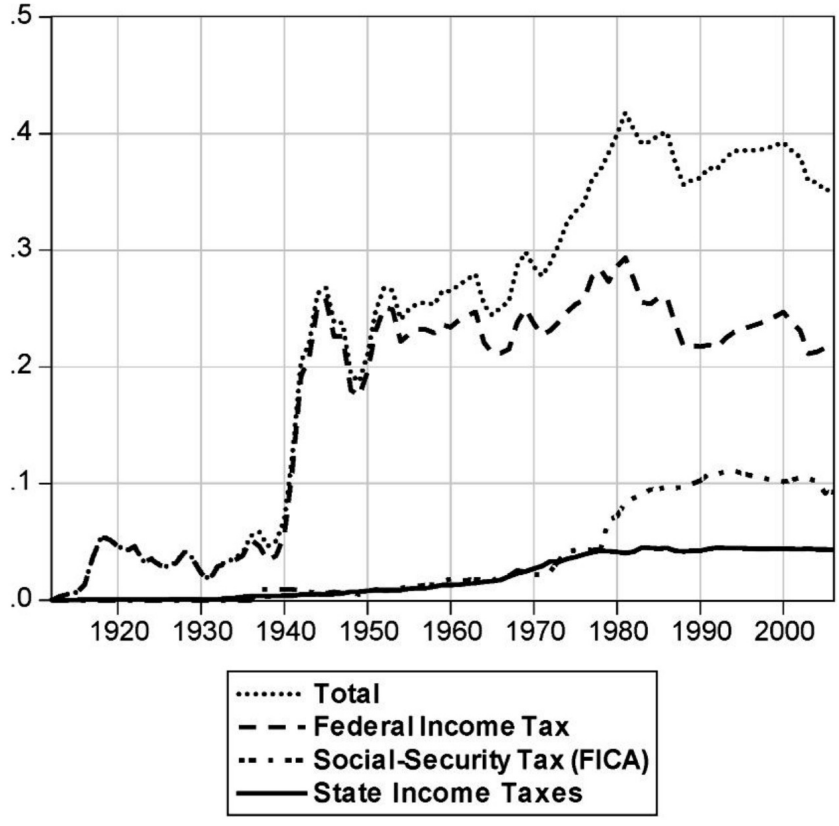


FIGURE III
Average Marginal Income Tax Rates, 1912–2006

The graph with large dashes is for the federal individual income tax, the graph with smaller dashes is for the Social Security payroll tax (FICA), and the solid graph is for state income taxes. The top graph is the total average marginal income tax rate. The data are from Table I.

Barro & Redlick, 2011

TABLE IV
Predicted Effects from Defense Spending on Components of GDP

	Predicted effect on:				
Increase in:	GDP	Consumption	Investment	Nondefense government purchases	Net exports
g: defense	+	−	−	−	−
g: defense news*	+	−	+	−	+

Notes. The table considers in the left-most column increases in current defense spending, g, or in news about future defense spending, $g*$. The five columns to the right show the signs of the predicted changes in GDP and its four components: private consumption, gross private domestic investment, nondefense government purchases, and net exports. The effects on nondefense government purchases follow if we view these purchases as primarily consumption, rather than investment. In our empirical application, we identify consumption with personal consumer expenditure on nondurables and services, and we consider consumer expenditure on durables as a form of investment.

Barro & Redlick, 2011

Let's turn the attention to evidence for the non-neutrality of monetary policy. Nakamura & Steinsson highlight three prominent pieces of evidence

1. Bad policy by the FED prior to the Great Depression which made things worse
2. The Volcker disflation
3. Break in volatility of US real exchange rate

Provided evidence gives a glimpse into preferred empirical methods

- Two cases are exclusively based on historical events
- One is example of identification based on discontinuity

Not appearing in this list: VARs

Four prevalent approaches

1. Large shocks
2. Narrative record to identify shocks
3. Discontinuity-based identification
4. 'Controlling' for confounding factors, i.e. VAR methods

Gold standard of empirical science is the controlled experiment

- Hard to implement when one is interested in the effect of monetary policy

Need to look for 'natural experiments' or large shocks

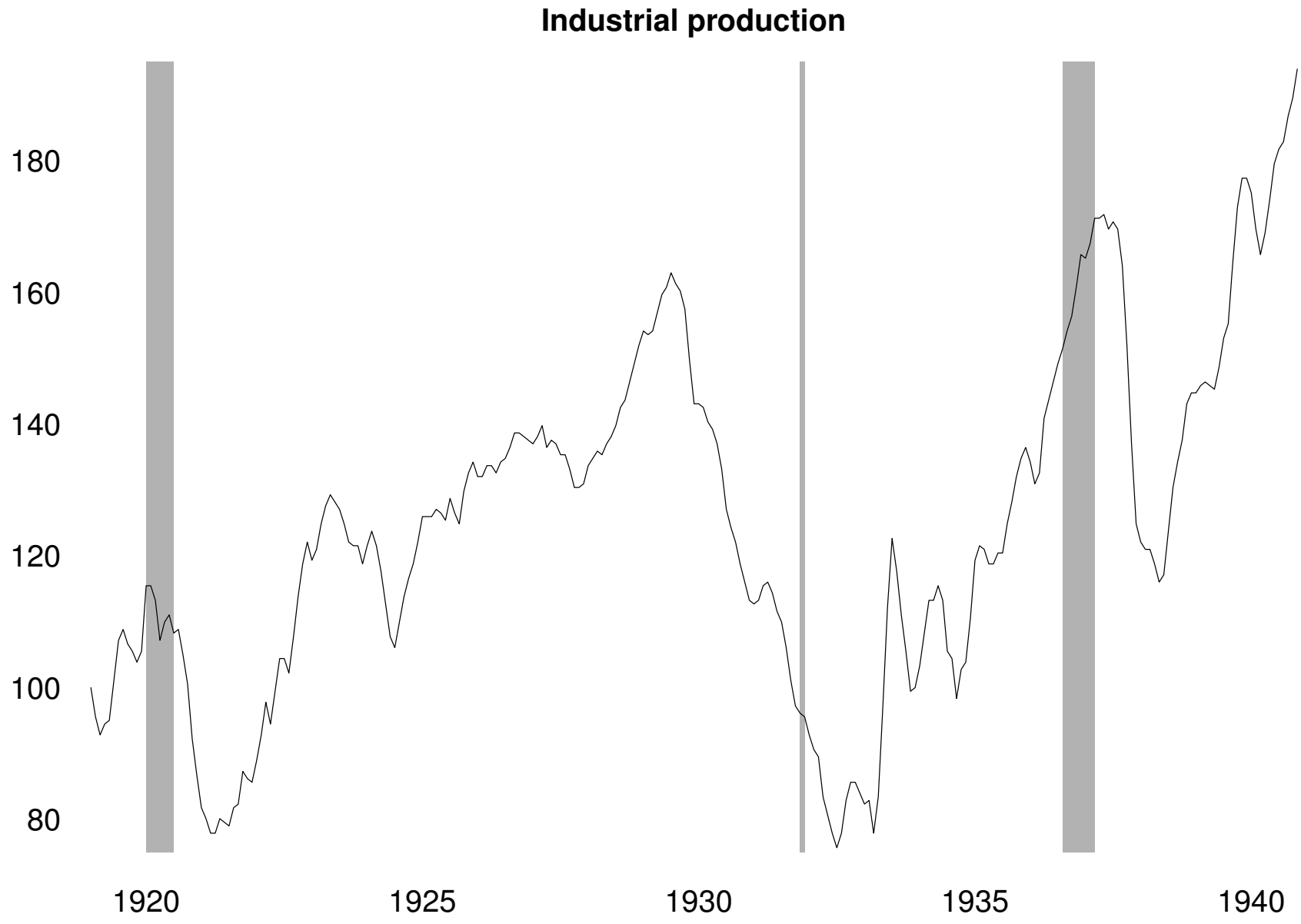
- i.e. situations where policy changes are relatively large to potential confounding factors that cannot be accounted for
- These type of changes are few and far between

Friedman & Schwartz argue that three policy actions taken by the FED in the interbellum were

1. 'of major magnitude'
2. 'cannot be regarded as necessary or inevitable economic consequences of contemporary changes in money income and prices'

They also argue that '*the results are so consistent and sharp as to leave little doubt about their interpretation.*' The dates of the events are

1. January-June 1920
2. October 1931
3. July 1936 - January 1937


Industrial production
180
160
140
120
100
80
1920
1925
1930
1935
1940

What where these policy mistakes Friedman & Schwartz identified? Let's look at the decision made in October 1931

- FED raised the discount rate from 1.5% to 3.5%
- Response to speculative attack on US dollar following Britain leaving the gold standard

FED tightened policy at a time that industrial production was decreasing rapidly; this might seem like clear monetary shock.

- Subsequent fall in industrial production not much different from preceding period
- Unclear how much of decrease can be attributed to policy shock

Volcker disflation followed after Volcker was appointed as chairman of the Federal Reserve Board in August 1979

- After end of Korean War in 1953 inflation was stable and low, but started to rise in late 1960s
- During 1970s inflation was high and volatile, often in double digits

Monetary policy was characterised by 'stop-go'

- Tight when the public was concerned about inflation, loose when public was concerned about unemployment

In November 1980 Volcker broke with this modus operandi and targeted deliberate disinflation

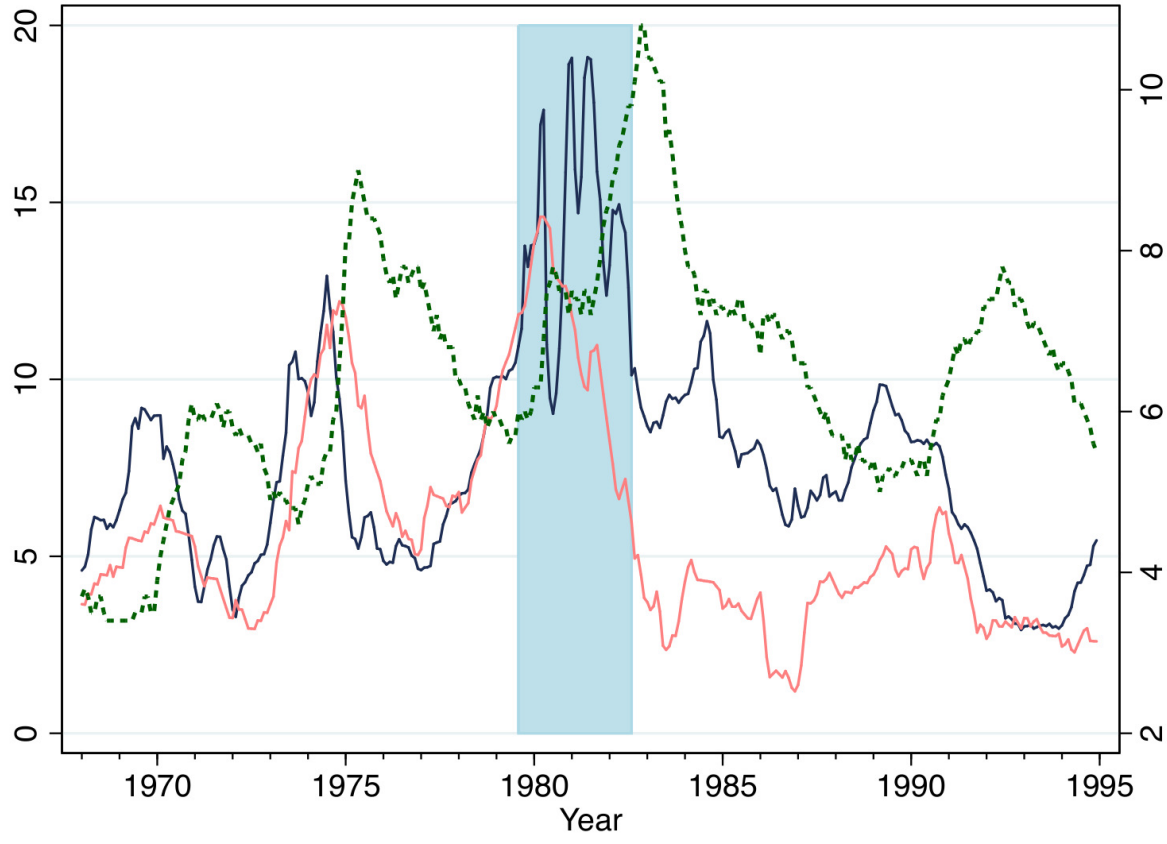
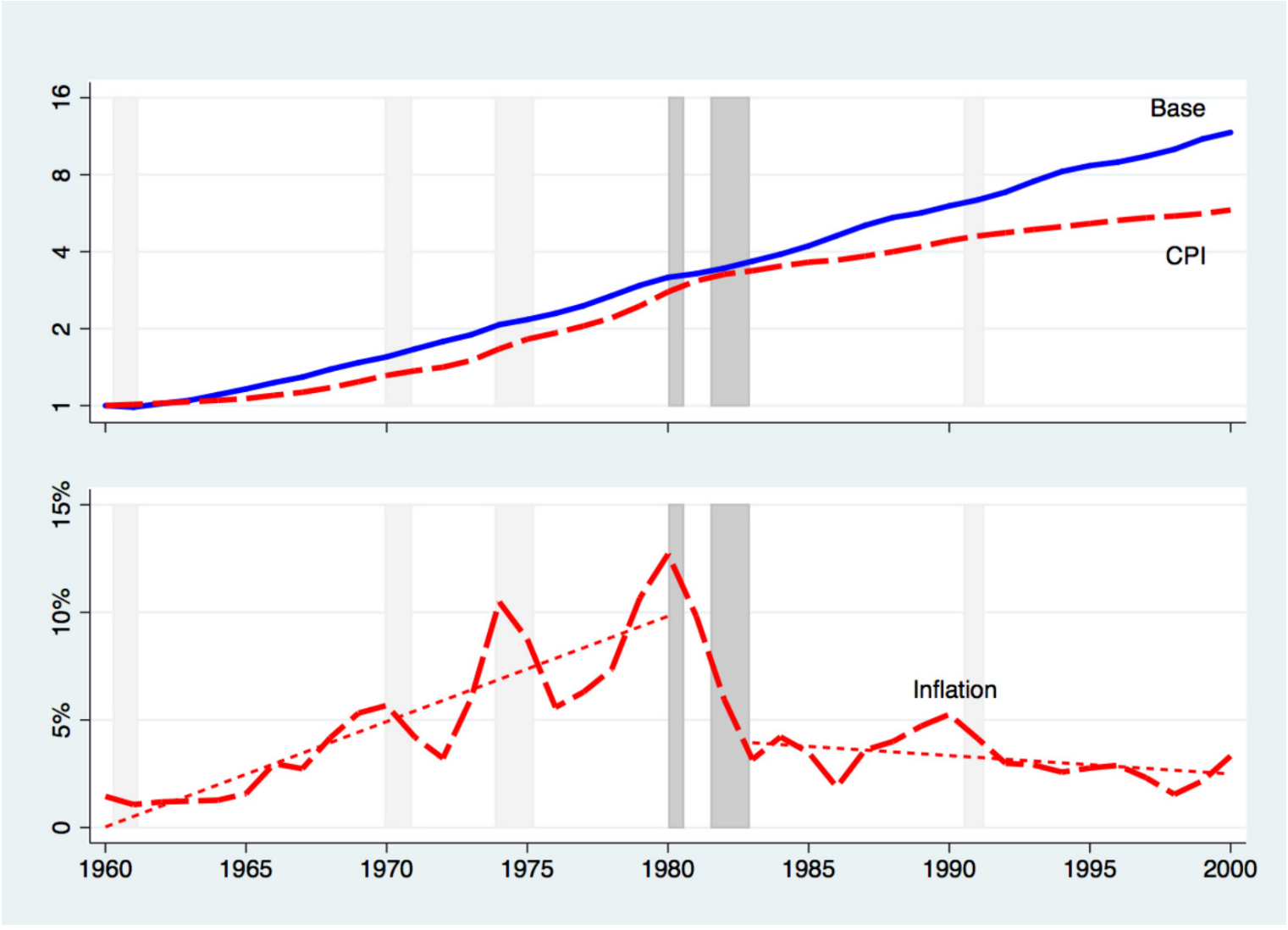


Figure 2: Federal Funds Rate, Inflation, and Unemployment from 1965 to 1995

Note: The figure plots the federal funds rate (solid blue, left axis), the 12-month inflation rate (solid pink, left axis), and the unemployment rate (dashed green, right axis). Volcker disinflation period shaded in blue (August 1979 to August 1982).

Nakamura & Steinsson (2017)


16
8
4
2
1
Base
CPI
15%
10%
5%
0
Inflation
1960
1965
1970
1975
1980
1985
1990
1995
2000

Romer (2016)

During the 1980s output seemed indeed to respond to monetary policy, but there are other factors

1. Oil shocks in 1979/1980
2. Credit controls in 1980
3. Tax cuts in 1981-82

Volcker episode is consistent with non-neutrality of monetary policy, but not concerning idea that policy affects output with long and variable lags.

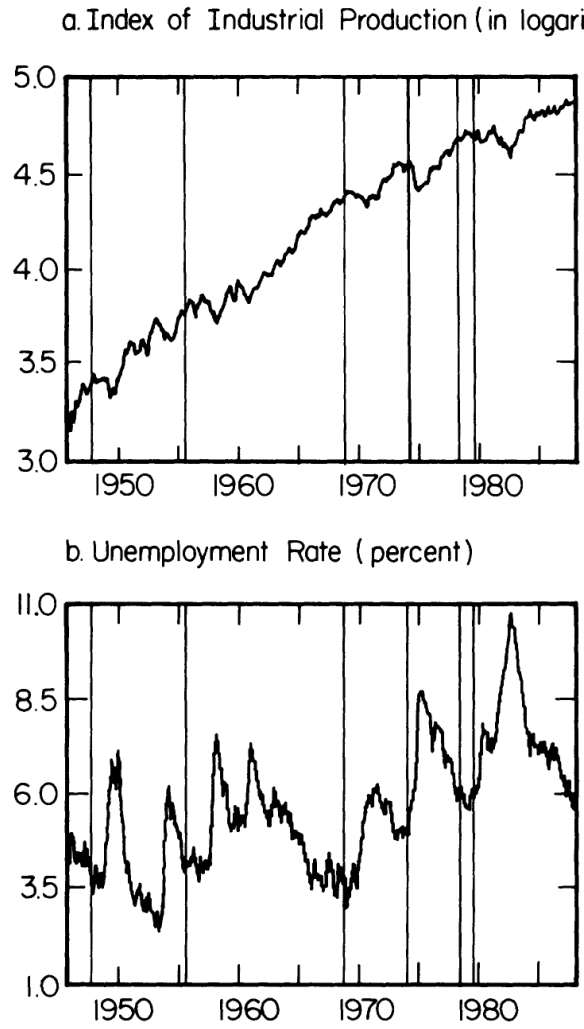
- Indeed output reacted largely synchronised with FED actions

Searching for natural experiments can also be done using the narrative record, which is what Romer & Romer (1989) did.

- They use Federal Reserve records to identify natural experiments
- Looking at attempt to exert contractionary influence on the economy to reduce inflation

Their paper is based on the earlier mentioned work by Friedman & Schwartz.

Figure 1 ECONOMIC ACTIVITY AND MONETARY SHOCKS.



Notes: Vertical lines are drawn at the dates of monetary shocks. The actual dates are October 1947, September 1955, December 1968, April 1974, August 1978, and October 1979. The sources of the data are described in the text. The data have been seasonally adjusted by a regression on monthly dummy variables.

Romer & Romer (1989)

Although interesting, there are some shortcomings with this approach

1. Unclear how narrative record is selected; risk of reverse-engineering
2. Few data points; some other factor might be correlated with monetary shock, e.g. oil shocks
3. Shock are endogenous because they might be predictable; hard to establish though

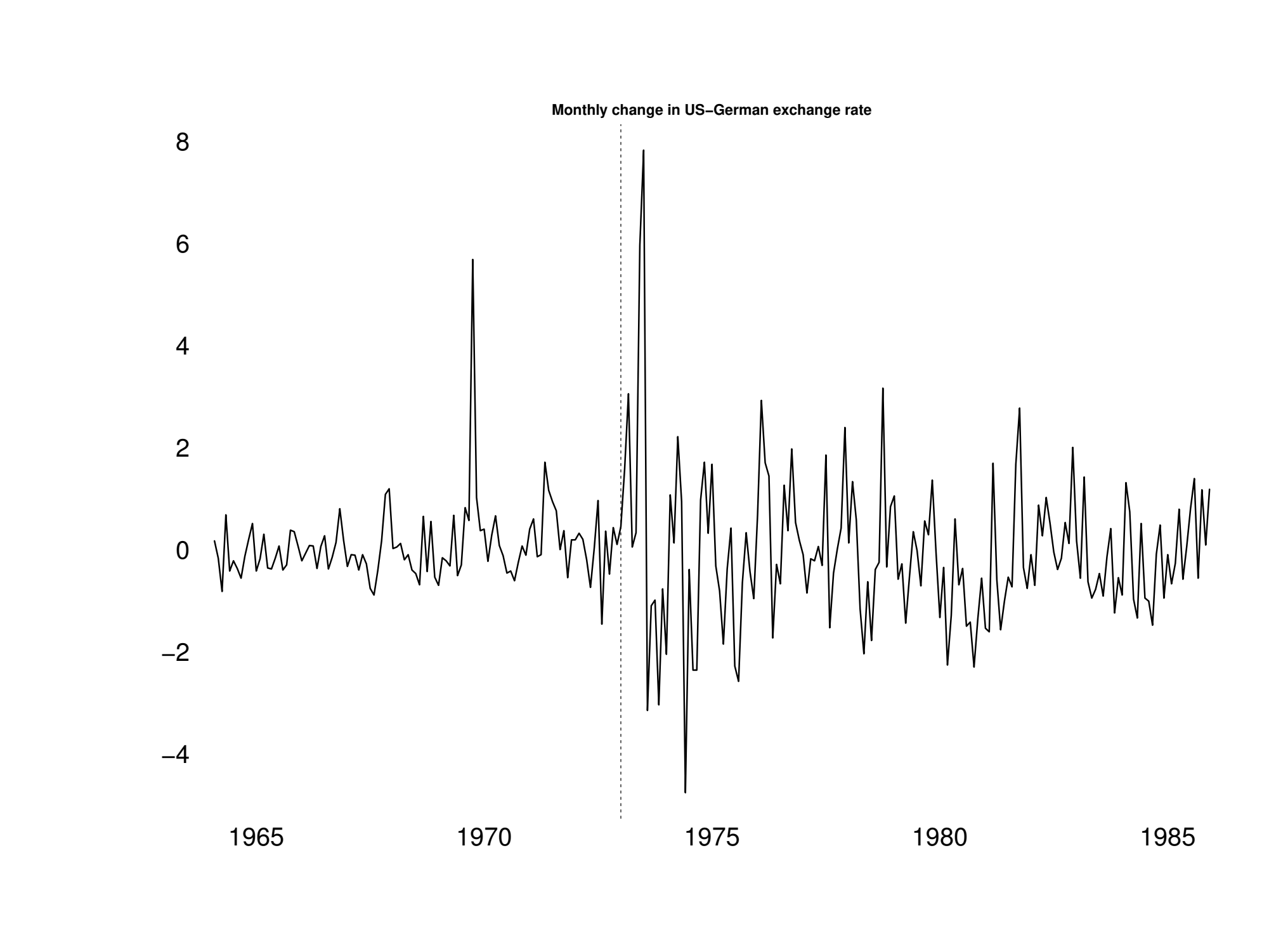
There is reduced-form evidence that monetary policy affects relative price based on discontinuity-based identification methods. Seminal paper here is Mussa (1986) who used abrupt change in monetary policy following the breakdown of the Bretton Woods system of fixed exchange rate.

- Breakdown in February 1973 caused large increase in volatility of US exchange rate

Switching from a fixed to flexible exchange rate is a strictly monetary action.

- If monetary policy has no real effects, this shouldn't have an impact on real variables such as the real exchange rate

NB - In discontinuity-based design the identifying assumption made is that other factors affecting the exchange rate do not change discontinuously.


Monthly change in US–German exchange rate
8
6
4
2
0
−2
−4
1965
1970
1975
1980
1985