MakØk3, Fall 2012 (Blok 2)

Business cycles and monetary stabilization policies

Henrik Jensen
Department of Economics
University of Copenhagen

Lecture 1, November 19: **Introduction** (Galí, Chapter 1)

Welcome

- Welcome to all!

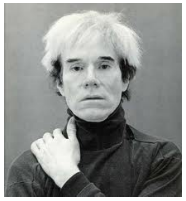
- Note, this is an "English" course
  - I speak English
  - All curriculum is in English, including the exam question (which can be answered in English or Danish).

- Who am I? Why am I here?
  - (...check out: **hjeconomics.dk/**)

Various "logistics" of the course

- Main curriculum:
  - Jordi Galí (2008): *Monetary Policy, Inflation and the Business Cycle*
    An Introduction to the New Keynesian Framework (Princeton University Press)

A book worth much more than the title of the cover painting:



- Course web page:
  www.econ.ku.dk/personal/henrikj/MakOk3_2012/

- *Imperative* to visit on a regular basis! It will feature (among other things):
  - "Breaking News": Where are we headed in the next lectures? What other important stuff has happened/is going to happen?
  - **Lots** of downloadable stuff:
    * Lecture slides
    * Various expository notes
      (note that the book has exercises that we will use heavily)
    * "F.A.Q." section if needed: Send me questions by e-mail; and they will (along with an answer) be posted there. If **you** are in doubt about something, chances are high that others are too. Everything is **anonymous,** so only I am sticking my neck out....
    * General links of relevance

- Please comment on the web-page as we move along!

- "Absalon"?
  - A place closed for the public and exceptionally user-unfriendly
  - Currently not applicable for serious University teaching i.m.h.o.!
  - Use it for signing up to the e-mail list—so please sign up so I have your e-mails

- Note: I am not using my own web site to make it—or myself—more "smart," but I refuse to hide my teaching from the public
  - Teaching is a very important dissemination tool concerning research and basic economic knowledge;
  - This should be accessible to others (and academia around the world)

Teaching "mode"

- Lectures combined with exercises in class

- **Lectures** on Mondays 9-13, Aud. 10
  - "Slide-with-pen based"
  - Slides are available just before the lectures (so you can take notes on them in class, don't read them prior to lectures, read the curriculum)

    (slides are subsequently posted on web page)
- **Exercises** normally on Tuesdays, 13-16, Aud. 4 (tomorrow we have lectures based on Chapter 2 in Galí)
  - In these classes we (either YOU, or I, or jointly) do exercises to get a feel for some of the important technicalities
  - Prepare for the exercises!

Course contents in brief

What are the main themes?

a) How does monetary policy affect macroeconomic aggregates?

- I.e., how can a central bank affect, e.g., output, employment, consumption and inflation?
- Focus on the short to medium run; i.e. at business cycle frequencies

b) What characterizes "good" monetary policymaking?

- I.e., what should the central bank aim to accomplish?
- I.e., which are the appropriate monetary policy regimes?

How are the main themes analyzed?

- Issues are addressed within a variety of a new type of theoretical models: The "New Keynesian Models"
  - Micro-founded general equilibrium models focusing on incomplete price/wage adjustment; i.e., *nominal rigidities*

- Theories are **mathematically founded**
  - Intuition will, however, be **very** important
- Formalism (the math) and intuition are not SUBSTITUTES but COMPLEMENTS
  - Math is a tool for organizing thoughts consistently
  - Also, mathematically formulated models can easier be taken to the data
    - So: Math does not create truth.
    - The true economic model of the world does not exist.
    - Math creates rigorous transparency about model assumptions and thus a model's implications.
    - Such transparency fosters economic intuition and thereby
      forms a solid basis for informed discussions (=science)

Overview: Rest of today

1. Basic empirical regularities about money and the macroeconomy

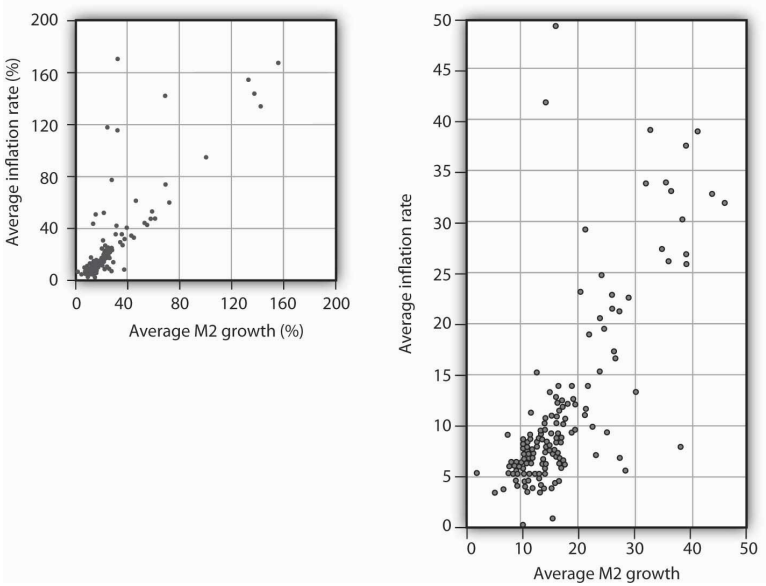
2. Why microfoundations are important: Avoiding the "Lucas critique"

3. What is "New Keynesian" Theory?

Basic empirical regularities about money and the economy

Long run correlations

- Consensus estimates show correlations between growth in monetary aggregates and inflation close to one
  - Hence, a reasonable characterization is that long-run changes in money growth are reflected in equivalent changes in inflation rates
  - Causality?



Cross-country evidence; 30 year averages for 160 countries (De Grauwe and Polan, 2005)

- Long-run effects on output growth are less robust
  - Some find positive correlations between money growth and output growth
  - Some find no correlation between inflation and output growth
  - Some find negative correlation between inflation and output growth
  - Results hinge on which countries are used; e.g., some find negative inflation effects in high inflation countries and zero or slightly positive effects for low-inflation countries
- Despite more uncertainty about the relationship between of monetary aggregates and real economic activity the following quote by John Taylor represents the consensus view in the economics profession:

  "*about which there is now little disagreement, ... that there is no long-run trade-off between the rate of inflation and the rate of unemployment*"
- I.e., the long-run Phillips curve is *vertical*
- Nobel prizes to Milton Friedman (1976), Robert E. Lucas (1995), Edmund Phelps (2006) all support the "mainstream" property of the view

- Inflation and nominal interest rates in the long run?
  - Fisher equation: $i_t = r_t + \mathrm{E}_t\pi_{t+1}$; In steady-state, $i^{ss} = r^{ss} + \pi^{ss}$
  - Higher long-run inflation should raise long-run interest rates (roughly confirmed by empirical analyses)

Short run correlations

- Examining the short-run effects of monetary policy on real activity: much more controversial
- Aim is to assess whether monetary aggregates are correlated with real activity at *business cycle frequencies*
  - One usually uses de-trended data; i.e., data exhibiting deviation from an underlying, hypothetical trend value which would prevail in absence of any shocks or frictions in the economy
  - Issue is then whether above average monetary aggregates are associated with above or below average economic activity

- Problem: simple correlations tell little about causality
- E.g., Friedman and Schwartz' classic 1964 study, which concluded that money movements *cause* output movements after long (and variable) time, has been questioned
- The positive correlations may as well reflect that money adjust endogenously to real output movements ("reverse causality")
  - The endogeneity of money is predominant for broader measures of money (such as M2), and in cases where the central bank uses the nominal interest rate as an instrument
  - Indeed, some find that the positive correlation is only prevalent for broad monetary aggregates ("inside money"), as it reflects the banking system's endogenous response to changes in economic activity.
    - E.g., increased demand for deposits by firms and consumers in anticipation of an upcoming boom, will increase broad monetary aggregates, even though the ensuing boom in *not* caused by money
- Alternatively, no measured correlation may reflect fantastic stabilization properties of money!

- Lots of econometric work has therefore been conducted to assess the effects of money on output

Using VAR analysis for assessing policy effects

(based on Walsh, 2010, *Monetary Theory and Policy*)

- Vector Autoregressive (VAR) methods (Sims) have been widely adopted to assess the impact of monetary policy
- One estimates a system like

$$\begin{bmatrix} y_t \\ x_t \end{bmatrix} = A(L) \begin{bmatrix} y_{t-1} \\ x_{t-1} \end{bmatrix} + \begin{bmatrix} u_{yt} \\ u_{xt} \end{bmatrix} \tag{1}$$

  - y_t is, e.g., output and x_t is the monetary policy variable
  - $A(L)$ is a matrix polynomial in L (the lag operator) — so independent variables can go far back in time
  - u_{yt} and u_{xt} are innovations to output and policy, defined as linear combinations of output and policy shocks:

$$\begin{bmatrix} u_{yt} \\ u_{xt} \end{bmatrix} = \begin{bmatrix} e_{yt} + \theta e_{xt} \\ \phi e_{yt} + e_{xt} \end{bmatrix} = \begin{bmatrix} 1 & \theta \\ \phi & 1 \end{bmatrix} \begin{bmatrix} e_{yt} \\ e_{xt} \end{bmatrix}$$

- Main purpose is to estimate the impact of a policy shock on output (and prices)
- I.e., how will a certain realization of e_{xt} affect output in the short, medium and long run?
  - What is the *impulse response pattern*?

- Problem: Estimation of (1) gives the parameters of $A(L)$, and the residuals u_{yt} and u_{xt}
- One cannot, however, as long as $\theta \neq 0$ and $\phi \neq 0$, say anything about the individual effects of e_{yt} and e_{xt}
  - As θ and ϕ are unknown, knowledge about $u_{yt} = e_{yt} + \theta e_{xt}$ and $u_{xt} = \phi e_{yt} + e_{xt}$ makes inference about e_{yt} and e_{xt} impossible <=> The VAR model is not *identified*
  - One needs to place an *a priori* **restriction** on either θ or ϕ
- E.g., *assign* a particular value to θ. Then one can estimate ϕ, and infer the shocks e_{yt} and e_{xt}:
  - Use that

$$\begin{aligned} u_{xt} &= \phi e_{yt} + e_{xt} \\ &= \phi \left[u_{yt} - \theta e_{xt} \right] + e_{xt} \\ &= \phi u_{yt} + (1 - \phi\theta) e_{xt} \end{aligned}$$

  - Estimate u_{xt} on u_{yt}, and obtain an estimate of ϕ
  - The residual from the estimation is $(1 - \phi\theta) e_{xt}$ from which e_{xt} can be inferred as both ϕ and θ are known (the shock e_{yt} can then readily be inferred)
- One can then assess the impact of a shock e_{xt} as the system

$$\begin{bmatrix} y_t \\ x_t \end{bmatrix} = A(L) \begin{bmatrix} y_{t-1} \\ x_{t-1} \end{bmatrix} + \begin{bmatrix} 1 & \theta \\ \phi & 1 \end{bmatrix} \begin{bmatrix} e_{yt} \\ e_{xt} \end{bmatrix}$$

  is identified

- How can one just assign a value to either θ or ϕ?
- By using appropriate *identifying restrictions*. NOTE: "Appropriate" leaves room for judgement.....
- Example with simple version of the VAR:

$$\begin{bmatrix} y_t \\ x_t \end{bmatrix} = \begin{bmatrix} a_1 & a_2 \\ 0 & 0 \end{bmatrix} \begin{bmatrix} y_{t-1} \\ x_{t-1} \end{bmatrix} + \begin{bmatrix} 1 & \theta \\ \phi & 1 \end{bmatrix} \begin{bmatrix} e_{yt} \\ e_{xt} \end{bmatrix}, \quad 0 < a_1 < 1$$

- Hence,

$$\begin{aligned} y_t &= a_1 y_{t-1} + a_2 x_{t-1} + e_{yt} + \theta e_{xt} \\ x_t &= \phi e_{yt} + e_{xt} \end{aligned}$$

- One (common) identifying assumption is $\theta = 0$: Monetary policy has no contemporaneous effect

- A representative VAR analysis (with "$\theta = 0$" type identifying restriction(s) together with assumptions about nominal interest rate setting):

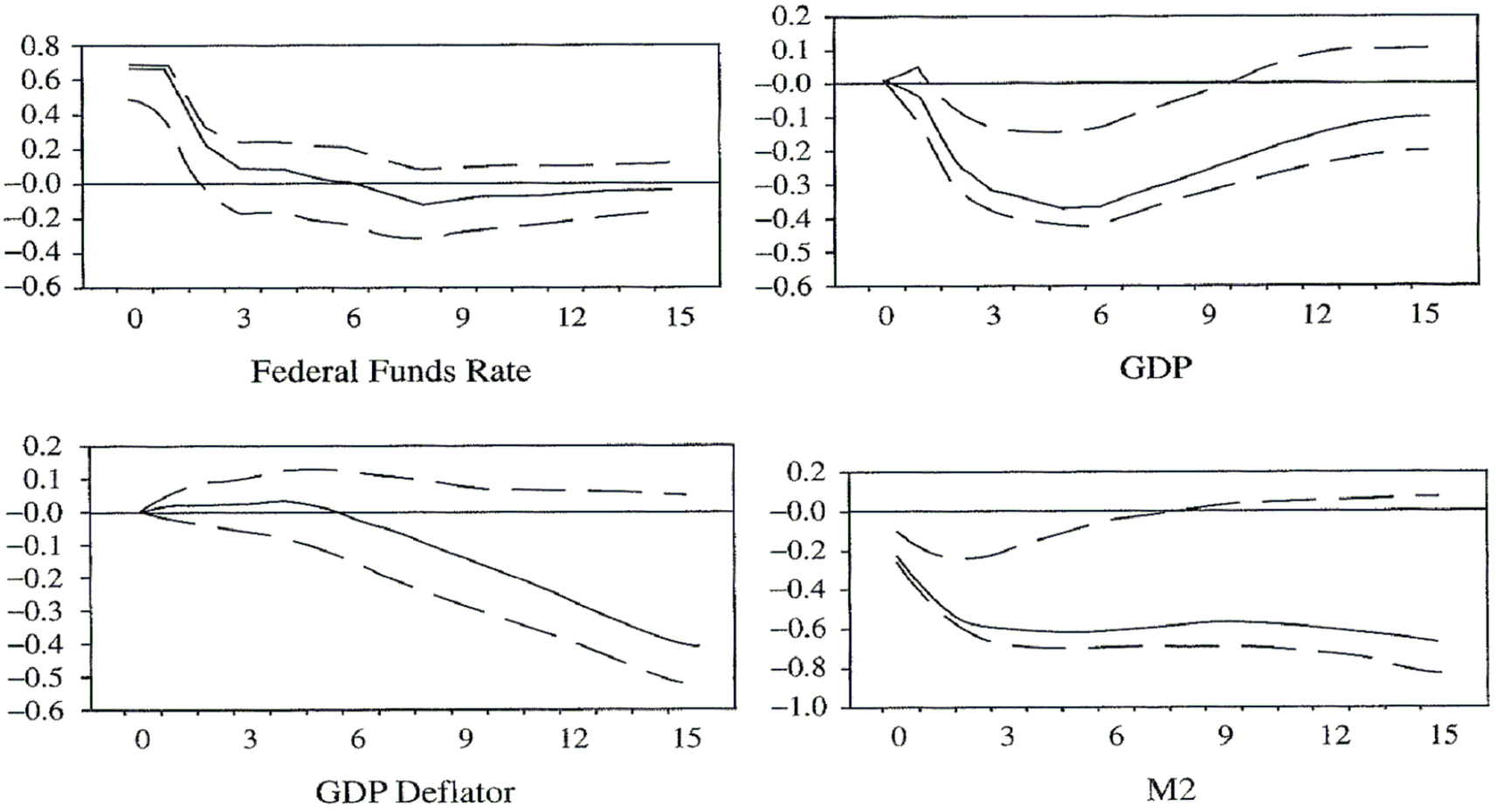


Figure 1.1 Estimated Dynamic Response to a Monetary Policy Shock

Source: Christiano, Eichenbaum, and Evans (1999).

- In the long run:
  - Monetary policy has predominantly effects on prices, and not output
  - Changes in money growth rates are reflected in changes in inflation rates, and nominal interest rates and very small effects on output (and of unclear sign)
- In the short run:
  - The impact of monetary policy on real output is more controversial
  - Many empirical problems arise when assessing the impact
  - Some consensus have emerged: Monetary policy shocks produce a "hump-shaped" impact on output, and the maximum effect is reached after some lag
  - Monetary policy shocks affect prices with an even longer lag; evidence of *nominal rigidities*

- But we need *theories* to think about how monetary policy affects the economy, if we want to use this empirical knowledge to make policy recommendations!
- Monetary policy responses, and their impact, are best understood within models, which are not vulnerable to the "Lucas critique" (Robert Lucas, 1976)

Why microfoundations are important: Avoiding the "Lucas critique"

Illustrating the Lucas critique

- Estimated relationship between log output, y_t, and log nominal money, m_t:

$$y_t = c_0 m_t + c_1 z_t + c_2 z_{t-1} + u_t \tag{1}$$

- Output-stabilizing money-supply rule (given z_t and u_t are zero in expectations and unknown when m_t is set):

$$\begin{aligned} m_t &= -\frac{c_2}{c_0} z_{t-1} + v_t \\ &= -\beta z_{t-1} + v_t, \qquad \beta \equiv \frac{c_2}{c_0} > 0 \end{aligned}$$

  v_t is a "control error" — an unanticipated, *unsystematic* part of monetary policy

- Resulting output *if* (1) is true: $y_t = c_0 v_t + c_1 z_t + u_t$. Hence, the *systematic* monetary policy response towards z_{t-1} works!

  – No theory needed in order to stabilize output!

- This can be *dangerous* in design of the policy rule (Sargent): Suppose the *true* model for output is:

$$y_t = d_0 v_t + d_1 z_t + d_2 z_{t-1} + u_t \tag{2}$$

I.e., only *unanticipated* monetary policy,

$$v_t = m_t - \mathrm{E}_{t-1} m_t$$

has real effects. *Many* theoretical models have this feature; here: $\mathrm{E}_{t-1} m_t$ captures behavioral responses by population. I.e., what in principle would be captured by microfoundations

- With the policy rule, we have $v_t = m_t + \beta z_{t-1}$, so:

$$\begin{aligned} y_t &= d_0 \left[m_t + \beta z_{t-1} \right] + d_1 z_t + d_2 z_{t-1} + u_t \\ &= d_0 m_t + d_1 z_t + \left[d_2 + d_0 \beta \right] z_{t-1} + u_t \end{aligned}$$

- This is *observationally equivalent* to (1):

$$y_t = c_0 m_t + c_1 z_t + c_2 z_{t-1} + u_t \tag{1}$$

- **I.e., even if only unsystematic monetary policy matters — (2) is true — a simple estimation can give the false impression that systematic monetary policy matters, i.e., false belief that (1) is true**

- Even "worse": The estimated coefficients depend on policy parameters!
  - Here: coefficient "$d_2 + d_0\beta$" depends on β
  - Hence, a systematic change in policy (here, a change in β) will change the estimated coefficients
  - Simple estimated relationships will "break down" when the policy rule changes

=> One *cannot* evaluate the implications of a policy change using the estimated relationships

- **Estimated coefficients are obtained from a policy regime of the past!**
  - An example of Lucas' (1976) famous and influential *critique of policy evaluation*

- "Proof": Assume one believes in (1) based on an empirical investigation, and one wants to assess output effects less policy response towards z_{t-1}:

$$m_t = -(\beta - \varepsilon) z_{t-1} + v_t, \qquad \varepsilon > 0$$

- Resulting output when one believes in the estimation, (1):

$$\begin{aligned} y_t &= c_0 \left[-(\beta - \varepsilon) z_{t-1} + v_t \right] + c_1 z_t + c_2 z_{t-1} + u_t \\ &= c_0 \left[\left(-\frac{c_2}{c_0} + \varepsilon \right) z_{t-1} + v_t \right] + c_1 z_t + c_2 z_{t-1} + u_t \\ &= c_0 v_t + c_1 z_t + c_0 \varepsilon z_{t-1} + u_t \end{aligned}$$

  One will conclude that z_{t-1} now affects y_t by $c_0\varepsilon$

- But if (2) is the true model, changes in policy rule have *no output effect*, and the conclusion is false!
  - Even though m_t systematically responds less towards z_{t-1} — allowing a greater impact on output of size $d_0\varepsilon = c_0\varepsilon$ — this will be perfectly neutralized by the *decrease in the coefficient* on z_{t-1}: $d_2 + d_0(\beta - \varepsilon)$; it falls by $d_0\varepsilon$
  - *No output effects* of a systematic change in the policy rule
  - By definition, $v_t = m_t - \mathrm{E}_{t-1} m_t$: Systematic changes in m_t, change $\mathrm{E}_{t-1} m_t$ accordingly!

- This calls for use of models where coefficients are *invariant* to changes in policy rules
  - This is the aim of microfounded theories on how money affects the economy

What is "New-Keynesian" Theory?

- Recent research on monetary policymaking has indeed focused on models with solid micro-foundations

- Recent research has built a bridge between academics and practitioners
  - Uses models that academics can "accept"
  - Are empirically oriented, and cast in ways that real-life central banks appreciate (and therefore heavily use)

- Research has had enormous influence in recent focus (or return?) on the importance of monetary policymaking for business cycles

- New issues are discovered/developed; old results re-emerge in new settings
  - I.e., a healthy mix of progress and confirmation (=science)

- We will look at variations of the simplest, and widely applied, variant of a micro-founded, small-scale macro model

- Model is dubbed as belonging to the "New Neoclassical Synthesis"
  - The "Old" Neoclassical Synthesis reflected a consensus blend of Keynesian and classical models of 1950s and 1960s
    - Keynesian demand-side and classical supply-side modelling
  - The term "New" reflects emphasis on micro foundations and market imperfections
    - Keynesian demand-side and "real business cycle" supply-side modelling
- Galí and many others denote the models "New Keynesian"
  - "Keynesian" as output is demand-determined in short run, and because the frictions providing a role for monetary policy are nominal rigidities
  - "New" as the models opposed to "Old" Keynesian models are derived from first principles; i.e., are microfounded

- Hence, the Lucas critique does not apply (*if* behavior is modelled appropriately, and that is **always** debatable!)

Next times

Tuesday, November 20:

Lectures: A classical Monetary Model (Galí, 2008, Chapter 2)

Monday, November 26:

Lectures: The Basic New Keynesian Model (Galí, 2008, Chapter 3)