What do we really know about the sources of macroeconomic fluctuations?

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0. Motivations

- What do I mean by "macroeconomic fluctuations"?
- Long story made short: what is left after removing "some" trend if needs be.

Figure 1: US real GDP and Hodrick-Prescott Trend

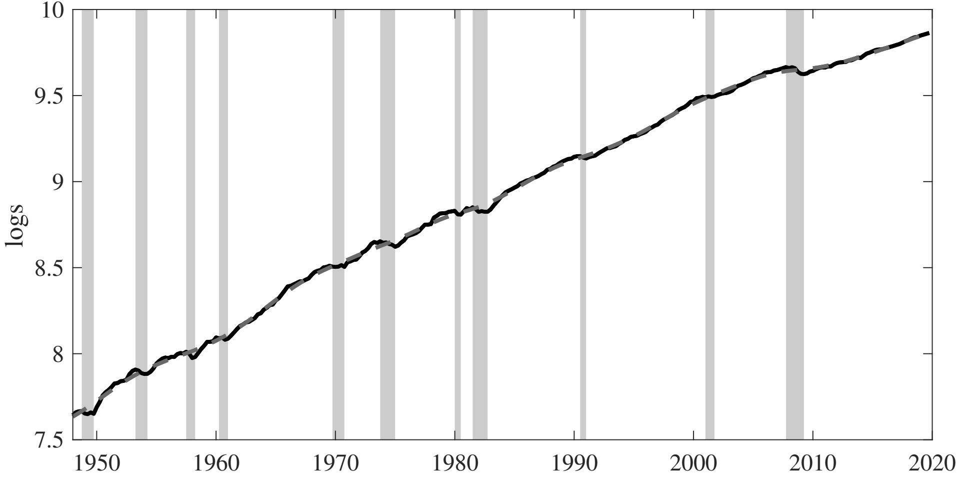
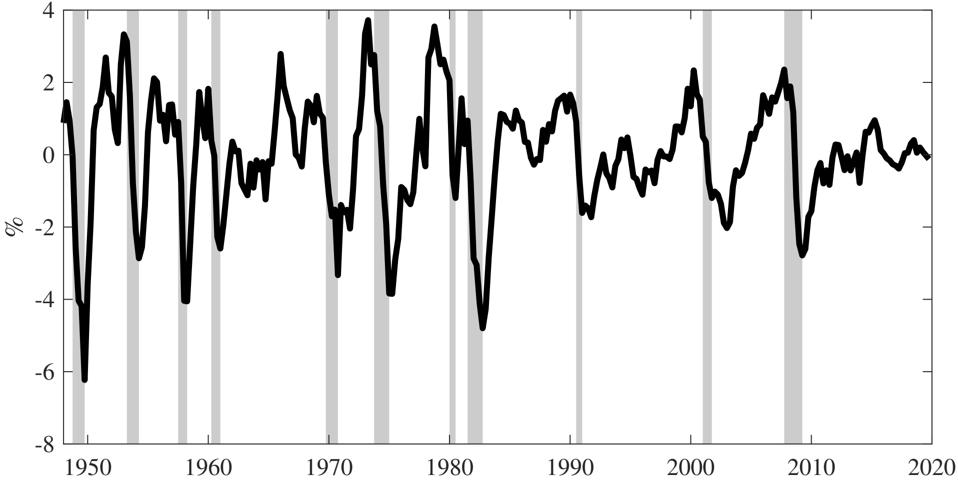
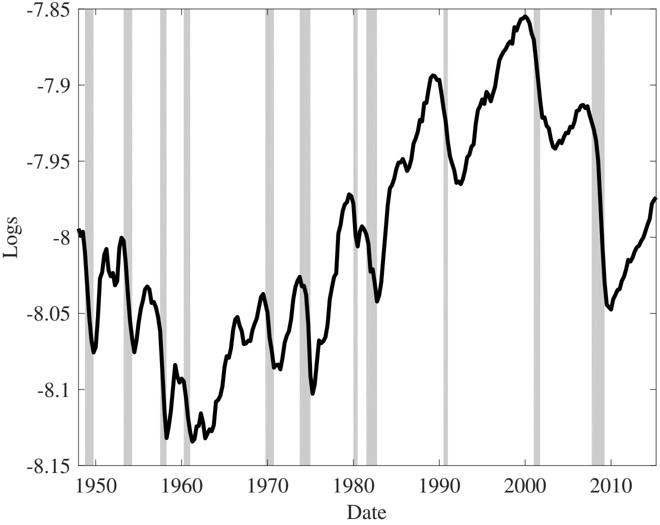


Figure 2: US Real GDP Hodrick-Prescott Cycle



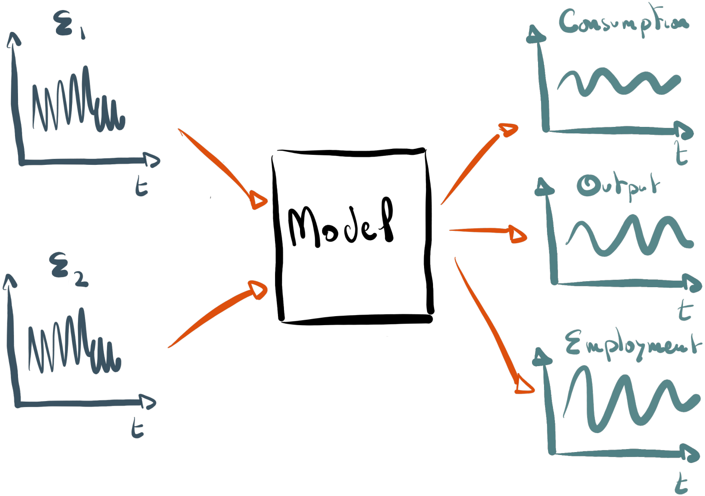
0. Motivations

Figure 3: Non-Farm Business (NFB) Hours Per Capita



0. Motivations

Figure 4: Impulse-Propagation approach to macroeconomic fluctuations



0. Motivations

- Two research questions
  - What are the impulses? ("Shocks")
  - What are the propagation mechanisms? ("Model")
- The framework (Shocks + Model) can then be used for policy evaluation.

0. Motivations

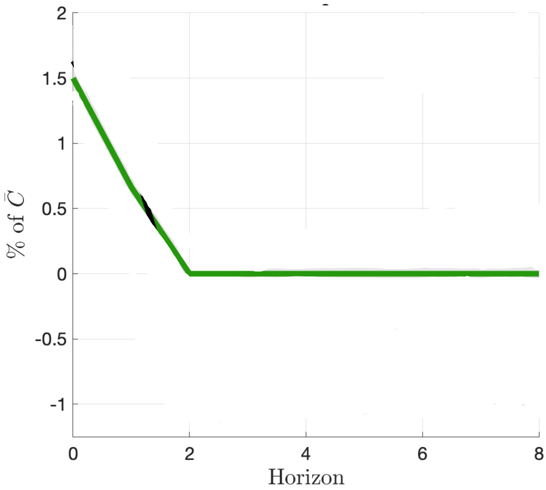
- After all this time, why don't we know for sure what are the shock and what are the propagation mechanisms?
- Because identification is hard in macro.
  - × *Almost everything* is endogenous
  - × We cannot do RCT.
  - × We need models to identify shocks and mechanisms ... in order to build models
- Let's take a real life example.

- Parker, Souleles & McClelland, AER [2013]
- 2008 Economic Stimulus Act
- 100 billion dollar program that sent tax rebates to approximately 130 million US tax filers.
- Key point: the timing of receipt was determined by the final two digits of the recipient's Social Security number (random)
- Use this random variation to estimate the causal effect of the receipt of the payments on household spending ...
- ... by comparing the spending of households that received payments in a given period to the spending of households that received payments in other periods

- One can then estimate the *partial equilibrium* impact of the tax rebates,
- meaning excluding demand multipliers, price effects and government budget constraint,
- (which almost everything macro is about).

0. Motivations
A Real Life Example

Figure 5: Consumption

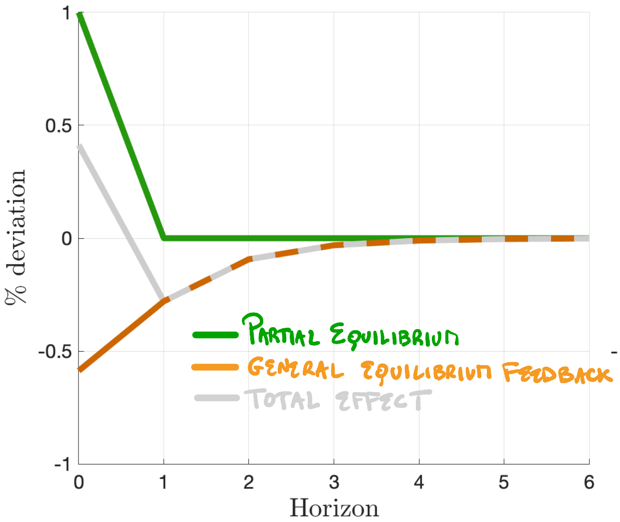


- One needs a model to then compute the *general equilibrium* effect of the tax rebate.

0. Motivations
A Real Life Example

- Flex price model ("RBC" model)
- Savers and spenders
- (Wolff [2020])

Figure 6: Consumption



0. Motivations

A Real Life Example

- Sticky price model
- A lot of heterogeneity in savings
- (“HANK” model)
- (Wolff [2020])

Figure 7: Consumption

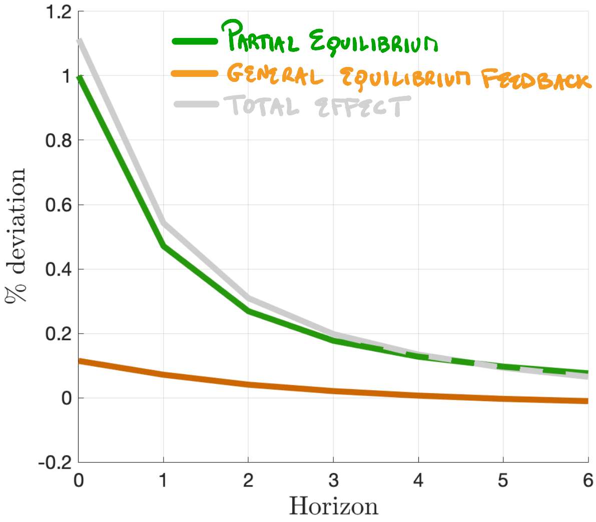
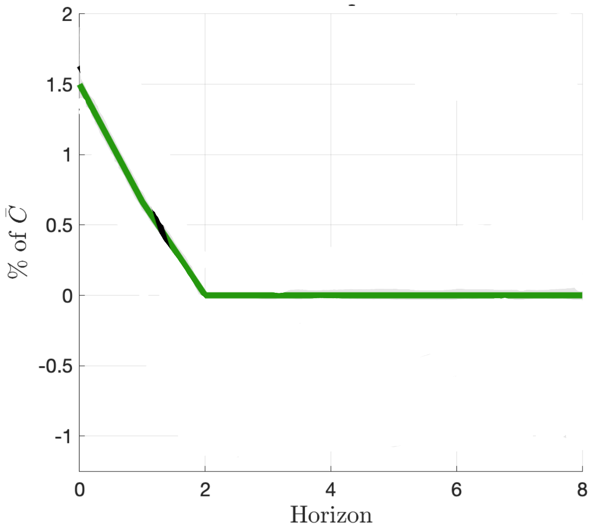


Figure 8: Consumption



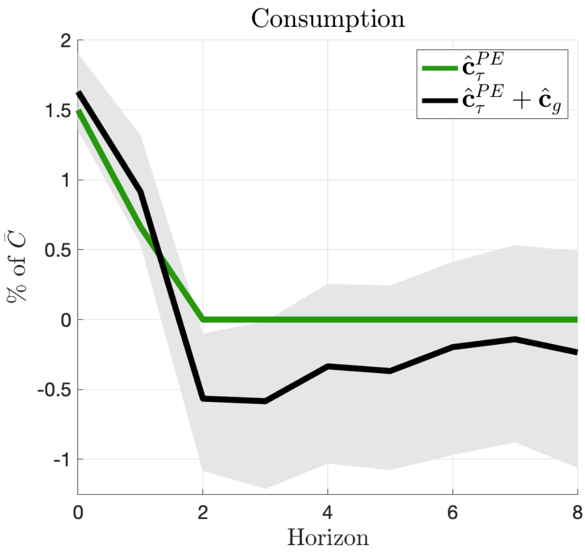
- Partial equilibrium effect in the data (from Parker, Souleles & McClelland, AER [2013])

0. Motivations

A Real Life Example

- Best estimates of the general equilibrium effect (from Wolff [2020])
- (under many assumptions)

Figure 9: Consumption



- This shows that
  - We need to find ways to identify aggregate shocks in the data (we cannot use diff-in-diff)
  - If we want to do policy analysis, we need a model, i.e. a set of propagation mechanisms

Roadmap

1. Shocks
2. Models
3. Real Keynesian Approach

Roadmap

1. Shocks
2. Models
3. Real Keynesian Approach

1. Shocks

- Here I want to show how do macroeconomist can identify shocks using Structural VARs

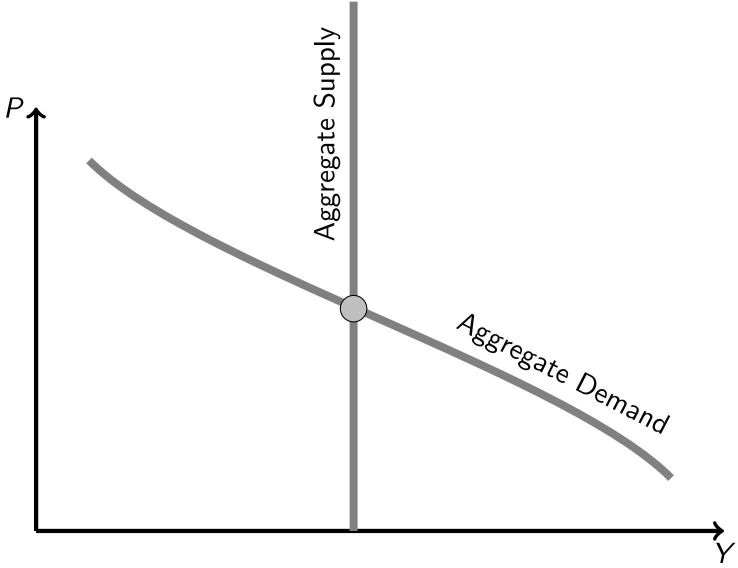
1. Shocks

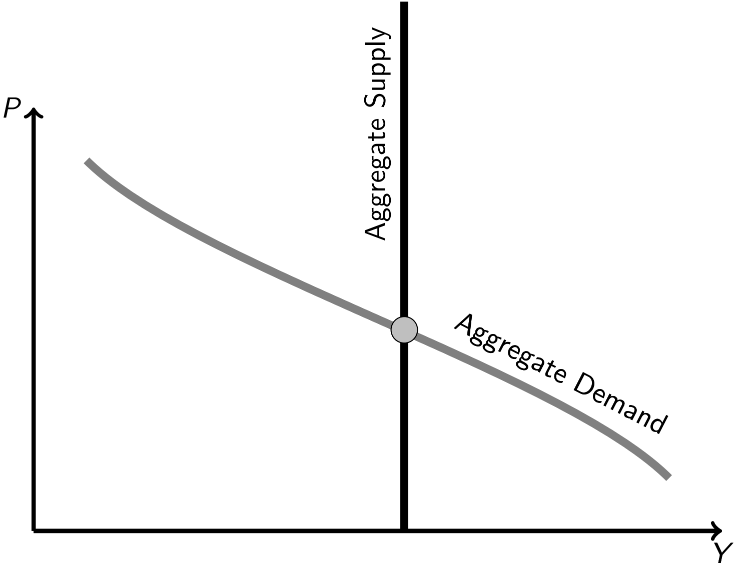
- The economy is hit by “shocks”,
- Realistic shocks are either “supply” or “demand”,
- Supply:
  - Technology,
  - Oil price,
  - Taxes.
- Demand:
  - Monetary shocks,
  - Fiscal,
  - World demand
  - News and expectations revisions (consumers and investors “mood swings”)

- Models are of two types: “Real Business Cycles” Models and “New-Keynesian” ones:
- Real Business Cycles:
  - Flexibles Prices,
  - Supply shocks are dominant

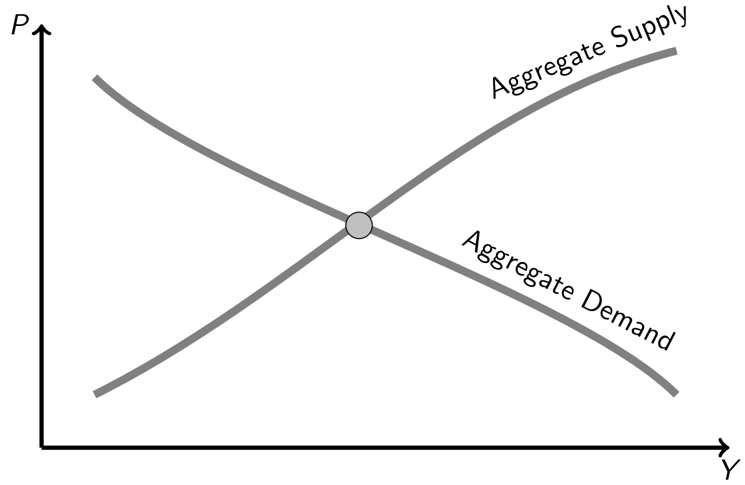
1. Shocks

Real Business Cycles Models




P
Aggregate Supply
Aggregate Demand
Y

- Models are of two types: “Real Business Cycles Models” and “New-Keynesian” ones:
- New-Keynesian Models:
  - Prices are sticky,
  - Monetary rules (Taylor rules) matter,
  - Demand shocks.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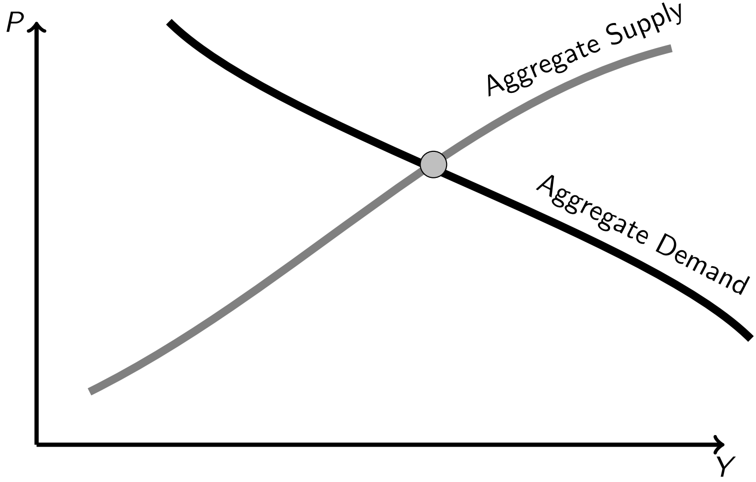

P
Aggregate Supply
Aggregate Demand
Y

- Let's take literally the AD-AS model to identify demand and supply shocks

- Assume that the model economy is the following AD-AS:

$$\begin{cases} P = -\alpha Y + \varepsilon^D & (AD) \\ P = \beta Y - \varepsilon^S & (AS) \end{cases}$$

- α and β are positive constants
- Shocks are zero-mean stochastic variables

Figure 10: Observation: The economy went from A to B and C

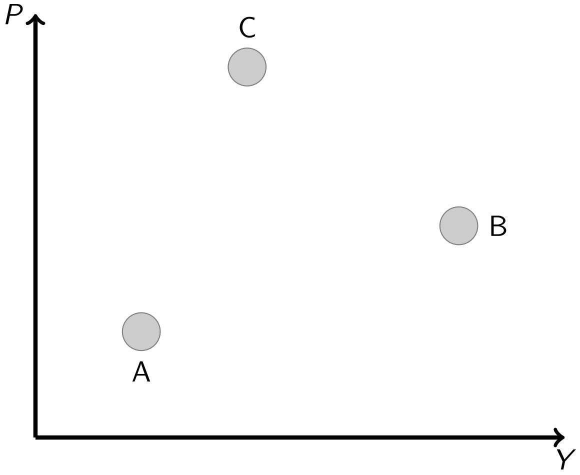


Figure 11: We aim at putting names (stories) on those wiggling arrows

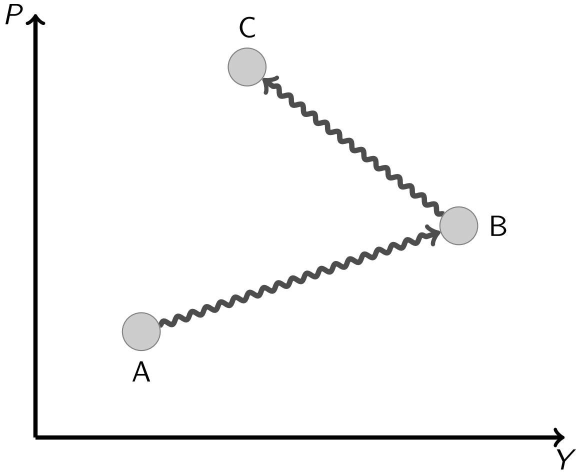


Figure 12: The AD-AS model provides us with a theory of economic fluctuations (the wiggling arrows) with the help of the gray shifters

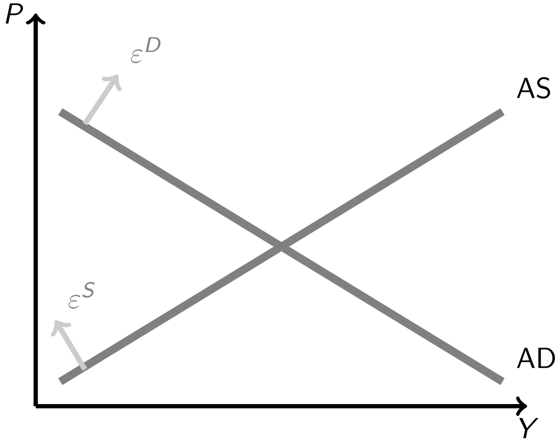


Figure 13: Each Observation is at the crossing of one AD and one AS curve

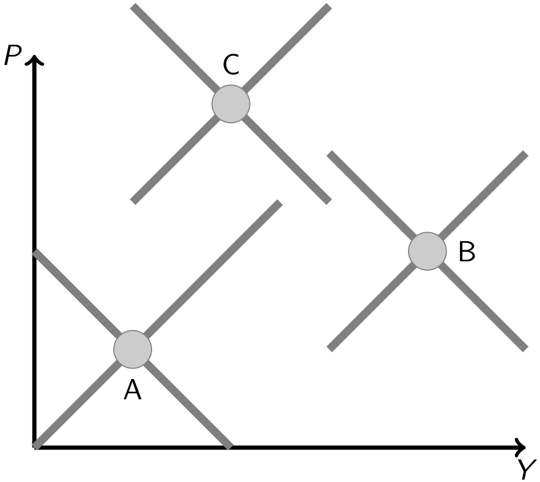


Figure 14: This is the structural interpretation of the move from A to B

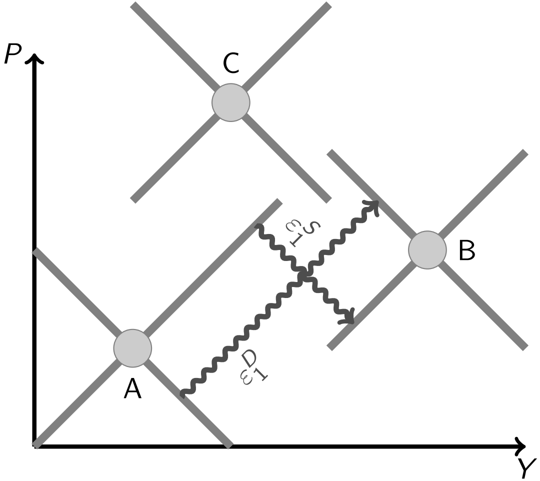


Figure 15: This is the structural interpretation of the move from B to C

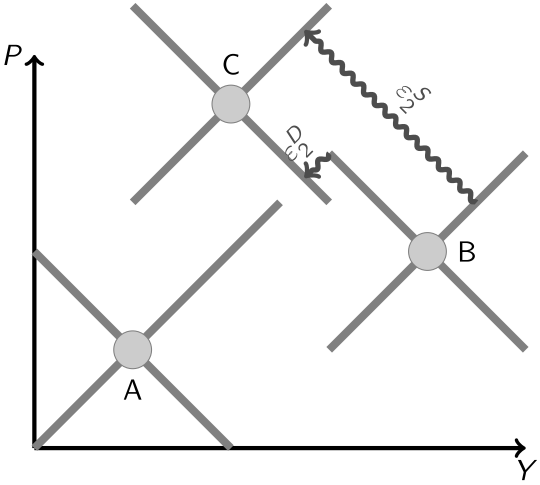
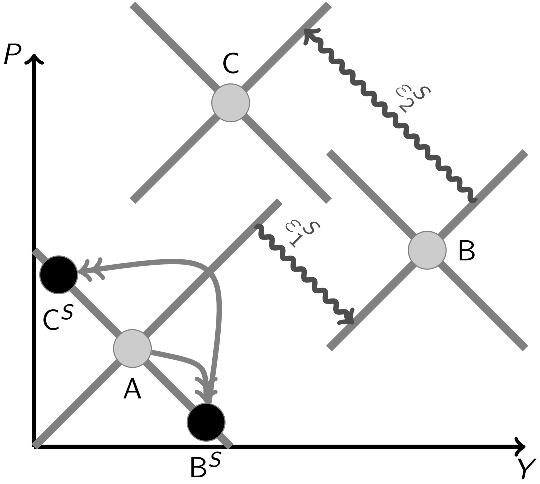


Figure 16: Counterfactual: What would have happen absent of demand shocks



- Algebra: solving the model

$$\begin{cases} P = -\alpha Y + \varepsilon^D & (AD) \\ P = \beta Y - \varepsilon^S & (AS) \end{cases}$$

one gets

$$\begin{cases} P = \frac{\beta}{\alpha+\beta}\varepsilon^D - \frac{\alpha}{\alpha+\beta}\varepsilon^S \\ Y = \frac{1}{\alpha+\beta}\varepsilon^D + \frac{1}{\alpha+\beta}\varepsilon^S \end{cases}$$

- When one observes Y and P, this is a set of 2 equations with 2 unknowns, ε^D and ε^S $\rightsquigarrow$ one can recover the structural shocks.
- The problem is that in the real world, we do not know α and β

- One way could be to estimate each of the two equations using instrumental variables (oil price when estimating AD, money supply or Gvt expenditures when estimating AS)
- But
  - × hard to find valid instruments (oil price react to demand shocks, Gvt expenditures react to supply shocks),
  - × it is very unlikely that this very simple and static model captures a significant part of the economy variance.

- Assume that the economy is best described by the following dynamic model:

$$\begin{cases} P_t &= \alpha_0^D Y_t + \alpha_1^D Y_{t-1} + \alpha_2^D Y_{t-2} + \cdots + \alpha_N^D Y_{t-N} \\ &+ \beta_1^D P_{t-1} + \beta_2^D P_{t-2} + \cdots + \beta_N^D P_{t-N} + \varepsilon_t^D \qquad (AD) \\ P_t &= \alpha_0^S Y_t + \alpha_1^S Y_{t-1} + \alpha_2^S Y_{t-2} + \cdots + \alpha_N^S Y_{t-N} \\ &+ \beta_1^S P_{t-1} + \beta_2^S P_{t-2} + \cdots + \beta_N^S P_{t-N} + \varepsilon_t^S \qquad (AS) \end{cases}$$

- Demand and Supply shocks are independent.
- Let's use the lag operator notation:
  $LX_t = X_{t-1}$, $L^i X_t = X_{t-i}$, $i \in \mathcal{Z}$

- We can write

$$X_t = \widehat{A}(L)X_{t-1} + B\varepsilon_t$$

  with $X_t = (Y_t, P_t)'$ and $\varepsilon_t = (\varepsilon_t^D, \varepsilon_t^S)$
- This is the VAR (Vector AutoRegressive) representation of the equilibrium.

- It is convenient to work with the VMA (Vectorial Moving Average) representation

$$X_t = \frac{B}{I - \widehat{A}(L)L}\varepsilon_t$$

or

$$X(t) = \sum_{j=0}^{\infty} A(j)\varepsilon_{t-j}$$

with $\text{Var}(\varepsilon_t) = I$ and

$$A(j) = \begin{pmatrix} a_{11}(j) & a_{12}(j) \\ a_{21}(j) & a_{22}(j) \end{pmatrix}$$

- Here I derive some summary statistics from the VMA representation
- Let us consider output. We have

$$Y_t = \sum_{j=0}^{\infty} a_{11}(j)\varepsilon_{t-j}^{D} + \sum_{j=0}^{\infty} a_{12}(j)\varepsilon_{t-j}^{S}$$

- The IRF to a demand shock is $\{a_{11}(0), a_{11}(1), a_{11}(2), ...\}$ and the IRF to a supply shock is $\{a_{12}(0), a_{12}(1), a_{12}(2), ...\}$

- Historical decomposition : what would have happen if only demand or supply shocks have been there?

$$Y_t^D = \sum_{j=0}^{\infty} a_{11}(j)\varepsilon_{t-j}^D$$

$$Y_t^S = \sum_{j=0}^{\infty} a_{12}(j)\varepsilon_{t-j}^S$$

- Let us estimate a VAR model with Y and P.

$$X_t = \widetilde{A}(L)X_{t-1} + \nu_t$$

  with $\text{Var}(\nu) = \Omega$.

- Note that the νs are different from the ϵs (they are an unknown linear combination of the ϵs)

$$X_t = \widehat{A}(L)X_{t-1} + B\varepsilon_t$$

- From this estimated VAR form, one can recover the following *non structural* (or *reduced form)* VMA representation

$$X(t) = \sum_{j=0}^{\infty} C(j)\nu_{t-j}$$

  with $C(0) = I$.

- How can ν be cut into two orthogonal pieces that we will label demand and supply shocks?

- Compare this VMA representation with the *structural* one

$$X(t) = \sum_{j=0}^{\infty} C(j)\nu_{t-j}$$

$$X(t) = \sum_{j=0}^{\infty} A(j)\varepsilon_{t-j}$$

- As the two equations are representations of the same model,

$$\nu = A(0)\varepsilon \text{ and } A(j) = C(j)A(0) \text{ for } j > 0.$$

- Estimation gives us C.
- Once we know $A(0)$, we have everything. We have therefore 4 unknowns: $a_{11}(0), a_{12}(0)$, $a_{21}(0)$ and $a_{22}(0)$.

- How do we get $A(0)$? First, if $\nu = A(0)\varepsilon$, then ν and $A(0)\varepsilon$ have the same variance-covariance matrix.
- The one of ν is the Ω (estimated). The one of ε is I by assumption.
- Therefore, one has

$$V(A(0)\varepsilon) = V(\nu) \Longleftrightarrow A(0)A(0)' = \Omega$$

or

$$\begin{pmatrix} a_{11}(0) & a_{12}(0) \\ a_{21}(0) & a_{22}(0) \end{pmatrix} \times \begin{pmatrix} a_{11}(0) & a_{12}(0) \\ a_{21}(0) & a_{22}(0) \end{pmatrix}' = \begin{pmatrix} \omega_{11}(0) & \omega_{12}(0) \\ \omega_{12}(0) & \omega_{22}(0) \end{pmatrix}$$

- This gives us 3 equations (because Ω and $A(0)A(0)'$ are symmetrical) for 4 unknowns (the 4 coefficients of $A(0)$)

- We need one identifying assumption, that will allow us to separate aggregate demand shocks from aggregate supply ones.
- This last condition cannot come from the math. It has to be a restriction imposed by the economist, based on some “reasonable” property of the economy.

- Here only one extra restriction is needed because we have a 2-variables VAR. It could be more in larger models.
- This restriction should come from a model.
- Blanchard & Quah (1989) proposed the following restriction: *Only supply shocks affect output in the long run* or in other words *Demand shocks do not affect output in the long run*.
- The long run effect of a demand shock is $a_{11}(\infty)$
- But $A(\infty) = C(\infty)A(0)$ or

$$\begin{pmatrix} a_{11}(\infty) & a_{12}(\infty) \\ a_{21}(\infty) & a_{22}(\infty) \end{pmatrix} = \begin{pmatrix} c_{11}(\infty) & c_{12}(\infty) \\ c_{21}(\infty) & c_{22}(\infty) \end{pmatrix} \times \begin{pmatrix} a_{11}(0) & a_{12}(0) \\ a_{21}(0) & a_{22}(0) \end{pmatrix}$$

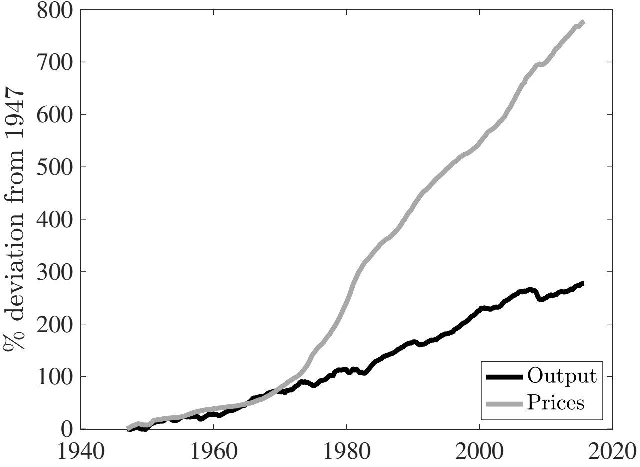
- The fourth restriction is therefore

$$c_{11}(\infty)a_{11}(0) + c_{21}(\infty)a_{21}(0) = 0$$

- Recall that the $c_{ij}(\infty)$ are known (from estimation).
- We can therefore compute $A(0)$.
- Once we have $A(0)$, and the estimated VAR, we can compute IRF to shocks and do counterfactual analysis.

- Data: US 1947Q1-2015Q4 quarterly data
- Output is Real GDP per capita, Prices series is the GNP deflator.
- With some abuse of the interpretation of the AD-AS model, we consider not P and Y but ΔP and ΔY.
- Take 12 lags in the VAR

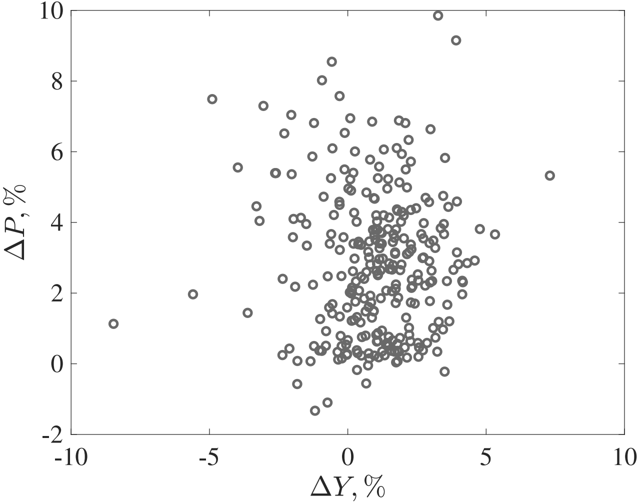
Figure 17: US Output and Prices, 1947Q1-2015Q4



1. Shocks

Data

Figure 18: US Growth Rates of Output and Prices, 1947Q1-2015Q4



1. Shocks

Results : IRF and Variance Decomposition

Figure 19: IRF

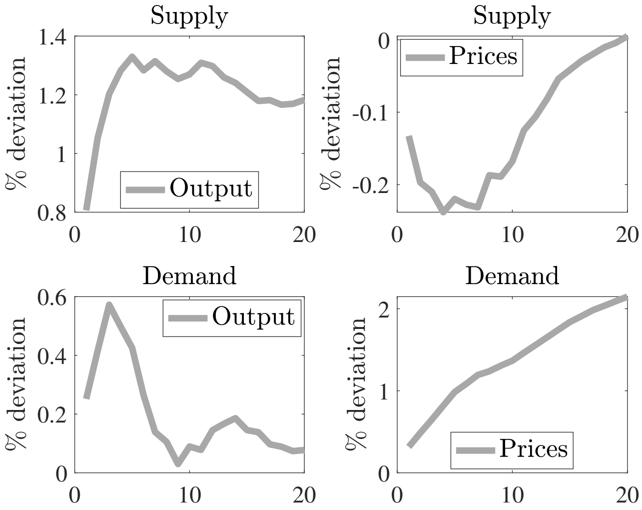


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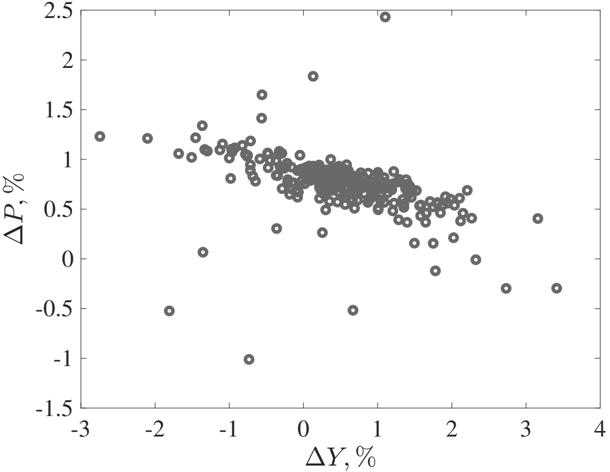
Figure 20: Whole Sample - Supply Shocks Only



- Here we identify the slope of the demand curve

Figure 21: Whole Sample - Supply Shocks Only

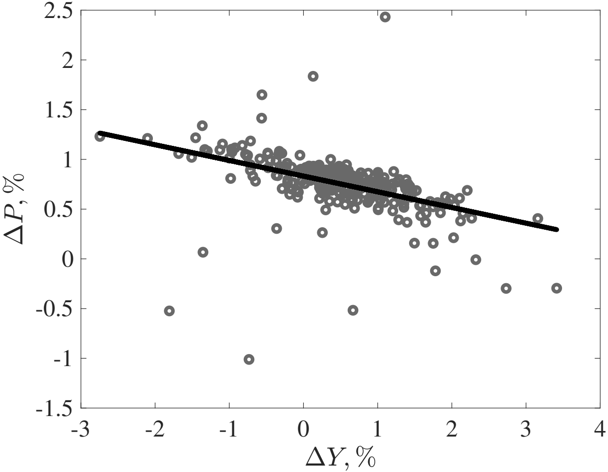


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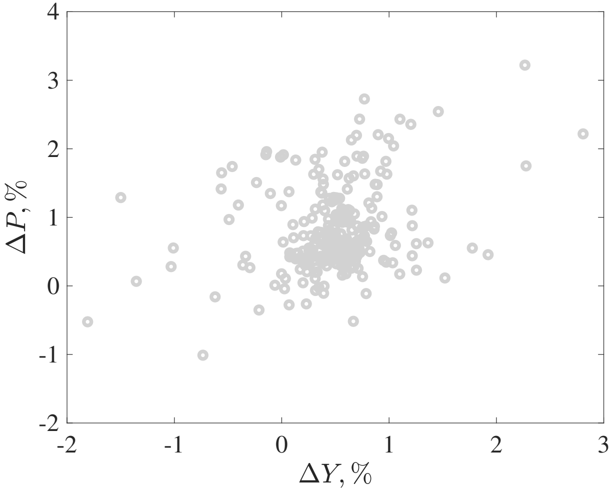
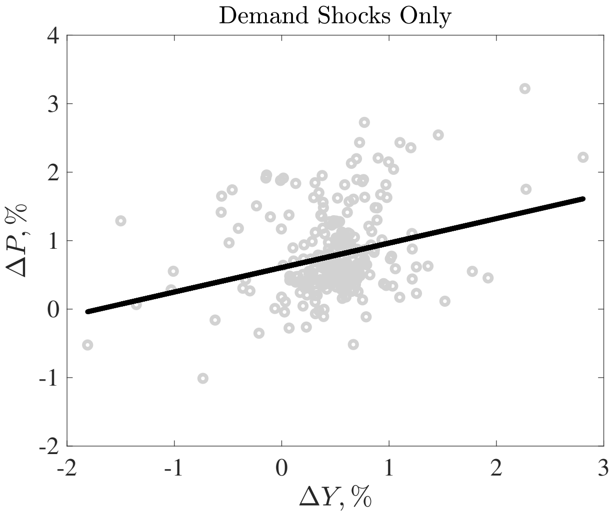
Figure 22: Whole Sample - Demand Shocks Only



- Here we identify the slope of the supply curve

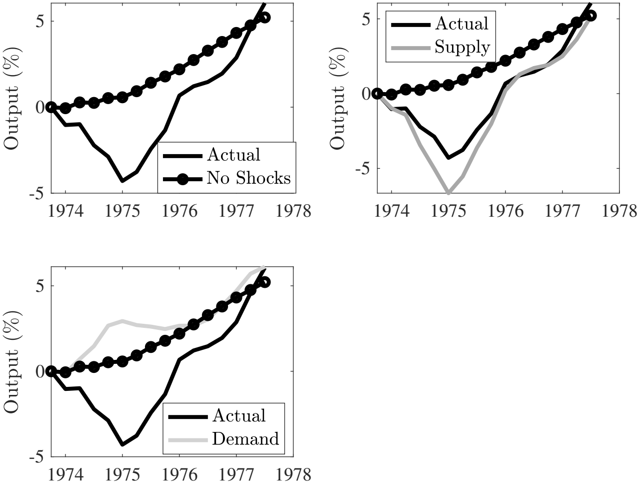
Figure 23: Whole Sample - Demand Shocks Only



1. Shocks

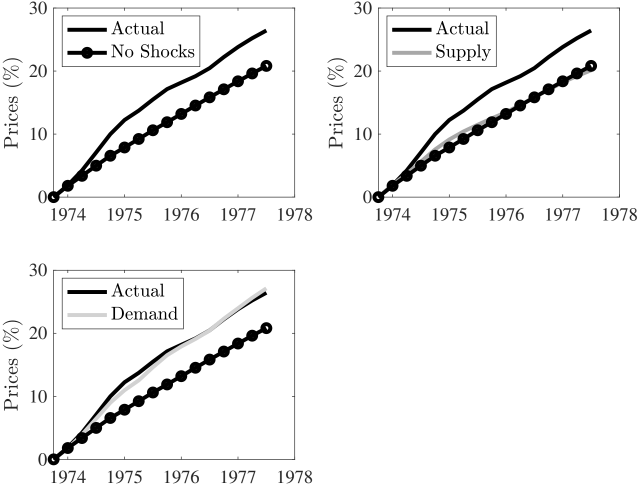
Results : Historical Decomposition

Figure 24: First Oil Shock



1. Shocks
Results : Historical Decomposition

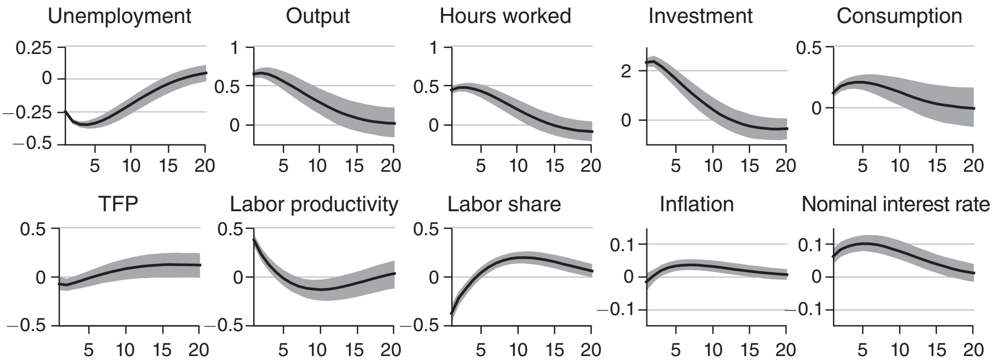
Figure 25: First Oil Shock



- Such a Structural VAR identification strategy is used to identify the effects of policy shocks (Taxes, Gvt Spendings, Monetary)... which do not explain a large share of the total variance of the economy.
- More agnostic exercises are possible: Looking for the “main business cycle shocks”.
- Look for the orthogonal shock that explains the maximum variance of the data between 6 and 32 quarters (frequency domain)
- This is what is done in Angeletos, Collard & Dellas, AER [2020]

1. Shocks

Figure 26: Impulse Response to the "Main Business Cycle Shocks"



Angeletos, Collard & Dellas, AER [2020]

- Question: How to interpret this shock in a model?

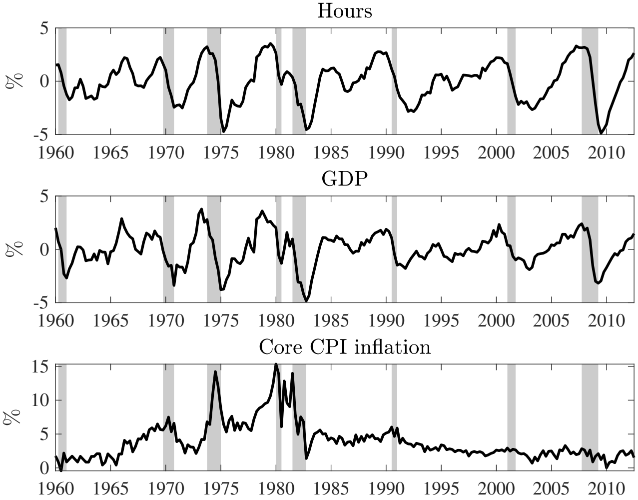
Roadmap

1. Shocks
2. Models
3. Real Keynesian Approach

2. Models

- Here I want to show that current models and shocks have are time to explain the recent periods (say the last 30 years).

Figure 27: Some Intriguing Facts over the last 3 cycles: Non inflationary business cycles

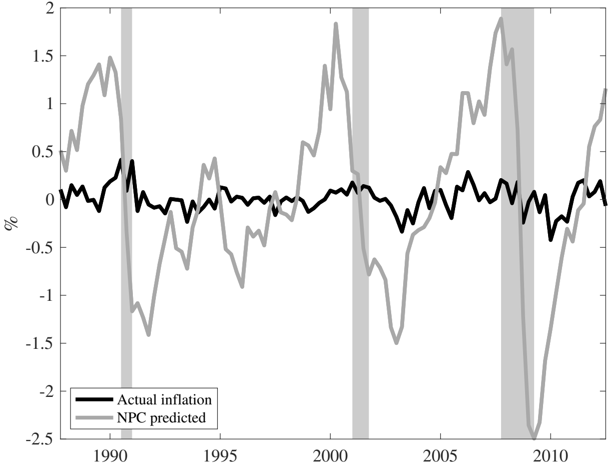


- Demand shocks?
  - Should be inflationary in New-Keynesian models,

2. Models

- Post Volcker, New Phillips Curve implies that s.d. of inflation is **350%** of the actual one

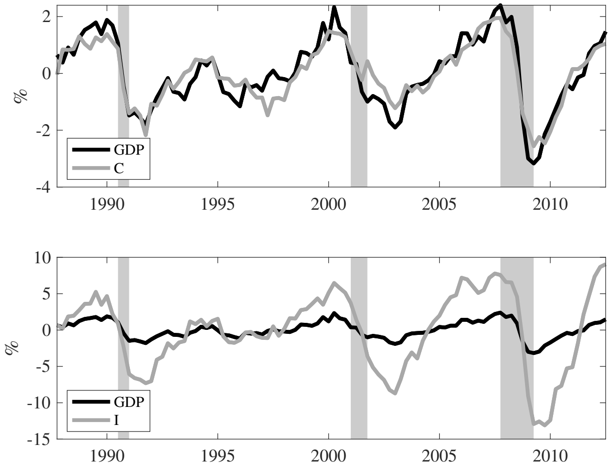
Figure 28: The Trouble with New Keynesian Models



- Demand shocks?
  - × Should be inflationary in New-Keynesian models,
  - × In flex prices, C and I move in opposite direction following a demand shock.
  - × Why?
    - Consumption and leisure are two normal goods,
    - Demands shocks typically do not distort their relative price,
    - If C increases, leisure increases, and I should decrease to finance the C increase.

- Post-Volcker, correlations with HP filtered output are **.92** for C and **.91** for I.

Figure 29: Comovements



- Demand shocks?
  - × Should be inflationary in New-Keynesian models,
  - × In flex prices, C and I move in opposite direction following a demand shock
- Supply shocks?
  - × Total Factor Productivity should be procyclical

2. Models

The Trouble with RBC Models: TFP

- Post-Volcker, correlation between hours worked and TFP is **-.64**, correlation between GDP and TFP is **-.23**.

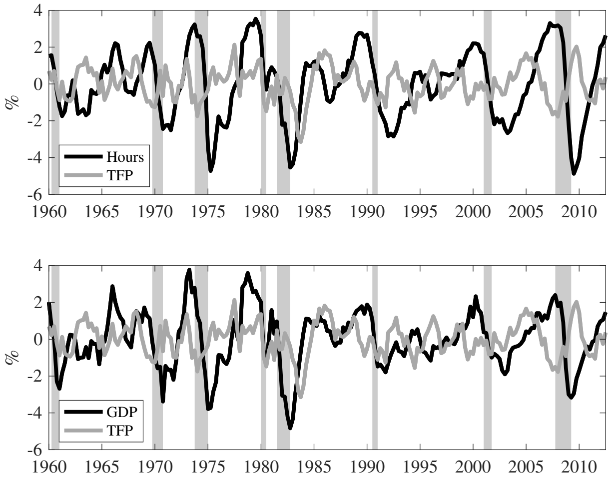
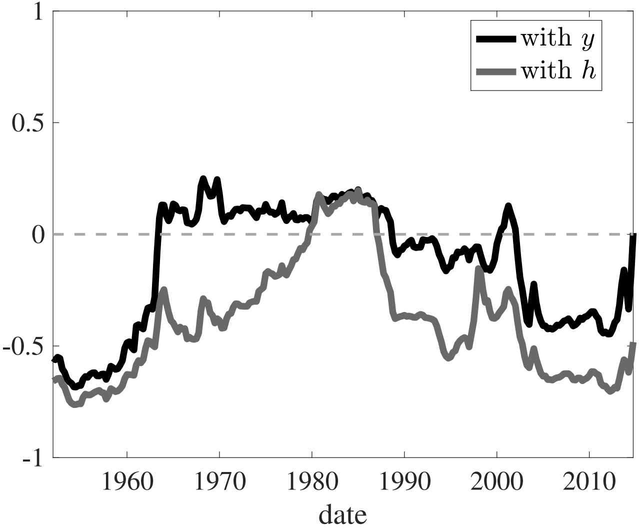


Figure 30: TFP correlation with y and h on 10 years rolling window centered on date

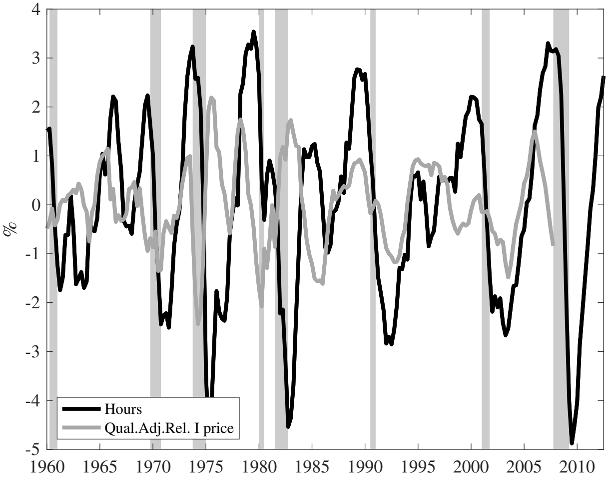


- Demand shocks?
  - × Should be inflationary in New-Keynesian models,
  - × In flex prices, C and L move in opposite direction following a demand shock
- Supply shocks?
  - × Total Factor Productivity should be procyclical
  - × Investment Specific Technology shocks: investment price should be countercyclical

2. Models

- Post-Volcker, correlation between hours worked and relative price of investment is **.56**.

Figure 31: Investment Specific Technology Shocks



- Possible to "fix" these commonly used RBC or NK models to fit facts: "Marginal Efficiency of Investment" shocks, preference shocks, fixed price ("backward-looking" Phillips curve), adjustment costs to the investment rate, in-sample correlation of shocks, etc...
- Those explanations in my opinion are not very compelling, intuitive or robust.
- Am alternative is to consider that demand shocks move the economy, but not because prices are sticky $\rightsquigarrow$ *Real Keynesian models*

Roadmap

1. Shocks
2. Models
3. Real Keynesian Approach

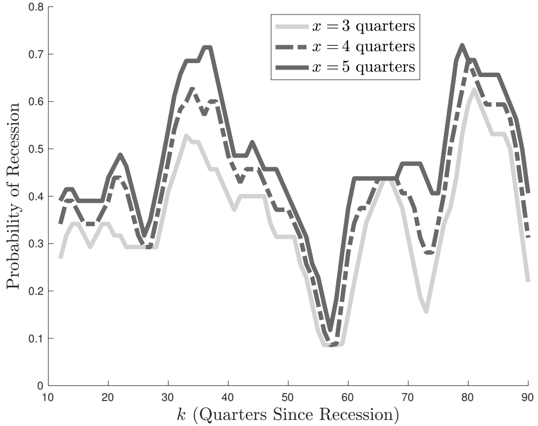
3. Real Keynesian Approach

- We observe demand shocks that are related to expectations, expectation revisions (fundamentals or sunspots) and high order expectations $\rightsquigarrow$ "News shocks" Beaudry & Portier, JME [2004], AER [2006], JEL [2014]
- Demand shocks matter but not because of sticky prices: *Real Keynesian models*
- Real Keynesian models: Role of complementarities, incomplete markets and thick market externalities.
- Applied Micro has to deal with *unobserved heterogeneity*, Macro shall understand *observed homogeneity*
- Propagation is perhaps more important than shocks: models with cyclical fluctuations.

- Cycles are “recurrent movements in economic activity”
- Booms and busts
- Can be thought as the consequence of shocks hitting an otherwise stable economy...
- ... Or as the very indication that that market (capitalist) economies are intrinsically unstable.
- Let’s try to see what’s in the data.
- Start with the NBER series of 1 and 0 for expansions and recessions.
- Compute the probability of being in a recession in k quarters *conditional* on being in a recession today.

3. Real Keynesian Approach
Cyclicality

Figure 32: Conditional Probability of Being in a Recession (US)



Notes: This shows the fraction of time the economy was in a recession within an x-quarter window around time $t + k$, conditional on being in a recession at time t, where x is allowed to vary between 3 and 5 quarters.

- What is meant by cyclicality?
  - If activity is high today,
  - at say $N/2$ period in the future, economic activity is expected to be low (below trend),
  - and then at N expected to be high again and so on.
- This translates in cyclicality in the auto-covariance or equivalently in peaks in the spectral density.
- Note: *nothing deterministic* about this definition, its only about conditional expectations.
- Different from the more standard "auto-regressive" (AR(1)) view.
  - If activity is high today,
  - we expect it to return to mean.

Figure 33: Absence of Cyclicality

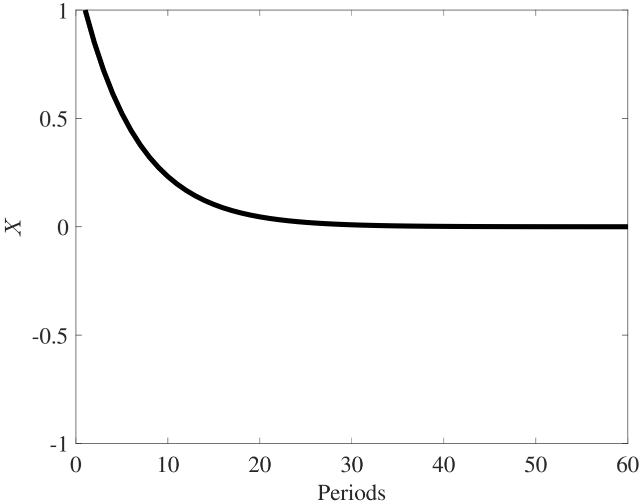


Figure 34: Cyclicality

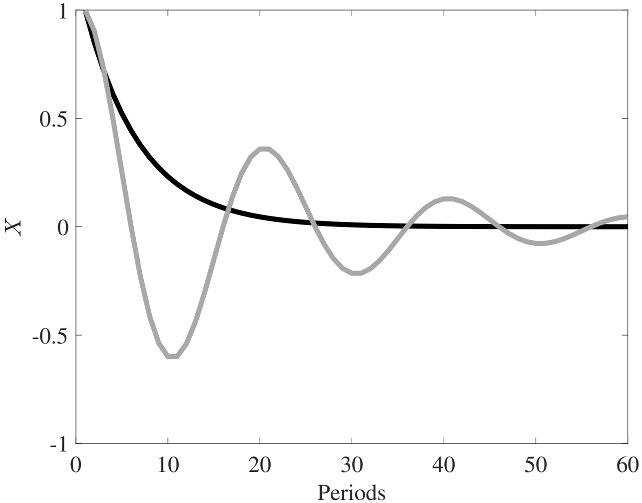
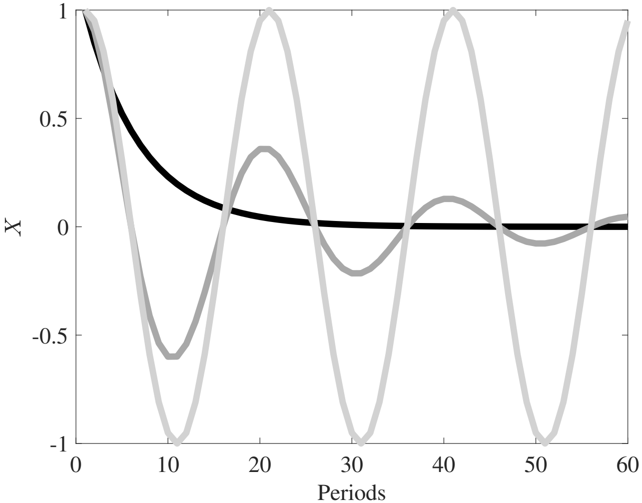


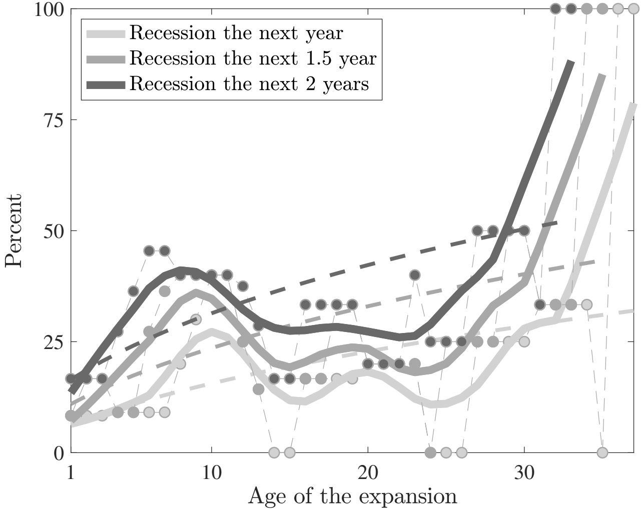
Figure 35: "Strong" Cyclicality



- The two views differ on whether or not we should worry about big booms.
- In a cyclical world, expansions do die of old age.

3. Real Keynesian Approach
Cyclicality

Figure 36: Prob. of an expansion ending the next year, year and a half or the next two years

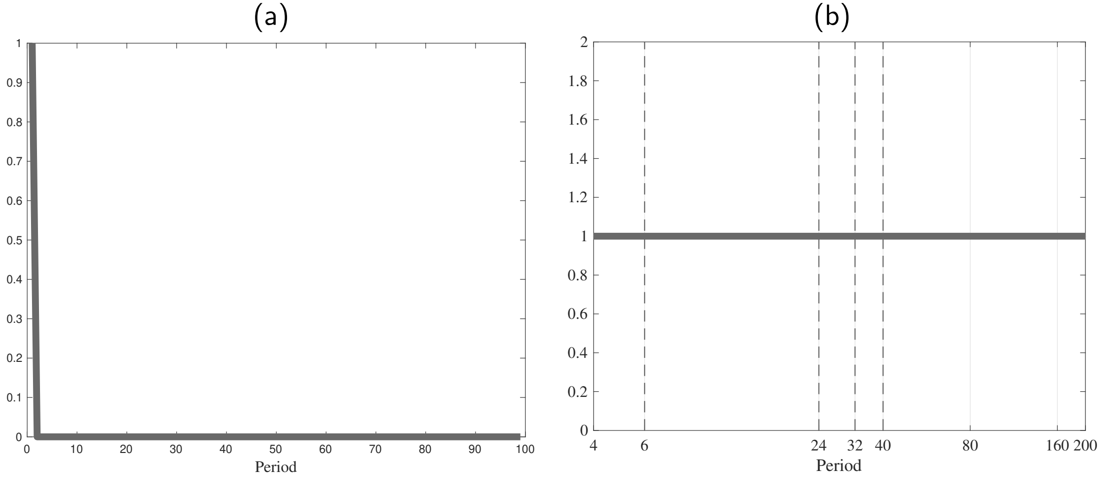


- A way to look at cyclicality is to look at spectral density
- Spectral density tells us the share of the total variance of a series that is accounted by a sine wave of different periodicities.

3. Real Keynesian Approach

Cyclicality: $x_t = \varepsilon_t$

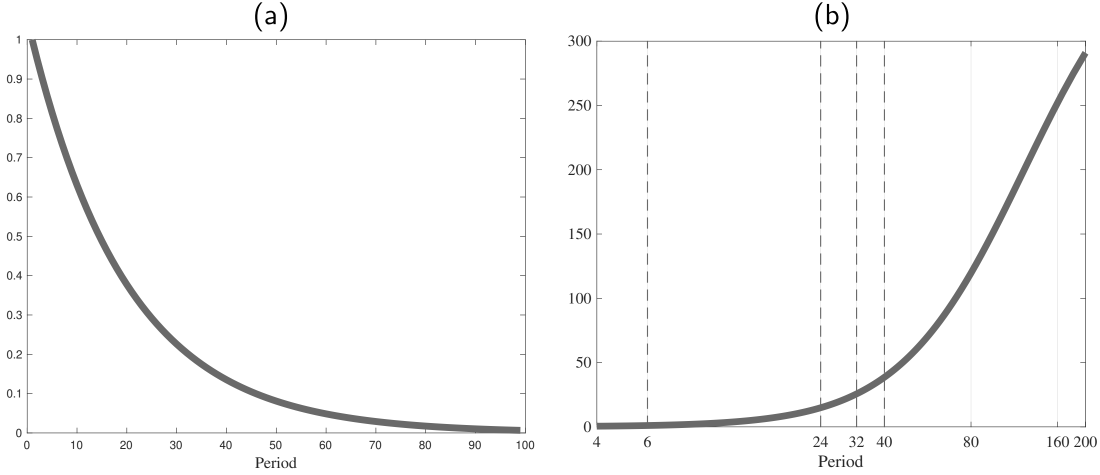
Figure 37: (a) IRF and (b) Spectrum



3. Real Keynesian Approach

Cyclicality: $x_t = .95x_{t-1} + \varepsilon_t$

Figure 38: (a) IRF and (b) Spectrum



3. Real Keynesian Approach

Cyclicality: $x_t = 1.92x_{t-1} - .95x_{t-2} + \varepsilon_t$

Figure 39: (a) IRF and (b) Spectrum

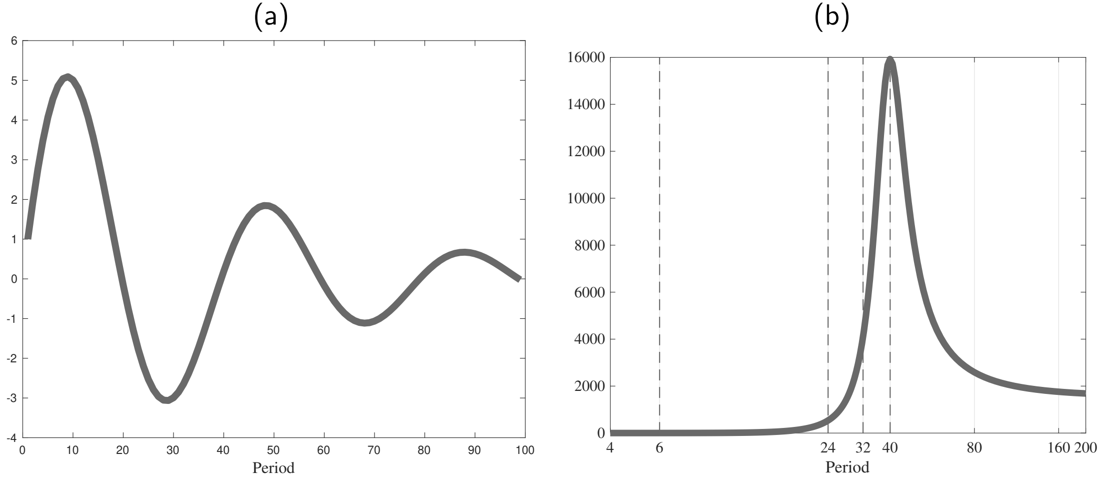


Figure 40: Conventional Wisdom-Granger [1969]

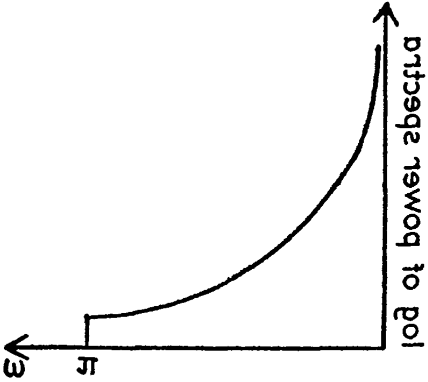


FIGURE 1.—Typical spectral shape.

3. Real Keynesian Approach

Cyclicality

Figure 41: Non-Farm Business (NFB) Hours Per Capita

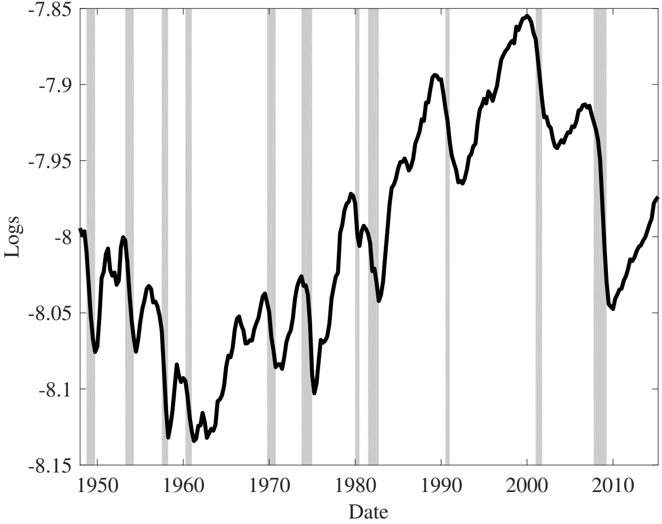


Figure 42: Non Farm Business Hours per Capita Spectrum

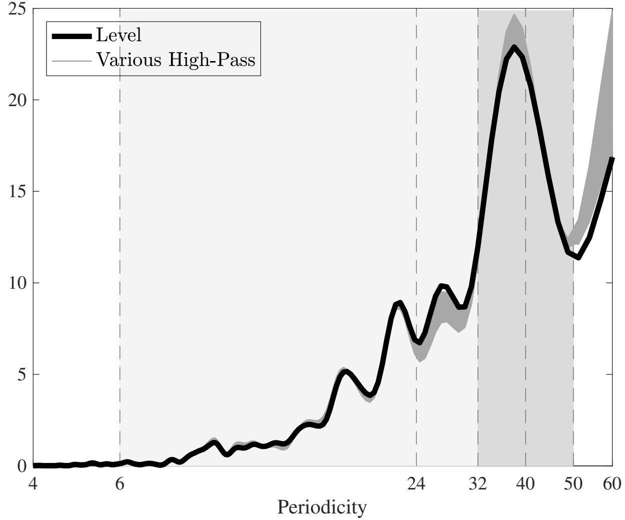
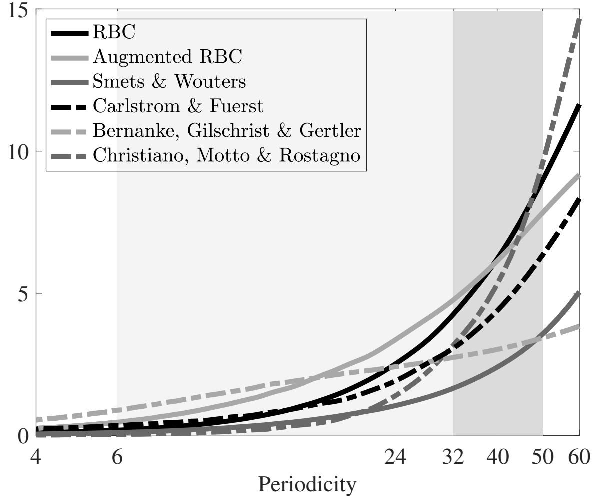


Figure 43: Hours Spectrum in Various Models



- BEAUDY, GALIZIA & PORTIER, AER, [2020]
- Main mechanism:
  - in booms, less defaults
  - $\rightsquigarrow$ cheap credit
  - $\rightsquigarrow$ more borrowing to buy goods (in particular durable goods and houses) $\rightsquigarrow$ less risk of unemployment and bankruptcy $\rightsquigarrow$ even less defaults $\rightsquigarrow$ even cheaper credit
  - $\rightsquigarrow$ the boom is even bigger
- But at some point, satiation (lot of houses, TV sets, etc...), so that demands goes down
  - $\rightsquigarrow$ less sales $\rightsquigarrow$ more risk of unemployment and bankruptcy $\rightsquigarrow$ defaults increase
  - $\rightsquigarrow$ credit becomes more expensive $\rightsquigarrow$ less demand $\rightsquigarrow$ more default etc...
- Can this mechanism be strong enough to create cycles when estimated?
- Note: Expansion sows the seed of the next recession.

Figure 44: Spectrum fit for Hours

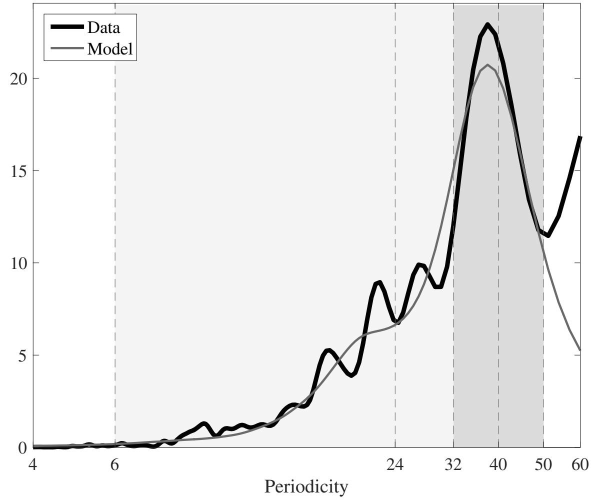


Figure 45: Sample Draw for Hours

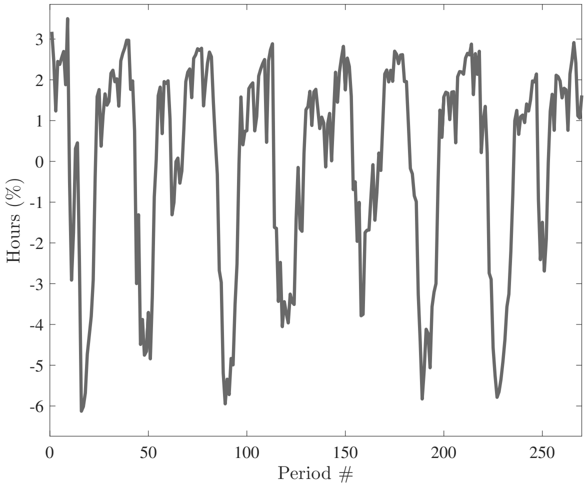
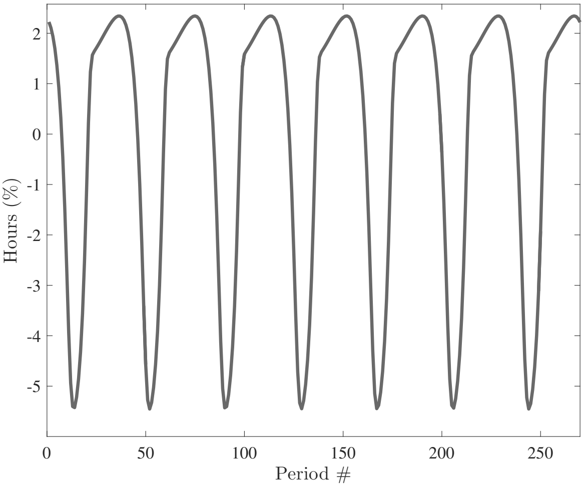


Figure 46: Sample Draw for Hours, no shocks



- Different view: fluctuations are mainly endogenous
- But shocks are needed to make them not fully predictable
- Market economies are unstable, but not explosive.
- Change of perspective on
  - The contribution of shocks
  - What is stabilization policy