Booms and Busts. New Keynesian and Behavioral explanations

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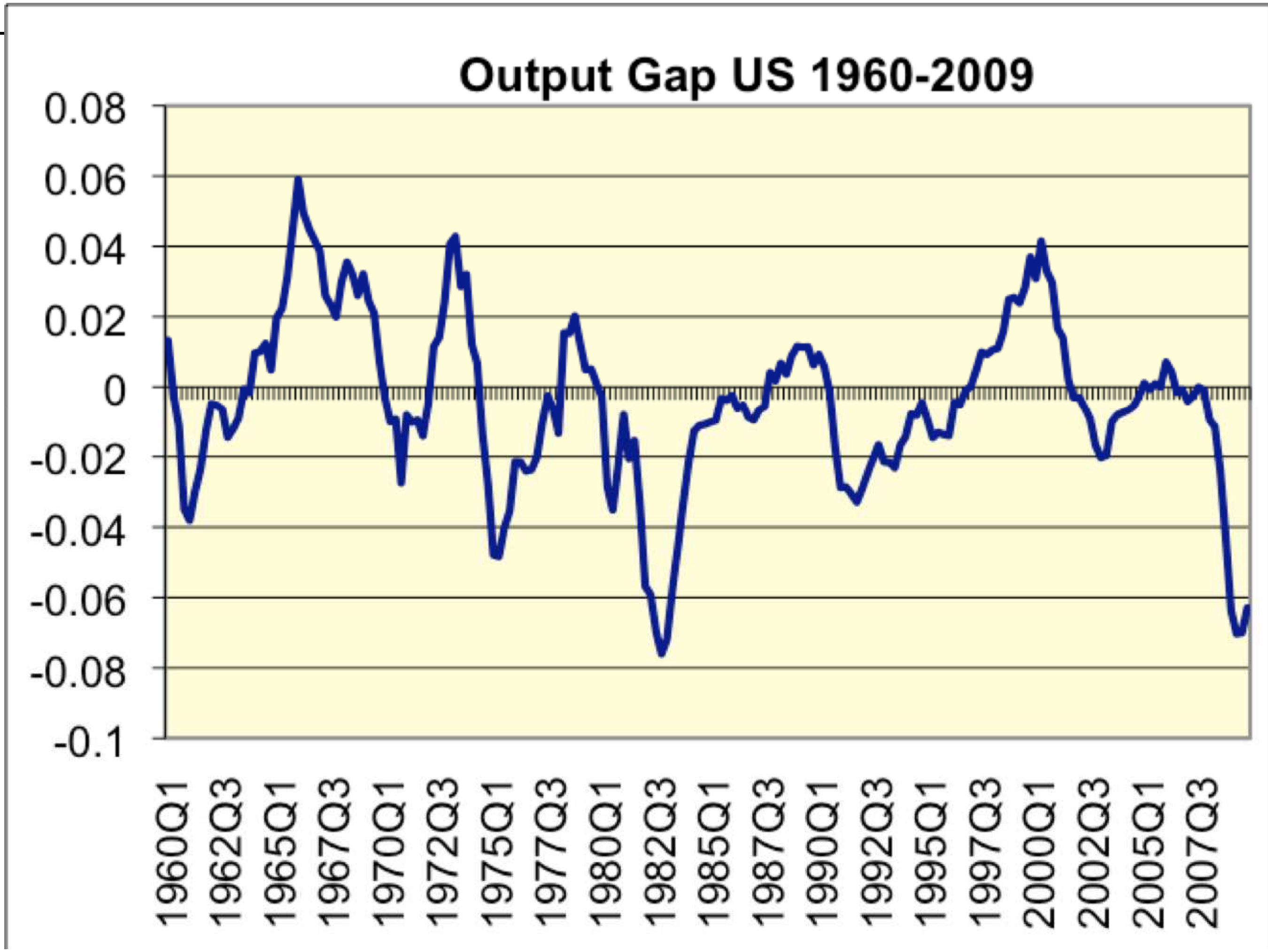
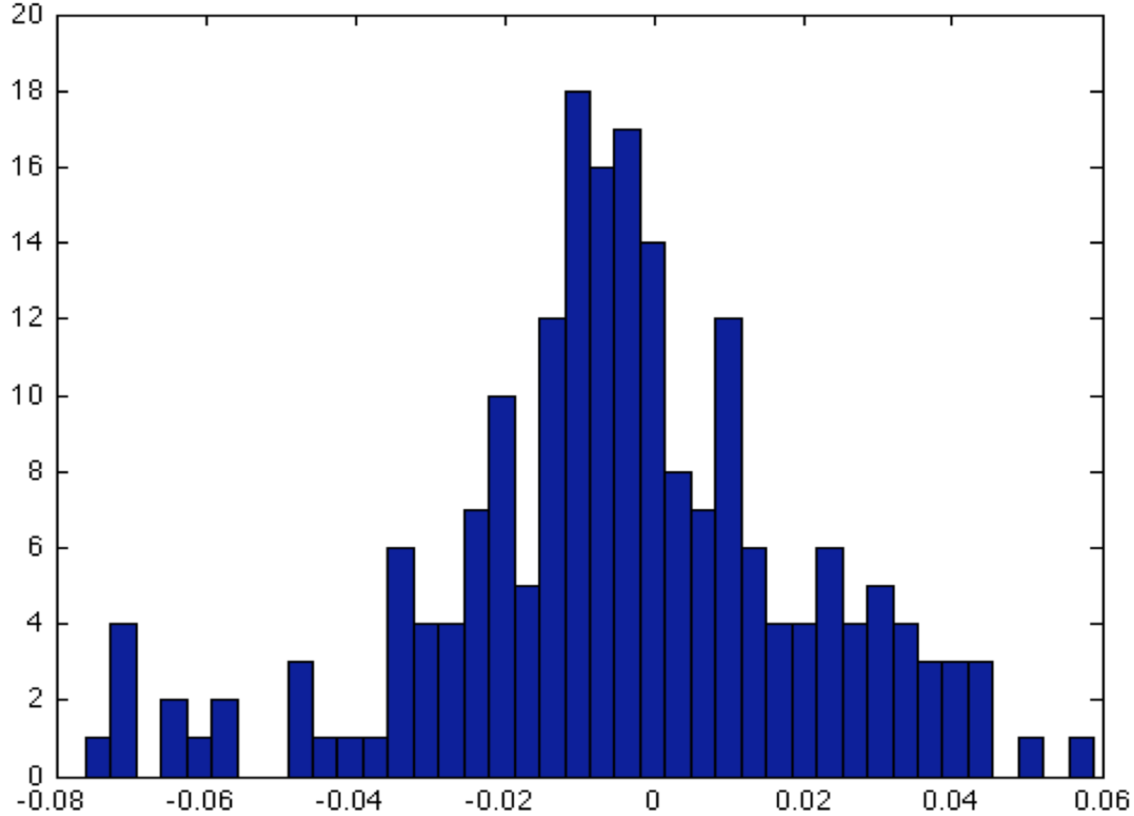
- Capitalism is characterized by booms and busts;
- How does the New Keynesian (DSGE) model explain booms and busts in economic activity?
- And how does an alternative, behavioural, model explain these features?
- These are the questions analyzed in this paper.

- Let us first look at the facts
- US output gap movements during last 50 years



Source: US Department of Commerce and Congressional Budget Office

Frequency distribution of US Output gap (1960-2009)



kurtosis: 3.61; Jarque-Bera: 7.17 with p-value=0.027

Figure 9.3: Frequency distribution of UK output gap

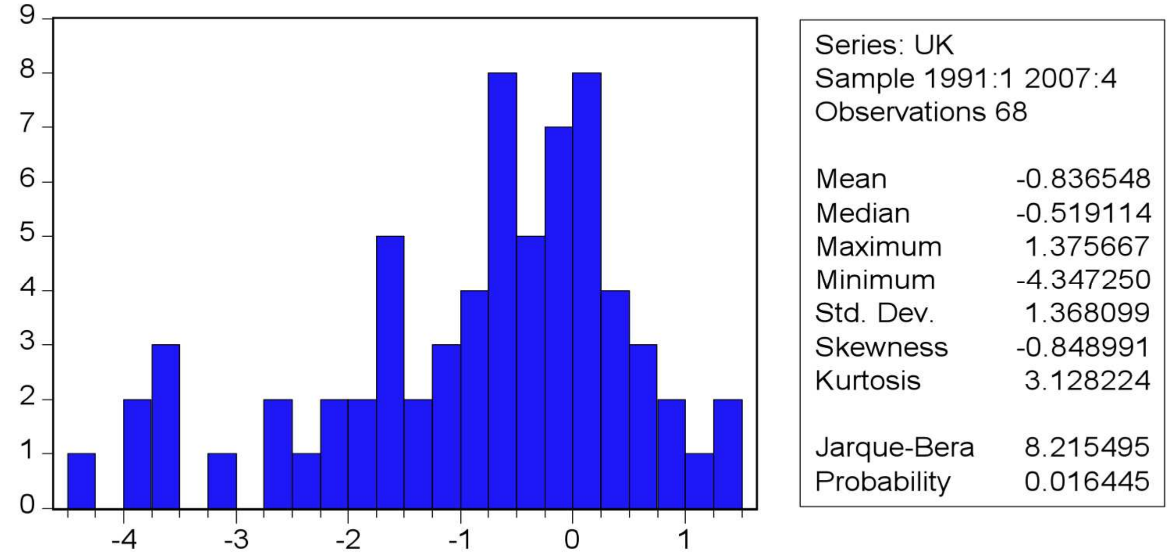
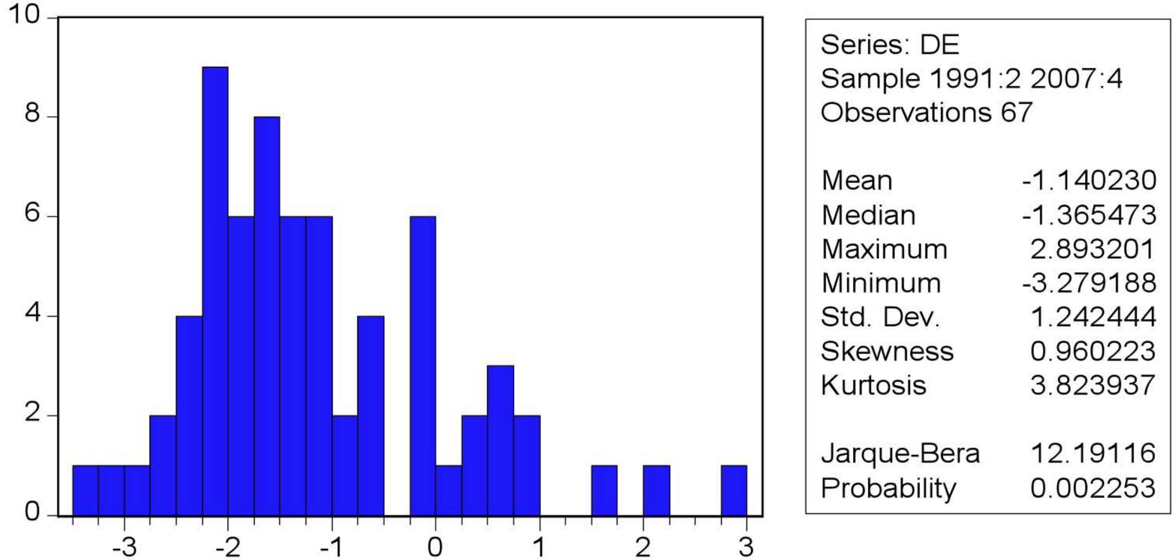


Figure 9.4: Frequency distribution of German output gap



Source: OECD

Two stylized facts

- Cyclical movements: autocorrelation coefficient = 0.94
- Output gap is not normally distributed
  - There is excess kurtosis
  - Fat tails
- In this paper I contrast New Keynesian (DSGE) model with behavioral model

- It is useful to make distinction between top-down and bottom-up systems
- top-down system: one or more agents fully understand the system.
  - agents are capable of representing the whole system in a **blueprint** that they can store in their mind.
  - depending on their position in the system they can use this blueprint to take over the command, or they can use it to optimize their own private welfare.
  - there is a **one to one mapping** of the information embedded in the system and the information contained in the brain of one (or more) individuals.
  - Example: a building that can be represented by a blueprint and is fully understood by the architect.

- Bottom-up systems: no individual understands the whole picture.
  - Each individual understands only a very **small part** of the whole.
  - These systems function and grow as a result of the application of **simple rules** by the individuals populating the system.
  - Most living systems follow this bottom-up logic (e.g. the embryo)
  - The market system is also a bottom-up system.

- The best description of this bottom-up system was made by Hayek(1945): no individual is capable of understanding the full complexity of a market system.
  - individuals only understand small bits of the total information.
- The main function of markets consists in aggregating this diverse information.
- If there were individuals capable of understanding the whole picture, we would not need markets.
  - This was Hayek’s criticism of the “socialist” economists who took the view that the central planner understood the whole picture,
  - and would be able to compute the whole vector of optimal prices, making the market system superfluous.

- My contention is that the rational expectations models are the **intellectual heirs** of these central planning models.
- Not in the sense that individuals in these rational expectations models aim at planning the whole,
- but in the sense that they understand the whole picture.
- These individuals use this superior information to obtain the "optimum optimorum" for their own private welfare.
- In this sense they are **top-down** models.

Objective of my presentation

- To contrast the rational expectations top-down model with a bottom-up macroeconomic model.
- This will be a model in which agents have **cognitive limitations** and do not understand the whole picture (the underlying model).
  - Instead they only understand small bits and pieces of the whole model
  - and use simple rules to guide their behavior.
- Rationality will be introduced through a **selection mechanism** in which agents evaluate the performance of the rule they are following
- and decide to switch or to stick to the rule depending on how well the rule performs relative to other rules.

The model: structure is the same in behavioral model and in DSGE

- **Aggregate demand**

$$\tilde{y}_t = a_1 \hat{E}_t \tilde{y}_{t+1} + (1 - a_1)\tilde{y}_{t-1} + a_2(r_t - \hat{E}_t \pi_{t+1}) + \varepsilon_t$$

  - Forward and backward looking term (habit formation)
  - ^ above *E* means: non rational expectation

- **Aggregate supply**: New Keynesian Phillips curve

$$\pi_t = b_1 \hat{E}_t \pi_{t+1} + (1 - b_1)\pi_{t-1} + b_2 \tilde{y}_t + \eta_t$$

- **Taylor rule** describes behavior of central bank

$$r_t = c_1(\pi_t - \pi^*) + c_2 \tilde{y}_t + c_3 r_{t-1} + u_t$$

when $c_2 = 0$ there is strict inflation target

Introducing heuristics: output forecasting

- I assume two possible forecasting rules
  - A fundamentalist rule
  - An extrapolative rule
- Fundamentalist rule: agents estimate equilibrium output gap and forecast output gap to return to steady state
- Extrapolative rule: agents extrapolate past output gap
- Note: more complicated rules can be introduced. Surprisingly they do not affect the dynamics much
- Aim: how far can we get with such simple rules?

output forecasting

- Fundamentalist rule

$$\tilde{E}_t^f y_{t+1} = 0$$

- Extrapolative rule

$$\tilde{E}_t^e y_{t+1} = y_{t-1}$$

- Clearly the rules are ad-hoc but not more so than assuming that agents understand the whole picture.
- It a parsimonious representation of a world where agents do not know the “Truth” (i.e. the underlying model).
- The use of simple rules does not mean that the agents are dumb and that they do not want to learn from their errors.
- I will specify a learning mechanism in which these agents continuously try to correct for their errors by switching from one rule to the other.

- Market forecasts are weighted average of fundamentalist and extrapolative forecasts

$$\tilde{E}_t y_{t+1} = \alpha_{f,t} \tilde{E}_t^f y_{t+1} + \alpha_{c,t} \tilde{E}_t^e y_{t+1}$$

$\alpha_{f,t}$ = probability agents choose fundamentalist rule

$\alpha_{e,t}$ = probability agents choose extrapolative rule

$$\alpha_{f,t} + \alpha_{e,t} = 1$$

Inflation forecasts

- We also allow inflation forecasters to be heterogeneous.
- We follow Brazier et al. (2006) in allowing for two inflation forecasting rules.
  - One rule is based on the announced inflation target which provides anchor (as in the previous model)
  - the other rule extrapolates inflation from the past into the future.
  - Here also agents select the rule that forecasts best
  - They switch from the bad to the good forecasting rule

Inflation “targeters”: $\hat{E}_t^{tar}\pi_{t+1} = \pi^*$

Inflation extrapolators: $\hat{E}_t^{ext}\pi_{t+1} = \pi_{t-1}$

Market forecasts are weighted average of these two forecasting rules

$$\hat{E}_t\pi_{t+1} = \beta_{tar,t}\hat{E}_t^{tar}\pi_{t+1} + \beta_{ext,t}\hat{E}_t^{ext}\pi_{t+1}$$

Introducing discipline

- Agents continuously evaluate their forecast performance.
- We apply notions of **discrete choice theory** (see Brock & Hommes(1997)) in specifying the procedure agents follow in this evaluation process
- Discrete choice theory takes the view that agents are boundedly rational: utility has a deterministic component and a random component

Forecast performance

Agents compute mean squared forecast errors obtained from using the two forecasts

This determines the utility of using a particular rule:

$$U_{f,t} = -\sum_{k=0}^{\infty} \omega_k \left[y_{t-k-1} - \tilde{E}_{f,t-k-2} y_{t-k} \right]^2$$

$$U_{e,t} = -\sum_{k=0}^{\infty} \omega_k \left[y_{t-k-1} - \tilde{E}_{e,t-k-2} y_{t-k} \right]^2$$

Applying discrete choice theory

$$\alpha_{f,t} = \frac{\exp(\gamma U_{f,t})}{\exp(\gamma U_{f,t}) + \exp(\gamma U_{e,t})}$$

$$\alpha_{e,t} = \frac{\exp(\gamma U_{e,t})}{\exp(\gamma U_{f,t}) + \exp(\gamma U_{e,t})} = 1 - \alpha_{f,t}$$

- when forecast performance of the extrapolators (utility) improves relative to that of the fundamentalists agents are more likely to choose the extrapolating rule about the output gap for their future forecasts.

- γ = intensity of choice parameter; it parametrizes the extent to which the deterministic component of utility determines actual choice

- This switching mechanism is the disciplining device introduced in this model on the kind of rules of behaviour that are acceptable.
- Only those rules that pass the fitness test remain in place.
- The others are weeded out.

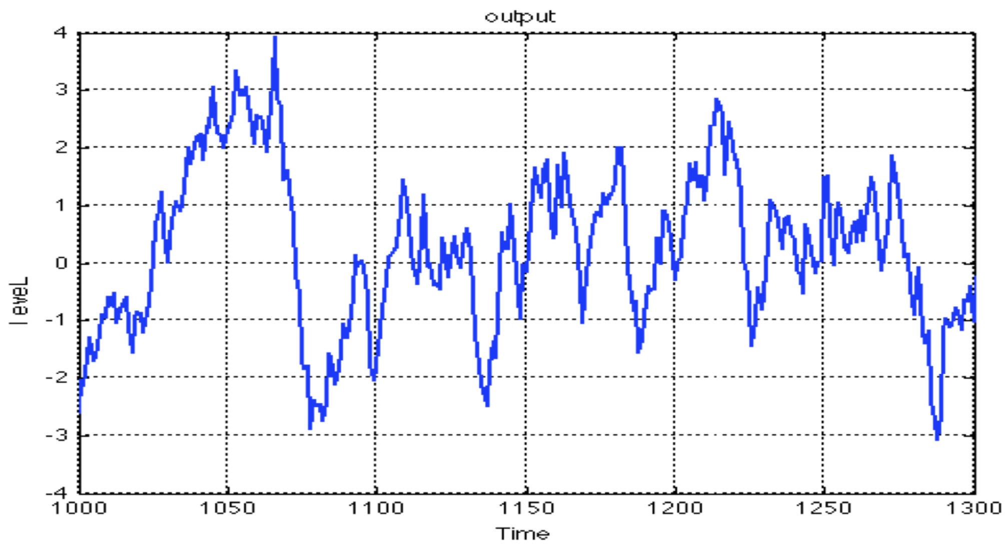
Note on learning

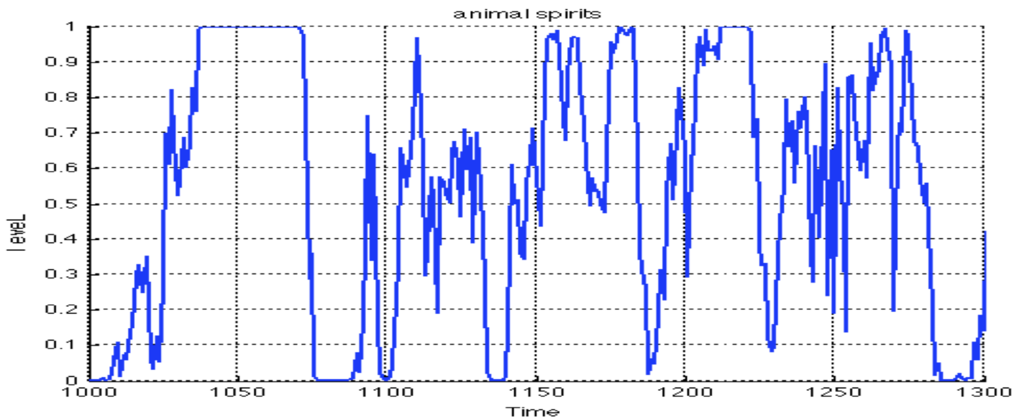
- Individuals use simpe rules in forecasting the future: these can lead to systematic errors
- But the fitness criterion ensures that the market forecast is unbiased
- This is ensured by a willingness to switch to the more performing rule
- Thus this is a model of learning based on “trial and error”
- Contrast with statistical learning, which imposes a stronger cognitive burden on individuals

Calibrating the model

- I calibrate the model by giving numerical values to the parameters that are often found in the literature
- And simulate it assuming i.i.d. shocks with std deviations of 0.5%

Output gap



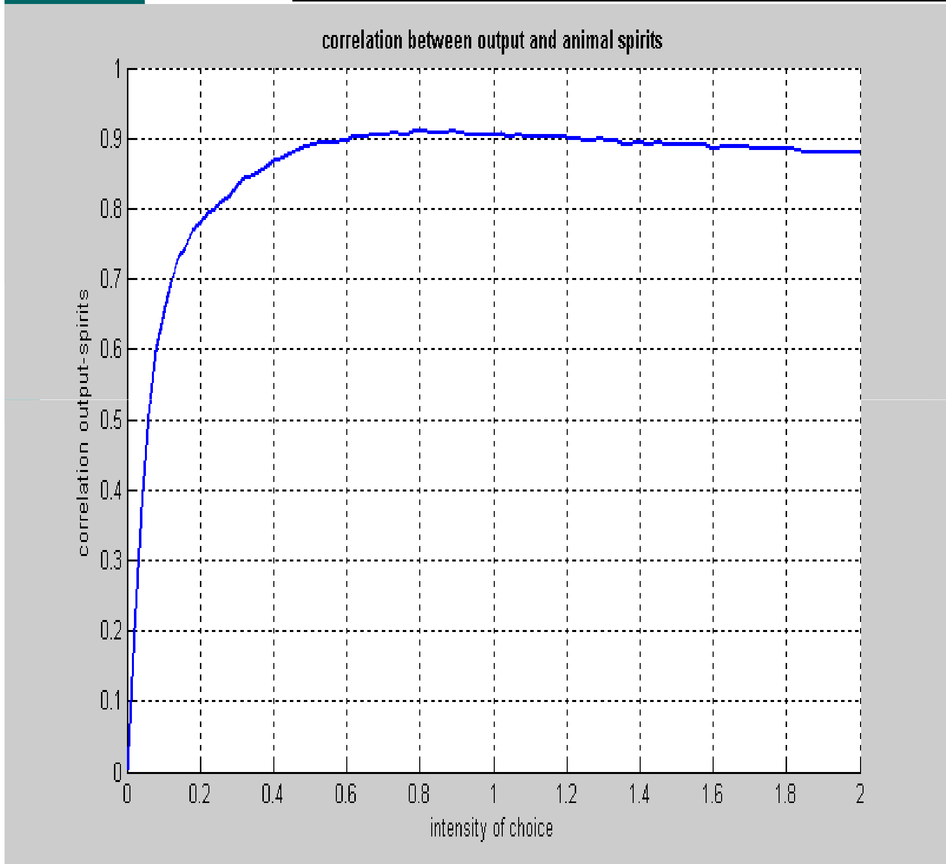


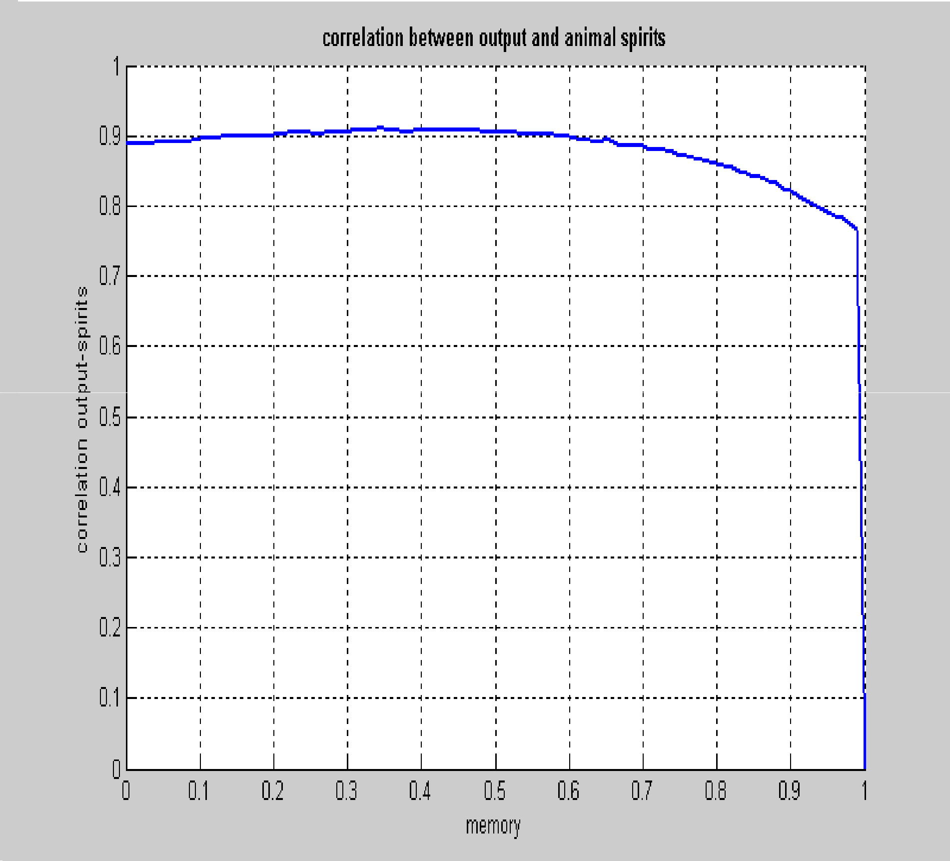
- strong cyclical movements in the output gap.
- the source of these cyclical movements is the fraction of those who forecast positive output gaps (optimists)
- The model generates endogenous waves of optimism and pessimism
- Keynes' "animal spirits"
- Timing is unpredictable
- Optimism and pessimism self-fulfilling
- Correlation output gap and fraction optimists = 0.86

Correlation animal spirits and output gap

- We find a correlation coefficient between fraction of optimists and output gap in a range of 0.8-0.9
- This correlation depends on a number of parameters

Conditions for animal spirits willingness to learn and forgetting

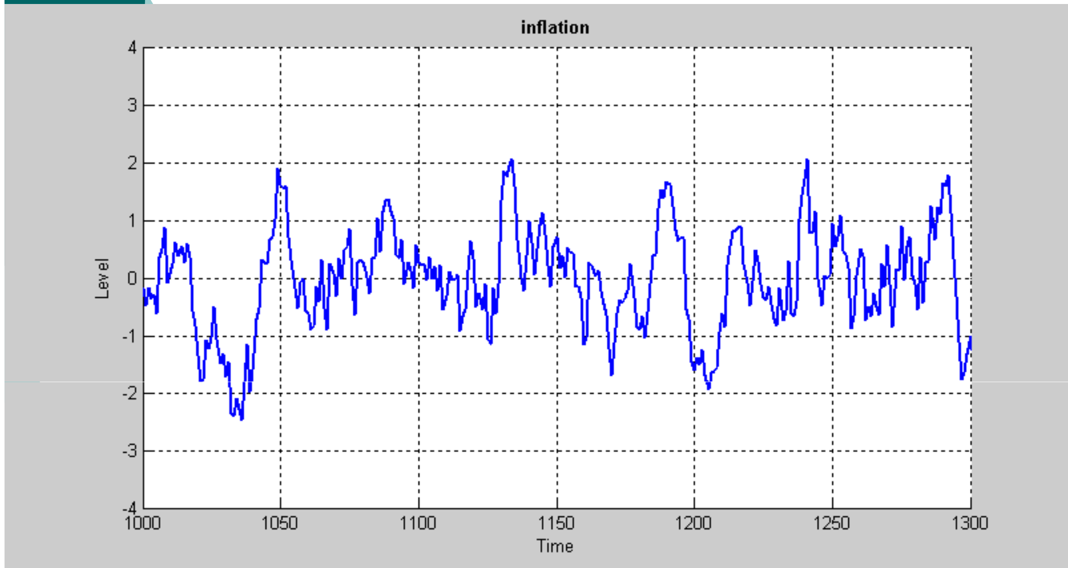


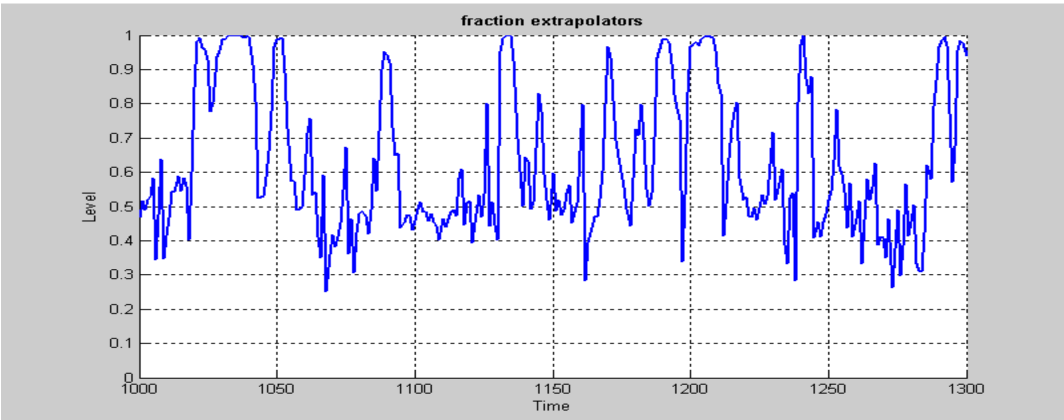


Agents should be willing to learn

Agents should exhibit some forgetfulness

Inflation: credibility is fragile

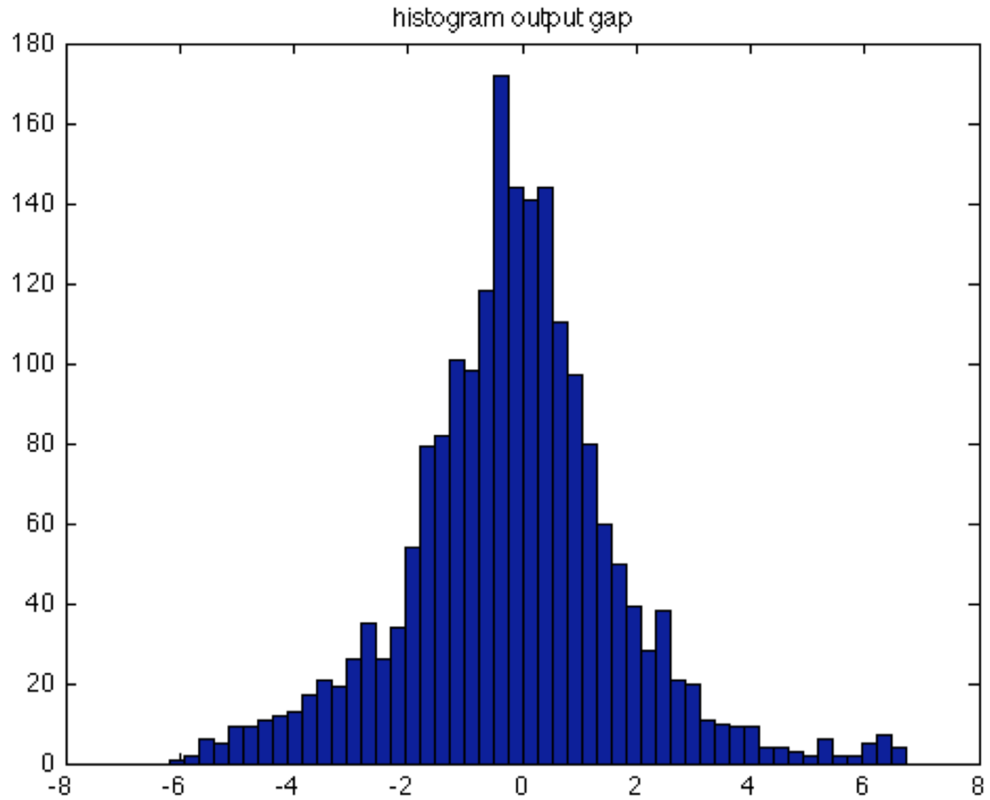




- When fraction of extrapolators and targeters fluctuates around 50%
- rate of inflation remains within a narrow band around the central bank's inflation target.
- When the extrapolators are dominant inflation fluctuates significantly more.
- Thus the inflation targeting of the central bank is fragile.
- Central banks can however strengthen credibility
- This will be analyzed later

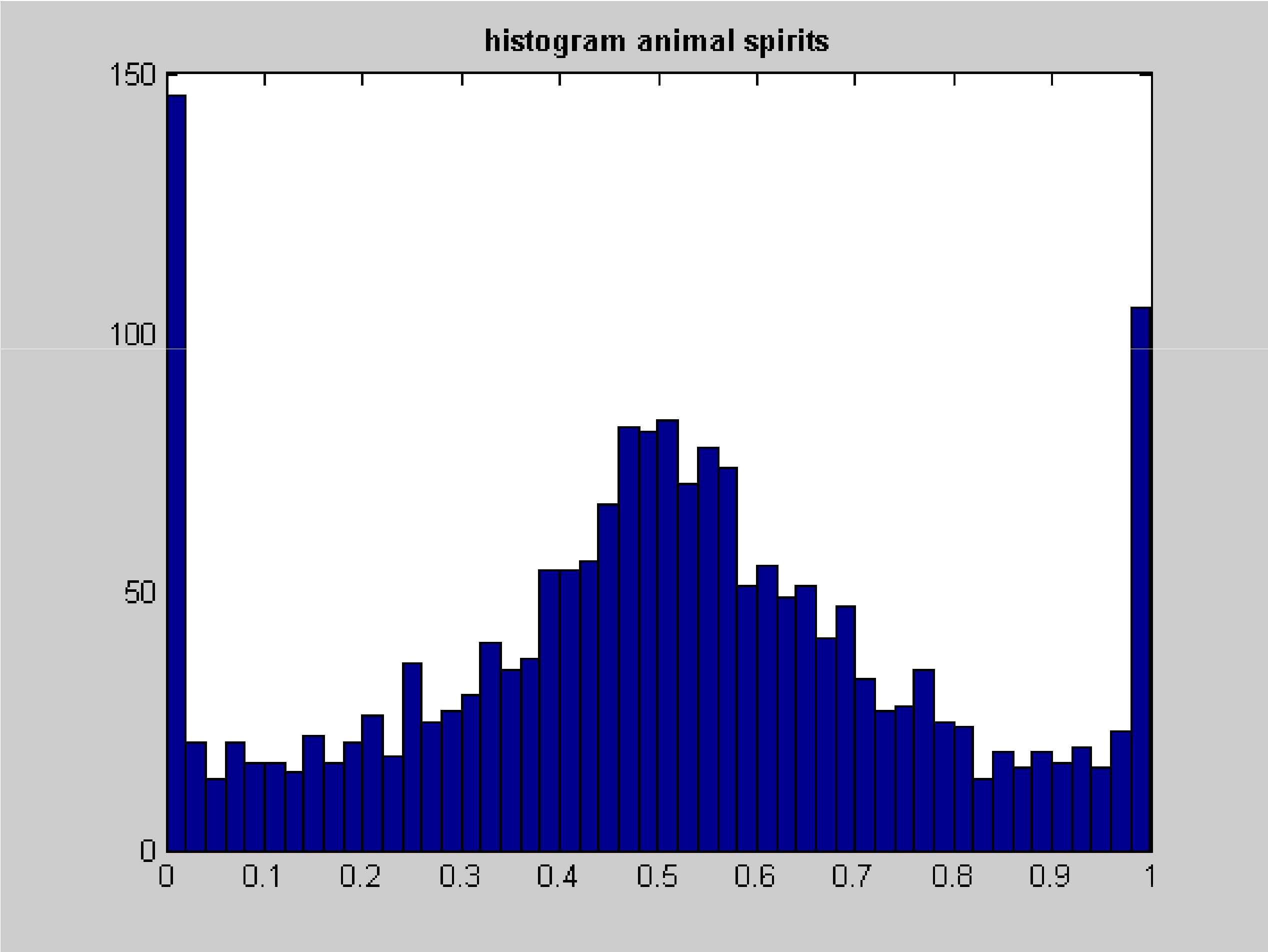
Two different business cycle theories

- Are the behavioural and the New-Keynesian models capable of mimicking empirical regularities?
- We first focus on the behavioural model.
- First finding: strong autocorrelation output gap, i.e. = 0.95
- Second finding: output gap non-normally distributed (despite the fact that shocks are normally distributed)

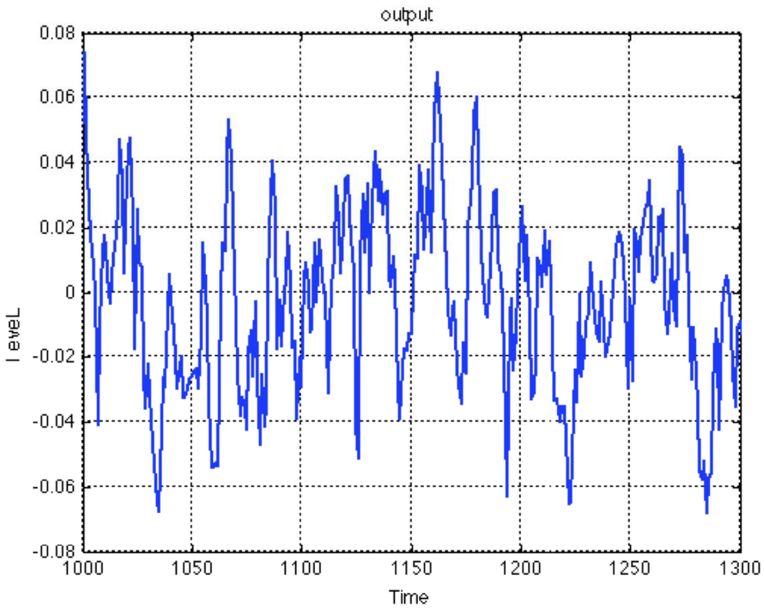


Kurtosis=4.4, Jarque-Bera = 178.4 (p-value = 0.001)

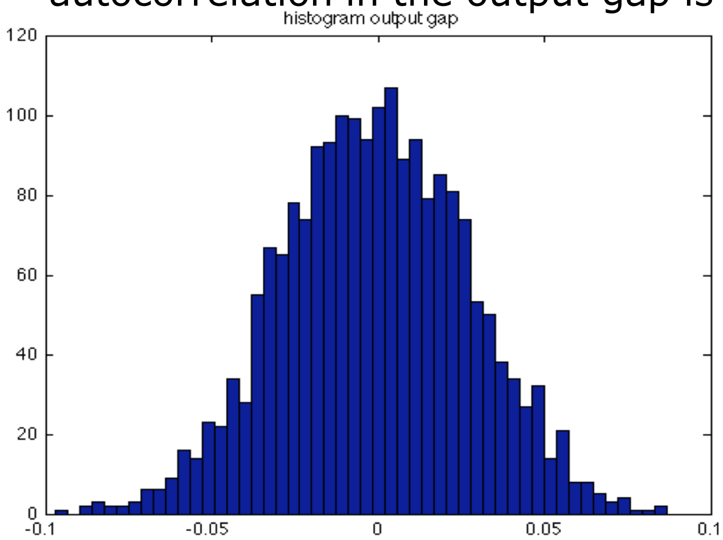
Non-normality created by animal spirits



- Behavioral model correctly predicts that large swings in output gap are a regular feature of reality.
- And that this is made possible by dynamics of animal spirits
- What about the DSGE rational expectations model?
- I show results of simulation of DSGE-model



autocorrelation in the output gap is 0.77



- Standard practice has been to add autocorrelation in error terms (scientifically questionable procedure) to improve the empirics
- I do this with DSGE model assuming AR1 error terms.
- autocorrelation output gap (not surprisingly) increases to 0.98
- But output gap remains normally distributed

Contrast between two models

- In DSGE model business cycles are the result of combination of external shocks and slow transmission produces due to inertia
- waves in output gap and inflation
- Large booms and busts can only occur because of large exogenous shocks: they are not created internally
- Thus business cycle theory is **exogenous**
- DSGE-model produces meteor theory of the business cycle

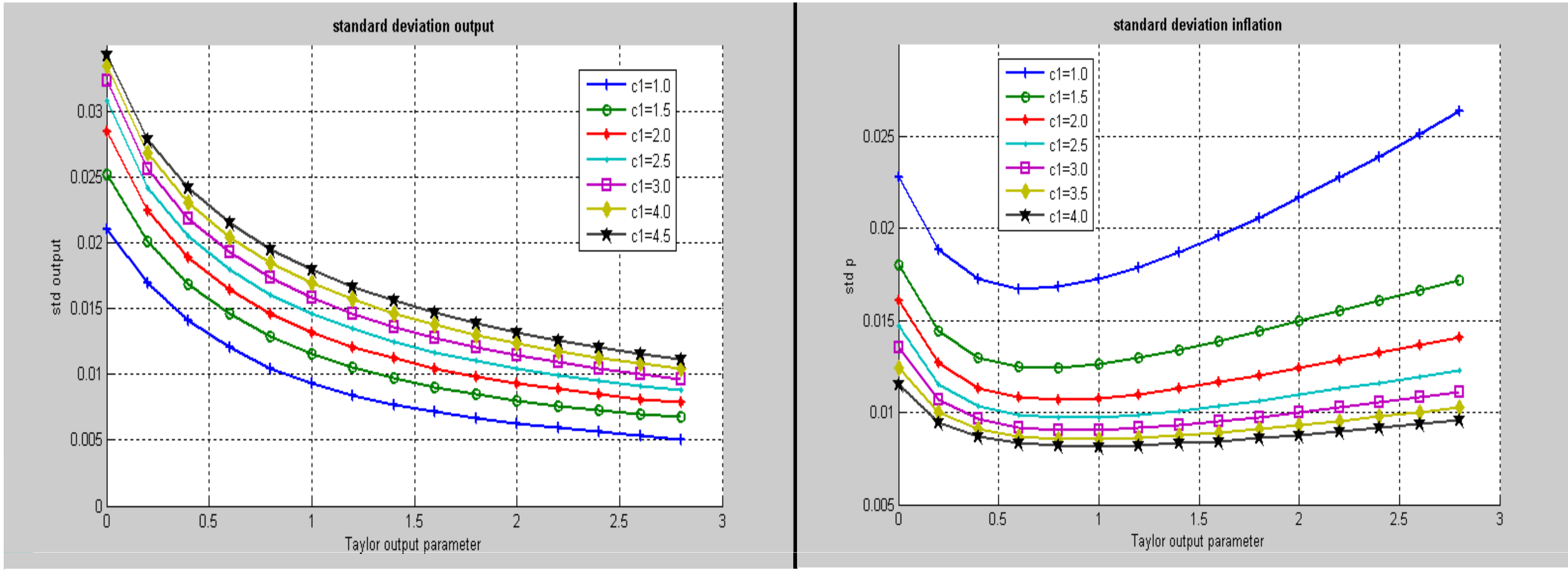
- Agents in behavioral model grope to understand the underlying structure and nature of shocks.
- They follow a procedure that functions as a "trial and error" learning mechanism
- This is a slow bottom-up process that leads to waves of optimism and pessimism
- It generates an **endogenous** business cycle into the model.
- Large booms and bust generated internally even in absence of large exogenous shocks

Applying these different views to present economic downturn

- In top-down (RE) model: the economic downturn is result of exogenous and unpredictable increase in risk premia in August 2007
  - Not very satisfactory theory
- In bottom-up model the cause of the economic downturn must be found in the (excessive) boom prior to 2007.
  - Economic downturn is result of previous excesses

The role of output stabilization

- In order to analyze the role of stabilization in behavioral model I construct tradeoffs
- The model was simulated 10,000 times and the average output and inflation variabilities were computed for different values of the Taylor rule parameters.
- We first show how output variability and inflation variability change as we increase the output coefficient (c_2) in the Taylor rule from 0 to 1.
- Thus, when c_2 increases central bank becomes increasingly active in stabilizing output (inflation targeting becomes less strict)



Each line represents the outcome for different values of the inflation coefficient (c1) in the Taylor rule.

Left panel exhibits the expected result, i.e. as the output coefficient increases (inflation targeting becomes less strict) output variability tends to decrease.

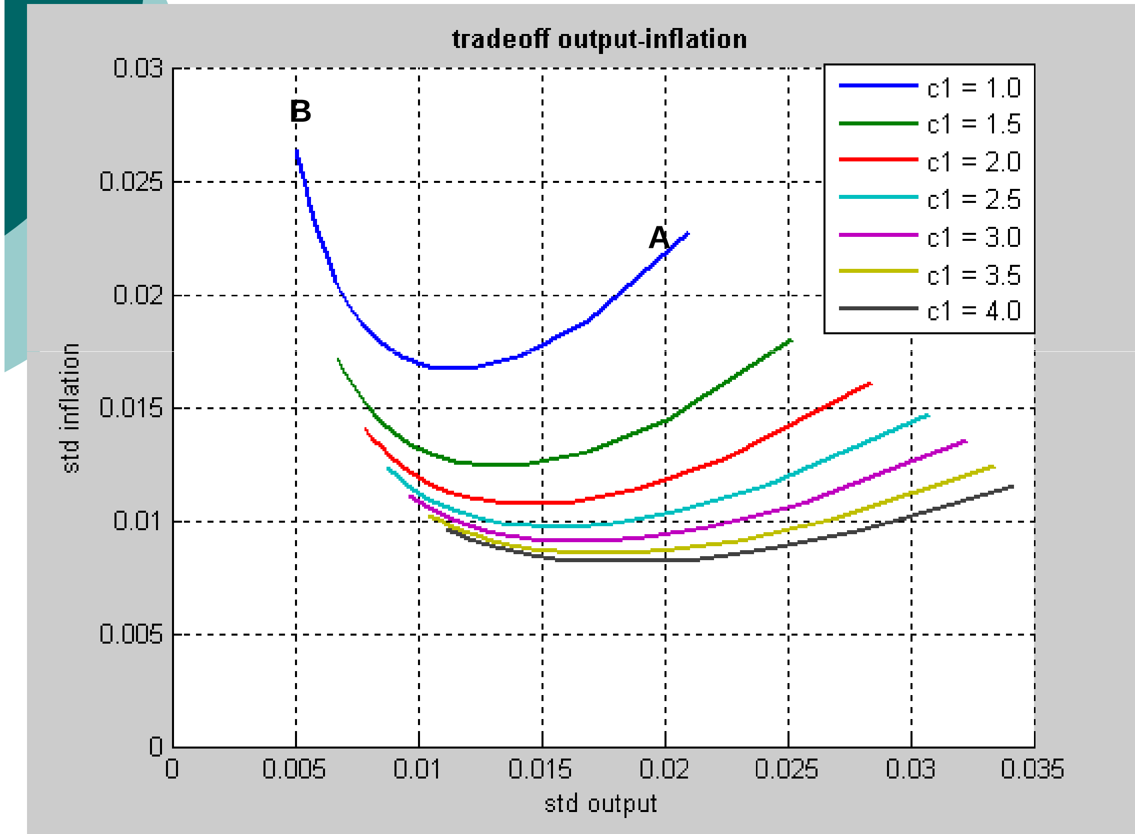
Right panel is surprising. We observe that the relationship is non-linear. As the output parameter is increased from zero, inflation variability first declines and then increases.

Thus the central bank can reduce both output and inflation variability when it moves away from strict inflation targeting ($c_2=0$) and engages in some output stabilization.

Too much stabilization is not good though.

Too much output stabilization turns around the relationship and increases inflation variability.

The trade-off



Take the tradeoff AB. In point A, the output parameter c2=0 (strict inflation targeting).

As output stabilization increases we first move downwards.

Thus increased output stabilization by the central bank reduces output and inflation variability.

The relation is non-linear, however. At some point, with too high an output stabilization parameter, the tradeoff curve starts increasing, becoming a “normal” tradeoff,

- How can we interpret these results?
- When there is no attempt at stabilizing output at all we obtain large movements in output
- These lead to stronger waves in optimism and pessimism
- which in turn leads to high inflation variability
- Thus some output stabilization is good because it also leads to less inflation variability
- Not too much though

- Too much output stabilization reduces the stabilization bonus provided by a credible inflation target.
- When the central banks attaches too much importance to output stabilization it creates more scope for better forecasting performance of the inflation extrapolators, leading to more inflation variability.

- Note that increasing the inflation parameter in the Taylor rule has the effect of shifting the tradeoffs downwards,
- i.e. the central bank can improve the tradeoffs by reacting more strongly to changes in inflation
- Reason: probability extrapolators take over is reduced
- Credibility is enhanced
- Credibility creates strong stability bonus

Policy implications

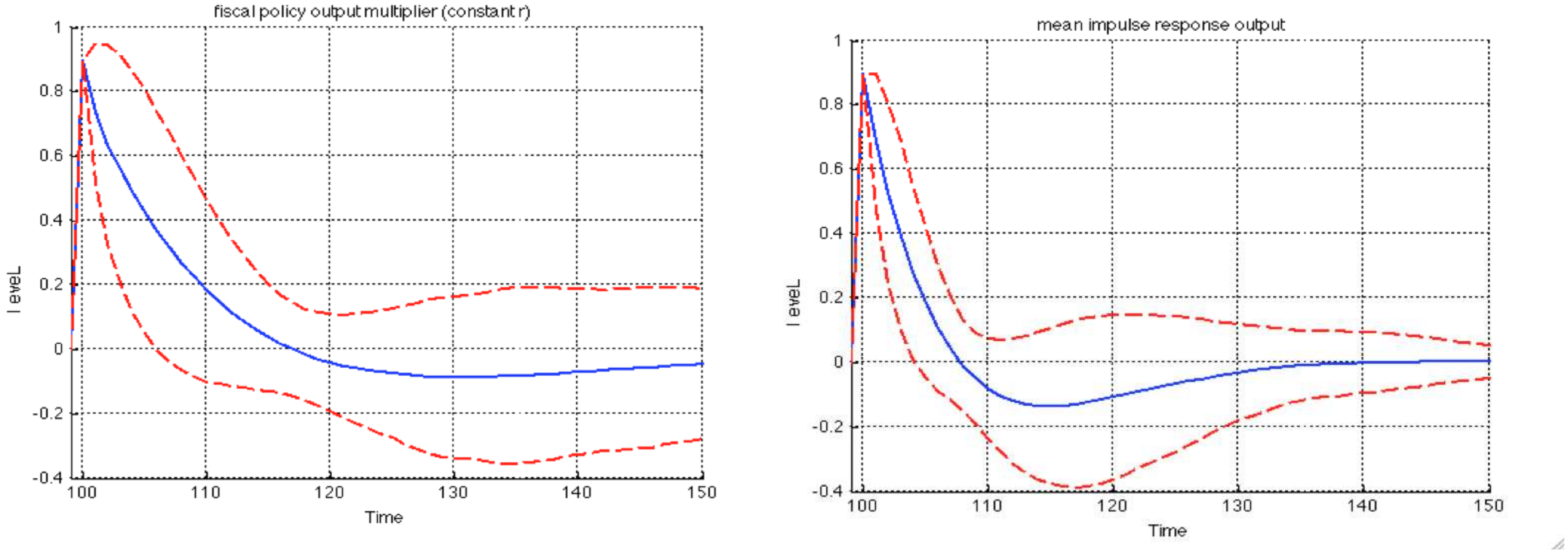
- Inflation targeting is **necessary** to stabilize the economy
- It is **not sufficient** though
- Central bank must also explicitly care for output stabilization
- So as to reduce the ups and downs produced by excessive optimism and excessive pessimism

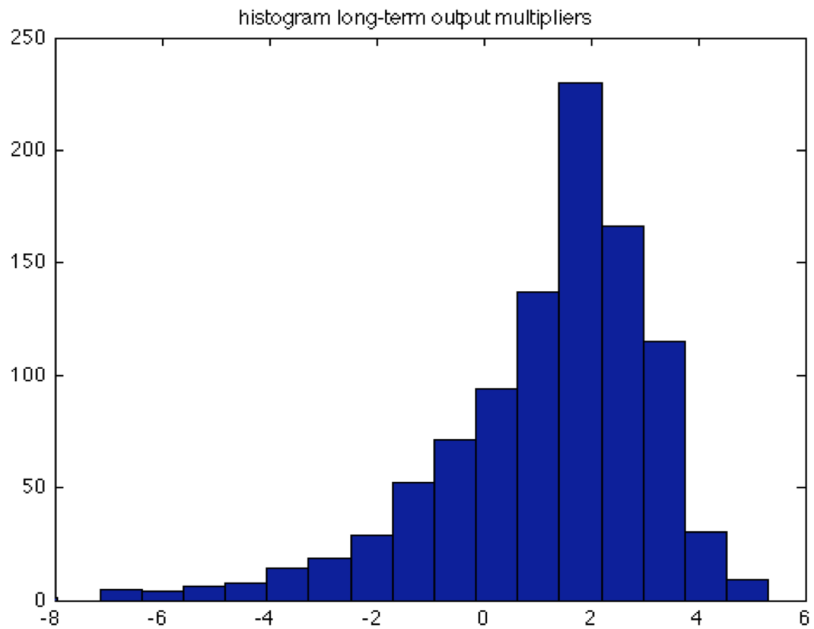
Some fiscal policy experiments

- Since eruption of the financial crisis governments have applied massive policies of fiscal stimulus.
- This has led to heated debate about the size of the fiscal policy multipliers.
- This debate has revealed (once more) how divergent economists’ views are about the size of these multipliers (see Wieland, at al. (2009).

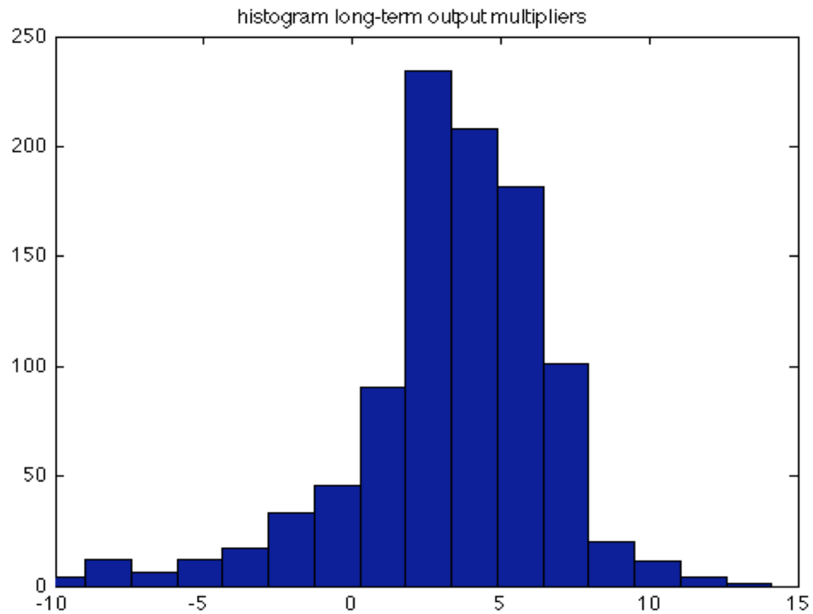
- Many reasons for this divergence
- Here I focus on only one of them
- I model fiscal policy as a positive shock in aggregate demand
- Assuming two different monetary policy regimes
  - Variable interest rate
  - Fixed interest rate

Impulse response to 1 s.d fiscal policy shock (extra spending)





Variable interest rate

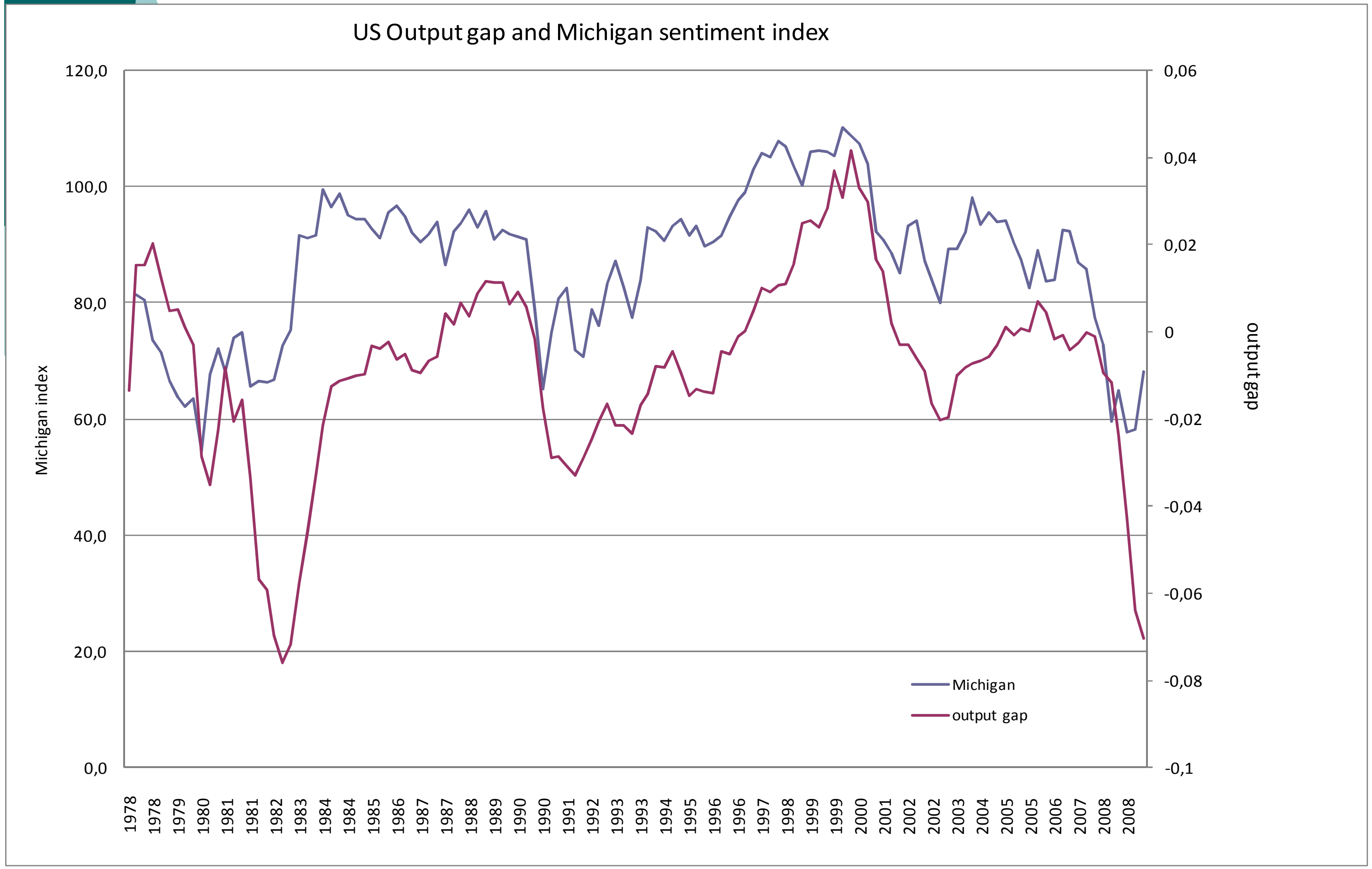


Constant interest rate

- Main results
  - Large differences in effects of same fiscal policy shocks
  - These effects of fiscal policy depend on animal spirits
  - Differences are even more pronounced in fixed rate regime
  - This is regime corresponding to present situation of liquidity trap (zero bound)
    - Since central bank in this regime is keeping interest rate constant, fewer constraints on animal spirits exist

Animal Spirits: some empirics

- Concept of animal spirits, i.e. waves of optimism and pessimism, plays a central role in our model
- Is there an empirical counterpart for this concept?
- There is one: Many countries use survey based consumer and/or business sentiment indicators as a tool of analyzing the business cycle and as a predictive instrument.
- How well do these indicators correlate with output movements?



Correlation is 0.6

Causality goes both ways

This is confirmed by Granger causality tests

We also find this feature in our behavioral model

Source: US Department of Commerce, Bureau of Economic Analysis, and University of Michigan: Consumer Sentiment Index.

Table 1: Pairwise Granger Causality Tests

Null Hypothesis:	Obs	F-Statistic	Probability
Output does not Granger Cause optimism	1948	31.0990	5.1E-14
Optimism does not Granger Cause output		32.8553	9.3E-15

Table 2: Pairwise Granger Causality Tests

Null Hypothesis:	Obs	F-Statistic	Probability
MICHIGAN does not Granger Cause GDP	123	15.83	0.00001
GDP does not Granger Cause MICHIGAN		4.83	0.0096

Conclusion: some policy implications

- The problem of the Top-down models is that they assume extraordinary cognitive capabilities of individual agents.
- This is a model that is inappropriate to understand macroeconomic fluctuations

- Top-down (RE) models have also led to a minimalist view of the role of central bank. Why?
- Cyclical movements are result of exogenous shocks and rigidities (e.g. present problem is result of "exogenous increase in risk premia)
- Central banks can do nothing about these shocks and about the rigidities

- All it can do is to keep prices stable so that microeconomic distortions are minimized (e.g. prices are as close at possible to marginal costs)
- By stabilizing prices it makes the best possible contribution to economic growth and macroeconomic stability
- It is clear that this view has failed
- It has contributed to neglect by major central banks to act when bubbles backed by bank credit explosions occurred.

- Central banks should enlarge their responsabilities