Top-Down versus Bottom-Up Macroeconomics

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Introduction

- The financial crisis came about as a result of
  - inefficiencies in the financial markets (bubbles and crashes)
  - and a poor understanding of economic agents, in particular of investors, of the nature of risks.
- Yet mainstream macroeconomic models as exemplified by the Dynamic Stochastic General Equilibrium models (DSGE-models) are populated by agents who are maximizing their utilities in an inter-temporal framework using all available information including the structure of the model
- In other words, agents in these models have incredible cognitive abilities.
  - They are able to understand the complexities of the world
  - and they can figure out the probability distributions of all the shocks that can hit the economy.

- These are extraordinary assumptions that leave the outside world perplexed about what macroeconomists have been doing during the last decades.
- There is a need to develop different kind of macroeconomic models
- that do not make these implausible assumptions about the cognitive capacities of individual agents

- 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 lecture

- 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.

- Ultimate purpose is to show that bottom-up models are better capable to make us understand the nature of the macroeconomic fluctuations than top-down models

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

- **Aggregate demand** is determined by
  - Real interest rate
  - Expected future output (the forward looking term)
  - Lagged output (the backward looking term) reflecting inertia in output

- **Aggregate supply** (New Keynesian Philips curve):
- Inflation is determined by
  - Expected future inflation (forward looking term)
  - Lagged inflation (backward looking term) expressing price and wage rigidities
  - Output gap

- **Taylor rule:** central bank sets interest rate
  - To keep inflation close to target (c1)
  - To stabilize output (c2)
  - To smooth interest rate

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

- 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
- Weights are time dependent:
  - Weights of a particular rule increases when this rule performs better
  - Thus if fundamentalist performs better (low forecast errors) more agents switch to the fundamentalist rule, and vice versa

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

- 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.

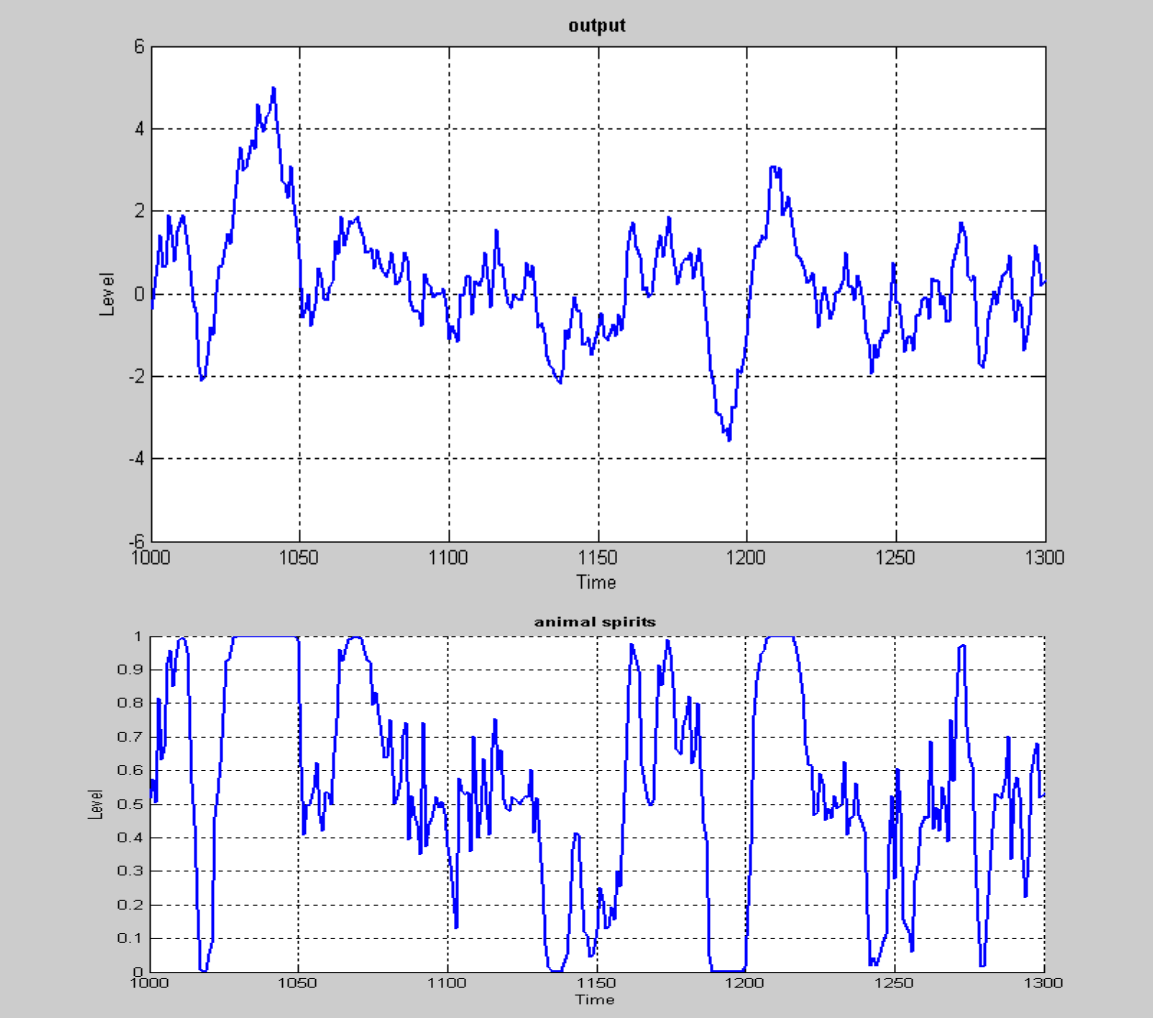
Note on learning

- 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

- I now proceed to show how this model leads to a view of macroeconomic dynamics that contrasts greatly with the view obtained from the rational expectations (top down) macroeconomic models.
- And comes closer to understanding the booms and busts that are inherent in free market economies

- I concentrate on three areas.
  - the **business cycle theories** implicit in the behavioural and the rational expectations models.
  - the nature of the **uncertainty** in the two models
  - the implications for **monetary policies**.

Two different business cycle theories

- Bottom-up (behavioral) and Top-down (rational expectations) models lead to very different views on the nature of business cycle.

- In rational model agents immediately find the optimal levels of output and inflation after unanticipated shock.
- This results from their top-down position, i.e. they can compute the effects this shock has on all the variables of the model making it possible to compute the optimal plan today and in the future.
- In order to produce the required inertia (and the business cycle movements), lags in the transmission preventing instantaneous adjustment to the optimal plan, are necessary.
- Thus business cycle theory is **exogenous**

- Agents in behavioral model do not fully understand how the shock will be transmitted.
- They have no top-down position.
- they follow a procedure (heuristics together with a selection mechanism) that functions as a “trial and error” learning mechanism aimed at revealing the information about shocks and the transmission process.
- This is a slow bottom-up process that uses backward evaluation processes.
- It generates an **endogenous** inertia (and business cycle) into the model.

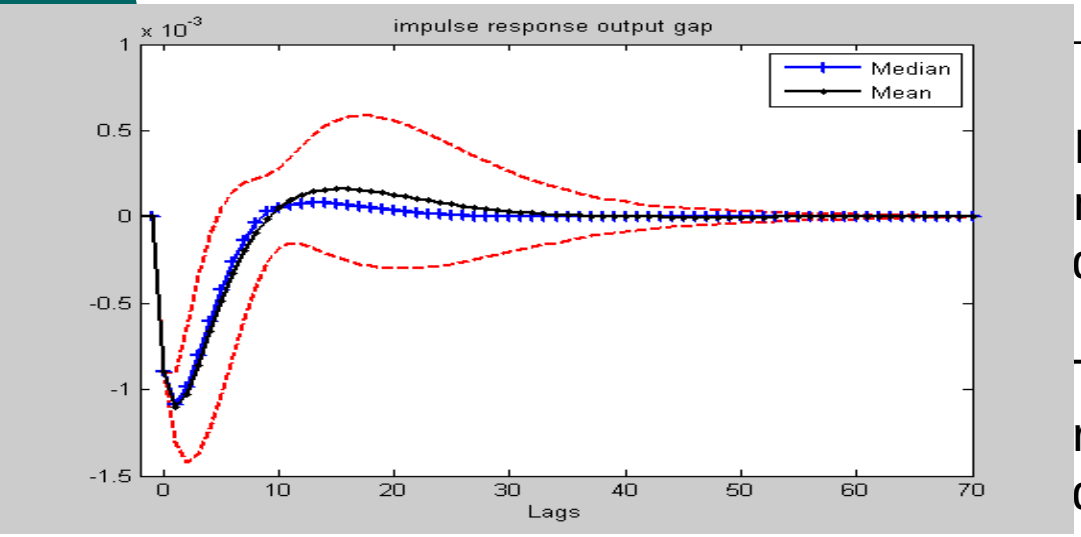
Applying these different views to present economic downturn

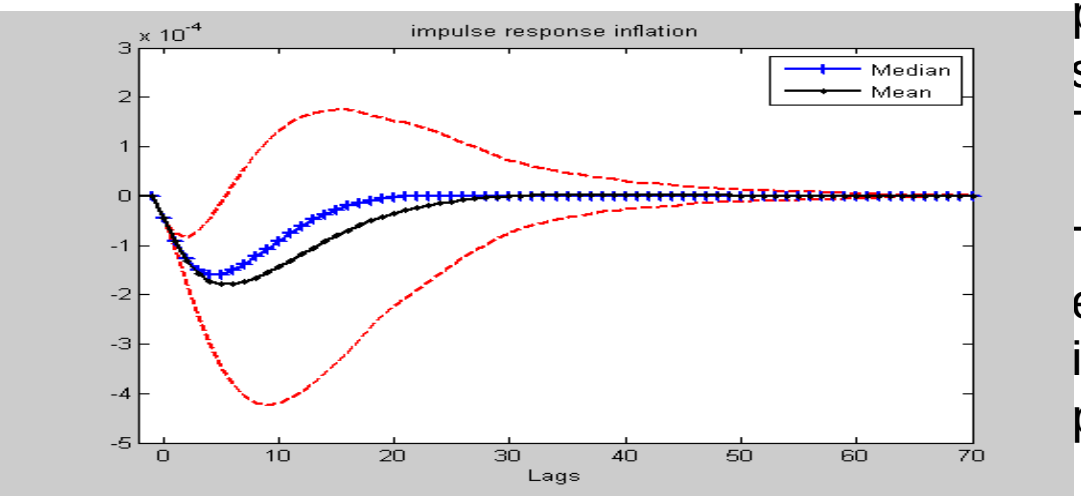
- In top-down (RE) model: the economic downturn is result of exogenous and unpredictable increase in risk premia in August 2007
  - Not very satisfactory theory
- In bottom-up model the cause of the economic downturn must be found in the (excessive) boom prior to 2007.
  - Economic downturn is result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

The nature of uncertainty in the two models

- The behavioural and the rational expectations models produce a different view about the nature of uncertainty.
- I illustrate this feature by presenting impulse responses to interest rate shock.
  - defined as plus one standard deviation of the shock in the Taylor equation.

Impulse response to interest rate shock





Impulse responses (in short and medium run) are different for different realizations of shocks

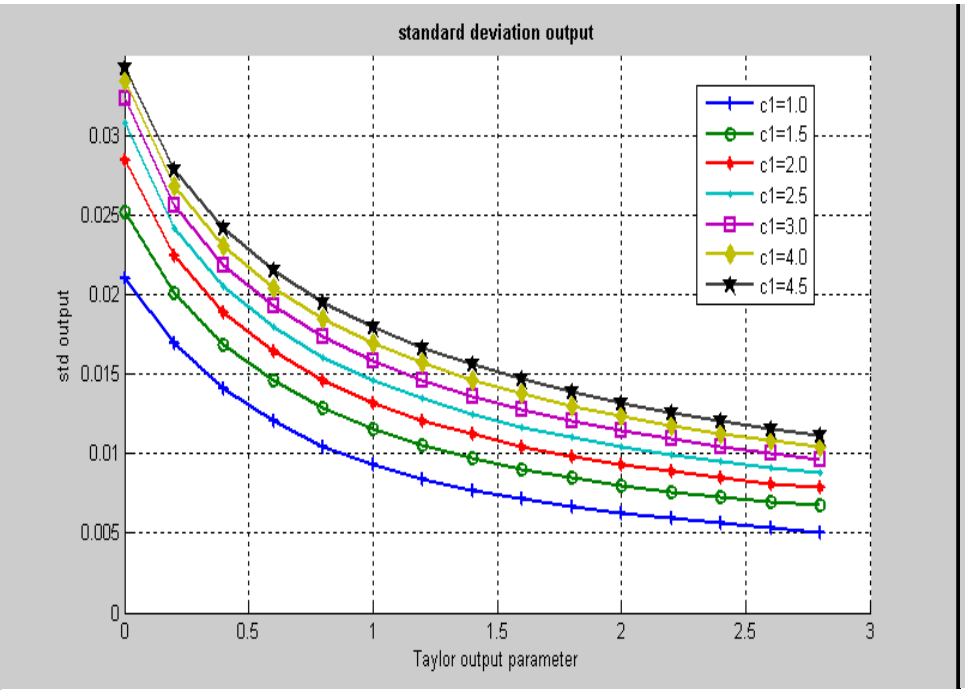
This is because different realizations of shocks create different waves of optimism and pessimism (different “market sentiments”)
Timing matters.

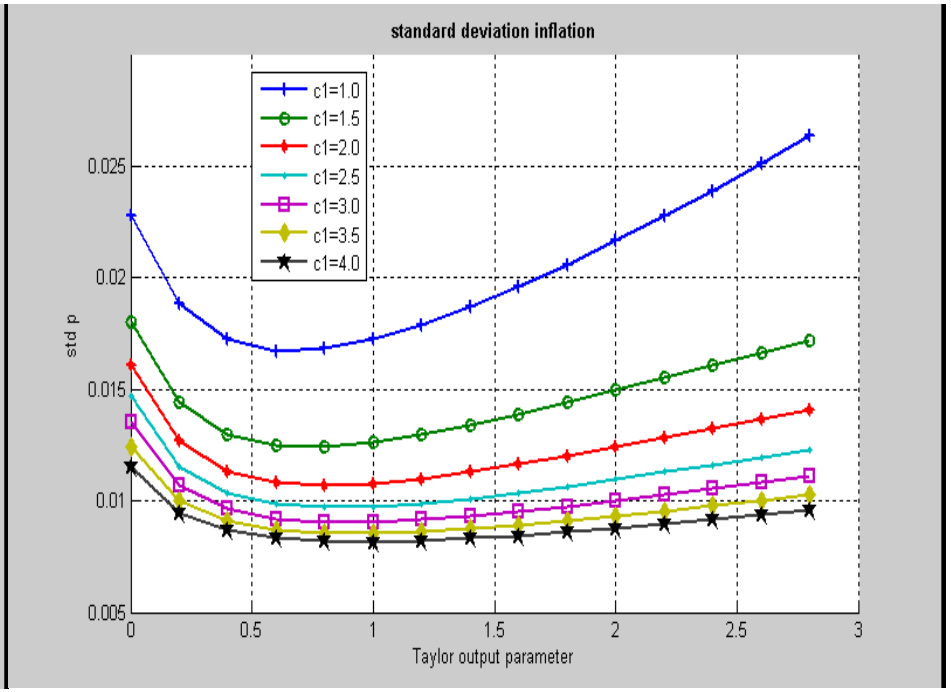
This contrasts with rational expectations model where there is no such uncertainty (only parameter uncertainty)

Conclusion: our understanding of transmission is inherently limited

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.

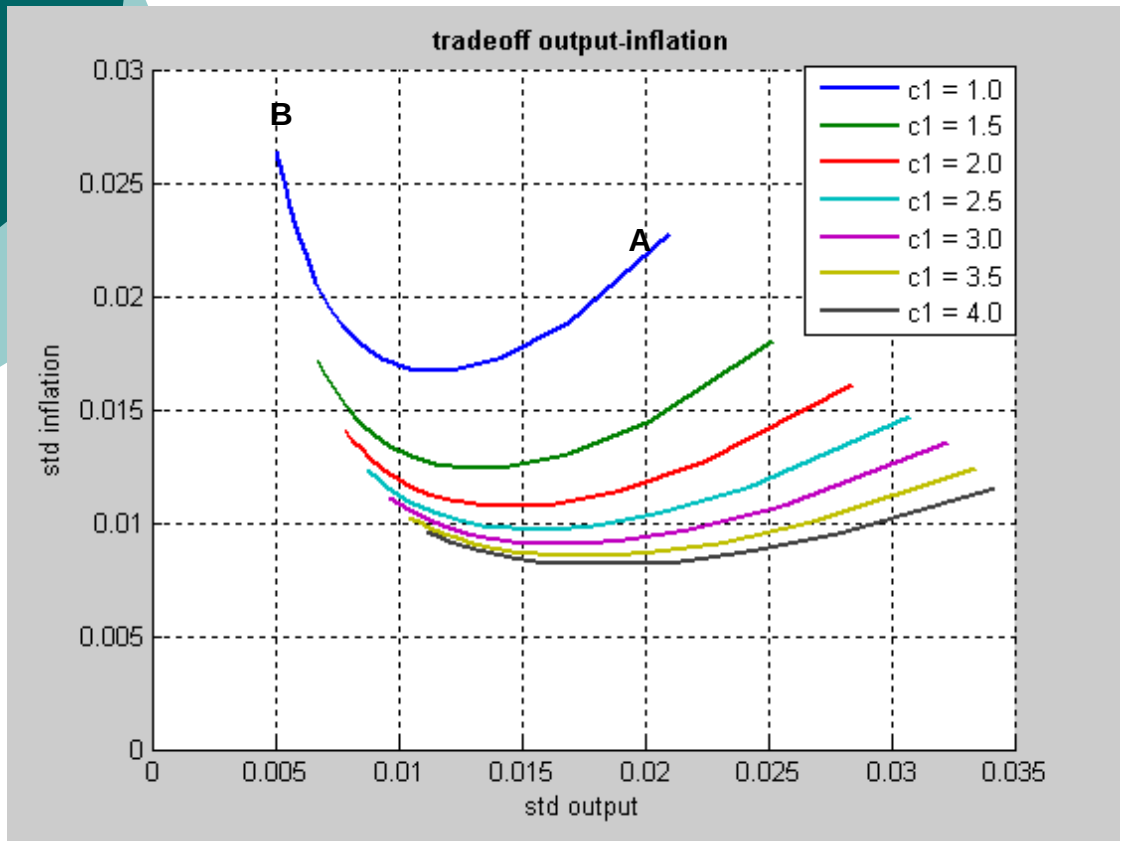
Right panel is surprising. We observe that the relationship is non-linear. As the output parameter is increased from zero, inflation variability first declines and then increases.

Thus the central bank can reduce both output <u>and</u> 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

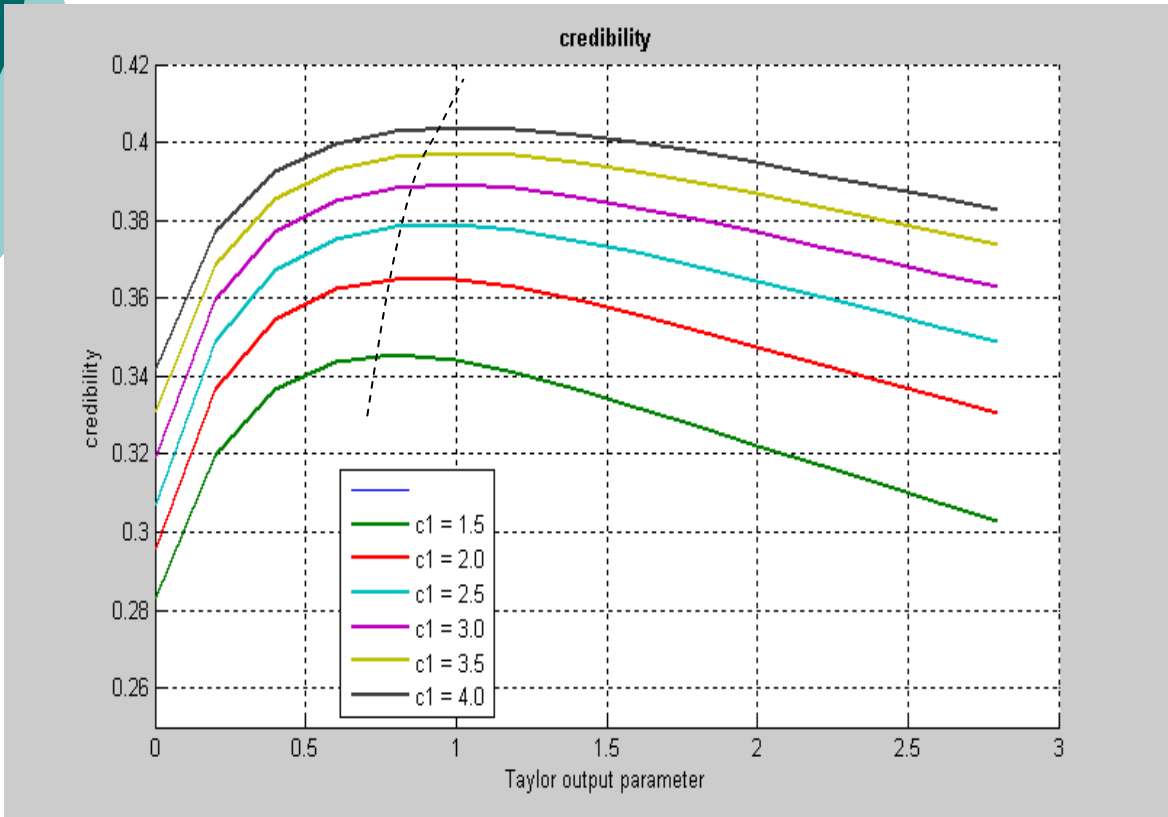
- Too much output stabilization reduces the stabilization bonus provided by a credible inflation target.
- When the central banks attaches too much importance to output stabilization it creates more scope for better forecasting performance of the inflation extrapolators, leading to more inflation variability.

- 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

The credibility of inflation targeting

- There is relation between credibility of inflation targeting and the parameters c1 and c2
- Credibility can be given precise meaning in behavioral model
- We define it as the fraction of agents using the announced inflation target to forecast inflation

Some output stabilization enhances inflation credibility



C2 should be between 0.5 and 1

Econometric evidence shows that this is the typical value central banks apply

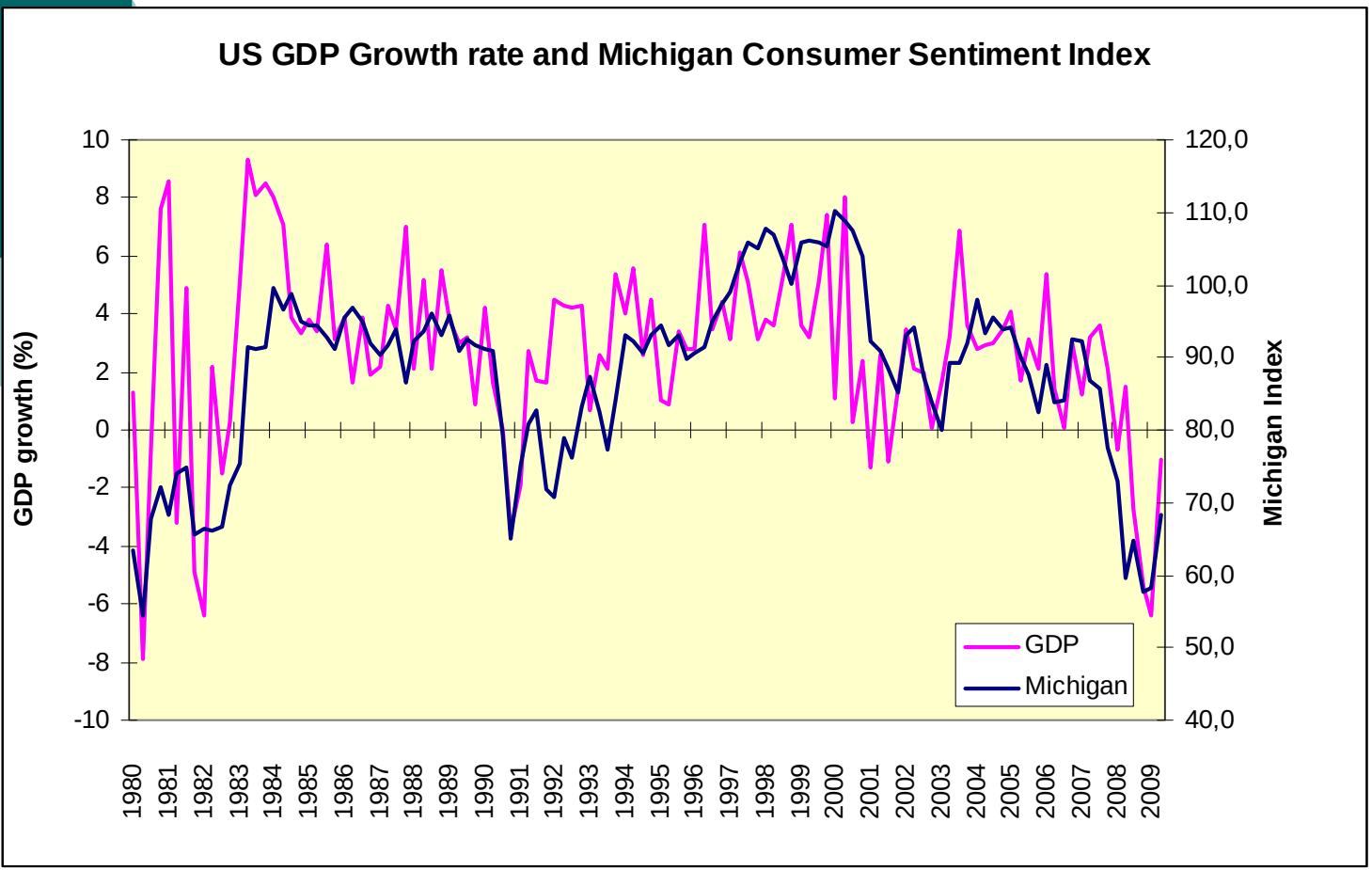
Central banks seem to apply a degree of output stabilization that is consistent with our theory of animal spirits

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

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 0.56

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.

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