Monetary theory

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Chapter 3: Rules vs discretion and time inconsistency of monetary policy

Introduction, definitions and concept

Introduction

- Macroeconomic equilibrium depends on present and future monetary policies $\rightarrow$ importance of expectations (see chapter 2).
- In order to anticipate, agents can rely on monetary rules (ex: Taylor Rule).
- General issue: is the adoption of a monetary rule (as opposed to discretionary MP) desirable ?
- This raises the issue of incentives of agents to commit to or to deviate from the rule.
- example: if the CB commits to some inflation rule $\rightarrow$ expectations of workers and trade unions $\rightarrow$ bargaining on the level of the nominal wage $\rightarrow$ once the bargaining over, the CB may deviate from the rule to boost output.

Rules vs discretion

- Intuitively, the incentives to adopt a strict rule are low.
- At the limit, one can adopt a rule and reassess the rule regularly and if suboptimal, deviate. $\longrightarrow$ until the mid 70's, superiority of discretion
- Views start to change with the seminal contribution of Kydland and Prescott in 1977 $\longrightarrow$ Nobel prize winners in 2004.
- Stress the importance of credibility of the CB and the gains of precommitment : adoption in advance of a given strategy
- Introduction of the concept of time consistency .

Definition

- **Definition of time consistency**: a particular policy is time-consistent if the planned response to new information remains the optimal response once the new information arrives .
- A policy is time inconsistent if at time $t + i$ it will not be optimal to respond as originally planned.

Why is it important?

- This leads to set up positive theories of the inflation rate: explains why some countries (i.e. South American countries, Turkey, Israel, ...) face over time high inflation rates.
- Leads to normative theories: the optimal design of a CB, how to create incentives, how to control for possible deviations. $\longrightarrow$ one theory useful for the design of the European Central Bank .

Section 1: Inflation in a discretionary regime

Inflation in discretion

- First, we are going to study what happens if MP is conducted in a discretionary way. $\longrightarrow$ analysis due to Barro and Gordon (1983)
- Can make understand why one sometimes observes levels of inflation which are obviously too high from a social point of view (inflationary bias).
- The answer : MP is time-inconsistent, i.e. a low inflation MP is time-inconsistent even though low inflation is socially optimal.
- Trapped in a suboptimal equilibrium because agents will anticipate the time inconsistency of MP.

MP objectives

- To define what is optimal $\rightarrow$ definition of the CB preferences
- At this stage government=central bank .
- 2 variables: output y and inflation π.
- Loss function of Utility linear wrt output: authorities maximize

$$U = \lambda(y - y_n) - \frac{1}{2}\pi^2$$

.

- y: actual growth rate of output.

MP objectives

- y_n: natural growth rate of output. depends on the stocks of production factors, technical progress, etc ...
- π: observed inflation rate
- λ: weight of preference relative to output (as opposed to inflation). $\lambda = \infty$: government cares only for output;$\lambda = 0$: government only adverse to inflation;
- authorities have an incentive to boost output because this increases the probability of being reelected and because there are distortions (tax, monopolies) leading to y_n inferior to the full-employment level.

Quadratic preferences

- authorities minimize the los function:

$$V = \frac{1}{2}\lambda(y - y_n - k)^2 + \frac{1}{2}\pi^2$$

.

- 3 objectives instead of 2
- authorities aims at minimizing inflation (like in the linear specification)
- authorities have an incentive to boost output: we assume $k > 0$ so that y_n is too low $\rightarrow$ bias in favour of economic expansions
- authorities have an incentive to stabilize output

Comparing specifications

- we can rewrite the quadratic specification as:

$$V = -\lambda k(y - y_n) + \frac{1}{2}\pi^2 + \frac{1}{2}\lambda(y - y_n)^2 + \frac{1}{2}k^2$$

  .

- $-\lambda k(y - y_n)$: incentive to boost output
- $\frac{1}{2}\pi^2$: incentive to minimize inflation
- $\frac{1}{2}\lambda(y - y_n)^2$ incentive to stabilize output around natural level.

Equilibrium in Barro-Gordon

- the equilibrium takes the form of a Nash (non cooperative) equilibrium with interaction between
- authorities (or CB) with preferences
- public (private agents, trade unions, ...)
- the loss function of public takes the form : $L^p = E(\pi - \pi^e)^2$ with π^e capturing expected inflation $\rightarrow$ the public is adverse to inflation surprise because it affects the way it can negotiate nominal wages.

The economic structure

- aggregate production is given by the Lucas surprise function (see AS in chapter 2) : $y = y_n + a(\pi - \pi^e) + e$
- if $\pi > \pi^e$, decrease of real wage and expansion of output through the increase in labor demand
- e is a AS shock
- Relationship between inflation and MP is straightforward: $\pi = \Delta m + \nu$
- ν is money velocity shock
- the instrument in this model is the money stock $\rightarrow$ no investigation of the optimal instrument (see chapter 4).
- no uncertainty on the transmission of MP $\rightarrow$ choosing the stance of MP is equivalent to choosing almost directly the level of inflation π.

Sequence of events

- public sets up wages w on the basis of π^e
- realization of supply shock e
- the CB (authorities) chooses Δm
- realization of ν which in turn determines π.
- We see that authorities have an informational advantage over the public (private sector)$\longrightarrow$ possibility to make surprises and to fool the public .

Inflation equilibrium

- First consider the linear case (Barro-Gordon)
- the CB maximizes

$$U = \lambda[a(\pi - \pi^e) + e] - \frac{1}{2}\pi^2$$

$$U = \lambda[a(\Delta m + \nu - \pi^e) + e] - \frac{1}{2}(\Delta m + \nu)^2$$

- $\frac{\partial U}{\partial \Delta m} = 0 \Rightarrow \Delta m = a\lambda > 0$
- $\pi^* = \Delta m + \nu = a\lambda > 0$.
- The optimal inflation for the monetary authorities is positive . This explains the inflationary bias .

Inflation equilibrium

- What about the public ?
- The public (which behaves in a rational way) will anticipate that $\rightarrow \pi^e = E(\Delta m) = a\lambda$
- There is therefore no gain in terms of output: $y = y_n + a(\pi - \pi^e) + e$
- Under discretionary MP, the inflation rate is positive .
- Under discretionary MP, no gain in terms of output .
- the size of the inflationary bias ($a\lambda$) depends on the impact of monetary surprises on output (a) and the weight of output growth in the authorities' preferences (λ).

Explaining the inflationary bias

- Let us explain the inflationary bias using a traditional cost benefit analysis.
- The marginal benefit of inflation is equal to $a\lambda$
- The marginal cost is equal to π (see $-\frac{\partial U}{\partial \pi} = \pi$)
- the equilibrium is found when $mc = mb$
- Cost-benefit analysis.
- at $\pi = 0$, marginal benefit of creating inflation is above marginal cost $\rightarrow$ temptation for the CB to increase π. $\rightarrow$ incentive remains until marginal costs crosses the level of marginal benefit:$\pi^* = a\lambda$.

Expected loss under discretion

We can compute the expected loss that the monetary authorities face if they use discretion :

$$E(U^d) = E\{[\lambda(a\underbrace{(\pi - \pi^e)}_{\nu}) + e] - \frac{1}{2}[\underbrace{a\lambda}_{\Delta m} + \nu]\}$$

$$= \underbrace{E[a\lambda\nu]}_{0} + \underbrace{E[e]}_{0} - \frac{1}{2}[a^2\lambda^2 + 2\underbrace{E[a\lambda\nu]}_{0} + \underbrace{E[\nu^2]}_{\sigma_v^2}]$$

$$= -\frac{1}{2}[a^2\lambda^2 + \sigma_v^2]$$

Expected loss under discretion

- The loss depends on the size of the inflationary bias which in turn depends on the weight in the loss function and the impact of surprises : $a^2\lambda^2$.
- The loss also depends on the size of the liquidity shocks: σ_v^2
- we can compare that with the expected loss if the monetary authorities can commit to follow a rule such as :$\Delta m = 0$

Expected loss under commitment

- We can compute the expected loss that the monetary authorities face if they commit and if they are credible :

$$E(U^c) = E\{\lambda(a\nu + e) - \frac{1}{2}v^2\}$$
$$= -\frac{1}{2}[\sigma_v^2] > E(U^d)$$

- no inflationary bias any longer $\rightarrow$ supremacy of the rule wrt discretion if the monetary authorities can be credible .
- But can they be credible ?

A Barro-Gordon example

- $U_G = \lambda(y - y_n) - \frac{1}{2} f \pi^2$
- suppose that $\lambda = 2$ and $f = 2$
- $U_p = -[\pi - \pi^e]^2$
- Consider 2 possible strategies of the government : $\pi = 0$: virtuous monetary policy and $\pi = 1$: inflationary monetary policy
- The public will anticipate the strategy of the government
- we can compute the pay-offs related to each pair of strategy and looked for the equilibrium of the (non cooperative) game

Nash equilibrium under discretion

	$\pi^e = 0$	$\pi^e = 1$
$\pi = 0$	0,0	-2,-1
$\pi = 1$	-1,-1	-1,0

- We see that the Nash equilibrium is socially sub-optimal since the virtuous policy would yield better pay-offs
- we see that this socially optimal outcome is not possible because the government has always some incentive to deviate, to fool the public. $\rightarrow$ The rule is better but here the rule (virtuous policy) is not implementable since the monetary authorities are always expected to deviate from the rule.$\rightarrow$ time inconsistency of MP.

Inflationary bias in the quadratic case

- $V = \frac{1}{2}\lambda[a(\Delta m + \upsilon - \pi^e) + e - k]^2 + \frac{1}{2}(\Delta m + \upsilon)^2$
- Since ν is observed only after the decision, monetary authorities take $\nu = 0$
- take the min: $\frac{\partial V}{\partial \Delta m} = 0 \Rightarrow \Delta m = \frac{a^2\lambda\pi^e + a\lambda(k-e)}{1+a^2\lambda}$
- We should compare that with the inflationary bias in the linear case ($\Delta m = a\lambda$)
- in this case,Δm depends on e: authorities want to stabilize output around the target $\rightarrow$ authorities respond to e

Inflationary bias in the quadratic case

- $V = \frac{1}{2}\lambda[a(\Delta m + v - \pi^e) + e - k]^2 + \frac{1}{2}(\Delta m + v)^2$
- we see that Δm depends on $\pi^e \rightarrow$ optimal monetary policy depends on expectations
- we want to compute a value of Δm which does not depend on π^e
- Using rational expectations: $\pi^e = E(\Delta m) = a\lambda k$

Inflationary bias in the quadratic case

- we want to compute a value of Δm which does not depend on π^e
- Using rational expectations: $\pi^e = E(\Delta m) = a\lambda k$
-

$$\pi^d = \Delta m + \nu$$
$$= a\lambda k - (\frac{\alpha\lambda}{1 + a\lambda^2})e + v$$

- $\rightarrow$ on average inflation is equal to $a\lambda k$
- no impact on output since $\pi^e = a\lambda k$
- the inflationary bias is increasing in distortions k and (as before) in a and λ

Graphical interpretation of the IB

- equilibrium reached at the intersection of the optimal policy (OP) curve and the 45° line of equal values between π and π^e
- $OP \equiv \Delta m = \frac{a^2\lambda\pi^e + a\lambda(k-e)}{1+a^2\lambda}$ ($e = \nu = 0$)
- IB graphics.
- slope : $\frac{a^2\lambda}{1+a^2\lambda} < 1$
- intercept : $\frac{a\lambda k}{1+a^2\lambda}$

Graphical interpretation of the IB

- the optimal inflation rate for $\pi^e = 0$ is positive
- as π^e increases, authorities increase π in order to obtain the same surprise and the same effect on output; but since the cost of inflation increases,π increases less quickly than π^e
- At the equilibrium : $\pi = \pi^e \rightarrow$ intersection of the 2 curves;

Graphical interpretation of the IB

- What about an increase of k: upward shift of OP $\rightarrow \pi^*$ increases
- increase of a: two opposite effects : increase of the slope of OP because impact of surprises stronger but intercept may decrease ; but the net effect is positive ($\pi^* = a\lambda k$)
- Role of e : see the negative coefficient of e in the π^d equation: if there is a positive supply shock (positive on output) $\rightarrow$ restrictive monetary policy to stabilize output $\rightarrow$ equilibrium inflation rate decreases.

Expected loss in the quadratic case

- Substitute the value of π^d in the loss function and take the expectation in order to obtain the value of the expected loss in the discretionary regime

$$V^d = \frac{1}{2}\lambda[a(\Delta m + \nu - \pi^e) + e - k]^2 + \frac{1}{2}\left[\pi^d\right]^2$$

$$V^d = \frac{1}{2}\lambda[(\frac{1}{1+a^2\lambda})e + a\nu - k]^2 + \frac{1}{2}\left[a\lambda k - (\frac{a\lambda}{1+a^2\lambda})e + \nu\right]^2$$

- Take the expectation and we can stress the role of shocks; reminder : $E(e) = E(\nu) = 0$; $E(e^2) = \sigma_e^2; E(\nu^2) = \sigma_\nu^2$

Expected loss in the quadratic case

- One gets :
  $E[V^d] = \frac{1}{2}[(\frac{\lambda}{1+a^2\lambda})\sigma_e^2 + (1 + a^2\lambda)\sigma_\nu^2] + \frac{1}{2}\lambda(1 + a^2\lambda)k^2$
- We see the role of inflationary bias through $\lambda(1 + a^2\lambda)k^2$;
- We see the role of shocks :σ_e^2 and σ_ν^2

Commitment in the quadratic case

- Let us compare the discretionary outcome with commitment; to do that, we have to assume a rule which, in the quadratic case, depends on e
- Take a particular rule for Δm in function of e (commitment)
- rule: $\Delta m^c = b_0 + b_1 e \Rightarrow \pi^e = E[\Delta m^c] = b_0$
- substitute π^e in expected loss:
  $V^d = \frac{1}{2}\lambda[a(b_1 e + v) + e - k]^2 + \frac{1}{2}\left[b_0 + b_1 e + v\right]^2$

Commitment in the quadratic case

- Compute the expected value of V^d et minimize this expected loss wrt to b_0 and b_1
- we get (not explained): $b_0 = 0 \Rightarrow$ average inflation is zero
- $b_1 = \frac{a\lambda}{1+a^2\lambda}$
- $\Delta m^c = \frac{a\lambda}{1+a^2\lambda} e$
- using this value, we get the expected loss under (credible) commitment :
  $E[V^c] = \frac{1}{2}[(\frac{\lambda}{1+a^2\lambda})\sigma_e^2 + (1 + a^2\lambda)\sigma_v^2] + \frac{1}{2}\lambda k^2$

Cost of discretion in the quadratic case

- $E[V^d] - E[U^d] = (a\lambda k)^2/2$
- $(a\lambda k)^2/2 > 0 \rightarrow$ discretion is costly
- the cost is due to the higher average inflation rate (inflationary bias) : $(a\lambda k)$ while under commitment, inflation is zero.
- Inflationary bias for two reasons: the CB has always some incentive to fool the private sector once the inflation expectations have been set up; the CB cannot convince that it will follow a strategy $\pi = 0$.

Summary of costs in both cases

- Why is it impossible to convince the private sector ?
- Assume that $\pi = \pi^e = 0$. Can the CB convince that it will target $\pi = \Delta m = 0$?
- In the linear case : marginal cost of inflation is : $\frac{\partial \frac{1}{2}\pi^2}{\partial \pi} = \pi = 0$; Marginal benefit: $\frac{\partial \lambda a[\Delta m + ...]}{\partial \Delta m} = a\lambda$
- In the quadratic case : marginal cost identical : 0 .
- Marginal benefit : $-a^2\lambda(\pi - \pi^e) + a\lambda k = a\lambda k$
- the CB has always some incentive to deviate from $\pi = 0$.

The Friedman rule

- The modern theory suggests that under a credible commitment, rule is better than discretion
- Nevertheless, before, the debate favored the use of discretion .
- in the 50 and 60's, Milton Friedman was a proponent of a specific rule in term of monetary supply : $\Delta m = km$: proposes a constant growth of monetary stock ; the aim is to get rid of counterproductive fine tuning policies (not to solve credibility problems).
- opponents said that discretion was better than the Friedman rule because better response in terms of stabilization and at the limit, one can follow the rule when optimal
- see what happens in our analysis.

The Friedman rule

- Suppose $k = 0$:$\Delta m = 0 \rightarrow$ no inflation bias but no possibility to stabilize
- We get : $E[V^{c'}] = \frac{1}{2}[\lambda\sigma_e^2 + k^2] + \frac{1}{2}(1 + a^2\lambda)\sigma_v^2$ which can be compared with
$E[V^d] = \frac{1}{2}[(\frac{\lambda}{1+a^2\lambda})\sigma_e^2 + (1 + a^2\lambda)\sigma_v^2] + \frac{1}{2}\lambda(1 + a^2\lambda)k^2$
- We see that $E[V^d] = E[V^{c'}]$ iff $\frac{a^2\lambda}{(1+a^2\lambda}\sigma_e^2 < a^2\lambda^2k^2$
- The first term captures the gain from stabilisation ; the second term capture the inflation cost of discretion.
- we see that depending on the structure of the economy and the amplitude of the supply shocks, discretion might sometimes be better than rules.

Section 2: Solutions to the inflationary bias

The problem

- The crucial issue : the authorities cannot commit to a non inflationary monetary policy
- Why ? as soon as the public believes than $\pi = \Delta m = 0$, the authorities will create inflation because the marginal benefit>marginal cost.
- How to solve the problem ? $\rightarrow$ 3 main proposed solutions (rk : 2 other solutions but less important in practice : see Walsh(2001, ch.8) for further information.

Solutions to time inconsistency

3 main solutions

- Increase the actual marginal cost of an inflationary policy faced by the CB : introduction of reputation of the CB and extension to a dynamic game analysis
- Increase the perceived marginal cost faced by the authorities : Delegation of MP to a conservative and independent central bank $\rightarrow$ most important in practice
- Limit the flexibility of the authorities : adoption of monetary rules or adoption of inflation targeting regime which induce a cost when the CB deviates.

Section 2.1.: Reputation

Notion

- In the preceding analysis, one big limitation : action at time *t* has no impact on the behaviour of agents at time $t+1 \rightarrow$ inconsistent with rational agents
- Here : take the time dependency into account through a reputation effect of the monetary authorities
- Notion: a vertuous behaviour of the CB will influence the way the public sets its expectations of future policy and inflation.
- As a result, we have a dynamic game between the CB and the public $\rightarrow$ extension of the previous Barro-Gordon static game with new results

Extending the dynamic game

- Extension of the preferences of the authorities : U_t is replaced by $V_t = \sum_{i=0}^{\infty} \beta_i E_t[U_{t+i}]$
- The authorities take into account the present and the future levels of utility.
- The future levels are discounted : $0 \leq \beta \leq 1$ is a discount factor
- 2 extreme cases : $\beta = 0 \Rightarrow$ static game : the authorities do not take the future into account
- $\beta = 1 \Rightarrow$ the authorities put an equal weight to the future outcomes (unrealistic)

Extending the dynamic game

- Introduction of the effect of reputation : effect in terms of the way agents set their expectations
- $\pi_t^e = \overline{\pi} < a\lambda$ if $\pi_{t-1} = \pi_{t-1}^e$
- $\pi_t^e = a\lambda$ otherwise
- Idea : if the authorities fool the public, i.e. set up some inflation rate different from the one expected by the public, the public will expect the inflationary strategy ; if the authorities behave in a virtuous way (caution nevertheless), they expect some inflation rate inferior to the one obtained under discretion.
- Note : this approach is not fully satisfying : suppose that in period 1, the CB fools the public; if the CB in period 2 plays $\pi = a\lambda$, then in period 3, we have $\pi_t^e = \overline{\pi} < a\lambda \Rightarrow$ wired !!!

Is there an equilibrium?

- Question: does an equilibrium exist for $\pi = \overline{\pi} < a\lambda$?
- assume that $\pi_s = \overline{\pi}\ \forall s < t \Rightarrow \pi_t^e = \overline{\pi}$
- What is the gain to deviate, to fool the public ? Let us assume $e = \nu = 0$; assume that the CB wants to fool with $\Delta m = \epsilon > \overline{\pi}$
- Net gain at time t : $G = [a\lambda(\epsilon - \overline{\pi}) - \frac{1}{2}\epsilon^2 - (-\frac{1}{2}\overline{\pi}^2)]$
- The first term captures the gain obtained through fooling while the second term is the utility if the CB does not fool
- Rearranging : $G = a\lambda(\epsilon - \overline{\pi}) - \frac{1}{2}(\epsilon^2 - \overline{\pi}^2)$
- Maximizing $\frac{\partial G}{\partial \epsilon} = 0 \Rightarrow \epsilon = a\lambda$
- If the CB fools, it chooses the discretionary outcome.

Equilibrium values for $\overline{\pi}$

- Let us find the possible equilibrium values for $\overline{\pi}$ by comparing the temptation to cheat and the cost to cheat
- Temptation (Gain) to cheat is given by:

$$G(\overline{\pi}) = a\lambda(a\lambda - \overline{\pi}) - \frac{1}{2}(a\lambda^2 - \overline{\pi}^2)$$
$$G(\overline{\pi}) = \frac{1}{2}(a\lambda - \overline{\pi}^2) \geq 0$$

The temptation is positive for all $\overline{\pi}$ and reaches a minimum at the discretionary outcome.

Equilibrium values for $\overline{\pi}$

- Net cost to cheat that accounts for the intertemporal nature of the concept of reputation :

$$C(\overline{\pi}) = \beta(-\frac{1}{2}\overline{\pi}^2) - \beta(-\frac{1}{2}(a\lambda)^2)$$
$$C(\overline{\pi}) = \beta[(a\lambda)^2 - \overline{\pi}^2]$$

- The first term captures the cost if the CB does not cheat; the second term captures the cost if the CB cheats; since this cost is supported at time $t+1$, it is discounted by the discount factor β.

Equilibrium values for $\overline{\pi}$

- Possible values for inflation are those for which the cost to cheat is higher than the gain to cheat.
- See Figure $C(\overline{\pi})$vs $G(\overline{\pi})$.
- We see that $\pi^{min} \leq \overline{\pi} \leq a\lambda \rightarrow$ reputation allows to reach an inflation rate inferior to the discretionary outcome.
- One can show that : $\pi^{min} = \frac{(1-\beta)}{(1+\beta)} a\lambda < a\lambda \rightarrow$ Importance of the discount factor: the minimum inflation rate is decreasing in β (interpret!!!) At the extreme, for $\beta = 0$, discretionary solution ; for $\beta = 1$,$\pi^{min} = 0$.

Additional remarks

- Question of the coordination of inflation expectations: why all the private agents expect π^e? One answer : labour unions tend to produce the same expectations
- If the public's sanction (in terms of higher inflation expectations for next period) credible $\rightarrow$ the answer is not straightforward but not addressed here.

Section 2.2.: Preferences

Idea

- The idea is to have another type of preferences for monetary authorities
- How ? By delegating to a central banker more averse to inflation than society (and the government): solution proposed by Rogoff (1985)
- Let us extend the previous preferences (quadratic version): $V = \frac{1}{2}\lambda(y - y_n - k)^2 + \frac{1}{2}(1 + \delta)\pi^2$

Solution

- δ: degree of conservatism of the central banker: more averse to inflation than society.
- Why is it a solution ? We get :

$$\pi^d = \Delta m + \nu$$
$$= \frac{a\lambda k}{1+\delta} - \left(\frac{\alpha\lambda}{1+\delta+a\lambda^2}\right)e + v$$

Optimal δ

- We see that the inflationary bias has decreased; nevertheless no complete disappearance of the IB for normal values of δ;
- For $\delta \to \infty$, no IB; but is $\delta = \infty$ optimal? the answer is no.
- We see that the stabilization coefficient has decreased; there is some distortion in the response of monetary authorities $\to$ less answer and less stabilization
- Auxiliary question: what is the optimal value of δ ?

Optimal δ

- First compute the expected loss under conservatism
- $E[V^d] = \frac{1}{2}[\lambda k^2 + \lambda(\frac{1+\delta}{(1+\delta+a^2\lambda)})^2\sigma_e^2 + a^2\lambda\sigma_v^2] + \frac{1}{2}[(\frac{a\lambda k}{1+\delta})^2 + (\frac{a\lambda}{1+\delta+a^2\lambda})^2\sigma_e^2 + \sigma_v^2]$
- Maximizing wrt δ, i.e. $\frac{\partial E[V^d]}{\partial \delta} = 0$, we get :
  $\delta = \frac{k^2}{\sigma_e^2}\frac{(1+\delta+a^2\lambda)^3}{1+\delta} \equiv g(\delta)$
- Note that $\lim_{\delta\to\infty} g(\delta) = \frac{k^2}{\sigma_e^2} > 0$
- graphically, the optimal δ is the one for which $\delta = g(\delta)$; this means that we should look at the intersection between the 45° line and the $g(\delta)$ function :
  graph optimal degree of conservatism.

Optimal δ

- We see that $\delta^* > 0 \rightarrow$ it is desirable to delegate MP to an inflation-adverse central banker.
- This solution holds provided the CB can be independent wrt the government . Otherwise, the CB cannot choose its own objectives and/or cannot implement the policy corresponding to its preferences
- This gives a testable empirical relationship : Does an independent CB deliver less inflation ? $\rightarrow$ see later. But we should keep in mind that there are two important points : independence and aversion to inflation.

Optimal δ

- This solution gives rise to some cost : trade-off between bias reduction and loss in terms of stabilization : if we compute the variance of output : $\sigma_y^2 = (\frac{1+\delta}{1+\delta+a^2\lambda})\sigma_e^2 + a^2\sigma_\nu^2$
- the variance of output is increasing wrt to δ : more variability due to output shocks because distortion in the stabilization response
- This gives a second testable empirical proposition : The volatility of output is higher in countries in which the CB is relatively independent .

Section 2.3.: Inflation targeting

Idea of IT

- Rather than working on preferences, one solution is to reduce the flexibility of MP
- How ? By imposing a target to the central bank. This target is on the level of inflation : Inflation Targeting .
- First country to implement IT program was New-Zealand in 1989 with an explicit target of 2 prcents; the governor of the CB has to account for the performances and might face some sanctions like getting fired , ...
- Other examples : Canada, UK, Israel; What about the ECB : this is a mixed regime (the two-pillars strategy) and in no case is the 2 percent an explicit target.

Idea of IT

- IT is only one way of reducing the freedom of the CB $\rightarrow$ other ways like
- Exchange rate systems : fully fixed like in a monetary union or currency boards (Argentina) , adjustable like the EMS. One argument in favor of EMS for countries like Italy or Belgium
- Two different types of IT :
- Flexible rules : penalty if deviation from the inflation target π^T but deviation is allowed $\rightarrow$ possibility of following other goals than inflation
- Strict rules : the CB has to adopt a given rule . Example : Friedman rule $\rightarrow$ Effects similar to a credible rule seen before
- $\rightarrow$ Let us investigate the effects of flexible rules.

IT with flexible rules

- The CB is penalized if the performance deviates from the target : more general loss function;
- Example: Bank of Canada: in 2005, target band in terms of inflation rate : between 1 and 3 % with a median of 2%
- Nevertheless, room to deviate from the target but in this case penalized

IT with flexible rules

- Modified loss function:

$$V = \frac{1}{2}\lambda(y - y_n - k)^2 + \frac{1}{2}(\pi - \pi^*)^2 + \frac{1}{2}h(\pi - \pi^T)^2$$

- π^*: optimal inflation rate (was zero up to now)
- π^T: inflation target
- h: weight related to the fact that the CB deviates from the target: captures the penalty faced by the central banker
- Note that because $\pi^* \neq 0$ now, inflation rate under discretion becomes:

$$\pi^d = \Delta m + \nu$$

$$= \pi^* + a\lambda k - (\frac{\alpha\lambda}{1 + a\lambda^2})e + v$$

IT with flexible rules

- Modified loss function:

$$V = \frac{1}{2}\lambda(y - y_n - k)^2 + \frac{1}{2}(\pi - \pi^*)^2 + \frac{1}{2}h(\pi - \pi^T)^2$$

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Inflation under IT

- Modified loss function:

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- π^*: optimal inflation rate (was zero up to now)
- π^T: inflation target
- h: weight related to the fact that the CB deviates from the target: captures the penalty faced by the central banker

Inflation under IT

- $V_{CB} = \frac{1}{2}\lambda[a(\Delta m + \upsilon - \pi^e) + e - k]^2 + \frac{1}{2}(\Delta m + \upsilon - \pi^*)^2 + \frac{1}{2}h(\Delta m + \upsilon - \pi^T)^2$
- $\frac{\partial V}{\partial \Delta m^T} = 0$ ($\upsilon = 0$ because unknown)
- $\Delta m^T = \frac{1}{1+h+a^2\lambda}(a^2\lambda\pi^e - a\lambda e + a\lambda k + \pi^* + h\pi^T)$
- Using rational expectation hypothesis:
  $\Delta m^T = \frac{1}{1+h+a^2\lambda}(a^2\lambda\pi^e - a\lambda e + a\lambda k + \pi^* + h\pi^T)$
- $\Delta m^T = \frac{a\lambda k + \pi^* + h\pi^T}{1+h} - (\frac{a\lambda}{1+h+a^2\lambda})e$
  $\Delta m^T = \pi^* + \frac{a\lambda k}{1+h} + \frac{h(\pi^* - \pi^T)}{1+h} - (\frac{a\lambda}{1+h+a^2\lambda})e$

Inflation under IT

- If we assume that the CB targets the optimal inflation rate, i.e. $\pi^* = \pi^T$
- $\Delta m^T = \pi^* + \frac{a\lambda k}{1+h} - (\frac{a\lambda}{1+h+a^2\lambda})e$
- We see that we get a lower inflationary bias : $\frac{a\lambda k}{1+h} < a\lambda k$
- This at the expense of a lower stabilization coefficient
- We see that inflation targeting reduces the marginal cost of inflation and reduces the inflationary bias but leads to a distortion of the answer of monetary policy in terms of stabilization.

Comparison with conservative CB

- The h parameter (penalty if deviation) plays exactly the same role of the δ parameter in the context of MP delegation (see before)
- We can thus applied the same conclusions as before
- There is a an optimal positive h
- $h = \infty$ is suboptimal
- Inflation targeting should lower the inflationary bias but increase output volatility wrt to discretion.

Section 4. Policy implications: the independence of the CB

independence and delegation

- Solution to time inconsistency issue : delegation to an inflation CB
- This solution works if the CB is independent from the government
- Since preferences are not directly observable, the only way is to test the relationship between independence and the level of inflation
- it is therefore assume that inflation aversion goes hand in hand with the degree of independence
- Based on the theory, the relationship should be negative.

How to measure independence

- There are two types of independence
- Political independence : ability of the CB to choose the final objective of monetary policy $\rightarrow$ freedom to choose a low inflation rate
- Economic independence : ability to choose the instruments of monetary policy in order to reach the chosen goals.
- Analysis proposed by Grilli, Masciando and Tabellini (1991, Economic policy) on the 18 major central banks

political independence

- degree or political independence depends on
- the way governors and policy board members are appointed
- relations with the government
- constitution or status of the CB
- indexes of political independence.
- Most (politically) independent CBs: Bundesbank, Nederlandsche Bank, Fed

Economic independence

- degree or economic independence depends on
- the extent to which fiscal deficits can be financed by money
- control of the CB over policy instruments
- Results: indexes of economic independence.
- Most (economically) independent CBs: Bundesbank, Bank of Swiss, Bank of Canada, National Bank of Belgium

Degrees of independence

- Does economic and political independence go hand in hand ?
- Not always : see relationship between both types.
- a significant number of CBs in the South-East quadrant.

Impact of independence

- Econometric analysis : cross section analysis (no time series dimension)
- estimated relationship :
  $inf_i = int + \beta_1 ecind_i + \beta_2 poind_i + \beta_3 EMS_i + \epsilon_i$
- EMS equal 1 if country i belongs to the European exchange rate mechanism, 0 otherwise
- estimated over the 1950-1989 period and subperiods of 10 years
- Results : Not always : see Impact of independence.
- Conclusion: economic independence matters, political independence less !! . $\rightarrow$ support for the theory.

Is there a cost?

- Theory says that delegation to inflation-adverse CB lowers the response in terms of stabilisation
- $\rightarrow$ see relationship between output variability and independence
- 2 measures : output growth and output variability
- same type of econometric models
- see Cost of independence.
- No significant relationship between independence and output variability $\rightarrow$ no support for the theory

Conclusion

- Economically CBs are found to generate less inflation
- More conservative CBs do not seem to generate a distorted response in terms of stabilisation $\rightarrow$ no real cost to conservatism
- $\rightarrow$ Strong empirical support for independence and conservatism.

Updating: independence of the ECB

- The ECB is one of the most independent banks in the world
- See comparison of the major central banks using various measures
- Updating indexes of independence.
- The ECB is the most independent for all indexes
- the ECB is even more independent than the former Bundesbank $\rightarrow$ implicit recognition of the importance of the issue of time inconsistency and the need to avoid its consequences.

Accontability

- Recently, attention shifts to accountability of central banks
- idea: in a democracy, the CBs should account to the population, the parliament or the government
- The concept of accountability encompasses 3 dimensions:
- Clarification of ultimate objectives of MP
- Transparency of monetary policy
- Ultimate control of the government of parliament over the MP. (might be a problem for independence).

Measuring accountability

- Measures of 3 dimensions to compute an index of accountability
- analysis conducted on 5 major central banks including the ECB
- results :see Accountability Measures.
- low accountability of the ECB due to poor transparency and poor final responsibility