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Optimal policy in the New Keynesian model

- Distortions in the model

- A ‘constructive’ characterization of optimal policy in the case of efficient shocks

- Optimal policy with discretion and commitment: strict price stability against efficient shocks (the ‘divine coincidence’), optimal trade-off between inflation and output gap if shocks are not efficient

I Efficient allocation

From a social planner perspetive, abstracting from money, the country is populated by many identical households with unit mass. Output is produced with labor only in many varieties, with unit mass. Productivity shock is identical across varieties. Assuming no government spending, and adopting Galí notation:

$$\text{flow utility:} \qquad U(C_t, N_t) = \zeta_C \frac{C^{1-\sigma}}{1-\sigma} - \frac{N_t^{1+\varphi}}{1+\varphi}$$

$$\text{where:} \qquad C_t = Y_t = \left[\int_0^1 C_t(i)^{1-\frac{1}{\epsilon}} di\right]^{\frac{\epsilon}{\epsilon-1}}$$

$$\text{production:} \qquad C_t(i) = A_t N_t(i)_t^{1-\alpha}$$

$$\text{resource constraint} \quad : \qquad N_t = \int_0^1 N_t(i)\, di$$

Efficient allocation benchmark

To define a welfare benchmark for our policy analysis, consider the allocation chosen by a benevolent social planner, with the goal of maximizing the expected utility of the representative individual subject only to resource constraint. The f.o.c.s of the problem are:

$$
\begin{aligned}
C_t^{fb}(i) &= C_t^{fb}; \qquad N_t^{fb}(i) = N_t^{fb}; \\
-\frac{U_{N,t}^{fb}}{U_{C,t}^{fb}} &= MPN_t^{fb} => \quad \zeta_C \frac{\left(N^{fb}\right)^{\varphi}}{\left(C^{fb}\right)^{-\sigma}} = (1-\alpha)\, A_t \left(N_t^{fb}\right)^{-\alpha}
\end{aligned}
$$

where fb stands for first-best. Goods are symmetric in preferences and production, utility is concave. A symmetric allocation is efficient: all goods are produced in the same quantity. Marginal rate of substitution between consumption and labor is equal to the marginal rate of transformation.

Note that the efficient allocation responds to both productivity and preference shocks — which are accommodated by a benevolent social planner. This is why these shocks are called '**efficient shocks',** as opposed to shocks such are markup shocks which are not accommodated by the social planner (**inefficient shocks**).

Observe that by the first welfare theorem, in our specification, the difference between the natural (flexible price) output and the first best output consists of markups. So we can define gaps either relative to the natural rate n.r. (flexible price) allocation, or to the first best f.b. (efficient) allocation. For output:

$$\widetilde{x}_t = \widehat{y}_t - \widetilde{y}_t^{nr} = \widehat{y}_t - (\widetilde{y}_t^{fb} + \frac{\widehat{\mu}_t}{\sigma + \varphi + \alpha}).$$

Note that a ˜ denotes flexible prices. nr natural rate. fb first best.

The market allocation in the prototype New-Keynesian (NK)

1. The NK Phillips Curve (**NKPC**)

$$\pi_t = \beta E_t \{\pi_{t+1}\} + \kappa \widetilde{x}_t$$

where $\widetilde{x}_t = \widehat{y}_t - \widetilde{y}_t^{nr}$ is output gap, and $\kappa(\sigma, \varphi, \beta, \theta, \epsilon)$.

2. the **Dynamic IS (DIS)**

$$\widetilde{x}_t = -\frac{1}{\sigma}\left(i_t - E_t \{\pi_{t+1}\} - r_t^{nr}\right) + E_t \{\widetilde{x}_{t+1}\}$$

where r_t^{nr} is the natural rate $r_t^{nr} = \rho + \sigma E_t \left\{\Delta \widehat{y}_{t+1}^{nr}\right\}$, independent of monetary policy.

II. How many distortions in the model?

Given the benchmark and the market allocations defined above, we now consider three distortions which are potentially relevant for policy design: (a) monetary distortions (b) monopolistic distortions and (c) distortions due to nominal rigidities.

Distortion 1: **monetary distortions**.

- Modelling money demand via Cash In Advance, Shopping costs or Money in Utility, introduces in the model monetary distortions which tend to support the Friedman rule as an attribute of optimal policies.

Monetary distortions are typically disregarded in the NK model below.

- As in many New-Keynesian models, money demand is ‘appended’ to the model by assuming an ad-hoc demand, as a function of output (=consumption) and interest rates. This way of modelling money demand does not impinge on welfare (neither through preferences, nor through the resource constraint).

- Otherwise, monetary distortions would create a policy trade-off between business cycle stabilization, and reducing costs of money management, requiring a reduction of the nominal interest rate to zero, hence a negative trend in inflation. Modelling trends in inflation is a tricky issue in the Calvo-Yun model, though, as this is conceptually consistent with a zero inflation environment.

Distortion 2: **monopolistic competition**

The assumption of monopolistic competition in the modern monetary macro-economics is to be understood as a complement of nominal rigidities. Indeed it is logically consistent (a) with the hypothesis that firms and workers optimally set prices and wages subject to nominal frictions (i.e. they are not price takers); and (b) with the idea that output is demand determined over some range (over which firms (workers) can produce at non-negative profits (surplus)).

Posit: No entry (a high fixed cost), which makes each firm a monopolistic supplier of a particular good variety (in the short and the long run). Then, with flexible prices, firms would set

$$p_t = \frac{\epsilon}{\epsilon - 1} \frac{W_t}{MPN_t} = \mathcal{M} \cdot \text{Nominal Marginal Costs}$$

- Monopoly power induces a *wedge between the Marginal Rate of Substitution (MRS) and the Marginal Rate of Transformation (MRT)*:

$$MRS = -\frac{U_{N,t}}{U_{C,t}} = \frac{W_t}{p_t} = \frac{MPN_t}{\mathcal{M}} < MPN_t = MRT$$

  Since MRS is increasing in labour, MRT (MPN) is decreasing in labour, total employment is below the efficient level.

Monopolistic distortions can be eliminated using subsidies

Pigouvian taxes (subsidies) can eliminate this wedge. Set τ (tax rate on wages) such that

$$\frac{W_t}{P_t} = \frac{MPN_t}{(1-\tau)\mathcal{M}} = MPN_t => \tau = \frac{1}{\epsilon}$$

Subsidize wages as to reduce the firms' cost of labour and raise output up to the efficient level.

- With optimal subsidies in place, the steady state allocation is not distorted.
  - Analytically, this simplifies welfare analysis and policy design.
  - but consequential for policy design: how seriously we should take this distortion?

- Note: we can model markup shocks as stochastic variation in τ around the optimal subsidy

Distortion 3 Nominal-rigidities related distortions.

With imperfect competition, nominal rigidities imply **two distortions**:

1. First, when a firm does not adjust optimally its product price, markup varies suboptimally in response to shocks. Define the *average* markup $\mathcal{M}_t = P_t / (1-\tau_t) \left(\frac{W_t}{MPN_t}\right)$. Using the optimal subsidy $\mathcal{M}(1-\tau_t) = 1$, it is easy to show that **suboptimal average markup fluctuations** move the economy away from the efficient allocation:

$$MRS = \frac{W_t}{p_t} = MPN_t \frac{\mathcal{M}}{\mathcal{M}_t} \neq MPN_t$$

At an optimum: stabilize markups, $\frac{\mathcal{M}}{\mathcal{M}_t} = 1$. This first distortion follows from any form of nominal rigidities (preset prices, Taylor, Calvo, Adjustment costs of changing prices etc.). What is distorted is the average price of output relative to factors of production (labor).

2. The second distortion follows from staggered price setting: only a subset of firms re-optimize prices each period; hence goods which are symmetric in preferences and technology are sold at different prices, and produced in different quantities.

$$C_t(i) \neq C_t; \qquad N_t(i) \neq N_t$$

Price dispersion violates efficiency conditions: to address this distortions, policy should avoid price dispersion.

Optimal policy design: a first pass

Let's now characterize optimal policy in a 'constructive' way. Let's posit that initially there is no price dispersion inherited from the past, i.e. *Assumption*: $P_{t-1}(i) = P_{t-1}$.

As monetary distortions are assumed away, supporting the efficient allocation then requires:

- a subsidy which eliminates monopolistic distortions

- a monetary policy which completely and permanently stabilizes nominal marginal costs consistent with each firm's desired markup *at unchanged (symmetric) product prices*

Consider efficient shocks (markup fluctuations are taken care by the subsidy): markup stabilization is marginal costs stabilization

The monetary policy is such that $P_{t+s}(i) = P_{t+s} = P_{t-1}$, for all $s \geq 0$, that is

$$P_{t+s}(i) = \text{constant} = \mathcal{M}_{t+s} \quad \frac{\overbrace{(1-\tau)\, W_{t+s}}^{\text{Nominal marginal costs}}}{MPN_{t+s}} \quad = \mathcal{M} \cdot \text{constant}$$

As monetary policy makes marginal costs constant in nominal terms in all periods, no firm would ever have an incentive to change its price, and prices would remain constant even if there were no nominal rigidities.

- The set of allocation under fixed prices contains the flex-price allocation: hence the optimal allocation under sticky prices makes households at least as well off as under fixed prices.

A close inspection of stabilization policy (1)

Solving forward the euler equation for bonds

$$\frac{U_{c,t}}{P_t} = \beta(1 + i_t)E_t\left[\frac{U_{c,t+1}}{P_{t+1}}\right] = \Pi_{k=1}^{T} E_t\left\{\beta^k(1 + i_{t+k-1})\left[\frac{U_{c,t+T}}{P_{t+T}}\right]\right\}$$

The left hand side is a function of nominal spending (i.e. $(P_t C_t^{\sigma})^{-1}$); the right hand side — of the path of interest rates. Define 'monetary stance' $P_t/U_{c,t}(= P_t C_t^{\sigma})$. With competitive labour markets

$$W_t = -U_{N,t}\frac{P_t}{U_{C,t}} = \frac{-U_{N,t}}{\text{Monetary stance}}$$

An expansion of the monetary stance raises nominal wages. Monetary transmission works as follows: demand$=>$employment$=>W_t$ adjusts.
(Note: an interesting question is concerns monetary transmission when both prices and nominal wages are sticky)

A close inspection of stabilization policy (2)

Conditional on $P_t = P_{t-1}$, consider a temporary positive productivity disturbance in the current period t. By itself, this shock would open a negative output gap: given demand, the same level of output can be satisfied with less input; employment falls, dragging current output below natural output.

Optimal policy stabilization prescribe the central bank to react by 'leaning against the wind' of insufficient demand: engineer a monetary expansion raises wages in line with productivity:

$$P_t(i) = \text{constant} = \mathcal{M} \frac{\overbrace{(1-\tau)\, W_t}^{\text{this is raised by monetary policy}}}{\underbrace{MPN_t}_{\text{this rises exogenously}}}$$

... and raises aggregate demand. To see this: for given expectations of future consumption and prices

$$\frac{U_{c,t}}{P_t} = \beta(1 + i_t)\overbrace{E_t\left[\frac{U_{c,t+1}}{P_{t+1}}\right]}^{\text{constant}}$$

the monetary expansion translates into a fall in real rate, which raises current demand C (via DIS) up to buying the natural rate of output at unchanged prices.

Redo the analysis for preference shocks.

Leaning against the wind once again

Now, suppose that the positive productivity gain is expected to materialize in the future, at time $t+1$. If monetary policy did not move interest rates, firms reoptimizing in the current period would lower prices, in anticipation of lower marginal costs in the future, generating negative inflation:

$$\pi_t = \beta E_t \{\pi_{t+1}\} + \kappa \widetilde{x}_t$$

Note that in absolute terms current inflation moves less than expected inflation.

In anticipation of higher income and consumption in the future, households revise their consumption plans up in the current period, driving demand above natural output. There would be excess demand and 'overheating'. What is the optimal reaction by the central bank?

Since current productivity has not changed, ensuring price stability means that monetary authorities need to keep current demand in line with an unchanged natural rate of output. To keep current monetary stance unchanged:

$$\overbrace{\frac{U_{c,t}}{P_t}}^{\text{keep unchanged}} \quad (= \text{monetary stance}) = \beta(1+i_t) \quad \overbrace{E_t\left[\frac{U_{c,t+1}}{P_{t+1}}\right]}^{\text{anticipated lower } \mathrm{U}_C}$$

nominal rates need to be raised in line with expectations of higher consumption (hence lower marginal utility) in the future. Higher rates would cause households to postpone optimally any additional consumption plan, to the period in which productivity and hence the natural output will be higher. At $t+1$, however, monetary policy needs to be expansionary, as explained above.

Conclusion: strict price stability is optimal in response to all efficient shocks. Monetary policy move aggregate demand hence marginal costs so to keep the latter constant in nominal (and therefore real) terms.

Characterizing the optimal policy in general

- Note that according to our results above, the objective of price stability is not pursued based on policy-makers 'preferences' about low inflation, but as a condition for 'efficiency' of the allocation.

- With staggered price setting, *under the assumptions specified above (namely a subsidy guaranteeing that the steady state is efficient)*, it is possible to derive a second order approximation to the expected utility of the representative households which 'looks like' the traditional ad hoc function with π and $\widetilde{x}$ as arguments:

$$\mathbb{W} = \frac{1}{2\lambda} E_0 \Sigma_{t=0}^{\infty} \beta^t \left(\epsilon \pi_t^2 + \kappa \widetilde{x}_t^2 \right)$$

here the loss is measured in terms of ‘equivalent permanent consumption’ decline, as a fraction of steady state consumption.

Remarks on welfare: In equilibrium, $C = Y$ and Y is a function of aggregate N and a measure of price dispersion d$=(1-\alpha)\log\int_0^1 \left(\frac{P_t(i)}{P_t}\right)^{-\frac{\epsilon}{1-\alpha}}$. The crucial passage consists of showing that the latter measure is a function of the variance of individual prices, and then in turn that the present discounted value of such variance can be written as a linear function of the present discounted value of inflation π. See appendix in Galí.

- Important: when the steady state is distorted, to define a welfare criterion a first order approximation to the structural equation of the model is not enough.

Now it is plausible that multiple distortions create trade-offs (as stressed by traditional analysis). Using micro-founded models, we can be precise on the nature of possible trade-offs.

- A loss function is derived from approximating the expected utility around a zero-inflation steady state.

- The policy problem is defined as ‘min loss s.t. the model’ Note: this is not necessarily a realistic description of policymakers’s problem, but it is useful to define welfare benchmarks.

- Policies will be characterized under discretion and commitment.

A model with (1) an efficient steady state, and (2) short run deviations of natural output from efficiency

Define the **welfare-relevant output gap (x_t)**

$$x_t = \widehat{y}_t - \widetilde{y}_t^{fb}.$$

as opposed to the **output gap** $\widetilde{x}_t$. Inefficient shocks do not affect $\widetilde{y}_t^{fb}$, efficient ones do.

Example of inefficient shocks: change in markups around the steady-state efficient level due to stationary shocks to preferences (ϵ), changing symmetrically the elasticity of goods demand (this assumes that these shocks are not offset by state-contingent subsidies τ_t). Alternative, one can assume stochastic shocks to τ_t.

Example: optimal pricing with stationary shocks to elasticity

Optimal pricing with flexible prices and staggered price setting is:

$$p\left(i\right)^{flex} = \left(1 - \tau\right) \frac{\epsilon_{t+k}}{\epsilon_{t+k} - 1} \left(\frac{W_t}{MPN_t}\right) = \left(1 - \tau\right) \mu_t^{nr} \left(\frac{W_t}{MPN_t}\right)$$

Set a constant subsidy τ. If ϵ is stochastic, the equilibrium markup μ_t^{nr} varies randomly, and the flex-price equilibrium ratio $p\left(i\right)/mc$ is not constant. The log-linearized optimal price setting is then

$$p_t^* = \left(1 - \beta\theta\right) \sum_{k=1}^{\infty} \left(\beta\theta\right)^k E_t \left[\mu_{t+k}^{nr} + mc_{t+k} + p_{t+k}\right]$$

Note that, given marginal costs, a positive markup shock tends to increase prices.

- monetary policy could still 'stabilize' nominal marginal costs such that the sticky price equilibrium coincides with the flex-price equilibrium. The question is whether it is optimal to do so.

The NKPC with cost push shocks

Since markup shocks move $\widetilde{y}_t^{nr}$ without affecting $\widehat{y}^{fb}$, many authors find it convenient to rewrite the NKPC adding and subtracting $\kappa \widehat{y}_t^{fb}$:

$$\pi_t = \beta E_t \{\pi_{t+1}\} + \overbrace{\kappa x_t}^{\kappa(\widehat{y}_t - \widetilde{y}_t^{nr}) - \kappa\left(\widehat{y}_t^{fb} - \widetilde{y}_t^{nr}\right)} + \overbrace{u_t}^{\kappa\left(\widehat{y}_t^{fb} - \widetilde{y}_t^{nr}\right)}$$

For a given monetary policy fixing demand $\widehat{y}_t$, a positive markup shock lowers $\widetilde{y}_t^{nr}$ $(u_t > 0)$, and creates inflationary pressures: thus it is a **cost push.**

- The disturbance u_t is exogenous to policy.

- If policy pursues zero inflation, $\widehat{y} = \widetilde{y}_t^{nr}$, but this is not efficient in general. It is impossible to attain at the same time zero inflation and an efficient level of production.

- A note on calibration: assuming a process driving u_t is not the same as assuming a process driving the markup. You have to translate them into each other.

The policy problem

Posit (a) that shocks to $\widehat{y}_t^{fb} - \widetilde{y}_t^{nr}$ are stationary, and (b) a time-invariant subsidy is in place, the steady state is efficient. As we have seen in the previous lecture, the optimal steady state inflation is zero.

A second order approximation to the expected utility of the representative household around the zero inflation steady state yields the following **loss function**:

$$E_0 \Sigma_{t=0}^{\infty} \beta^t \left(\pi_t^2 + \alpha_x x_t^2 \right)$$

where $\alpha_x = \frac{\kappa}{\epsilon}$ (see derivation in the JG book). The model is described by the sequence of NKPC

$$\pi_t = \beta E_t \left\{ \pi_{t+1} \right\} + \kappa x_t + u_t$$

where for simplicity we posit $u_t = \rho_u u_{t-1} + \varepsilon_t^u$. The policy problem consists of maximizing social welfare subject to the model of the economy (i.e. the NKPCs).

Preferences and policy instruments

- Once again: the objective function is derived from the structure of the model. This is an advantage over traditional analysis, where policy preferences are 'ad hoc.' As in the traditional analysis, we maximize (an approximation to) expected utility with respect to x and π.

- To back out interest rate policies, you can use the Dynamic IS:

$$x_t = -\frac{1}{\sigma}\left(i_t - E_t\left\{\pi_{t+1}\right\} - r_t^{fb}\right) + E_t\left\{x_{t+1}\right\}$$

  Note that r_t^{fb} will generally differ from r_t^{nr}.

1. Case of 'Discretionary Policy'

Policy makers minimize current period loss without committing to any future actions. Hence they take current and future expectations as given:

$$Min\ \pi^2 + \alpha_x x_t^2 \qquad s.t. \quad \pi_t = \kappa x_t + \underbrace{\beta E_t \{\pi_{t+1}\} + u_t}_{\upsilon_t}$$

$f.o.c.$ yields the following TARGETING RULE:

$$\pi_t = -\frac{\alpha_x}{\kappa} x_t = -\frac{\alpha_x}{\kappa} \left(\widehat{y}_t - \widehat{y}_t^{fb} \right)$$

i.e., an equilibrium relation between variables that a central bank optimally targets at each point in time. Under discretion,

- the optimal policy reacts to efficient shocks by preventing any opening of the output gap (move symmetrically) and thus keeping inflation equal to zero. Since $\widetilde{y}_t^{nr} = \widetilde{y}_t^{fb}$, closing the output gap $\widehat{y}_t = \widetilde{y}_t^{nr}$ is the same as targeting the efficient allocation. Hence $\pi_t = 0$ and $\widehat{y}_t = \widetilde{y}_t^{nr} = \widetilde{y}_t^{fb}$ for all t.

- Conversely, when inefficient cost push shocks $\widetilde{y}_t^{nr} \neq \widetilde{y}_t^{fb}$. Maintaining price stability would require to engineer a large recession. Recall that what matter for pricing is the conventional gap $\widehat{y}_t - \widetilde{y}_t^{nr}$:

$$\widehat{y}_t < \widetilde{y}_t^{fb}; \qquad \widehat{y}_t > \widetilde{y}_t^{nr} => \pi_t > 0$$

  At an optimum, cost push shocks are not completely ‘accommodated’, in the sense that while policymakers drive $\widehat{y}$ below $\widehat{y}^{fb}$, opening a negative welfare-relevant output gap, they do not go all the way as to prevent inflation. They apply the optimal trade-off given by the targeting rule: inflation is $\frac{\alpha_x}{\kappa}$ times the (negative) output gap.

- Another way of looking at it: the weighted of inflation and output gap is equal to the welfare relevant output gap:

$$\left[\pi_t + \frac{\alpha_x}{\kappa}\left(\widehat{y}_t - \widetilde{y}_t^{nr}\right)\right] = \frac{\alpha_x}{\kappa}\left(\widehat{y}_t^{fb} - \widetilde{y}_t^{nr}\right)$$

- Deviations from strict price stability are only optimal if $\widehat{y}_t^{fb} \neq \widetilde{y}_t^{nr}$.

The inflation process under discretion

How much inflation is desirable? Substituting the f.o.c. above in the NKPC:

$$\pi_t = \frac{\alpha_x \beta}{\alpha_x + \kappa^2} E_t \{\pi_{t+1}\} + \frac{\alpha_x}{\alpha_x + \kappa^2} u_t$$

Solving forward and using the distribution of u_t we obtain the equilibrium inflation rate

$$\pi_t = \frac{\alpha_x}{\kappa^2 + \alpha_x (1 - \beta \rho_u)} u_t = \alpha_x \Psi u_t \qquad \text{and} \qquad x_t = -\kappa \Psi u_t$$

Deviations from price stability are proportional to the current value of the cost push shock.

- The coefficient Ψ is increasing in the persistence of the shock ρ_u.

2. *Optimal policy under commitment*

Consider now policymakers who can credibly commit to pursue monetary rules. Using the law of iterated expectations $E_t E_{t+k} \{\pi_{t+k}\} = E_t \{\pi_{t+k}\}$, rewrite the policy problem as

$$Min_{\{\pi,x\}} E_0 \sum_{t=0}^{\infty} \beta^t \left[\frac{1}{2}\left(\pi_t^2 + \alpha_x x_t^2\right) + \gamma_t \left(\pi_t - \kappa x_t - \beta \pi_{t+1} - u_t\right)\right]$$

where $\{\gamma_t\}$ is the sequence of Lagrange multipliers. The solution consists of a state-contingent sequence $\{x_t, \pi_t\}_0^\infty$ satisfying:

$$\begin{aligned} \alpha_x x_t - \gamma_t \kappa &= 0; \\ \pi_t + \gamma_t - \gamma_{t-1} &= 0 \end{aligned}$$

Inflation and output gap under commitment

The inflation equation in $t-1$ is not a constraint on the central bank, so that $\gamma_{t-1} = 0$. Hence, the allocation associated with the optimal policy is

$$\begin{aligned} x_0 &= -\frac{\kappa}{\alpha_x}\pi_0 \qquad\qquad at\ 0 \\ x_t - x_{t-1} &= -\frac{\kappa}{\alpha_x}\pi_t \quad for\ t \geq 1 \end{aligned}$$

that is the targeting rule is:

$$\begin{aligned} \pi_t &= -\frac{\alpha_x}{\kappa}\Delta x_t = \\ &-\frac{\alpha_x}{\kappa}\left[\Delta\left(\widehat{y}_t - \widetilde{y}_t^{nr}\right) + \Delta\left(\widetilde{y}_t^{nr} - \widetilde{y}_t^{fb}\right)\right] \end{aligned}$$

Similar to the case of discretion, price stability is the optimal policy only if $\widetilde{y}_t^{nr} = \widetilde{y}_t^{fb}$. However, under commitment inflation optimally rises with the growth rate of output gaps, not with the output gap itself.

Interpreting the solution: a price level target

Rewrite the solution under commitment as

$$\begin{aligned} x_1 &= x_0 - \frac{\kappa}{\alpha_x}\pi_1 = -\frac{\kappa}{\alpha_x}(\pi_1 - \pi_0) = -\frac{\kappa}{\alpha_x}(p_1 - \mathbf{p}_{-1}) \\ &=> \quad x_t = -\frac{\kappa}{\alpha_x}(p_t - \mathbf{p}_{-1}) \equiv -\frac{\kappa}{\alpha_x}\widehat{p}_t \end{aligned}$$

where $\widehat{p}_t = p_t - \mathbf{p}_{-1}$. The optimal monetary policy requires the welfare relevant output gap to be negative as long as the **price level** is above the initial level $\mathbf{p}_{-1}$.

Under discretion, instead, the price level is taken as given by the policy makers: if a bout of inflation raises it at time t, there is no commitment to use future policy to offset the increase over time.

Dynamics of monetary stance

To understand the optimal monetary policy above, pay attention to the difference between output gap and welfare-relevant output gap. Consider a purely temporary shock $u_t > 0$: $\widetilde{y}_t^{fb}$ raises above $\widetilde{y}_t^{nr}$ only at t.

- When it occurs at time t, the shock motivates a positive deviation of the price level from the 'implicit target' p_{t-1} (positive inflation): monetary policy raises $\widehat{y}_t$ above $\widetilde{y}_t^{nr}$, opening a positive output gap. Yet the welfare-relevant gap x is negative, since $\widehat{y}_t < \widetilde{y}_t^{fb}$.

- In the future (at time $t+k$), by assumption $\widetilde{y}_t^{fb}$ is equal to $\widetilde{y}_t^{nr}$: a negative x coincides with a contractionary monetary policy (hence a negative output gap $\widehat{y}_t < \widetilde{y}_t^{nr}$,), until the price level is back to target (p_{t-1}).

Why targeting (implicitly) the price level?

Rewrite the NKPC

$$\pi_t = \kappa x_t + \kappa \sum_{\kappa=1}^{\infty} \beta^k E_t \{x_{t+\kappa}\} + u_t$$

and consider once again a purely temporary shock. A positive shock u_t creates inflationary pressure. At the time of the shock, it is optimal to keep demand somewhat close to $\widetilde{y}_t^{fb}$, and above the post-shock natural rate $\widetilde{y}_t^{nr}$. The problem is that the implied expansionary monetary stance let inflation rise, which is costly because it causes inefficient price dispersion. With forward-looking prices, however, a commitment to a contractionary stance over time partly offset the inflationary consequences of an expansionary monetary stance at t, improving the short-run trade-off between inflation and the output gap. [Note that the loss function is quadratic in x (and π): it is optimal to 'spread' the contractionary stance over time.]

Discretion vs. commitment: the 'stabilization bias'

In the above example, markup shocks move natural (flex-price) output below or above efficient output, without however affecting efficiency of the steady state (implicitly assuming subsidies). Different from the classical model after Kydland and Prescott, there is no 'inflationary bias', i.e. no incentive to resort systematically to monetary expansions, causing average inflation to be permanently above zero.

Discretionary and optimal (cum commitment) policies however do not coincide. Since discretionary policymakers cannot lower current inflation by committing to a contractionary stance in the future, they are less effective in containing inflation at time t, thus contract output gaps by more, relative to the case of perfect commitment. In this sense, discretion induces a 'stabilization bias' in policymaking.

Conclusions

- The NK literature has provided possible microfoundations to traditional stabilization analysis. The expected utility of the representative households is a natural welfare criterion for policy assessment.

- We have analyzed a *stabilization bias* in discretionary policy making, relative to optimal policies derived under credible commitment.

  - In accord to traditional wisdom, discretion worsens the short-run inflation/output trade-offs: relative to full commitment, in response to a cost-push shock, output is lower (x_t is more negative) and inflation is higher in the short run.

- In the analysis above, the micro-foundations of cost-push shocks have been carefully defined. For a given efficient level of output, shocks that increase the monopoly power in the goods or labor market reduce the natural rate of output. Similar effect could be attributed to distortionary taxation.

- In reading the literature, be aware that the cost-push gap is sometimes modelled in an ad hoc fashion, appending a shock to the NKPC

$$\pi_t = \beta E_t \{\pi_{t+1}\} + \kappa (\widehat{y}_t - \widetilde{y}_t^{nr}) + \omega_t$$

  implying that inflation is positive even if $\widehat{y}_t = \widetilde{y}_t^{nr}$, in contrast with the basic assumptions of Calvo pricing.

- The NK baseline model provides an instance of ‘divine coincidence’: in response to efficient shocks, there is not trade-off between output and inflation stabilization. One instrument (monetary policy) is enough to stabilize two objectives.

- This is because, barring markups, the natural rate allocation is efficient. A meanigful trade-off only arises in response to inefficient shocks, which drive a wedge between natural and first-best allocation.

- Breaking the divine coincidence:

  – multiple nominal distortions: wage and prices, two-sector models

- financial frictions: credit constraints, model with heterogeneous agents and incomplete markets

- tax distortions etc.