Macro3 EUI 2009: **Lecture 8**

In this and the next lecture, we carry out a micro-founded reconsideration of stabilization policy in the New-Keynesian framework. With start with an economy in which policymakers face no trade-offs in equilibrium: they can support the efficient allocation.

- A prototype model: 3 relevant distortions
- A ‘constructive approach’ to policy design
- Issues in implementation via interest rate and monetary rules: indeterminacy; simple rules, welfare analysis.

I Prototype model: structure of the economy (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:

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

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

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

resource constraint : $$N_t = \int_0^1 N_t(i)\, di$$

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:

$$\begin{aligned} C_t(i) &= C_t; \qquad N_t(i) = N_t; \\ -\frac{U_{N,t}}{U_{C,t}} &= MPN_t = (1-\alpha)\, A_t N_t^{-\alpha} \end{aligned}$$

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.

Recall the market allocation pricing in the prototype New-Keynesian (NK)

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

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

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

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

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

   where r_t^{nr} is the natural rate $r_t^{nr} = \rho + \sigma E_t \left\{\Delta y_{t+1}^{nr}\right\}$, independent of monetary policy. On top of these. On top of these, 3. money demand

II. Distortions in the model (sources of suboptimality)

Given the benchmark and the market allocations defined above, we now consider a list of distortions which are potentially relevant for policy design. We focus on one distortion at a time, and define fiscal and monetary policies which can address it.

(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 however 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).

Distortion 2: **monopolistic competition**

The assumption of monopolistic competition in the modern monetary macroeconomics 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?)

Distortion 3 Nominal-rigidities related distortions.

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

- First, when a firm does not adjust optimally its product price, markup varies suboptimally in response to shocks. Define the *average* markup $\mathcal{M}_t = P_t / (1-\tau)\left(\frac{W_t}{MPN_t}\right)$. Using the optimal subsidy $\mathcal{M}(1-\tau) = 1$, 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).

- 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.

III. A constructive approach to optimal policy design

Let's characterize policies which make the market allocation coincide with the efficient allocation. 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*

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. $(P_tC_t^{\sigma})^{-1}$); the right hand side — of the path of interest rates. Define 'monetary stance' $P_t/U_{c,t}(= P_tC_t^{\sigma})$. 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)

Consider random productivity. Conditional on $P_t = P_{t-1}$, a temporary positive productivity disturbance in the current period t 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.

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:

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

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.

A graphical re-play of the main arguments

To sum up the optimal policy requires that for all t :

- output gap is identically equal to zero

- inflation is identically equal to zero

- since the allocation coincides with the flex-price allocation and inflation is zero, $i = r = r^{nr}$.

Space (N,C): helpful to carry out welfare analysis.

Indifference curves: from utility flow, IC (drawn for $U(C,N) = U_0$) in the N,C space have slope

$$\frac{\partial U}{\partial C}dC + \frac{\partial U}{\partial N}dN = 0 \quad => \quad \left[\frac{\partial C}{\partial N}\right]_{dU=0} = N^{\varphi}C^{\sigma}$$

which is positive and increasing in C and N (thus convex). The utility level is of course increasing as we move North-East in the diagram.

The *production function* $Y = C = AN^{1-\alpha}$ in the N,C space draws an upward sloping, concave curve.

The benchmark efficient allocation (MRS=MRT) is identified by the point of tangency between the IC and the production function (fig.1).

In a *market economy with flexible prices*, firms optimally set

$$P = \mathcal{M} \cdot MC = \mathcal{M} \cdot \frac{W}{(1-\alpha) A N^{-\alpha}}$$

This expression, together with the f.o.c. of the household problem and the production function function, characterizes the *natural rate of employment* N^{nr}

$$\begin{aligned} P &= \mathcal{M} \cdot \frac{P C^{\sigma} N^{\varphi}}{(1-\alpha) A N^{-\alpha}} = \mathcal{M} \cdot \frac{P \left(A_t N_t^{1-\alpha}\right)^{\sigma} N^{\varphi}}{(1-\alpha) A N^{-\alpha}} \\ &= > N_t^{nr} = \left[(1-\alpha) A_t^{1-\sigma}\right]^{1/(\sigma(1-\alpha)+\alpha+\varphi)} \end{aligned}$$

drawing a vertical line in the N,C space. Note that N_t^{nr} can be increasing or decreasing in A depending on σ.

The market equilibrium allocation is determined by the intersection of the vertical N_t^{nr} line with the production function. With monopoly power, MRS<MRT: at the equilibrium point, the IC cuts the production function from below (fig 2).

Using subsidies, policy makers can however restore the efficiency condition $MRS = MRT$.

In a *market equilibrium with nominal rigidities*, the allocation is determined by the dynamic IS and the production function

$$\begin{aligned} \frac{C_t^{-\sigma}}{P_t} &= \beta\left(1+i_t\right) E_t\left[\frac{C_{t+1}^{-\sigma}}{P_{t+1}}\right] \\ Y &= C = AN^{1-\alpha} \end{aligned}$$

The DIS draws an horizontal line in the N,C space (fig. 3).

Monetary shocks move C inversely to the real interest rate (fig. 4).

Positive productivity shocks shift the PF, and induce a marginal adjustment in the DIS depending on their impact on the real rate (Fig. 5). Since prices adjust, graph is not very useful to analyze transmission.

With the *optimal policy in places,* prices remain optimally unchanged and constant, hence:

$$C_t^{-\sigma} = \beta\left(1+i_t\right)E_t\left[C_{t+1}^{-\sigma}\right] = \beta\left(1+r_t^{nr}\right)E_t\left[C_{t+1}^{-\sigma}\right]$$

In setting monetary policy, the central bank targets the efficient allocation. This makes the distortions due to nominal rigidities irrelevant in equilibrium. (fig. 6).

Remark on the allocation

- Stabilizing the economy *around the natural rate* is different from stabilizing output *around a smooth trend*. In a NR allocation, the flex price output and consumption optimally fluctuate with productivity shocks.

IV. ISSUES IN IMPLEMENTATION

- How can the policymakers implement the efficient allocation?

$$\widetilde{y}_t = 0; \qquad \pi_t = 0; \qquad i_t = r_t^{nr}$$

Recall that the first and third terms are not observable. In what follows, we consider a number of policy 'rules' with different characteristics. Issues:

- Indeterminacy: does a candidate rule lead to a unique equilibrium?

- Performance (welfare): if a rule does not support exactly the efficient allocation, how close is the economy in terms of welfare?

- Information requirement; Robustness.

Welfare criterion

- 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 $\widetilde{y}$ as arguments.

Specifically, one can derive the following **welfare loss function:**

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

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

This function is minimized at the efficient allocation. It can be used to assess the relative performance of alternative policy rules.

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.

Interest rate rules: nominal vs. real indeterminacy

Consider the rule: set the **nominal** interest rate equal to the **real natural** rate in each period $i_t = r_t^{nr}$?

- With *flexible prices*, interest rate rules raises issues in *nominal* indeterminacy. Recall the DIS,

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

with flexible prices output gaps are always zero, hence it must be true that

$$i_t - E_t\left\{\pi_{t+1}\right\} - r_t^{nr} = 0$$

Setting $i = y^{nr}$ nails down expected inflation, but not current inflation.

Any path of the price level satisfying $p_{t+1} = p_t + i_t - r_t^{nr} + \xi_t$, where ξ_t is a shock unrelated to fundamentals (sunspot), would be consistent with equilibrium.

- Note that the above price path satisfies money market equilibrium with ad hoc demand functions such as $m_t - p_t = y_t^{nr} - \eta i_t$.
  - As central bank targets $i = r^{nr}$, money supply is driven by demand: any change in the price level will be immediately accommodated by monetary authorities.
  - Because of neutrality, however, this indeterminacy is not consequential for the allocation.

- With *nominal rigidities*, the issue is *real* determinacy. Write the NK model after setting $i = y^{nr}$ as

$$\begin{bmatrix} \widetilde{y}_t \\ \pi_t \end{bmatrix} = \begin{bmatrix} 1 & 1/\sigma \\ \kappa & \frac{\kappa}{\sigma} + \beta \end{bmatrix} E_t \begin{bmatrix} \widetilde{y}_{t+1} \\ \pi_{t+1} \end{bmatrix} = \mathbf{A} E_t \begin{bmatrix} \widetilde{y}_{t+1} \\ \pi_{t+1} \end{bmatrix}$$

Note that both inflation and output can 'jump' in the current period today (there is no initial condition nailing their value down). This means that there could be self-fulfilling equilibria of the type: given the nominal rate, an increase in expected inflation translates into a lower real interest rate, which raises demand and output, thus current inflation.

With two forward-looking variables, if both eigenvalues of the matrix $\mathbf{A}$ lie inside the unit circle, there would be only one solution fulfilling stability of the system — the saddle-path. Otherwise, the solution is not unique.

- It is easy to check that one of the two eigenvalues of the matrix $\mathbf{A}$ above is always larger than one. There are many other solutions in addition to $\widetilde{y}_t = \pi_t = 0$.

- Different from the flex price case, indeterminacy now has consequences for the real allocation.

Addressing indeterminacy: Taylor principle

We have already seen that the above problem is 'easy' to fix. Posit that central bank responds to *current inflation (and current output gap)*

$$i_t = r_t^{nr} + \phi_\pi \pi_t + \phi_y \widetilde{y}_t$$

The matrix $\mathbf{A}$ becomes

$$\mathbf{A}_T = \left[\begin{array}{cc} \sigma & 1 - \phi_\pi \\ \sigma\kappa & \kappa + \beta\left(\sigma + \phi_y\right) \end{array} \right]$$

where T stands for 'Taylor'.

It can be shown that determinacy is ensured by $\kappa\left(\phi_\pi - 1\right) + \left(1 - \beta\right)\phi_y > 0$.

- Intuitively, set $\phi_y = 0$. If inflation is expected to be positive, other things equal the Euler equation raises current demand, which raises inflation in a self-fulfilling way. However, this cannot be an equilibrium if the current interest rate respond to inflation with sufficient strength, $\phi_\pi \geqslant 1$.

- This can be interpreted as 'fully credible threat', which however is never observed in equilibrium. As long as ϕ_π is large enough, its actual value does not matter.

- Do not confuse the Taylor parameter, with the coefficient of inflation in the loss function: $\frac{1}{2\lambda} E_0 \Sigma_{t=0}^{\infty} \beta^t \left(\epsilon \pi_t^2 + \kappa \widetilde{y}_t^2 \right)$.

Question: how come, for high values of $\phi_y > 0$, determinacy can be guaranteed for values of ϕ_π below 1?

Determinacy with forward-looking interest rules

Posit that central bank responds to expected inflation (not to current inflation):

$$i_t = r_t^{nr} + \phi_\pi E_t \{\pi_{t+1}\} + \phi_y E_t \{\widetilde{y}_{t+1}\}$$

Verify that, to ensure determinacy, ϕ_π needs to be large (as before), but not too large. Intuitively: start with expectations of positive inflation (which is the percentage change in prices). If the central bank reacts very strongly, the contraction in current demand is deflationary: the price level actually falls, validating the initial inflation expectations.

Reacting to 'current inflation' rules out this possibility: the fall in current inflation would bring the interest rate down.

Simple rules

The problem with the rules analyzed above is that both the natural rate of interest and the output gap are not observable. Define simple rules as rules satisfying these two conditions

1. policy is a function of observable variables only (i.e. not of r^{nr} or output gap);

2. rules deliver good results across a variety of model and parameters' specifications. [rule does not require precise knowledge of the model, its parameters and the current shocks.]

Are there simple rules which perform well?

Examples of simple rules

- Inflation (actually price level) targeting. Just define an interest rate rule with $\phi_{y=0}$ and $\phi_\pi > 1$, so to keep $\pi = 0$. This solution addresses condition 1 (making the unobservable output gap irrelevant here). However, as we will see later, this solution is only efficient in the precise context of the above model, i.e. it violates condition 2.

- Below we review other solutions with some historical or policy relevance.

Traditional view of output gaps as 'output in deviation from smooth trends'

Traditional wisdom in monetary theory (Friedman) sees the natural rate of output as a slowly evolving variable. Consistently with this wisdom, central bank and policy analysts have long estimated output gap as deviations from trend output.

The NK literature instead shares the view that the natural rate of output (and thus the natural rate of interest) can actually be quite volatile, in response of many shocks hitting the economy in any given period.

A remark of terminology. It is useful to distinguish between natural and neutral rate. The latter is the 'long-run' counterpart of the former (loosely speaking, an average of the former).

A Taylor type interest rate rule

The traditional view of output gap underlies a popular formulation of the Taylor rule:

$$\begin{aligned} i_t &= \rho + \phi_\pi \pi_t + \phi_y \widehat{y}_t = \\ &= \rho + \phi_\pi \pi_t + \phi_y \widetilde{y}_t + \upsilon_t \end{aligned}$$

where $\widehat{y} = \log\left(Y_t / Y^{ss}\right)$ and $\upsilon_t = \phi_y \log\left(Y_t^{nr} / Y^{ss}\right)$. Note that the optimal allocation implies $\pi = 0$, but in general $\widehat{y} \neq 0$. So, the interest rate that this rule delivers is generally different from r^{nr}.

Issues with traditional Taylor rules

If the business cycle is primarily driven by supply shocks, it is not surprising to learn that a large weight on $\widehat{y}_t$ turns out to reduce welfare. Intuitively, consider a positive productivity shock which raises output but opens a negative output gap. The optimal policy would require a monetary expansion. According to the rule above, a positive ϕ_y instead implies that monetary policy reacts to any movement of output above trend by raising interest rates, which is destabilizing.

Correspondingly, it works better if shocks are mostly demand driven.

A constant money growth rule

Without loss of generality, consider

$$\Delta m = 0$$

Rewrite money demand including a velocity shock ζ_t

$$m_t - p_t = l_t = y_t - \eta i_t - \zeta_t$$

a constant money growth rule translates into a process for the nominal rate which depends on current nominal output but also on velocity disturbances:

$$i_t = \frac{-(p_t + y_t) - \zeta_t - m}{\eta}$$

Issues with money growth rule

- This rule shares the problem discussed in relation to the traditional Taylor rule: any increase in output (even driven by gains in productivity) would raise interest rates.

- The second translates welfare-irrelevant financial volatility (money demand disturbances) into welfare-relevant real volatility (output gap and inflation).
  - It is the latter element which really worsen the performance of the rule, relative to Taylor's. See Table 4.1 in Galí's textbook.

Concluding remarks

In the simple economy analyzed in this lecture (chapter 4 of Galí book) has the remarkable feature that (a) monetary policy is effective in supporting a flexible price allocation and (b) the flexible price allocation is efficient. Hence, at an optimum, there is no policy makers face no trade-offs among objectives: by pursuing zero inflation, they support an efficient allocation.

This is generally not the case. Closed economy and open economy literature provide some examples of multiple distortions (mark up shocks, wage and price rigidities, terms of trade distortions) which generate policy trade-offs. The question is to what extent these trade-offs modify the optimal policy prescriptions derived in this chapter (i.e. what are the welfare losses from pursuing $\pi = 0$).