Lectures in Monetary Economics
Lecture 7

The DSGE model

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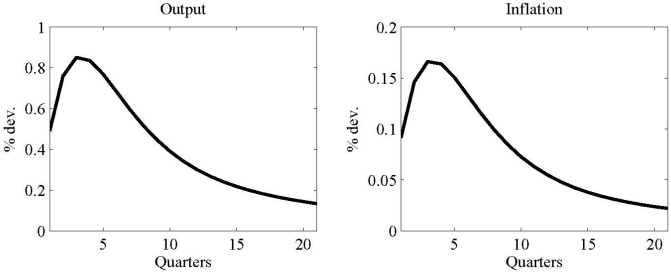
The DSGE model

The baseline line version of the NK model seems to be a failure. Is it possible to improve its empirical performance?

Yes. But only by abandoning rationality and introducing arbitrary, controversial, non-rational features. In other words, by abandoning the hard won discipline that Lucas and his followers brought to the profession.

Figure: Inertia in the DSGE model



Two major modifications:

- In price setting
- In the formulation of real rigidities

A. Price setting: Baseline version

Optimizers:

$$\hat{P}_t^o = (1 - \beta(1-q))E_t \sum_{\tau=0}^{\infty}(1-q)^{\tau}\Lambda_{t+\tau}\hat{\Psi}_{t+\tau} \tag{1}$$

Non-optimizers:
Constant prices or prices indexed to steady state inflation.

B. Price setting: DSGE version

B1. Myopia in price setting

Optimizers, share $1-\omega$ of population, P^o
The same as in the baseline NK model
Non-optimizers (myopic), share ω of population, P^N

$\hat{P}_t^N = \hat{P}_{t-1}^o + \pi_{t-1}$

$\hat{P}_t = (1-q)\hat{P}_{t-1} + q\hat{P}_t^{new}$

$\hat{P}_t^{new} = (1-\omega)\hat{P}_t^o + \omega\hat{P}_t^N$

This leads to a -hybrid- Phillips curve of the type

$$\pi_t = \gamma_f E_t \pi_{t+1} + \gamma_b \pi_{t-1} + \lambda\hat{\psi}_t \qquad (2)$$

$$\phi = (1-q) + \omega(1-(1-q)(1-\beta))$$

$$\lambda = (1-\omega)q(1-\beta(1-q))\phi^{-1} \qquad (3)$$

$$\gamma_f = \beta(1-q)\phi^{-1} \qquad (4)$$

$$\gamma_b = \omega\phi^{-1} \qquad (5)$$

B2. Backward indexation in price setting

An alternative (but quite similar) price setting scheme:

The non-optimizing firms set prices according to

$$P_{it} = \xi_t P_{it-1} \tag{7}$$

$\xi_t = \pi_{t-1}$ with $\pi_t = P_t/P_{t-1}$. That is, the firms index their prices to the lagged, economy wide rate of inflation.

Real rigidities

Preferences of the representative household

$$\mathbb{E}_t \sum_{\tau=0}^{\infty} \beta^{\tau} \left[\log(c_{t+\tau} - \vartheta c_{t+\tau-1}) + \frac{\nu^m}{1-\sigma_m} \left(\frac{M_{t+\tau}}{P_{t+\tau}} \right)^{1-\sigma_m} - \frac{\nu^h}{1+\sigma_h} h_{t+\tau}^{1+\sigma_h} \right]$$

Habit persistence

Budget constraint

$$E_t Q_t B_t + M_t + P_t(c_t + i_t + a(u_t)k_t) = B_{t-1} + M_{t-1} + P_t z_t u_t k_t + P_t w_t h_t + \Omega_t + \Pi_t$$

Variable capital utilization

Law of motion for capital

$$k_{t+1} = \Phi(i_t, i_{t-1}, k_t) + (1-\delta)k_t$$

Either **capital or investment adjustment costs**

Evaluation: Empirical success. The model manages to generate inertia (Christiano et al., 2005). But still too much nominal rigidity. Altig et al. 2005 try to fix it but run into other problems.

What are the critical elements?
Examine the properties of the model under

- An exogenous money supply rule
- A Taylor rule

2. Various forms of nominal rigidities.

- Only prices are sticky and wages are flexible, $q = 0.25$ (price contracts of 4 quarters).
- Both prices and wages are sticky. Following Christiano et al. we set $q_p = 0.50$ and $q_w = 0.30$: prices are reset on average every semester, while it takes 3 quarters on average to reset wages.

With real rigidities but no price indexation

- The model fails to generate inflation inertia independent of the type(s) of real rigidity considered.
- Output inertia does not obtain under any single real rigidity but emerges when all of them are combined together.
- Investment adjustment costs are the only feature that can help the model produce a liquidity effect.
- Problems with unconditional moments (investment is not volatile enough and inflation is too volatile.
- It implies strong countercyclicality in the real and nominal interest rate.
- An informational lag: Observing the growth rate of the money supply with a one period lag does not help.

Introduce price indexation on top of the real rigidities

- First, the model can now generate inflation persistence.
- Lagged indexation is not sufficient for that, the model also needs to include investment adjustment costs.
- The same real rigidity is also responsible for a liquidity effect.
- The other real rigidities do not contribute to inflation inertia but all together they help generate inertial output dynamics.
- Predetermined expenditure is particularly important for the last pattern.
- But he model does not perform noticeably better relative to the standard version with regard to unconditional moments. The same weaknesses are observed, in particular with regard to the cyclical properties of the interest rates.

From these findings one can claim that the existence of the price indexation scheme is sina qua non for the ability of the Keynesian model to produce inflation inertia.

Nominal wage rigidities are claimed by Christiano et al, 2005, to be the dominant source of nominal rigidity.

We repeat the preceding analysis using nominal wage in place of price rigidity.

The dynamic patterns are virtually identical to those obtained under price rigidity.

- No inflation inertia ever obtains no matter what type(s) of real rigidities are present.
- When all the real rigidities are combined together then the model produces hump shaped dynamics for output and a liquidity effect (due mostly to investment adjustment costs).
- The overall performance of the model as judged by the unconditional moments is worse relative to the case of price rigidities because of excessively large volatility.
- The strong countercyclicality in interest rates remains.

The role of the price re-setting scheme (Calvo vs Taylor)
Random Duration (Calvo)
Non-optimizing firms

$$P_{it} = \xi_t P_{it-1} \tag{8}$$

$\xi_t = \pi_{t-1}$ or $\xi_t = \overline{\pi}$.

Optimizing firms: The usual

The aggregate price level is

$$P_t = \left(q P_t^{\star 1-\theta} + (1-q)(\xi_t P_{t-1})^{1-\theta} \right)^{\frac{1}{1-\theta}} \tag{9}$$

Fixed Duration

Intermediate producers set prices for N periods of time in a staggered fashion.

In each and every period, a fraction $1/N$ of producers chooses a new optimal price $P^\star_t(i)$. During the following $N-1$ periods this price evolves according to

$$P_{it} = \xi_t P_{it-1} \tag{10}$$

with either $\xi_t = \overline{\pi}$ or $\xi_t = \pi_{t-1}$ as in the Calvo case above.

Prices are set so as to maximize the expected sum of discounted profits from period t to period $t+N-1$.

The aggregate price index is

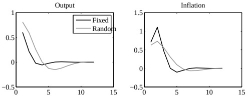
$$P_t = \left(\frac{1}{N} \sum_{\tau=0}^{N-1} (\Xi_{t-\tau,\tau} P^\star_{t-\tau})^{1-\theta} \right)^{\frac{1}{1-\theta}} \tag{11}$$

Main findings:
With the help of backward indexation the model can generate inflation inertia independent of the price setting mechanism (Calvo vs Taylor).

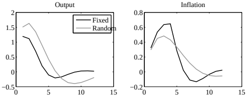
But it needs more price stickiness under the Taylor scheme in order to generate sufficient inertia in output.

Figure: The role of the price resetting scheme: Fixed (Taylor) vs Random (Calvo)

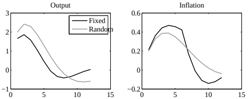
(a) 2 periods



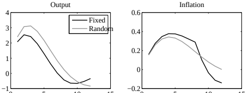
(b) 4 periods



(c) 6 periods



(d) 8 periods



Overall Evaluation

The DSGE model seems to work well empirically. But this requires non-rational price setting schemes and also "novel" real rigidities.

A. What is the problem with the backward indexation assumption?

- Conceptually: It violates strict rationality. Feasible, alternative indexation schemes lead to higher profits (for indexation to expected rather than past inflation or to R) and eliminate inertia.
- It is at variance with the empirical evidence regarding pricing behavior (Dhyne et al. 2005). Individual price changes do not move in tandem with aggregate inflation. Unlike the lagged indexation assumption which implies that all individual prices move roughly at the rate of aggregate inflation "...individual price changes are sizeable compared to the inflation rate prevailing in each country ..."(Dhyne et al. 2005).

Note that the arguments of Eichenbaum and Fisher, 2004 and De Walque, Smets and Wouters, 2005, cannot save the model.

Model Structure:

Agents

There are five different types of economic agents:

- households: consume, invest in physical capital, supply differentiated labor services, set wages, trade in domestic and foreign bonds.
- intermediate-good firms: use labor and capital as inputs, produce differentiated goods sold domestically and abroad, set prices.
- final-good firms: combine domestic and foreign intermediate goods to produce final goods used for domestic private and public consumption and investment purposes.
- the fiscal authority: purchases public consumption goods, issues bonds, levies distortionary and lump-sum taxes.
- the monetary authority: sets the nominal interest rate by following a Taylor-type interest-rate rule.

Frictions

Households and firms face various frictions which make adjustments costly (useful for generating inertia).

- external habit formation in consumption
- generalized adjustment cost in investment
- fixed cost in intermediate-good production
- monopolistic competition in intermediate-good and labor markets
- sticky prices and wages à la Calvo and (partial) backward indexation
- adjustment cost in imports
- financial frictions in form of an "external finance premium" and intermediation costs for trading foreign bonds.

The estimated version of the model uses 17 macroeconomic time series to estimate parameters.
A corresponding number of 17 structural shocks have been included to capture the stochastic nature of the macroeconomic data.
Besides checking formal statistical criteria, the estimated model is validated by assessing:

- the propagation of structural shocks through the economy (IRFs)
- the contribution of structural shocks to economic fluctuations (forecast error- variance decompositions)
- the implied variability and persistence of observed variables (standard deviations and autocorrelation functions)
- the out-of-sample forecasting performance (root mean-squared errors)