Open Economy Keynesian Macro: CGG (2001, 2002), Obstfeld-Rogoff Redux Model

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1. CGG (2001)
2. CGG (2002) and Monacelli, JMCB, 2005 (Low Pass-Through)
3. Obstfeld-Rogoff Redux Models, Lane (JIE, 2001)

CGG (2001): Features

- Floating exchange rate and perfect capital mobility.
- Central Result: Surprisingly, after all modifications are done, basic tradeoffs facing the central bank, in the scanario considered, remain the same, although they are different in quantitative terms.
- A two country model, symmetric in preferences but very different in sizes: foreign being very large compared to home. In this sense, home country is small.
- Consumption means that of home-produced goods and foreign-produced goods. Hence $\boxed{c_t \neq y_t}$.
- Makes a difference to the NKPC and expectational IS curve.
- $\boxed{\text{Difference between domestic inflation and CPI (consumer) inflation.}}$
- Additional equations: (i) Uncovered interest parity, (ii) a foreign demand function for domestic goods and (iii) expectational IS curve of the foreign country.

Equations

- (In log) $c_t = (1-\gamma)c_t^h + \gamma c_t^f \quad (1)$, where γ measures share of expenditure on domestically produced goods, hence the the measure of openness.
- C_t is a geometric average of differentiated brands.
- Let $s_t \equiv e_t + p_t^* - p_t$ is the real exchange rate but in the paper it is called the 'terms of trade.'

$$c_t^h - c_t^f = \eta s_t. \quad (2)$$

- 2 equations imply $c_t = c_t^h + \gamma\eta s_t. \quad (3)$
- $c_t^{h^*} = y_t^* + \eta s_t. \quad (4)$
- $y_t = (1-\gamma)c_t^h + \gamma c_t^{h^*} \quad (5).$
- $p_t^c = (1-\gamma)p_t + \gamma(e_t + p_t^*) = p_t + \gamma s_t. \quad (6)$
- $\Rightarrow \pi_t^c = \pi_t + \gamma(s_t - s_{t-1}) = \pi_t + \gamma\Delta s_t. \quad (7).$
- Slight change: $Y_t = A_t N_t \Rightarrow y_t = a_t + n_t \quad (8).$

Equations Continued

- Labor supply equation: $\omega_t - p_t - \gamma s_t = \Phi n_t + \sigma c_t + \xi_t \quad (9)$
  where ξ_t: "wage mark up" shock reflecting deviation of wage from its competitive level. Apparently, this shock seems to fit models to business cycle data in the U.S. economy.
- Expectational IS Curve:

$$\sigma(E_t c_{t+1} - c_t) = i_t - E_t(\pi_{t+1} + \gamma E_t \Delta s_{t+1}) \quad (10)$$

  since $\pi_{t+1} + \gamma \Delta s_{t+1} = \pi^c_{t+1}$.
- Since home goods are negligible in foreign country's consumption, we have $c^*_t \simeq y_t$, thus the IS curve in the foreign country:

$$\sigma E_t(y^*_{t+1} - y^*_t) = i^* - E_t \pi^*_{t+1}. \quad (11)$$

- Assumption: The *growth* process of y^*_t is stationary.

Interest Parity Equation

- This equation essentially determines the exchange rate.

$$
\begin{aligned}
1 + i_t &= \frac{(1 + i_t^*)E_{t+1}}{E_t} \\
\Rightarrow \ln(1 + i_t) &= \ln(1 + i_t^*) + e_{t+1} - e_t \\
\Rightarrow i_t &= i_t^* + (e_{t+1} + p_{t+1}^* - p_{t+1}) - (e_t + p_t^* - p_t) \\
&\quad - [(p_{t+1}^* - p_{t+1}) - (p_t^* - p_t)] \\
\Rightarrow i_t &= i_t^* + s_{t+1} - s_t - \pi_{t+1}^* + \pi_{t+1} \\
&= i_t^* + \Delta s_{t+1} - \pi_{t+1}^* + \pi_{t+1} \\
\Leftrightarrow E_t \Delta s_{t+1} + i_t^* - \pi_{t+1}^* &= i_t - E_t \pi_{t+1} \quad (12)
\end{aligned}
$$

- NKPC: π_t and π_{t+1} remain same, since these terms deal with prices set by domestic firms, referring to domestic inflation.

$$\pi_t = \beta E_t \pi_{t+1} + \delta(p_t^* - p_t) = \beta E_t \pi_{t+1} + \delta(\alpha + \omega_t - a_t - p_t) \quad (13)$$

where $\omega_t - a_t - p_t$ is the real marginal cost, "mc.", and α= mark-up.

Summary of Equations

$$c_t = c_t^h + \gamma\eta s_t. \quad (3); \quad c_t^{h^*} = y_t^* + \eta s_t. \quad (4)$$

$$y_t = (1-\gamma)c_t^h + \gamma c_t^{h^*} \quad (5).$$

$$p_t^c = (1-\gamma)p_t + \gamma(e_t + p_t^*) = p_t + \gamma s_t. \quad (6)$$

$$\Rightarrow \pi_t^c = \pi_t + \gamma(s_t - s_{t-1}) = \pi_t + \gamma\Delta s_t. \quad (7)$$

$$y_t = n_t + a_t \quad (8); \quad \omega_t - p_t - \gamma s_t = \Phi n_t + \sigma c_t + \xi_t \quad (9)$$

$$c_t = E_t c_{t+1} - \frac{1}{\sigma}[i_t - E_t(\pi_{t+1} + \gamma E_t \Delta s_{t+1})]. \quad (10)$$

$$i_t^* - E_t\pi_{t+1}^* = \sigma E_t(y_{t+1}^* - y_t^*). \quad (11)$$

$$E_t\Delta s_{t+1} + i_t^* - \pi_{t+1}^* = i_t - E_t\pi_{t+1} \quad (12)$$

$$\pi_t = \beta E_t\pi_{t+1} + \delta(p_t^* - p_t) \quad (13)$$

Relations

- (3), (4) and (5) give $y_t = (1-\gamma)c_t + \gamma y_t^* + \gamma\eta(2-\gamma)s_t$. (14).
- A Key Relation: Substitute (11) into (12) and eliminate $i_t^* - E_t\pi_{t+1}^*$. Next substitute the resulting eq in the IS eq and eliminate $i_t - E_t\pi_{t+1}$. We get $E_t c_{t+1} - c_t = \frac{1-\gamma}{\sigma} E_t \Delta s_{t+1} + E_t(y_{t+1}^* - y_t^*)$

$$\text{Or } E_t c_{t+1} - c_t = \frac{1-\gamma}{\sigma}(E_t s_{t+1} - s_t) + E_t(y_{t+1}^* - y_t^*)$$

- Both the l.h.s. and r.h.s are symmetric. Hence

$$c_t = \frac{1-\gamma}{\sigma} s_t + y_t^* \quad (15)$$

- Substitute (15) into (14) and eliminate c_t:

$$y_t = \frac{1+w}{\sigma} s_t + y_t^*, \text{ where } w \equiv \gamma(2\gamma-1)(\sigma\eta-1) \quad (16)$$

- Assume $\sigma\eta > 1$.

Important Implications

- Consumption and output gap are 1-1 related to terms of trade gap. From eq. (16)
- Reason for the 1-1 relation: As domestic output rises relative to foreign output, domestic good must get cheaper for the market to clear, which implies an improvement in the "terms of trade."
- Implication: No change in the NKPC equation or in the objective function – even though terms of trade changes appear in both expressions.
- Implication: Feedback rule linking inflation to output gap is contemporaneous and analogous to the closed-economy counterpart, i.e., it is lean against the wind kind. However, the difference lies in the magnitude of the coefficient of the feedback rule between x_t and π_t.

Flexi Price Equilibrium

- Defined by $p_t^0 - p_t = 0$ and $\xi_t = 0$. CGG (2001) normalize the product of (a) the mark-up parameter α and (b) a part of the invariant component of the parameter a_t such that it is equal to one and thus the log of it $= 0$; hence $p_t^0 = \omega_t - a_t$, i.e. $\omega_t - p_t^0 = a_t$.
- Using this, (9) reduces to $\Phi n_t^0 + \sigma c_t^0 = a_t - \gamma s_t^0$, where "0" refers to flexi price equilibrium. We have $n_t = y_t - a_t$ whether the economy is in flexi equilibrium or not. Thus

$$\Phi y_t^0 + s_t^0 = (1 + \Phi) a_t \quad (17)$$

- Solve y_t^0 and s_t^0 from eqs. (16) and (17):

$$y_t^0 = \frac{\frac{\sigma}{1+w} y_t^* + (1 + \Phi) a_t}{\frac{\sigma}{1+w} + \Phi}; \quad s_t^0 = \frac{\sigma}{1 + w} \cdot \frac{(1 + \Phi) a_t - \Phi y_t^*}{\frac{\sigma}{1+w} + \Phi}$$

$$y_t^0 - y_t^* = \frac{\sigma}{1 + w} \cdot \frac{\Phi y_t^* - (1 + \Phi) a_t}{\frac{\sigma}{1+w} + \Phi}; s_t^0 = \frac{\sigma}{1 + w} (y_t^0 - y_t^*).$$

- CGG solution of y_t^0 is wrong: it has '-' instead of $+$ coefficient of y_t^*.

Deviations from Flexi Price Equilibrium

- From (16) and (17)

$$\sigma(c_t - c_t^0) = (1-\gamma)(s_t - s_t^0); \quad \sigma(y_t - y_t^0) = (1+w)(s_t - s_t^0).$$

- Using these and (9),

$$\begin{aligned} p_t^0 - p_t &= p_t^0 - \omega_t + \omega_t - p_t \\ &= -\Phi n_t^0 - \sigma c_t^0 - \gamma s_t^0 + \Phi n_t + \sigma c_t + \gamma s_t + \xi_t \\ &= \Phi x_t + (1-\gamma)(s_t - s_t^0) + \gamma(s_t - s_t^0) + \xi_t \\ &= \Phi x_t + s_t - s_t^0 + \xi_t = \Phi x_t + \frac{\sigma}{1+w} x_t + \xi_t \\ &= \left(\frac{\sigma}{1+w} + \Phi\right) x_t + \xi_t. \end{aligned}$$

Deviations from Flexi Price Equilibrium Cont.

- Substituting this into NKPC relation,
  $\pi_t = \beta\pi_{t+1} + \lambda_w x_t + u_t$
  where $\lambda_w = \delta[\sigma/(1+w) + \Phi]$ and $u_t = \delta\xi_t$.
- $\Rightarrow$ The impact of output gap on current inflation is greater. Reason: An $\uparrow$ in the gap tends to reduce the price of the domestic good, improves terms of trade and hence consumer price. This increases real marginal cost, implying a greater impact on current inflation.
- Using the same relations, we get the IS equation

$$x_t = E_t x_{t+1} - \frac{1+w}{\sigma}(i_t - E_t\pi_{t+1} - rr_t^0),$$

  where rr_t^0 is defined in CGG (2001).
- $\Rightarrow$ aggregate demand is more sensitive to a real-interest change. Reason: real interest rate $\uparrow$ appreciates the domestic currency, depreciates terms of trade, making foreign goods cheaper, thus shifts consumption away from domestic goods.

Monetary Authority's Objective Function and Implications

- As terms of trade gap is 1-1 related to output gap, by 2nd order approximation, the objective function can be written as: minimize

$$\sum_{i=0}^{\infty} E_t[\alpha_w x_{t+i}^2 + \pi_{t+i}^2]$$

- Implication: Central bank should target domestic inflation and allow exchange rate to fluctuate freely, even though exchange rate fluctuations increase the variability of CPI.
- Implication: Policy problem isomorphic to that in the closed economy.
- As said earlier: A lean-against-the-wind feedback rule between output gap and domestic inflation.
- Given that the source is a cost-push shock, $\partial i_t / \partial E_t \pi_{t+1} > 1$, same as in the closed economy.
- A +ve cost push shock $\Rightarrow$ currency to depreciate - not surprising.
- Even under full commitment, there is a positive variability of the exchange rate. Supports a generally a variable exchange rate system.

Monetary Policy Coordination: CGG (2002)

- Two country, but each is "large" relative to each other, not one large and the other small. This apart, the model is the same.
- In Nash equilibrium, each country' optimal policy is isomorphic to the closed-economy case.
- However, in Nash equilibrium, there is a spillover. Monetary policy by one country affect the terms of trade or the real exchange rate, which is not internalized.
- $\Rightarrow$ gain from cooperation.
- In cooperative equilibrium, interest rate should respond to domestic inflation *and* foreign inflation.

Incomplete Pass-through: Monacelli, JMCB, 2005

- $p_t^c = (1-\gamma)p_t^h + \gamma p_t^f$, where p_t^f is the price at which foreign goods sell in the domestic market. This may be less than or equal to $p^* t + e_t$, where p_t^* is the price of foreign goods in foreign currency.
- $\psi_t = p_t^* + e_t - p_t^f$ is the measure of pass-through. $\psi_t = 0$ or 1 means no or complete pass-through. This is also law-of-one-price or "lop" gap – called by Monacelli.
- Isomorphism breaks down.

General Features of Standard Redux Model

- Lots of research following their JPE paper in 1995 - thrived into this decade; has come to be known as New Open Economy Macro Economics.
- Bench-mark is Mundell-Flemming, NOT traditional Phillips curve.
- Optimizing framework.
- Distinguishing features compared to NKPC approach
  - No separate monetary authority objective function - "optimal" policy is one that maximizes social welfare, specified by an utility function, almost exactly identical to one in Blanchard-Kiyotaki.
  - No interest rate targeting. Change in money supply or that in its growth rate is the focus. Hence money demand and money market clearing are integral part of the analytical system.
  - No NKPC, i.e., no dynamic optimizing behavior w.r.t. pricing in the face of rigidity.
  - Price and/or wage stickiness is modeled exogenously.

Specific Features

- Two countries. Household-Producers. No labor market. Production structure is same as in Blanchard-Kiyotaki.
- Utility function is same: positive utilities from consumption, money holding, and negative utility from work.
- One more asset, besides money: loans.
- Also a government sector $G_t = T_t + \underbrace{\frac{M_t - M_{t-1}}{P_t}}_{seigniorage}$

  No government borrowing.
- Household problem: Max $\frac{C_t^{h\,1-\rho}}{1-\rho} + \left(\frac{M_{dt}^h}{P_t}\right)^{1-\epsilon} - \frac{1}{1+\Phi} y_{ht}^{1+\Phi}$, where $C_t^h \equiv \int_0^1 (C_{jt}^h)^{\frac{\eta-1}{\eta}} dj$.. Budget Constraint: $P_t C_t^h + M_t + P_t B_t \leq p_{ht} y_{ht} + M_{t-1} + P_t(1+i_t)B_{t-1} - P_t T_t$
- $\Rightarrow$ Same Euler equation.
- If no capital mobility, i_t and i_t^f unrelated, bond markets segmented. In equilibrium, net $B_t = B_t^f = 0$.
- If capital mobility, i_t and i_t^f are related by interest parity. Net bond holding $\neq 0$.

Policy Focus

- Like Dornbusch: Impacts of an unanticipated $\uparrow$ of money supply on macro variables in the country, and abroad and the exchange rate, current acct, capital acct etc.
- Short Run Effects of an $\uparrow$ in domestic money supply:
  - increase in domestic consumption and output.
  - depreciation of the currency; worsening of domestic terms of trade (as domestic goods are pricier).
  - foreign consumption rises.
  - Foreign output may $\uparrow\downarrow$. Consumption increase (by substitution effect) $\Rightarrow$ output $\uparrow$ but relative price change $\uparrow$ output $\downarrow$.
  - Euler equations $\Rightarrow$ world real interest rate falls (which accommodates world wide increase in current consumption).
  - Domestic nominal interest rate $\downarrow$; $\Rightarrow$ cap. acct deficit and current acct surplus.
- Compared to Mundell-Flemming, (i) its prediction on world interest rate is novel. (ii) its prediction on dynamics of macro variables and long term effects are novel, where "long run" does NOT mean no rigidity but when the new steady state is arrived.