Summary Ch 5

Business Cycles in Emerging Countries:
Productivity Shocks vs. Financial Frictions

The SOE-RBC from before was a suitable model for Advanced SOE like Canada.

For Emerging-OE, however, we need to capture two additional facts:
1) EMEs are twice as much volatile than AEs.   2. Volatility of consumption is higher than that of GDP

We can try to fix this: for (1) increase σ_a^2 for (2) increase ρ

for (2) the intuition is that higher ρ generates a more persistent y that increases at first due to shock, but later keeps increasing as future investment becomes more productive, building up K). Then Permanent income increases more than Current and Consumption too (more volatile consumption)
(IRFy : without persistence: exponential decrease after positive effect. with persistency: hump shaped; Reason: gradual build up of K dominates gradual decline of productivity)

Problem (for 1): not all volatilities increase in the same proportion.
Problem (for 2): (we can no longer use ρ as before) There is a trade-off between using ρ to match the excess volatility of consumption or the autocorrelation of output.

Solution: Consider more shocks (more parameters with similar effects to deal with each feature)

Aguiar and Gopinath 2007: Add a second productivity shock, a non-stationary shock or a trend shock. (Adaptation of King, Plosser and Rebelo (1988) to SOE)

$$\max E_0 \sum_{t=0}^{\infty} \beta^t \frac{[C_t^{\gamma}(1-h_t)^{1-\gamma}]^{1-\sigma}-1}{1-\sigma}$$

subject to

(BC) $$\frac{D_{t+1}}{1+r_t} + Y_t = D_t + C_t + K_{t+1} - (1-\delta)K_t + \frac{\phi}{2}\left(\frac{K_{t+1}}{K_t} - g\right)^2 K_t,$$

$$Y_t = a_t K_t^{\alpha}(X_t h_t)^{1-\alpha}$$

(X_t: Non-stat. component of product.)

$$\lim_{j\to\infty} E_t \frac{D_{t+j+1}}{\prod_{s=0}^{j}(1+r_{t+s})} \le 0,$$

The country interest rate

$$r_t = r^* + \psi\left[e^{\tilde{D}_{t+1}/X_t - \bar{d}} - 1\right],$$

In equilibrium, $\tilde{D}_{t+1} = D_t$.

law of motion of productivity shocks: (g_t: gross growth rate of X_t; g: Parameter ~ Avg growth)

$\ln a_t = \rho_a \ln a_{t-1} + \sigma_a \epsilon_t^a$

$\ln\left(\frac{g_t}{g}\right) = \rho_g \ln\left(\frac{g_{t-1}}{g}\right) + \sigma_g \epsilon_t^g$, w/: $g_t = \frac{X_t}{X_{t-1}}$

Choice variables: $C_t, D_{t+1}, K_{t+1}, h_t$

Model can be transformed to be stationary given it Features a BGP (balanced growth path) →

New choice variables: $c_t, h_t, d_{t+1}, k_{t+1}$ (Stationary)

$c_t = \frac{C_t}{X_{t-1}}$, $d_{t+1} = \frac{D_{t+1}}{X_{t-1}}$, $\frac{K_t}{X_{t-1}}$, $\lambda_t = \frac{\Lambda_t}{X_{t-1}^{(1-\sigma)\gamma-1}}$

FOCs:

$[h_t]$: $\frac{1-\gamma}{\gamma}\frac{C_t}{1-h_t} = (1-\alpha)a_t X_t \left(\frac{K_t}{X_t h_t}\right)^{\alpha}$

$[C_t]$: $\gamma C_t^{\gamma(1-\sigma)-1}(1-h_t)^{(1-\gamma)(1-\sigma)} = \Lambda_t$ (Λ_t: LM of BC)

$[D_{t+1}]$: $\Lambda_t = \beta(1+r_t)\mathbb{E}_t \Lambda_{t+1}$

$[K_{t+1}]$: $\Lambda_t\left[1+\phi\left(\frac{K_{t+1}}{K_t}-g\right)\right] = \beta \mathbb{E}_t \Lambda_{t+1}\left[1-\delta+\alpha a_{t+1}\left(\frac{K_{t+1}}{X_{t+1}h_{t+1}}\right)^{\alpha-1} + \phi\frac{K_{t+2}}{K_{t+1}}\left(\frac{K_{t+2}}{K_{t+1}}-g\right) - \frac{\phi}{2}\left(\frac{K_{t+2}}{K_{t+1}}-g\right)^2\right]$

w/: $r_t = r^* + \psi\left[e^{\tilde{D}_{t+1}/X_t - \bar{d}} - 1\right]$

(BC)

$[h_t]$: $\frac{1-\gamma}{\gamma}\frac{c_t}{1-h_t} = (1-\alpha)a_t g_t \left(\frac{k_t}{g_t h_t}\right)^{\alpha}$

$[c_t]$: $\gamma c_t^{\gamma(1-\sigma)-1}(1-h_t)^{(1-\gamma)(1-\sigma)} = \lambda_t$

$[d_{t+1}]$: $\lambda_t = \beta(1+r_t)g_t^{\gamma(1-\sigma)-1}\mathbb{E}_t \lambda_{t+1}$

$[k_{t+1}]$: $\lambda_t\left[1+\phi\left(\frac{g_t k_{t+1}}{k_t}-g\right)\right] = \beta g_t^{\gamma(1-\sigma)-1}\mathbb{E}_t \lambda_{t+1}\left[1-\delta+\alpha a_{t+1}\left(\frac{k_{t+1}}{g_{t+1}h_{t+1}}\right)^{\alpha-1} + \phi\frac{g_{t+1}k_{t+2}}{k_{t+1}}\left(\frac{g_{t+1}k_{t+2}}{k_{t+1}}-g\right) - \frac{\phi}{2}\left(\frac{g_{t+1}k_{t+2}}{k_{t+1}}-g\right)^2\right]$

w/ $r_t = r^* + \psi\left[e^{\tilde{d}_{t+1}-\bar{d}} - 1\right]$ (same)

BC^{New}: $\frac{g_t d_{t+1}}{1+r_t} = d_t + c_t + g_t k_{t+1} - (1-\delta)k_t + \frac{\phi}{2}\left(\frac{g_t k_{t+1}}{k_t} - g\right)^2 k_t - a_t k_t^{\alpha}(g_t h_t)^{1-\alpha}$

Results: model matches data well. Matches the ratio of volatility of consumption to volatility of output (>1 - Mexican data)

How important is the inclusion of X_t? (Non-Stationary shock)

$TFP_t = Y_t/(K_t^{\alpha}(1-h_t)^{1-\alpha}) = a_t X_t^{1-\alpha}$

$\Delta \ln TFP_t = \Delta \ln a_t + (1-\alpha)g_t \rightarrow \frac{Var((1-\alpha)g_t)}{Var(\Delta \ln TFP_t)} = \frac{(1-\alpha)^2\sigma_g^2/(1-\rho_g^2)}{\sigma_a^2/(1+\rho_a) + (1-\alpha)^2\sigma_g^2/(1-\rho_g^2)} = 0.88$

In this model the TFP is driven mostly by the non-stationary shock

Furthermore for Canada the explained variance is only 40% ⇒ Trend shocks are more important for EMEs

Problems (of AG2007)
1. The sample is not long enough to distinguish permanent from transitory shocks (only 20 years, annual data)
2. Their model only considers productivity shocks. Troublesome for EMEs where other shocks such as Country spread and Interest rate innovations are important (Neumeyer and Perri, 2005; Uribe and Yue 2006)
3. Model is a frictionless RBC. Unsatisfactory for EMEs where Financial frictions matter

⇒ Add Financial Frictions (data will pick the debt elasticity parameter), and include working capital constraint

Garcia-Cicco, Pancrazi, and Uribe (2010): Other shocks compete with TFP innovations (cycle & trend)

Households: $$\max E_0 \sum_{t=0}^{\infty} \nu_t \beta^t \frac{[C_t - \omega^{-1}X_{t-1}h_t^{\omega}]^{1-\gamma}-1}{1-\gamma},$$

(ν_t: Pref. Shock; X_{t-1}: Trend enters Preferences: allows to use GHH (Not CD as AG2007) (in BGP context))

subject to

$$\frac{D_{t+1}}{1+r_t} = D_t - W_t h_t - u_t K_t + C_t + S_t + I_t + \frac{\phi}{2}\left(\frac{K_{t+1}}{K_t} - g\right)^2 K_t,$$

(S_t: Public Spending Shock)

$$K_{t+1} = (1-\delta)K_t + I_t,$$

Firms: $$\max_{\{h_t, K_t\}} \left\{a_t K_t^{\alpha}(X_t h_t)^{1-\alpha} - u_t K_t - W_t h_t\left[1 + \frac{\eta r_t}{1+r_t}\right]\right\},$$

(a_t: Cycle Shock; X_t: Trend Shock; $\frac{\eta r_t}{1+r_t}$: Working Capital, Fin. Friction)

Country Interest Rate: $$r_t = r^* + \psi\left(e^{\frac{\tilde{D}_{t+1}/X_t - \bar{d}}{\bar{y}}} - 1\right) + e^{\mu_t - 1} - 1,$$

(e^{μ_t-1}: Int. Rate shock)

Five Shocks

Productivity (cycle): $\ln a_{t+1} = \rho_a \ln a_t + \epsilon_{t+1}^a.$

Productivity (trend): $\ln(g_{t+1}/g) = \rho_g \ln(g_t/g) + \epsilon_{t+1}^g,$

Preferences shock: $\ln \nu_{t+1} = \rho_\nu \ln \nu_t + \epsilon_{t+1}^{\nu},$

Interest Rate Shock: $\ln \mu_{t+1} = \rho_\mu \ln \mu_t + \epsilon_{t+1}^{\mu}.$

Expenditure Shock: $\ln(s_{t+1}/\bar{s}) = \rho_s \ln(s_t/\bar{s}) + \epsilon_{t+1}^s,$

Financial Components: Int. Rate Shock (parameter now chosen by data; is larger ψ)
Working Capital Constraint (Fin. Friction); adj. costs of investment.

Result: Data is explained as well as AG2007. But Non-Stationary shock is not the main driver of dynamics
- $\sigma_{\Delta TFP}$ is only explained by 2.6% (before 88% in AG07)

After considering more shocks:
The trend shock (Non-Stationary) is no longer the main driver of the economic fluctuations.

Relevant shocks: Interest Rate Shocks → Partic. for investment and Trade Bal. (the most volatile components)
Technology (cycle-Stat)
Preferences

Financial Friction Parameter is key: With high ψ GPU can explain the autocorrelation of TB/y for various lags
∴ Financial frictions are more relevant for understanding EMEs dynamics than Non-Stationary (trend) shocks.

Other features: Firms will hold a non interest-bearing asset M_t (working capital). They will be subject to a working Capital constraint: $\mathcal{L} = \mathbb{E}_0 \sum_{t=0}^{\infty} \beta^t X_{t-1}^{-\gamma} \lambda_t \{Profits_t + \xi_t[W.K.\ Constraint]\}$ ⇒ In FOC: MPL = wage (1+wedge)
Wedge: Financial distortion ($\eta r_t/(1+r_t)$) affected by interest rates. Then the distortion introduces a supply-side mechanism through which the int. rates can affect production

The model includes a frictionless bank that intermediates assets and takes in the firms deposits. That allows to pin down the profits of banks. Those are added to the profits of firms and subst. into the BC to close the model

Estimation

annual data for Argentina 1900-2005.

Four observables used: Output growth, Consumption growth, Investment growth, trade-balance-to-output ratio

Theoretical counterparts of observables

$$O_t^* = \begin{bmatrix} \Delta \ln Y_t \\ \Delta \ln C_t \\ \Delta \ln I_t \\ TB_t / Y_t \end{bmatrix} \qquad O_t = O_t^* + \begin{bmatrix} \sigma_{gY}^{me} \epsilon_t^{me, g^Y} \\ \sigma_{gC}^{me} \epsilon_t^{me, g^C} \\ \sigma_{gI}^{me} \epsilon_t^{me, g^I} \\ \sigma_{TB/y}^{me} \epsilon_t^{me, TB/Y} \end{bmatrix}$$

17 parameters are estimated w/ these 4 series

10 defining processes of shocks σ_i, ρ_i for $i = \{g, a, \nu, s, \mu\}$

ϕ: adj. costs of capital ψ: debt elasticity of interest rate

η: scale of working capital constraint

and 4 non-structural: σ_{gY}^{me}, σ_{gC}^{me}, σ_{gI}^{me}, $\sigma_{TB/y}^{me}$

Role of Financial Frictions

Fin. Frictions here: Country Int Rate premium (debt elastic r_t (ψ)); Working Capital Constraint (η)

ψ captures imperfect enforcement of international loan contracts, a la Eaton & Gersowitz 81, or mechanism of models w/ collateral constraints that limit borrowing

η is not very important for the results. ψ on the other hand is key

To induce Stationarity: $\psi = 0.001$

To match downward sloping $\rho_{TB/y}$ (w/ lags): $\psi = 1.3$

also important to match $\sigma_{TB/y}$ (low ψ overestimates variance)

Effect of ψ (all other parameters constant)

low ψ: too persistent debt $\Rightarrow$ too persistent TB_t

high ψ: less persistent debt due to self stabilizing debt mechanism $\Rightarrow$ less persistent TB_t

However, fit will also depend on other parameters. Particularly on ϕ

Role of other parameters: the SGU (2003) model has low ψ and still generates a low correlation of TB/y $\quad \underset{(2.0)}{\phi^{GPU}} > \underset{(0.028)}{\phi^{SGU}}$

The comparable parameter w/ ϕ^{SGU} is ϕ^{GPU}/K^{SGU} $\quad (\phi^{SGU} = 0.028, \ \phi^{GPU}/K^{SGU} = 0.59)$

$\Rightarrow$ adj. costs parameter is 20 times higher in GPU.

$\Rightarrow$ w/ higher adj. costs of capital, Investment will be (smoothed) more persistent that persistence is transmitted to the TB_t $\Rightarrow$ to compensate we need $\psi = 1.3$ in GPU

Other types of shocks

To check the relevance of trend shocks a model with the structure of AG2007 but amplified to include imperfect information is estimated.

In this model the agents observe shocks on the TFP but cannot tell whether these originate from the cycle shock or the trend shock (non-stationary innovation).

TFP: $A_t = e^{z_t} X_t$ w/ $\hat{g}_t + g = \ln\left(\frac{A_t}{A_{t-1}}\right)$, $\hat{g}_t^x = \ln\left(\frac{X_t}{X_{t-1}}\right) - g$

To complement the problem, it is assumed agents receive a noisy signal about the state of the non-stationary component. Then, they solve a signal extraction problem.

Signal: $\hat{s}_t = \hat{g}_t^x + \eta_t$ (η_t: noise)

Under full info the agents would form expectations on the TFP as: $\mathbb{E}_t \hat{g}_{t+1} = (\rho_z - 1) z_t + \rho_x \hat{g}_t^x$

Unfortunately, the two components in the right hand side are not observed. But fortunately, they relate linearly to the observed TFP growth.

Thus, the **Kalman Filter** can be used to obtain a good estimate (that is updated iteratively) of the non-observable states. For the GE model this implies an amplification in the model and states to controls solution.

(details in final subsection of chapter 5 in book)

Results: after accounting for the imperfect information and presence of the noisy signal the model still captures the right ordering of variances and countercyclicality of TB.

However, the non-stationary shock is also not explaining most of the variance of the TFP (it now only explains 6% whereas in the AG2007 case with perfect info it explained 88%).

Additionally, the noise to signal ratio is 68%, implying the signal is not very informational about the unobserved non-stationary TFP shock.

A first read implies that the importance of trend shocks may be overstated in AG2007. Either competing with other types of shocks or with different information setups (with noisy signals), the non-stationary role is not the main driver of the TFP.

However, it's not inconsequential as it still explains most of the variance of the TB/y and h (labor supply). Conversely, the cycle shock explains most of the variance of C, I, Y.

Finally, the noise shock is still important. It does not explain most of the variance of variables, but generates the result where the stationary shock recovers explanatory power, and crucially, it affects the propagation mechanism of shocks in the model.