

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 (about as much as GDP)

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

for (1) the problem is that not all volatilities increase in the same proportion.

for (2) the intuition is that higher ρ generates a more persistent Y_t that increases at first due to shock, but later keeps increasing due to persistency future investment is more productive, then K builds up). Then Permanent income increases more than Current Income and Consumption will do it 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: (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)

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

subject to

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

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

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

The country interest rate

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

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

law of motion of productivity shocks: (g_t : growth rate of X_t)
 $\ln a_t = p_a \ln a_{t-1} + \Gamma_a \epsilon_a^a$
 $\ln \left(\frac{g_t}{g_{t-1}} \right) = p_g \ln \left(\frac{g_{t-1}}{g_{t-2}} \right) + \Gamma_g \epsilon_g^g, \text{ w: } g_t = \frac{X_t}{X_{t-1}}$

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)

$$c_t = \frac{C_t}{X_{t-1}}, \quad d_{t+1} = \frac{D_{t+1}}{X_{t-1}}, \quad \frac{K_t}{X_{t-1}}, \quad h_t = \frac{\lambda_t}{X_{t-1}^{1-\sigma}}$$

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

$$[C_t]: \tau C_t^{\frac{\gamma(1-\sigma)}{1-\sigma}-1} (1-h_t)^{(1-\gamma)(1-\sigma)} = \Lambda_t \quad (\text{No LM of BC})$$

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

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

$$[d_{t+1}]: \lambda_t = \beta(1+r_t) g_t E_t \lambda_{t+1}$$

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

$$[k_{t+1}]: \lambda_t [1 + \phi \left(\frac{g K_{t+1}}{K_t} - g \right)] = \beta g_t \frac{\gamma(1-\sigma)}{1-\sigma} \lambda_{t+1} \left[1 - \delta + \phi a_{t+1} \left(\frac{K_{t+1}}{g K_{t+1}} \right)^{\alpha-1} + \phi \frac{g K_{t+1}}{K_{t+1}} \left(\frac{g K_{t+1}}{K_t} - g \right)^2 \right]$$

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

$$\text{BC New: } \frac{g K_{t+1}}{1+r_t} = d_{t+1} + c_t + g_t K_{t+1} - (1-\delta) K_t + \frac{\phi}{2} \left(\frac{g K_{t+1}}{K_t} - g \right)^2 K_t - a_t K_t (g_t h_t)^{1-\sigma}$$

Results: model matches data well. Particularly important: it 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)

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

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

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

Furthermore for Canada the explained variance is only 40%. \Rightarrow 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
 \Rightarrow Add Financial Frictions (data will pick the debt elasticity parameter), and include working capital constraint

Garcia-Cicco, Pancrazi, and Uribe (2010): Letting other shocks compete with productivity innovations (cycle and trend)

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

Trend enters: Allows to use GHTX (not CD as AG2007)
Pref. Shock: ν_t

Five Shocks

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

subject to

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

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

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

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

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

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

$\Delta \ln TFP$ is only explained by 2.6% (before 82% in AG2007)

After considering more shocks:

The trend shock (Non-stationary) is no longer the main driver of the economic fluctuations.

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: $\int = E_0 \sum_t \beta X_t^\alpha \lambda_t \{ \text{Profits}_t + \beta \text{[WC constraint]} \} \Rightarrow$ in FOC: $MPL = \text{Wage} (1 + \text{wedge})$
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 taxes 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

$$O_t^* = \begin{bmatrix} \Delta \ln Y_t \\ \Delta \ln C_t \\ \Delta \ln I_t \\ TB_t/Y_t \end{bmatrix} \quad O_t = O_t^* + \begin{bmatrix} \sigma_{g_Y}^{me} E_t^{me, g_Y} \\ \sigma_{g_C}^{me} E_t^{me, g_C} \\ \sigma_{g_I}^{me} E_t^{me, g_I} \\ \sigma_{TB/Y}^{me} E_t^{me, TB/Y} \end{bmatrix}$$

17 parameters are estimated w/ these 4 series

10 defining processes of shocks σ_i, p_i for $i = \{g, a, u, s, h\}$

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

η : scale of working capital constraint

and 4 non-structural: $\sigma_{g_Y}^{me}, \sigma_{g_C}^{me}, \sigma_{g_I}^{me}, \sigma_{TB/Y}^{me}$

Role of Financial Frictions

Fin. frictions here: Country Int Rate premium (debt elasticity ψ); Working Capital Constraint (η)

ψ captures imperfect enforcement of international loan contracts, a la Eaton & Gersbach & I., 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 $P_{TB/Y}$ (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_t/Y $\phi_{(2.0)}^{CPU} > \phi_{(0.028)}^{SGU}$

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

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

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.

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

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

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 no longer explains 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.