

Small Open Economies

October 8, 2004

Very rough – you’ll have to go to the papers for details

Start of class:

- Problem set: questions?
- Name dropping. Economists aren’t famous. We’re all part of the same community, sharing ideas and having fun.
- Interaction of theory and fact.
- Presentation and paper topics:
 - Portfolio choice. Work out portfolios in the non-separable nontraded goods economy using log-linear approximation of portfolios. See Baxter-King-Jermann paper (JIE 1998).
 - Income and substitution effects. Apply King’s method to simple two-country models.
 - Shocks to investment productivity: suppose the shocks show up not in the production function but in the capital law of motion:

$$k_{t+1} = (1 - \delta)k_t + z_t x_t.$$

Jonas Fisher (Technology shocks matter) argues that this model provides a better description of US business cycles, including fluctuations in the relative price of capital goods. Would a two-country version be interesting? It will take some thought to decide how to extend this to a two-country environment, but it holds out the promise of contributing not only to the usual business cycle properties but to the growth question: do countries inherit technological advances by importing foreign capital goods? The nice thing about this project is that it has a clear doable element (extend to two countries) and also points in new directions (growth, capital goods, and trade). Related work includes Eaton and Kortum (EER 2001), Caselli and Wilson (JME 2004 + Kortum comment), and Hsieh and Klenow (NBER 9701).

- Composition of investment goods: redo the J-curve paper, suitably streamlined, with greater foreign content to investment goods. How does this affect consumption and output correlation? the behavior of the terms of trade? See Burstein, Neves, and Rebelo (JME 2003 and NBER 10238).

1 Issues

Today's class is really about a common modelling strategy: choosing to model one economy in a larger world. To give it some focus, we might keep in mind one of our stanbys:

- Dynamics of the trade balance. Countercyclical: countries tend to run deficits in booms.

Small open economy models allow us to gain some insight into the features of a model that are needed to reproduce it.

2 Benchmark environment

The idea behind a small open economy model is that the agent of the economy is a price-taker: her actions have no impact on the price she faces. However, we generally assume more than that, as we'll see shortly. For now, let's consider the ingredients of a typical model:

- List of agents: one agent, representing our small economy.
- List of commodities: one tradeable good plus leisure.
- Preferences: the utility function has the form

$$U(c, 1 - n) = E_0 \sum_{t=0}^{\infty} \beta^t u[g(c_t, 1 - n_t)],$$

where c is consumption of the good and $1 - n$ is leisure. We use power utility for u : $u(g) = g^{1-\gamma}/(1-\gamma)$. The consumption-leisure aggregator takes two forms:

$$g(c, 1 - n) = \begin{cases} c^\nu (1 - n)^{1-\nu} & \text{Standard} \\ c - \omega n^\nu & \text{GHH.} \end{cases}$$

The latter was suggested by Greenwood, Hercowitz, and Huffman (AER, 1988); it's become the industry standard for reasons that will become obvious below. Basically it changes the income effects.

- Technology: the country has a Cobb-Douglas production function subject to multiplicative shocks,

$$y_t = f(z_t, k_t, n_t) = z_t k_t^\alpha n_t^{1-\alpha}.$$

The law of motion for capital is

$$k_{t+1} = (1 - \delta)k_t + x_t,$$

where x is gross investment. The technology shock is AR(1):

$$z_{t+1} = (1 - \varphi)\bar{z} + \varphi z_t + \varepsilon_{t+1}$$

where ε has mean zero and variance σ^2 .

- Budget constraint:

$$a_{t+1} = r(a_t + y_t - c_t - x_t),$$

where a_t is net foreign assets at the start of date t (measured in units of the good) and r is the gross world interest rate. The idea here is that the agent owns the production process and its capital stock but may borrow or lend in world capital markets above and beyond this. There is a lower bound on a , too, that we will typically ignore: $a_t \geq \underline{a}$. (Recall the role this plays in Bewley models.)

The last item on the list is the source of differences from multi-country models of the whole world. In world models, the last piece of the puzzle is a resource constraint. Here the ROW (“rest-of-the-world”) must soak up any change in the international balance of goods. More than that, we have limited the ability of the local agent to hedge risk in world markets. In our multi-country models, we didn’t talk explicitly about the market structure, but what lay behind our optimal allocations was a competitive equilibrium in which each agent could trade in claims contingent on all the shocks of the model. Here the agent has access only to a single world asset. Making r stochastic would make the model more realistic in some ways, but would not change this feature.

3 Discussion

Small open economy models are a modelling strategy. What do we gain? lose?

What do we gain?

- Simplicity. We can focus on the structure of a single economy, giving its elements more attention than we would in a more complex multi-country world.
- Intuition. The models typically have a lot in common with permanent income models of consumption, and much of what we know there can be adapted. See, for example, Ljungqvist and Sargent, *Recursive Macroeconomic Theory (2nd ed)*, ch 17 (or ch 14 of the first edition).

What do we give up?

- Incomplete markets. We snuck this in, but by failing to include the possibility to trade in state-contingent claims, we apparently decided to look at a world with incomplete markets. This may be a good thing, who knows, but it’s important to realize that’s what we’re doing. You might ask yourself: What’s happening in the ROW? Where does the interest rate come from?
- Steady state. Foreign borrowing and lending is a linear technology, which in the growth model leads to non-existence of a steady state.

4 Establishing a steady state

The absence of a steady state is the major problem here: our most popular computational methods are approximations around a steady state, and if the latter doesn't exist it's not clear where to start. Moreover, lack of a steady state suggests that the model will wander around over a broad and possibly unlimited range, making any approximation around a point questionable. If there are barriers (the borrowing constraint, for example), these also place demands on our computational methods (one doubts linear decision rules will be very good if the range of the approximation is large).

To see the problem, consider the closely-related (but simpler) optimal growth model characterized by the Bellman equation:

$$J(k) = \max_{k'} u[f(k) - k'] + \beta J(k').$$

The first-order and envelope conditions are

$$\begin{aligned} u_c[f(k) - k'] &= \beta J_k(k') \\ J_k(k) &= u_c[f(k) - k'] f_k(k). \end{aligned}$$

A steady state value of k , if one exists, satisfies

$$\beta f_k(k) = 1.$$

In a typical application (eg, Sargent's *Dynamic Macroeconomic Theory*, pp 24-25), we add the boundary conditions $f_k(0) = \infty$ and $f_k(\infty) < 1$, which guarantees a solution. Graphically, we equate f_k (a downward-sloping line) with $1/\beta$. But what if f is linear: eg, $f(k) = rk$? Graphically, we have two parallel lines, so there need not be a solution. And even if, by chance, $\beta r = 1$, the relation does not determine k .

My claim is that the small open economy model has the same problem. It takes some effort to show (effort, not deep insight), but a sketch follows. The model as presented has three state variables (k , a , and z) and three controls (c , n , and x). The Bellman equation of the agent might be written:

$$J(k, f, z) = \max_{c, x, n} u[g(c, 1 - n)] + \beta E J[(1 - \delta)k + x, r(a + f(z, k, n) - c - x), \varphi z + \varepsilon].$$

The foc's and ec's are:

$$\begin{aligned} c : & \quad u_c(g)g_c(c, 1 - n) = \beta r E J_a(k', a', z') \\ n : & \quad u_c(g)g_n(c, 1 - n) = \beta f_n E J_a(k', a', z') \\ x : & \quad \beta E J_k(k', a', z') = \beta r E J_a(k', a', z') \\ k : & \quad J_k(k, a, z) = \beta(1 - \delta) E J_k(k', a', z') + \beta r f_k E J_a(k', a', z') \\ a : & \quad J_a(k, a, z) = \beta r E J_a(k', a', z') \end{aligned}$$

In a steady state, we set $z = \bar{z}$. If one exists, the last equation implies $\beta r = 1$, just as we saw for the optimal growth model.

The question is what you do about the absence of a steady state. A list of approaches:

1. Don't worry about it. Correia, Neves, and Rebelo (EER, 1995) do this.
2. Endogenous discount factor. The most common approach is to let β depend on g ($\beta(g)$ decreasing). (You can see in the graph how this would work.) If this seems strikes you as ad hoc, let me suggest that there is nothing special about the additive utility function (additive over time and across states) that virtually everyone uses. Koopmans derived something like $\beta(g)$ (slightly more general) from sensible axioms of intertemporal choice. The theory is reviewed in my paper with Routledge and Zin "(Exotic preferences," Section 2).
3. Endogenous r . We can, of course, apply the same trick to the other part of the equation: let r depend on a ($r(a)$ decreasing). The idea is that the more you invest abroad, the lower the return — or the more you borrow, the higher the rate — which tends to push you back toward a steady state. This doesn't have the obvious theoretical basis of the previous suggestion, but it works.
4. Cost of deviating from steady state. The idea is to choose a steady state value \bar{a} and subtract the cost $\eta(a - \bar{a})^2$ from the rhs of the budget constraint. Again, it works. (Look at its impact on the envelope condition for a .)
5. Portfolio choice. The most novel idea was proposed by Kraay and Ventura (QJE, 2000): solve the stochastic problem explicitly for a steady state. It works (under some conditions) because of the difference in risk characteristics between domestic capital k and foreign assets a . Evidently this rules out our linear approximation methods.

All but the last are nicely described by Scmitt-Grohe and Uribe (JIE, 1993). They argue that for modest sensitivities approaches 2-4 are very similar in terms of the behavior of short-term fluctuations.

5 Analysis

[This would be worth working through in some detail — maybe later.]

Given some approach to the steady state, we can look at the dynamics of the model. A quick summary: (i) You need adjustment costs to capital to get interesting dynamics. Otherwise, capital moves immediately to equate net marginal product with r . (ii) You need GHH preferences to undo the income effect of a positive productivity shock. Otherwise, higher productivity tends to be associated with lower n , flat y , and very little impact on the trade balance. The risk aversion parameter matters in both cases, because it affects the marginal utility of consumption.