Open Economy Macroeconomics in Developing Countries

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Clearly, in a perfect-foresight version of this setup where consumers are endowed with the average level of output in period 2, they would borrow in the first period (i.e., run a current account deficit) to fully smooth consumption over time, as analyzed in chapter 1.

We will first study the case of incomplete markets and then the case of complete markets.

2.3.1 Incomplete Capital Markets

Consider the following financial environment. This small economy can borrow from/lend to the rest of the world at a constant world real interest rate, r, as in chapter 1. However, it has no access to contingent debt; in other words, it cannot borrow contingent on the realization of output in the second period. In this sense, markets are incomplete.[6]

Box 2.1
How incomplete are markets?

When thinking about whether or not a small open economy faces complete markets, it proves insightful to first review the evidence on market completeness at the household level. If households within a financially sophisticated market, such as the United States, do not face complete markets, we would think that, if anything, countries would face even more market incompleteness because of international credit market imperfections stemming principally from the lack of contract enforcement at a transnational level. The question is then whether households can insure themselves against idiosyncratic shocks—such as illness, loss of job, and other shocks to income—through stock and security markets, borrowing and lending in credit markets, unemployment insurance, and help from family and/or community members.

While there are different econometric methods to test for full insurance, the basic strategy remains the same: reject the complete markets (full insurance) hypothesis if one can find idiosyncratic shocks that affect the marginal utility of consumption, after controlling for aggregate shocks. A common problem with tests for full insurance is the potential endogeneity of right-hand variables. Most studies attempt to address this problem by finding idiosyncratic variables that are genuinely exogenous, rather than choice variables for the household. Others, like Ham and Jacobs (2000), address the endogeneity problem using instrumental variables technique. Table 2.1 offers a summary of some of the most influential studies. While some of the evidence is mixed, it is fair to conclude that, by and large, available studies suggest that households in the United States are not able to fully insure against idiosyncratic shocks.

At an international level, complete markets would imply that domestic consumption should be very highly correlated with world consumption, rather than with domestic output. An extreme version of this idea can be illustrated in a two-country version of our two period model analyzed in exercise 5. Given the simple stochastic structure, the model predicts that consumption across countries should be perfectly correlated, whereas in the absence of world uncertainty, the correlation between domestic consumption and domestic output should be zero. As table 2.2 details, however, empirical studies

6. See Blanchard and Fischer (1989, ch. 6) for a detailed analysis of consumption under uncertainty. As box 2.1 documents, market incompleteness seems to be the rule in the actual world. While market incompleteness is just assumed in this chapter, it could be derived endogenously from enforcement constraints (e.g., see Kehoe and Perri 2002).

Box 2.1
(continued)

Table 2.1
Studies on market completeness based on household data

Author(s)	Dataset	Methodology	Main results
Cochrane (1991)	Panel Study of Income Dynamics, 1980–1983	Full consumption insurance implies that consumption growth should be independent of idiosyncratic shocks to households. Idiosyncratic shocks are captured by involuntary job loss (sickness, strike, move).	Full insurance rejected for long illness and involuntary job loss, but not for spells of unemployment, loss of work due to strike, or involuntary move.
Mace (1991)	Consumer Expenditure Survey, 1980–1983	Risk sharing implies that individual consumption varies positively with aggregate consumption only and not with individual income or changes in employment status. For specific preferences, changes in consumption or growth rates of consumption, net of preference shocks, should be equalized across individuals.	Once the change in aggregate consumption is accounted for, the change in household income does not help explain the change in household consumption. Results for the growth rate specification, however, reject full insurance.
Hayashi, Altonji, and Kotlikoff (1996)	Panel Study of Income Dynamics, 1968–1981 1985–1987	Full risk sharing implies that one-year consumption changes are uncorrelated with the wage rate at all leads and lags. This is tested by examining the correlation of long term and one-year changes in consumption and the wage rate.	Both intra- and interfamily risk sharing rejected, but not self-insurance.
Attanasio and Davis (1996)	Consumption Expenditure Survey and the Current Population Survey, 1980–1990	Examines the impact of systematic, publicly observable shifts in the hourly wage structure on the distribution of household consumption.	Relative wage movements among men had large impact on the distribution of household consumption, thus rejecting the hypothesis of consumption insurance.
Ham and Jacobs (2000)	Panel Study of Income Dynamics, 1974–1987	To avoid potential endogeneity problems, authors use current unemployment rates in the household head's industry and the head's occupation separately as instruments for idiosyncratic shock.	Strong rejection of full insurance hypothesis. Households not insured against changes in unemployment rate associated with the household head's occupation.

tend to reject the hypotheses that domestic and foreign consumption are highly correlated and/or that domestic consumption is less correlated with domestic output.

We thus conclude that, by and large, studies based on both household data and country data tend to reject the hypothesis of complete markets. However, some studies do find that, as one would expect, markets are less incomplete within a country than across countries (Kose, Prasad, and Terrones 2009).

Box 2.1
(continued)

Table 2.2
International evidence on market incompleteness

Author(s)	Dataset	Methodology	Main results
Atkeson and Bayoumi (1993)	US, 1963–1986 6 members of OECD, 1970–1987	Consumers should try to construct asset portfolios generating income that is negatively correlated with regional income.	Full insurance rejected in both panels. Despite opportunities available for consumers to smooth regional risks, a large fraction of consumers do not seem to privately insulate their consumption from regional conditions.
Crucini (1999)	US, 1972–1990 Canada, 1973–1991 G-7, 1970–1987	Imperfect risk sharing implies that after controlling for common income shocks, consumption should move together more closely across individuals that engage in more risk sharing.	Much more risk sharing is found across Canadian provinces and US states than across G7 countries.
Obstfeld (1994)	7 largest industrial countries, 1950–1988	In an integrated world asset market with representative national agents, the ex post difference between two countries' intertemporal marginal rates of substitution in consumption should be uncorrelated with any random shock that is insurable.	In the postwar period there is an increasing comovement between domestic and world consumption growth, but the correlation between them remains far below expected, even in a world of unrestricted international asset trade.
Kose, Prasad, and Terrones (2009)	69 countries, 1960–2004	Financial integration predicts countries' consumption growth to be more correlated with world output than with country's output growth.	For most countries the correlation between domestic consumption and output is higher than between domestic consumption and world output. The gap between the two measures is much larger for emerging markets and other developing countries than for industrial countries.

Budget Constraints

Let us begin by looking at the first period flow constraint. Assume that initial net foreign assets are zero. Then, since there is no uncertainty in period 1,

$$b_1 = y_1 - c_1. \tag{2.18}$$

The second-period flow constraint will depend on the realization of output. Let c_2^H and c_2^L denote second-period consumption in the high-output state of nature and low-output state of nature, respectively. Then, since the budget constraint must hold in every state of nature,

$$c_2^H = (1+r)b_1 + y_2^H, \tag{2.19}$$

$$c_2^L = (1+r)b_1 + y_2^L. \tag{2.20}$$

Combining equations (2.18), (2.19), and (2.20), we obtain an intertemporal budget constraint for each of the two possible output paths:

$$y_1 + \frac{1}{1+r}y_2^H = c_1 + \frac{1}{1+r}c_2^H, \tag{2.21}$$

$$y_1 + \frac{1}{1+r}y_2^L = c_1 + \frac{1}{1+r}c_2^L. \tag{2.22}$$

Utility Maximization

As is standard, we will assume that consumers maximize expected lifetime utility, given by

$$W = u(c_1) + \beta E\{u(c_2)\}. \tag{2.23}$$

Taking into account the distribution of output (given by equation 2.16), we can rewrite (2.23) as

$$W = u(c_1) + \beta[pu(c_2^H) + (1-p)u(c_2^L)]. \tag{2.24}$$

The consumer's problem consists in choosing c_1, c_2^H, c_2^L to maximize (2.24) subject to (2.21) and (2.22). In terms of the Lagrangian,

$$\begin{aligned}\mathcal{L} &= u(c_1) + \beta[pu(c_2^H) + (1-p)u(c_2^L)] \\ &\quad + \lambda^H\left(y_1 + \frac{1}{1+r}y_2^H - c_1 - \frac{1}{1+r}c_2^H\right) \\ &\quad + \lambda^L\left(y_1 + \frac{1}{1+r}y_2^L - c_1 - \frac{1}{1+r}c_2^L\right).\end{aligned} \tag{2.25}$$

The first-order conditions with respect to c_1, c_2^H, and c_2^L are given by, respectively,

$$u'(c_1) = \lambda^H + \lambda^L,$$

$$\beta p u'(c_2^H) = \frac{\lambda^H}{1+r},$$

$$\beta(1-p)u'(c_2^L) = \frac{\lambda^L}{1+r}.$$

Combining these three equations (and imposing the condition that $\beta(1+r) = 1$), we get

$$u'(c_1) = pu'(c_2^H) + (1-p)u'(c_2^L), \tag{2.26}$$

which can be rewritten as

$$u'(c_1) = E\{u'(c_2)\}. \tag{2.27}$$

This is the stochastic Euler equation (i.e., the counterpart of equation 2.8).

2.3.2 Equilibrium

The solution of the model will critically depend on the sign of $u'''(c)$.[7] Two pieces of information will be important in the derivations below.

First, notice that $u'(c)$ is linear, strictly convex, or strictly concave depending on whether $u'''(c) = 0$, $u'''(c) > 0$, or $u'''(c) < 0$, respectively. It follows that

$$pu'(c_2^H) + (1-p)u'(c_2^L) = u'[pc_2^H + (1-p)c_2^L], \quad \text{if } u'''(c) = 0, \tag{2.28}$$

$$pu'(c_2^H) + (1-p)u'(c_2^L) > u'[pc_2^H + (1-p)c_2^L], \quad \text{if } u'''(c) > 0, \tag{2.29}$$

$$pu'(c_2^H) + (1-p)u'(c_2^L) < u'[pc_2^H + (1-p)c_2^L], \quad \text{if } u'''(c) < 0. \tag{2.30}$$

Second, notice that by multiplying (2.21) by p and (2.22) by $1-p$, we can derive an intertemporal constraint in expected values:[8]

$$c_1 + \frac{E\{c_2\}}{1+r} = y_1 + \frac{E\{y_2\}}{1+r}. \tag{2.31}$$

7. We should note that the tight link to be established below between the sign of the third derivative and the existence of precautionary savings in this two-period model does not necessarily hold in models with longer but finite horizon (with time-varying degrees of risk aversion) or infinite horizon (see Huggett and Ospina 2001 and Roitman 2011).

8. A general point is in order. Since the intertemporal constraint must hold for *each* state of nature, it will always hold in expected value. The reverse, however, is *not* true. It would therefore be incorrect to solve a model with uncertainty using an intertemporal constraint that holds only in expected value.

We now consider each case individually.

Case 1 (Certainty equivalence) $u'''(c) = 0$. This case corresponds to quadratic preferences. Using (2.28), we can rewrite the Euler equation (2.26) as

$$u'(c_1) = u'[pc_2^H + (1-p)c_2^L],$$

or, equivalently,

$$u'(c_1) = u'(E\{c_2\}).$$

Since $u'(c)$ is a strictly decreasing function (recall that $u''(c) < 0$), it follows that

$$c_1 = E\{c_2\}. \tag{2.32}$$

In an expected value sense the economy therefore smooths consumption over time.[9] As will become clear below, however, c_1 will differ from actual period-2 consumption and hence the economy will not be able to smooth actual consumption over time, which will negatively affect welfare.

To compute a reduced form for consumption, combine the Euler equation for the quadratic case (equation 2.32) with the intertemporal constraint in expected value (equation 2.31) to obtain

$$c_1 = \frac{1+r}{2+r}\left[y_1 + \frac{E\{y_2\}}{1+r}\right]. \tag{2.33}$$

With quadratic preferences, certainty equivalence holds in the sense that consumption in the first period is the same as it would have been if consumers had been endowed in the second period with the average value of y_2.[10] This implies that with quadratic preferences, consumption in period 1 does not depend on the variance of output in period 2.

To derive the current account balance in period 1 (which, given the assumption of zero initial net foreign assets, is the same as the trade balance), combine (2.18) and (2.33) to obtain

$$b_1 = \frac{1}{2+r}[y_1 - E\{y_2\}] < 0.$$

As expected, the economy runs a current account deficit. The current account deficit is in fact the same as it would have been if second period's output were $E\{y_2\}$. Substituting this expression for the current account into (2.19) and (2.20), we obtain reduced-form expressions for c_2^H and c_2^L:

9. This is Robert Hall's (1978) celebrated result that under quadratic utility and $\beta(1+r) = 1$, consumption follows a random walk. In other words, the best predictor of tomorrow's consumption is today's consumption since, under rational expectations, news about permanent income are unforecastable.

10. Appendix 2.6 shows that the same result obtains in an infinite-horizon version of this model.

$$c_2^H = y_2^H + \frac{1+r}{2+r}\left[y_1 - E\{y_2\}\right] < y_2^H, \tag{2.34}$$

$$c_2^L = y_2^L + \frac{1+r}{2+r}\left[y_1 - E\{y_2\}\right] < y_2^L. \tag{2.35}$$

Two observations are worth making. First, consumption in period 2 will always be lower than output because of the need to repay the debt incurred in period 1. Second, consumption in period 2 depends on the actual realization of output, which implies that $c_2^H > c_2^L$.[11] Incomplete markets thus introduce a positive correlation between period 2 consumption and output. In fact, as should be obvious from (2.34) and (2.35) and is formally checked in exercise 1 at the end of this chapter, there is a perfect correlation between consumption and output in the second period.

Finally, notice that the fact that the economy is not able to smooth actual consumption over time has negative welfare consequences (compared to the certainty case). To show this, notice that in the certainty case, period-1 consumption would be given by c_1 (i.e., the same as in the quadratic case) while period-2 consumption would be given by $E\{c_2\}$. Hence we would like to show that

$$\underbrace{u(c_1) + \beta u(E\{c_2\})}_{\text{Welfare under certainty}} > \underbrace{u(c_1) + \beta[pu(c_2^H) + (1-p)u(c_2^L)]}_{\text{Welfare under uncertainty}},$$

which, given that first-period utility is the same, simplifies to

$$u(E\{c_2\}) > pu(c_2^H) + (1-p)u(c_2^L).$$

This inequality holds in light of the strict concavity of $u()$. Suitably relabeled in an obvious way, figure 2.1 would in fact apply to this case as well with point A denoting period-2 utility under certainty and point B denoting period-2 utility under uncertainty.

It is also easy to show that the more variable is output, the higher are the welfare costs. To see this, consider a mean-preserving spread of output; that is, suppose that the possible realizations of output are $\tilde{y}_2^H (> y_2^H)$ and $\tilde{y}_2^L (< y_2^L)$ but the expected value is the same. By analogy with (2.34) and (2.35), we know that in this case second-period consumption would be given by

$$\tilde{c}_2^H = \tilde{y}_2^H + \frac{1+r}{2+r}\left[y_1 - E\{y_2\}\right], \tag{2.36}$$

$$\tilde{c}_2^L = \tilde{y}_2^L + \frac{1+r}{2+r}\left[y_1 - E\{y_2\}\right]. \tag{2.37}$$

11. This illustrates the general point that, under incomplete markets, consumers are unable to equalize consumption across states of nature. This would also be true, of course, in a closed economy with idiosyncratic risk and is, in fact, at the core of empirical tests of market incompleteness at the household level (see box 2.1).

Then, by strict concavity of $u(.)$,

$$pu(\tilde{c}_2^H) + (1-p)u(\tilde{c}_2^L) < pu(c_2^H) + (1-p)u(c_2^L).$$

In terms of figure 2.1, period-2 utility for the mean-preserving spread would correspond to point C. Hence welfare is lower than before (point B).

Case 2 (Precautionary savings) $u'''(c) > 0$. Using (2.29), we can rewrite the Euler equation (2.26) as

$$u'(c_1) > u'[pc_2^H + (1-p)c_2^L].$$

It follows that

$$c_1 < E\{c_2\}. \tag{2.38}$$

Unlike the previous case, consumers do *not* smooth consumption in an expected value sense. From (2.31) and (2.38), it follows that

$$c_1 < \frac{1+r}{2+r}\left[y_1 + \frac{E\{y_2\}}{1+r}\right].$$

Consumption is thus lower than it would be in the certainty (or certainty equivalence) case. In other words, the economy engages in *precautionary savings*. The uncertainty regarding second-period output induces consumers to be more prudent and dissave less than they would otherwise. Hence the current account deficit will be smaller than in the quadratic case.[12] As before, the presence of uncertainty prevents consumers from achieving full consumption smoothing and introduces a positive correlation between output and consumption in period 2.

Two important observations are worth making at this point. First, it is important to distinguish between the concepts of "risk aversion" and "prudence" (see Kimball 1990). Risk aversion refers to the fact that consumers dislike uncertainty, while prudence refers to the idea that consumers are prepared to save in anticipation of an uncertain outcome. The degree of risk aversion is measured by the concavity of $u(.)$, whereas the degree of prudence is measured by the convexity of $u'(c)$ or, equivalently, the concavity of $-u'(c)$.

Second, standard preferences—such as constant relative (or absolute) risk aversion—are characterized by $u'''(.) > 0$ and will therefore exhibit precautionary savings. Exercise 2 at the end of this chapter examines the case where preferences exhibit constant absolute risk aversion and period-2 output follows a normal distribution. In this case we can compute a reduced-form for consumption in period 1. As one might expect, period-1 consumption is lower the higher is the

12. It may be even possible that the introduction of uncertainty induces consumers to *save* in the first period (i.e., run a current account surplus) even if $y_1 < E\{y_2\}$. You should check that this is indeed a possibility by constructing numerical examples using, say, a constant relative risk aversion function.

variance of period-2 output. Greater uncertainty thus makes consumers more prudent and leads to more precautionary savings.

Intuitively, recall the stochastic Euler equation—given by (2.27)—and notice that $u'''(c) > 0$ implies that the marginal utility of consumption is a *convex* function. Hence a mean-preserving spread—which, by construction, leaves expected consumption in period 2 unchanged—increases the corresponding expected marginal utility in period 2 and induces consumers to decrease consumption in period 1 (i.e., induces consumers to choose a steeper consumption path in an expected value sense). Finally, welfare is strictly decreasing in the variance of output.[13] Exercise 3 at the end of the chapter asks you to show numerically that the same results follow for the case of constant relative risk aversion.

Case 3 (Dissavings) $u'''(c) < 0$. Using (2.30), we can rewrite the Euler equation (2.26) as

$$u'(c_1) < u'[pc_2^H + (1-p)c_2^L].$$

It follows that

$$c_1 > E\{c_2\}. \tag{2.39}$$

In this case consumers are "imprudent" in the sense that they choose to dissave more than they would otherwise and will in fact consume more in period 1 than in the certainty case. Therefore the current account deficit in period 1 will be higher than in the certainty case. It is still the case that consumption is not smooth over time and that this is costly from a welfare point of view.

While utility functions that exhibit a negative third derivative are much less common in economic theory, an example would be the following:

$$u(c) = ac - bc^3, \quad c < \sqrt{\frac{a}{3b}}.$$

As can be easily checked, $u'(c) > 0$, $u''(c) < 0$, and $u'''(c) < 0$.[14] This consumer is thus risk averse but *imprudent*, which illustrates the fact that risk aversion does not necessarily imply prudence. Exercise 4 at the end of the chapter asks you to compute first-period consumption and welfare as a function of a mean-preserving spread in the distribution of second-period output. As expected, c_1 increases due to the fact that the consumer is imprudent, but welfare decreases since the consumer is still risk averse. Intuitively, recall once again the stochastic Euler equation—given by (2.27)—and notice that the marginal utility of consumption is now a concave function. Hence

13. See Jacobs, Pallage, and Robe (2005) for an empirical estimation of the welfare costs of incomplete markets using state-level data for the United States.

14. See Roitman (2011) for a detailed analysis of precautionary saving for this class of preferences.

a mean-preserving spread will *reduce* the expected marginal utility of period-2 consumption and thus induce consumers to increase c_1.

2.3.3 Complete Capital Markets

Suppose now that there are complete asset markets in the sense that households can buy contingent claims in international capital markets. In other words, households may buy a claim that promises to pay one unit of output in the good state of nature for the price (as of period 1) $q^H/(1+r)$ and a claim that promises to pay a unit of output in the bad state of nature for the price $q^L/(1+r)$. In addition there exists (as before) a risk-free asset that promises to pay one unit of output regardless of the state of nature, which can be acquired at the price $1/(1+r)$.[15]

Budget Constraints

Assume that initial net foreign assets are zero. Denote by b_1^j, $j=H,L$, the number of claims purchased in period 1 that promise to pay one unit of output in the second period in state of nature j. The flow budget constraint for period 1 is thus

$$\frac{q^H}{1+r}b_1^H + \frac{q^L}{1+r}b_1^L = y_1 - c_1. \tag{2.40}$$

As in the incomplete markets case, the second-period flow budget constraint will depend on the realization of output. We continue to use c_2^H and c_2^L to denote second-period consumption in the high-output state of nature and low-output state of nature, respectively. Then

$$c_2^H = b_1^H + y_2^H, \tag{2.41}$$

$$c_2^L = b_1^L + y_2^L. \tag{2.42}$$

Substituting (2.41) and (2.42) into (2.40), we obtain

$$y_1 + \underbrace{\frac{q^H y_2^H + q^L y_2^L}{1+r}}_{\text{Value of claims that can be sold}} = c_1 + \underbrace{\frac{q^H c_2^H + q^L c_2^L}{1+r}}_{\text{Value of claims that can be bought}}. \tag{2.43}$$

As indicated, the second term on the LHS captures the value of all the claims on output that can be sold, whereas the second term on the RHS denotes the value of all claims on consumption that need to be bought.

15. Notice, however, that as far as the consumer is concerned, the risk-free asset is redundant because it can be replicated with contingent claims (see below). For simplicity the consumer's problem below assumes that consumers only purchase contingent claims.