14.05 Lecture Notes

Consumption and Saving

George-Marios Angeletos

MIT Department of Economics

March 4, 2013

Two-Period Consumption/Saving Problem

Consider a household that lives two periods ($t \in \{0,1\}$), faces no uncertainty about its tastes, income, and interest rates, and chooses consumption/savings over these two periods:

$$
\begin{aligned}
&\max U(c_0, c_1) \\
s.t. \quad & c_0 + a_1 \leq (1+R)a_0 + w_0 \\
& c_1 + a_2 \leq (1+R)a_1 + w_1 \\
& a_0 = \bar{a}_0, \quad a_2 \geq 0
\end{aligned}
$$

with $\bar{a}_0 > 0$ exogenously given.

Here, $c_t \geq 0$ denotes consumption in period t, $a_t \leq\geq 0$ denotes the stock of assets in the beginning of period t (equivalently the savings accumulated by the end of period $t-1$), $R_t = R \geq 0$ is the return on these assets (the interest rate between $t-1$ and t), and $w_t \geq 0$ is the wage in period t (also the labor income of the household, since we are fixing labor supply to 1 unit). Finally, $U : \mathbb{R}^2_+ \to \mathbb{R}$ represents the life-time utility function, and is a strictly increasing, strictly concave, and twice differentiable.

Because U is strictly increasing in at least one of its arguments, it is clearly optimal to satisfy the budget constraints with equality and to set $a_2 = 0$: it would have been suboptimal to leave "food on the table". Thus let us set $a_2 = 0$ in the above problem and restate the budget constraints with equality instead of weak inequality.

Next, pick an arbitrary scalar $q_0 > 0$ and multiply both budget constraints by this number; clearly, this does not affect the budget set. Finally, solve the period-1 budget constraint for a_1 and substitute the solution into the period-0 budget constraint.

We can then restate the household's problem as

$$\max U(c_0, c_1)$$

$$s.t. \quad q_0 c_0 + q_1 c_1 = q_0 x_0$$

where

$$x_0 \equiv (1+R)a_0 + w_0 + \frac{q_1}{q_0} w_1$$

$$q_1 \equiv \frac{1}{1+R} q_0$$

(with arbitrary $q_0 > 0$).

Now focus on the following problem:

$$\max U(c_0, c_1)$$
$$s.t. \quad q_0 c_0 + q_1 c_1 = q_0 x_0$$

If I had not told you where this problem came from, all you would see here is a static, micro-style, consumer problem with two goods, whose quantities are denoted by c_0 and c_1 and whose prices are denoted by q_0 and q_1. The fact that these two goods represent consumption "now" and "tomorrow", rather than "apples" and "bananas", makes no formal difference.

Accordingly, note the relative price of two goods reflects the interest rate between the two periods:

$$\frac{q_1}{q_0} = \frac{1}{1+R}$$

An increase in the interest rate therefore translates to a fall in the price of future consumption relative to the price of current consumption.

Furthermore, the "effective wealth" of the household, captured above in x_0, includes not only the initial amount of assets, but also the labor income received in both periods of life.

Finally, it is as if the household faces a single budget constraint, which is given above by $q_0 c_0 + q_1 c_1 = q_0 x_0$. This constraint, which summarizes the constraints put on the dynamic path of consumption from the combination of the two per-period constraints, is customarily called the "intertemporal budget constraint".

Notwithstanding these interpretational issues, we have formalized—and can now proceed to solve—the intertemporal consumption/saving problem of the household as if it were a conventional, static, multi-good consumption problem in microeconomics.

Thus let λ be the Lagrange multiplier on the inter temporal budget constraint and set up the Lagrangian of the aforementioned problem:

$$\mathcal{L} \equiv U(c_0, c_1) + \lambda[q_0 x_0 - q_0 c_0 - q_1 c_1]$$

Taking the FOCs, and assuming an interior solution, we get that the optimal consumption bundle must solve the following system:

$$U_{c0}(c_0, c_1) = \lambda q_0$$

$$U_{c1}(c_0, c_1) = \lambda q_1$$

along with the intertemporal budget constraint

$$q_0 c_0 + q_1 c_1 = \Omega$$

Equivalently, the optimal consumption bundle must solve

$$\frac{U_{c1}(c_0, c_1)}{U_{c0}(c_0, c_1)} = \frac{q_1}{q_0} \qquad \left(\equiv \frac{1}{1+R}\right)$$

along with intertemporal budget constraint.

This can be represented graphically in the usual way: the optimum is where the indifference curve is tangent to the budget line.

Without loss of generality, we can normalize $q_0 = 1$ (remember that only relative prices matter, not nominal/absolute ones).

Now fix x_0 and consider an increase in R (equivalently, a reduction in q_1/q_0, the relative price of future consumption). What happens to the budget line? What do you expect to happen to c_0 and c_1? What are the income and substitution effects at work?

Alternatively, let us set $a_0 = 0$, so that $x_0 = w_0 + \frac{q_1}{q_0} w_1$, and fix w_0 and w_1, but let x_0 vary with q_1/q_0. What happens to the budget line? What do you expect to happen to c_0 and c_1? What are the income and substitution effects at work?

Show the above graphically...

Special case: separable preferences

Now, let as specify the following presences:

$$U(c_0, c_1) = u(c_0) + \beta u(c_1)$$

where $\beta \equiv \frac{1}{1+\rho} \in (0,1)$ is the "subjective discount factor" ($\rho > 0$ is the "subjective discount rate") and u is a strictly increasing, strictly concave, and twice differentiable. Then we can restate the key optimality conditions as

$$u'(c_0) = \beta(1+R)u'(c_1)$$

To interpret this condition, consider an incremental reduction in c_0 by a small $\epsilon > 0$ (equivalently, an incremental increase in savings). This reduces current utility by $u'(c_0)\epsilon$ but raises future consumption by $(1+R)\epsilon$, which in turn raises future utility by $u'(c_1)\epsilon$. Since the latter is discounted in today's terms by β, we conclude that $\beta(1+R)u'(c_1)$ represents the marginal benefit of savings while $u'(c_0)$ represents the marginal cost. At the optimum, the two must be equated, which gives the intuition behind the above condition.

Special case: $R = \rho$

Suppose that the interest rate happens to coincide with the subjective discount factor:

$$R = \rho \qquad (\text{equiv., } \beta(1+R) = 1)$$

Then, the aforementioned optimality condition reduces to $u'(c_0) = u'(c_1)$, which in turn gives

$$c_0 = c_1$$

That is, the household "smoothes" consumption across periods.

The key idea behind this form of consumption smoothing is the following. Because of the curvature of the per-period utility function, the household tends to like a flat consumption plan over his lifecycle. In particular, if the return to savings is just enough to compensate for intertemporal discounting ($R = \rho$), the household will find it optimal to choose a perfectly flat consumption path.

However, if the return to saving is higher, then the household will find it worthwhile to sacrifice some consumption today for the benefit of higher consumption in the future: when the price of current consumption is high relative to future consumption, it is optimal to substitute less consumption today for more consumption today. As a result, when $R > \rho$, the household will choose an upward sloping consumption path ($c_1 > c_0$). Conversely, when $R < \rho$, consumption today is sufficiently cheap relative to consumption tomorrow that the household opts for a downward sloping path ($c_1 < c_0$)

That been said, let us continue with the special case in which $R = \rho$ and, to further simplify, let $a_0 = 0$. We then have that $\frac{q_1}{q_0} = \frac{1}{1+\rho} = \beta$ and that the intertemporal budget becomes

$$c_0 + \beta c_1 = x_0 = w_0 + \beta w_1$$

[Check: How does the above change when $a_0 > 0$?] Using then the optimality condition that $c_0 = c_1$, we conclude that

$$c_0 = c_1 = \tfrac{1}{1+\beta} w_0 + \tfrac{\beta}{1+\beta} w_1$$

which means that the household consumes a certain weighted average of its labor income across its lifetime. This weighted average represents the "annuity value" of lifetime labor income.

Now, note that we have solved for the optimal consumption plan of the household but have not yet specified the saving (or borrowing) that the household is doing between periods 0 and 1 in order to support this optimal plan. To do this, we must simply go back to the per-period budget constraint and figure out the value of a_1 that supports the optimal consumption plan.

Using the period-0 budget (and the fact that $a_0 = 0$ by assumption), we get that a_1 is simply given by

$$a_1 = w_0 - c_1$$

We thus conclude that the following is true:

- if $w_0 > w_1$, then $c_0 < w_0$, $c_1 > w_1$, and $a_1 > 0$.
- if $w_0 = w_1$, then $c_0 = w_0$, $c_1 = w_1$, and $a_1 = 0$.
- if $w_0 < w_1$, then $c_0 > w_0$, $c_1 < w_1$, and $a_1 < 0$.

That is, if the household has lower income when "young" than when "old", then it borrows in order to sustain higher consumption early on for the expense of lower consumption later on. Conversely, if income is higher now than in the future, the household saves in order to bring its consumption in the future at par with its consumption in the present. In either case, the household is smoothing consumption, and saving/borrowing is merely the instrument that facilitates this smoothing.

[Homework: how does the above change if $a_0 > 0$?]

Smoothing vs intertemporal substitution vs wealth effects

Moving away from the case where $R = \rho$, the "consumption smoothing" forces we have described remain present, but now work in tandem with the earlier mentioned intermporal substitution and income effects.

In particular, if $R > \rho$, then the household has an incentive to postpone consumption because future consumption has become "cheaper". The substitution effect thus tends to tilt the optimal consumption plan toward the future: it tends to reduce c_0 and raise c_1 relative to the aforementioned perfect-smoothing benchmark.

At the same time, depending on whether the household was saving or borrowing, there is a positive or negative wealth effect. If the household was saving ($a_1 > 0$, or $c_1 > w_1$), then the amount of present consumption that the household must sacrifice in order to sustain a given level of future consumption decreases with an increase in the interest rate, which means that the household is, in effect, richer. This positive wealth effect tends to raise both c_0 and c_1. If, instead, the household was borrowing, then an increase in R means that the household is, in effect, poorer, which tends to reduce both c_0 and c_1.

Multi-Period Consumption/Saving Problem

- Consider a household named "j" that lives during periods $t \in \{0, 1, ...\tau\}$ for some finite $\tau \geq 1$. Its consumption/saving problem can be expressed as follows:

$$\max \sum_{t=0}^{\tau} \beta^t U(c_t^j) \tag{1}$$

$$s.t. \quad c_t^j + a_{t+1}^j = (1 + R_t)a_t^j + w_t \ell_t^j - T_t \quad \forall t \in \{0, 1, ..., \tau\} \tag{2}$$

$$a_0 > 0 \text{ given} \tag{3}$$

$$a_{\tau+1} \geq 0 \tag{4}$$

  where U is a strictly increasing and strictly concave utility function, c_t^j denotes consumption in period t, a_{t+1}^j denotes saving in period t (equivalently, the assets in the beginning of period $t+1$), ℓ_t^j denotes supply of labor (which is here exogenously fixed), w_t denotes the real wage, R_t denotes the real interest rate between periods $t-1$ and t, and T_t is a lump-sum tax.

- Condition (2) is the period-t budget constraint; (3) is the exogenously given initial amount of assets; and (4) is a constrain that rules out dying in debt.

The Intertemporal Budget

- Pick an arbitrary $q_0 > 0$ (say $q_0 = 1$) and define q_t recursively by

$$q_t = \frac{q_{t-1}}{1 + R_t} = ... = \frac{q_0}{(1 + R_1)(1 + R_2)...(1 + R_t)}.$$

  Note that q_t/q_s represents the price of period$-t$ consumption relative to period$-s$ consumption. Without any loss of generality, we can always normalize $q_0 = 1$ so that $q_t = q_t/q_0$ is the price of period$-t$ consumption relative to period-0 consumption.

- Multiplying the period-t budget by q_t, adding up over all t, and using the fact that the household will optimally set $a_{\tau+1} = 0$, we get

$$\sum_{t=0}^{\tau} q_t \cdot c_t^j = q_0 \cdot x_0^j \tag{5}$$

  where

$$x_0^j \equiv (1 + R_0)a_0^j + h_0^j,$$

$$h_0^j \equiv \sum_{t=0}^{\tau} \frac{q_t}{q_0}[w_t l_t^j - T_t].$$

- Condition (5) is called the "intertemporal budget constraint." It is a constraint on the entire path (sequence) of the consumption of the household over its lifespan.

- To interpret this constraint, note that $(1 + R_0)a_0^j$ is the household's *financial wealth* in the beggining of its life (at $t = 0$), while h_0^j is the present value of the labor income it receives over its life minus any tax obligations; we often call h_0^j the household's *human wealth* as of period 0. The sum $x_0^j \equiv (1+R_0)a_0^j + h_0^j$ therefore represents the household's total, or *effective*, wealth. This constraint therefore reads: the present value of the consumption expenditure of the household cannot exceed its effective wealth.

- Note that the set of per-period budgets (a total of $\tau + 1$ constraints) is a set of constraints on two kinds of endogenous variables: the consumption path $\{c_t\}_{t=0}^{\tau}$ and the saving/borrowing path $\{a_{t+1}\}_{t=0}^{\tau}$. On the other hand, the intertemporal budget constraint (which is a single constraint) is a constraint merely on the consumption path $\{c_t\}_{t=0}^{\tau}$. In effect, when we go from the set of per-period budgets to the single intertemporal budget, we are reducing out the saving/borrowing path. This underscores that saving/borrowing is merely an *instrument* through which the household seeks to attain a particular path in its consumption.

- By the same token, suppose we are given a consumption path $\{c_t\}_{t=0}^{\tau}$ that satisfies the intertemporal budget. Then, we can always find a path of saving/borrowing $\{a_{t+1}\}_{t=0}^{\tau}$ such that the per-period budgets are also satisfied for all t.

- Indeed, by direct analogy to (5), we have that, for any period $s \in \{0, 1, ...\tau\}$,

$$\sum_{t=s}^{\tau} q_t \cdot c_t^j = q_s \cdot x_s^j \equiv q_s \left[(1 + R_s)a_s + h_s^j\right] \tag{6}$$

where $h_s^j \equiv \sum_{t=s}^{\tau} \frac{q_t}{q_s}[w_t l_t^j - T_t]$. In words, the present value of consumption from period s on should equal the sum of the financial wealth of the household in that period and the present value of its labor income from that period on. It follows that

$$(1 + R_s)a_s = h_s^j - \sum_{t=s}^{\tau} \frac{q_t}{q_s} c_t^j$$

or equivalently (using the definition of h_s^j),

$$(1 + R_s)a_s = \sum_{t=s}^{\tau} \frac{q_t}{q_s}[w_t l_t^j - T_t - c_t]. \tag{7}$$

which simply says that the financial wealth of the household in period s (equivalently, its savings/borrowing in period $s-1$) should be just enough to offset any difference between the present value of its net-of-taxes labor income and its consumption from that period on.

- Therefore, we can always solve for the optimal consumption and saving/borrowing in two steps. First, we solve the following quasi-static optimization problem:

$$\max \sum_{t=0}^{\tau} \beta^t U(c_t^j) \tag{8}$$

$$s.t. \sum_{t=0}^{\tau} q_t c_t^j = q_0 x_0^j \tag{9}$$

The solution to this problem gives us the optimal consumption path. Next, once we have the optimal consumption plan, we use (7), or equivalently the set of per-period budgets, to recover the path of a_{t+1} that supports this consumption plan.

- *Important qualification: credit frictions.* The fact that we can replace the set of per-period budgets in (2) with the single intertemporal budget in (9) hinges on the assumption of frictionless credit markets. In particular, suppose that we solve the aforementioned quasi-static optimization problem, which only imposes the intertemporal budget, proceed to recover the path of a_{t+1} that supports the optimal consumption path, and find that, for some t, $a_{t+1} < 0$. This means that the household must borrow in period t in order to attain its optimal consumption path. But say that credit markets are imperfect and households are unable to borrow. Then, clearly, the aforementioned path will no more be feasible. The consumption path that is optimal in the presence of borrowing constraints and other credit frictions could thus be very different from the one that is optimal in the absence of such frictions, which is all that we have been studying so far. We will revisit this issue in due course. For the time being, let us put this qualification and continue analyzing the problem in the absence of credit frictions.

- To characterize the optimal consumption plan, we can set up the Lagrangian for the quasi-static optimization problem in (8)-(9). Letting $\lambda > 0$ be the Lagrange multiplier on the (single) intertemporal budget constraint, we have that the Lagragian of the problem is

$$\mathcal{L} = \sum_{t=0}^{\tau} \beta^t U(c_t) + \lambda \left\{ q_0 x_0 - \sum_{t=0}^{\tau} q_t c_t \right\} \tag{10}$$

  (Note that I have dropped the j superscript in order to simplify notation.) For any $t \in \{0, 1, ..., \tau\}$, the FOC with respect to c_t gives

$$\beta^t U'(c_t) = \lambda q_t, \quad \forall t \in \{0, 1, ..., \tau\}, \tag{11}$$

  Furthermore, since the objective is strictly concave in the choice vector $\{c_t\}_{t=0}^{\tau}$ and the constraint is linear in this vector, the combination of these FOCs conditions along with the intertemporal budget constraint are both necessary and sufficient for optimality, and pin down a unique optimal path.

- Note that the aforementioned FOCs gives us $\tau + 1$ equations (as many as the periods). Combining with the intertemporal budget, we get $\tau + 2$ equations. At the same time, we have $\tau + 2$

unknowns: the $\tau+1$ consumption levels (one for each period) and the Lagrange multiplier λ. Therefore, we have as many equations as unknowns. The existence and uniqueness of a solution to this system follows from the existence and uniqueness of the optimum, which in turn is guaranteed by the continuity and strict concavity of U

- It is useful to rewrite the FOCs in a way that reduces out the Lagrange multiplier. In particular, if we take the FOC for period $t+1$ and divide it, side by side, with the FOC for period t, we get the following set of equivalent optimality conditions:

$$\frac{U'(c_t)}{\beta U'(c_{t+1})} = \frac{q_t}{q_{t+1}} \equiv 1 + R_{t+1} \quad \forall t \in \{0, 1, ..., \tau - 1\}, \tag{12}$$

  This condition, which is known as the "intertemporal Euler condition", has a straightforward interpretation: the MRS between consumption in t and consumption in $t+1$ must equal the corresponding price ratio, which itself equal one plus the interest rate between t and $t+1$.

- Note then that an increase in R_{t+1} is necessarily associated with an increase in $\frac{U'(c_t)}{\beta U'(c_{t+1})}$. Since U is strictly concave, and therefore U' is strictly decreasing, this means that an increase in the interest rate induces the household to tilt its consumption from period t to period $t+1$: when the relative price of a good increases, the consumer substitutes away from that good.

The Consumption Problem with CEIS Preferences

- To get a sharper characterization of the optimal consumption plan, we now impose that the utility function takes the following isoelastic, or power, form:

  $$U(c) = \frac{c^{1-1/\theta}}{1-1/\theta}$$

  where $\theta > 0$ is an exogenous scalar.

- You can check that θ coincides with the elasticity of substitution between the two goods c_t and c_{t+1} evaluated at the point $c_t = c_{t+1} = \bar{c}$, for arbitrary $\bar{c}$. In this sense, θ parameterizes the willingness of the household to substitute consumption from one period to another. We thus customarily refer to θ as the "Elasticity of Intertemporal Substitution" (EIS). And because this elasticity is constant (invariant to the level of consumption), we refer to the aforementioned preference specification as "CEIS preferences" (for Constant Elasticity of Intertemporal Substitution). This is formally analogous to the standard CES preferences you must have seen in micro.

- With this specification for U, we have that $U'(c) = c^{-1/\theta}$ and therefore the intertemporal Euler condition (12) becomes

$$\frac{c_t^{-1/\theta}}{\beta c_{t+1}^{-1/\theta}} = \frac{q_t}{q_{t+1}} \equiv (1 + R_{t+1}) \tag{13}$$

or equivalently

$$\frac{c_{t+1}}{c_t} = [\beta(1 + R_{t+1})]^\theta \tag{14}$$

The growth rate of consumption between t and $t+1$ is therefore an increasing function of the corresponding interest rate, underscoring the substitution effect we discussed above.

- In fact, you can take the log of the above condition and use the fact that $\log(1 + x) \approx x$ for any small number x and that $\beta = 1/(1 + \rho)$ to rewrite this condition as

$$\log c_{t+1} - \log c_t \approx \theta(R_{t+1} - \rho)$$

We thus see that the slope of the (log)consumption path is determined by the difference between the real interest rate and the subjective discount rate, multiplied by the EIS.

- In particular, consumption grows over time if and only if the interest rate exceeds the subjective discount rate; and for any given gap between the interest rate and the discount rate, the associated consumption growth is higher the higher the EIS. These properties underscore the role of discounting and intertemporal substitution. When $R = \rho$, the return to saving is just enough to compensate for the subjective cost of postponing consumption. When $R > \rho$, the return to saving outweighs the subjective cost of postponing consumption (equivalently, the relative price of consumption today is particularly high) and induces the consumer to substitute away from current consumption to future consumption. The higher the EIS θ, the more the consumer is willing to substitute for any given relative prices, and the higher the optimal consumption growth for any given gap between the interest rate and the discount.

- Finally, to get a closed-form solution to the optimal consumption levels, we proceed as follows. First, using (13) recursively, we have that, for all t,

$$c_t = c_0(\beta^t)^\theta \left(\frac{q_t}{q_0}\right)^{-\theta}.$$

Substituting this into the intertemporal budget constraint and solving for c_0 we conclude that

$$c_0 = m_0 \cdot x_0$$

where

$$m_0 \equiv \frac{1}{\sum_{t=0}^{\tau} \left(\beta^t\right)^\theta \left(q_t/q_0\right)^{1-\theta}}.$$

Consumption is thus linear in effective wealth and m_0 represents the MPC (marginal propensity to consume) out of effective wealth as of period 0.

- Question: how does m_0 depend on the sequence of interest rates from 0 up to τ? What about x_0? Identify and interpret the competing income and substitution effects of interest rates on consumption.

- Consider now the special case in which the interest rate equal the discount rate, so that $R = \rho$ and $\beta(1+R) = 1$. Then, the Euler condition implies

$$c_t = c_0 \quad \forall t,$$

which together with the budget constraint (and letting $a_0 = 0$ for simplicity) gives

$$c_t = c_0 = \frac{\sum_{s=0}^{\tau+1} q_s w_s}{\sum_{s=0}^{\tau+1} q_s} \qquad \forall t$$

Consumption is therefore flat over time and its level is pinned down by the annuity value of labor income. You can think of this as follows: the consumer sells the entire stream of his labor income to a bank, receives the present value of this stream, deposits it to a savings account with interest rate R, and thereafter consumes the return of this account, plus a constant amount that is just enough to guarantee that the balance of the account becomes zero exactly at the moment the household dies (at $t = \tau$).

- To simplify further, take the limit as $\rho(= R) \to 0$ (zero discounting and zero interest). In this case, $q_t = q_0(= 1)$ for all t and the optimal consumption reduces to

$$c_t = c_0 = \frac{1}{\tau+1}\sum_{s=0}^{\tau+1} w_s \qquad \forall t$$

  That is, the household consumes the average of the labor income he receives over this lifetime. How is this achieved through borrowing and saving? In periods where his income is lower than average he runs down his savings or borrows; in periods where his income is higher than average, he accumulates savings or pays back any previous borrowing.

- When the interest rate is constant over time but different than the discount rate, the same general principle applies: the household uses saving and borrowing to transfer resources from periods where his income is relatively high to periods where his income is relatively low in order to "smooth" his consumption and insulate it from the fluctuations in his income. Formally, $\log c_t$ is a linear function of t, no matter how much $\log w_t$ fluctuates over time. The only difference is that the optimal consumption path is not necessarily flat: it can have either a positive or a negative slope, depending on whether the interest rate is higher or lower than discounting. As explained earlier, this slope is given by $\theta(R-\rho)$. We conclude that $\log c_t$ is a linear function of t, with slope equal to $\theta(R-\rho)$.

- Finally, suppose that the interest rate varies over time. Then, it is no more optimal to perfectly smooth consumption: $\log c_t$ is no more linear in t. Instead, in periods where the interest rates are relatively higher, it is optimal to tilt the consumption path upwards (i.e., to increase the growth rate of consumption); conversely, in periods where the interest rate is lower, it is optimal to tilt downwards (i.e., to reduce the growth rate of consumption). Therefore, variation in interest rates justify deviations from consumption smoothing, and can cause consumption to fluctuate even in the absence of any fluctuation in income.

- To recap, the key lessons we get from all the preceding analysis are the following: Other things equal, it is desirable to smooth consumption over time and to insulate consumption from income fluctuations. To the extent that households can freely borrow and save, consumption is therefore insulated from income fluctuations. What, instead, drives fluctuations in consumption is only fluctuations in interest rates—or, of course, in the ability to borrow and save.

Applications (mentioned in class and for you to think)

- Consider the lifecycle of the typical individual. When is his income relatively higher? When is it relatively lower? When do you expect him to borrow and when to save?

- Suppose an individual looses his job. Should he run down his savings and borrow? How does the response of his optimal consumption and saving/borrowing depends on the likely length of his unemployment spell?

- Interpret a whole country as a consumer that can borrow and save in international capital markets. Borrowing more from other countries means running a current account deficit; saving more abroad means running a current account surplus. Suppose now that the interest rate at which the country can save or borrow falls. How does this affects the country's optimal consumption in the present and how in the future? How does this depends on whether the country was a borrower or a saver?

- Consider either the case of the United States or the case of southern european countries such as Greece, Spain and Italy. During the 10 years or so before the crisis, these countries experienced a fall in the interest rates in which they could borrow from other countries. In the case of Greece, Spain and Italy, the fall in interest rates was probably the byproduct of entering the EuroZone; in the case of the US, some argue this was because of the increase in demand for US treasury bills and other US assets from China. Around the same time interval, these countries experience a consumption boom and a worsening of their current account. Are these facts—the reduction in interest rates, the consumption boom, and the current-account imbalances—consistent with one another under the lenses of the theory we have developed? If this is the right explanation of what happened, is there a case that the current account deficits of these countries were suboptimal, or excessive, and that their governments should have done something to correct them?

- Consider an economy that enters a recession. According to the theory we have develop, do you expect domestic consumption to fall as much as domestic income, more, or less? How does this may depend on whether the country is open (can borrow and save abroad) or closed?

- If the economy is closed, what is the instrument through which the country can smooth its consumption over time? If the economy is open, what is the additional instrument it can use?