Micro-foundations: Consumption

Instructor: Dmytro Hryshko

Why Study Consumption?

Consumption is the largest component of GDP (e.g., about 2/3 of GDP in the U.S.)

J. M. Keynes's Conjectures about the Consumption Function

1. $0 \leq MPC \leq 1$: out of each additional dollar, we spend MPC and save $1 - MPC$ dollars.
2. The average propensity to consume, $APC = \frac{C}{Y}$, falls as income increases. I.e., richer people save a higher proportion of their incomes.
3. Consumption is not responsive to the real interest rate.

The Keynesian Consumption Function

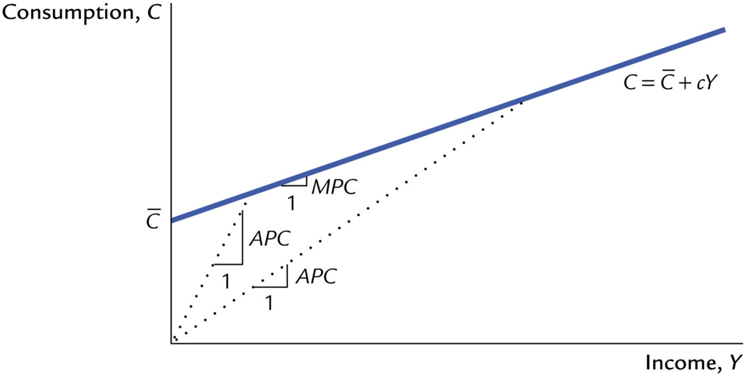
Summarizing, the Keynesian consumption function can be written as:

$$C = \overline{C} + \underbrace{c}_{=MPC} \times Y, \quad \overline{C} > 0, \quad 0 < c < 1.$$

$$APC = \frac{C}{Y} = \frac{\overline{C}}{Y} + c,$$

where Y is (disposable=after-tax) income.

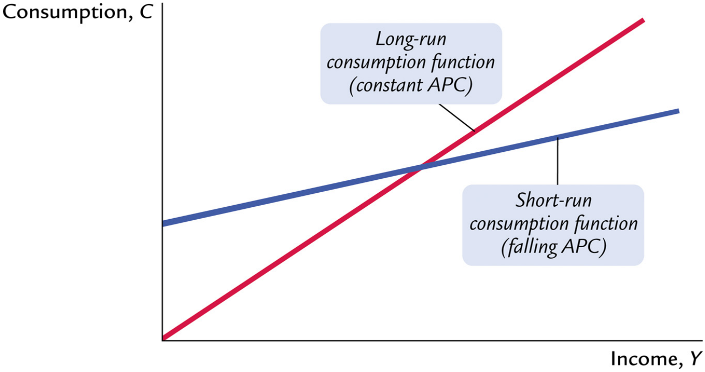
The Keynesian consumption function



Successes and Failures

- Successes
  - Household data: $0 < MPC < 1$, APC is smaller for higher income households.
  - Aggregate data (in-between the wars, when income was low): the ratio of C to Y was high; Y was the primary determinant of C.
- Failures
  - Falling APC+rising incomes during the WWII would lead to a *secular stagnation*—a long depression in absence of changes in G or T. This prediction about falling APC did not hold.
  - S. Kuznets assembled consumption and income data back to 1869. $\frac{C}{Y}$, i.e. the APC was stable (no trend).

Reconciliation of successes and failures: two consumption functions—for the short- and the long-runs



I. Fisher and the Intertemporal Choice

In reality, consumption responds not only to changes in *current* income but also to changes in (expected) income from future periods.

A Two-Period Model: The Consumption-Savings Decision and Credit Markets

Topics

1. Consumer's consumption/savings decision—responses of consumer to changes in income and interest rates.
2. Government budget deficits and the Ricardian Equivalence Theorem

A Consumer's Consumption/Savings Decision

- Decision involves a tradeoff between current and future consumption.
- Dynamic Decision: It has implications over more than one period of time.
  - By saving, a consumer gives up consumption in exchange for assets in the present to consume more in the future.
  - By borrowing, a consumer gains more current consumption sacrificing future consumption when the loan is repaid. (Borrowing is negative saving.)

The Consumer's Current-Period Budget Constraint

- Consumption (c) plus savings (s) in the current period must equal disposable income in the current period.
- Each consumer has real income y and pays lump-sum taxes t in the current period.

$$c + s = y - t \tag{1}$$

The Consumer's Future-Period Budget Constraint

- In the future period, the consumer has disposable income $y' - t'$ and receives the interest and principal on his or her savings, which totals $(1+r)s$.

$$c' = y' - t' + (1+r)s \tag{2}$$

The Consumer's Lifetime Budget Constraint

Solve (2) for s:

$$s = \frac{c' - y' + t'}{1 + r} \tag{3}$$

Substitute (3) in (1) obtaining lifetime budget constraint:

$$c + \frac{c'}{1 + r} = y - t + \frac{y' - t'}{1 + r} \tag{4}$$

Consumer's Lifetime Wealth

The present value of lifetime disposable income is the quantity of resources that the consumer has available to spend on consumption, in present-value terms, over his or her lifetime.

$$we(alth) = y - t + \frac{y' - t'}{1 + r} \tag{5}$$

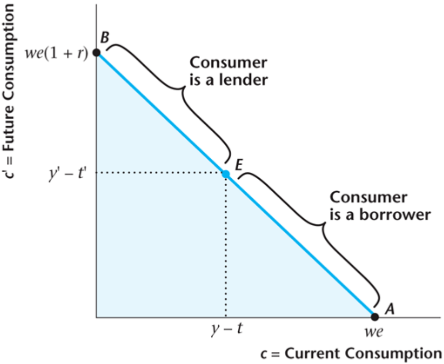
Consumer's Lifetime Budget Constraint

Substitute (5) in (4):

$$c + \frac{c'}{1+r} = we \tag{6}$$

$$c' = \underbrace{-(1+r)}_{\text{slope}} c + \underbrace{we(1+r)}_{\text{intercept}} \tag{7}$$

Consumer's Lifetime Budget Constraint

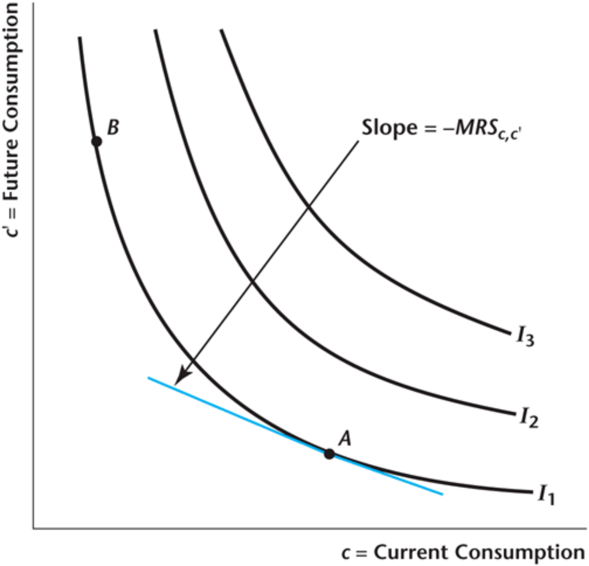


The lifetime budget constraint defines the quantities of current and future consumption the consumer can acquire, given current and future income and taxes, through borrowing and lending in the credit market.

Optimization

If the preferences are represented by utility function $U = U(c, c')$, then the consumer chooses c and c' that bring the highest utility index such that the budget constraint is exhausted.

A Consumer's Indifference Curves



Consumer Optimization

Marginal condition that holds when the consumer is optimizing:

$$MRS_{c,c'} = 1 + r \tag{8}$$

The marginal rate of substitution of current consumption for future consumption is equal to the relative price of current consumption in terms of future consumption.

Optimization

The highest possible utility is achieved at the point (c^*, c'^*), where *the slope of the indifference curve* is equal to *the slope of the budget constraint*.

Optimization

- The *indifference curve*: any combination of c and c' that bring the same utility index U. The slope of indifference curve is defined from: $dU = MU_1 dc + MU_2 dc'$, or $0 = MU_1 dc + MU_2 dc'$, i.e.,

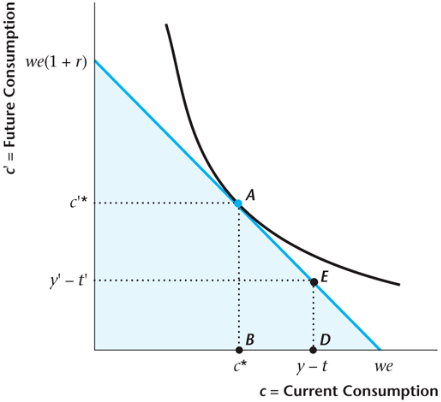
- The slope of the budget constraint: $-(1+r)$.

- When consumer maximizes utility, *on the margin*, the benefit of adjusting his optimal bundle of (c^*, c'^*) should be zero. *The period-1 cost* of reducing consumption by dc is $MU_1 \cdot dc$, and *the period-2 benefit* of this reduction is $MU_2 \cdot dc \cdot (1+r)$.

  Thus, at the optimum: $MU_1 \cdot dc = MU_2 \cdot dc \cdot (1+r)$, or

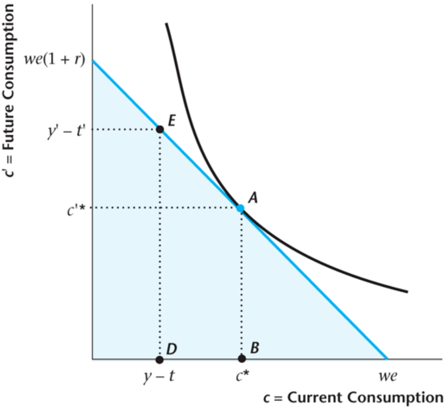
$$-\frac{MU_1}{MU_2} = -(1+r).$$

A Consumer Who Is a Lender



The optimal consumption bundle for the consumer is at point A. The consumer is a lender, as the consumption bundle chosen implies positive savings, with E being the endowment point.

A Consumer Who Is a Borrower

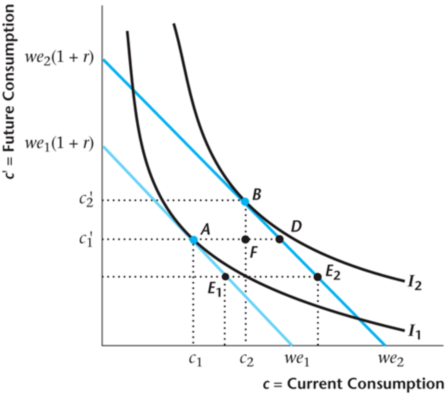


The optimal consumption bundle for the consumer is at point A. Because current consumption exceeds current disposable income, saving is negative, and so the consumer is a borrower.

An Increase in Current Income for the Consumer

- Because current-period and future consumption are normal goods, consumption in both periods increases.
- Saving increases.
- The consumer acts to smooth consumption over time.

The Effects of an Increase in Current Income for a Lender

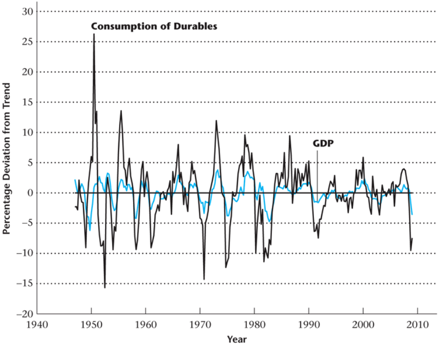


An increase in current income increases lifetime wealth form we_1 to we_2, shifting the lifetime budget constraint to the right and leaving its slope unchanged, because the real interest rate does not change. Initially, the consumer chooses A, and he or she chooses B after current income increases.

Observed Consumption-Smoothing Behavior

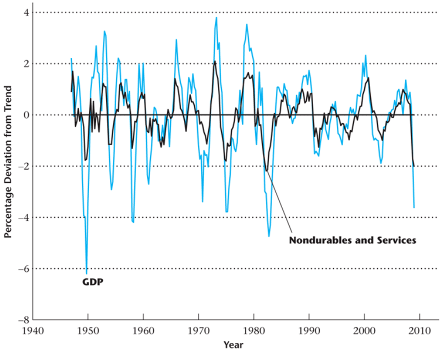
- Aggregate consumption of nondurables and services is smooth relative to aggregate income, but the consumption of durables is more volatile than income.
- This is because durables consumption is economically more like investment than consumption.

Percentage Deviations from Trend in Consumption of Durables and Real GDP



The consumption of durables is economically similar to investment expenditures, which is why consumer durables expenditure is more volatile than real GDP.

Percentage Deviations from Trend in Consumption of Nondurables and Services and Real GDP.

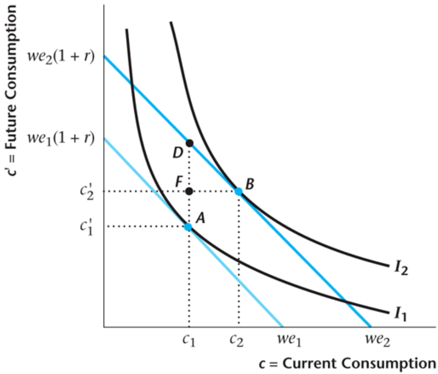


The consumption of nondurables and services is fairly close to a pure flow of consumption services. Consumption of nondurables and services is much smoother than real GDP, reflecting the motive of consumers to smooth consumption relative to income.

An Increase in Future Income for the Consumer

- Current and future consumption increase.
- Saving decreases.
- The consumer acts to smooth consumption over time.

The Effects of an Increase in Future Income

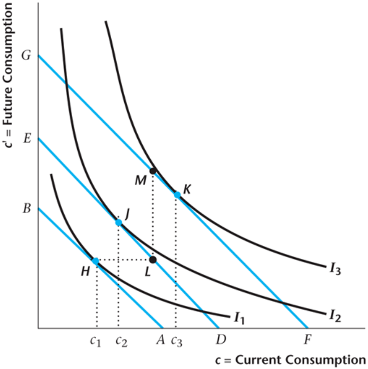


An increase in future income increases lifetime wealth form we_1 to we_2, shifting the lifetime budget constraint to the right and leaving its slope unchanged. The consumer initially chooses point A, and he or she chooses B after the budget constraint shifts.

Temporary and Permanent Increases in Income

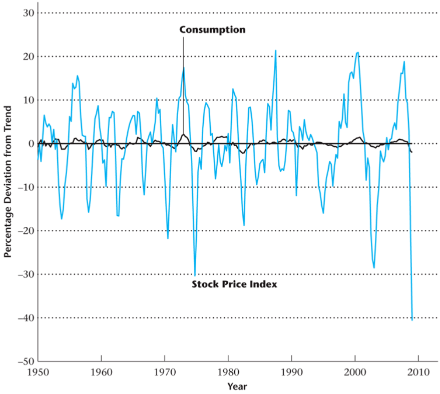
- A consumer will tend to save most of a purely temporary income increase.
- As a permanent increase in income will have a larger effect on lifetime wealth than a temporary increase, there will be a larger effect on current consumption.

Temporary versus Permanent Increases in Income



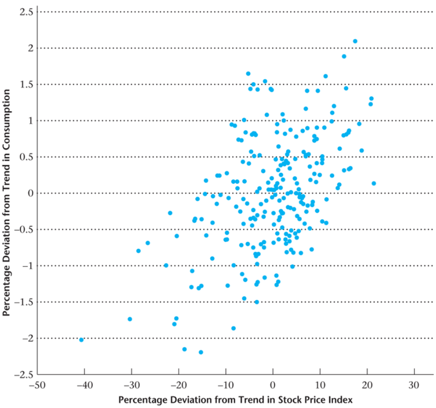
- A temporary increase in income is an increase in current income, with the budget constraint shifting from AB to DE and the optimal consumption bundle changing form H to J.
- When there is a permanent increase in income, current and future income both increase, and the budget constraint shifts from AB to FG, with the optimal consumption bundle changing from H to K.

Stock Prices and Consumption of Nondurables and Services



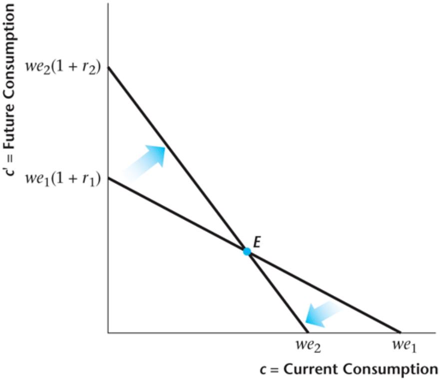
Percentage deviations from trend in stock prices and consumption are positively correlated, although stock prices are much more volatile than consumption.

Scatter Plot: Consumption of Nondurables and Services vs. Stock Price Index



Positive correlation between stock prices and consumption.

An Increase in the Real Interest Rate

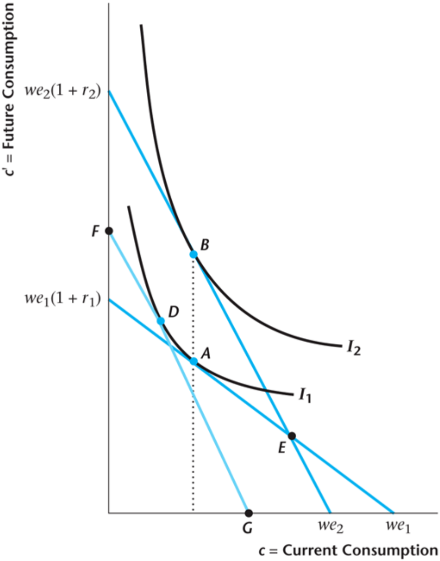


An increase in the real interest rate causes the lifetime budget constraint of the consumer to become steeper and to pivot around the endowment point E.

An Increase in the Market Real Interest Rate

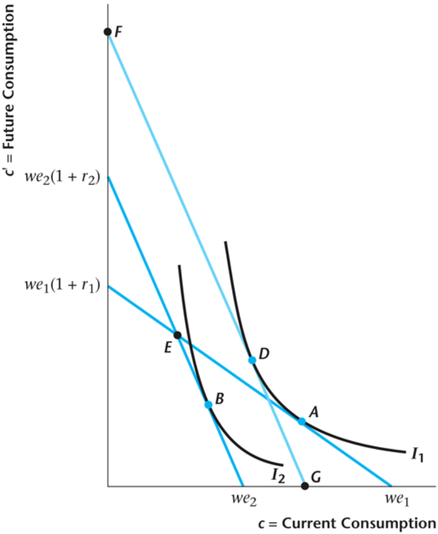
- The relative price of future consumption goods in terms of current consumption goods decreases—this has income and substitution effects for the consumer.
- It changes the slope of the budget constraint.
- Changes in the real interest rate are an important part of the mechanism by which shocks to the economy, fiscal policy, and monetary policy affect real activity.

An Increase in the Real Interest Rate for a Lender



When the real interest rate increases for a lender, the substitution effect is the movement from A to D, and the income effect is the movement from D to B. Current consumption and saving may rise or fall, while future consumption increases.

An Increase in the Real Interest Rate for a Borrower



When the real interest rate increases for a borrower, the substitution effect is the movement from A to D, and the income effect is the movement from D to B. Current consumption decreases while saving increases, and future consumption may rise or fall.

Effects of an Increase in the Real Interest Rate for a Lender

Current consumption	?
Future consumption	Increases
Current savings	?

Effects of an Increase in the Real Interest Rate for a Borrower

Current consumption	Decreases
Future consumption	?
Current savings	Increases

Example: Perfect Complements (1)

With perfect complements, the ratio of future consumption to current consumption is constant.

$$c' = ac \tag{9}$$

The consumer's budget constraint must hold:

$$c + \frac{c'}{1+r} = we \tag{10}$$

Example: Perfect Complements (2)

With perfect complements, we can solve explicitly for current and future consumption:

$$c = \frac{we(1+r)}{1+r+a} \tag{11}$$

$$c' = \frac{awe(1+r)}{1+r+a} \tag{12}$$

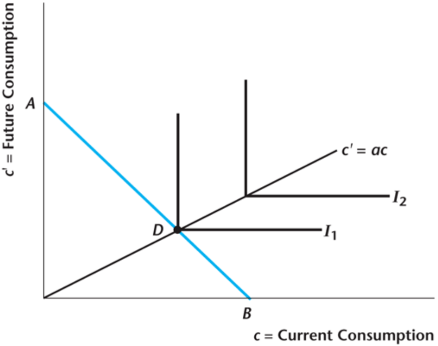
Example: Perfect Complements (3)

Substituting (5) in (11) and (12)

$$c = \frac{(y-t)(1+r)+y'-t'}{1+r+a} \tag{13}$$

$$c' = a\left[\frac{(y-t)(1+r)+y'-t'}{1+r+a}\right] \tag{14}$$

Example with Perfect Complements Preferences



The consumer desires current and future consumption in fixed proportions, with $c' = ac$. With indifference curves representing perfect complementarity between current and future consumption, the optimal consumption bundle is at point D on the lifetime budget constraint AB.

Government Budget Constraints (1)

- The government wishes to purchase G consumption goods, given exogenously.
- The aggregate quantity of taxes collected by the government is T. There are N consumers who each pay a current tax of t, so that $T = Nt$.
- The government can borrow by issuing bonds B, bearing the interest rate r.

Government Budget Constraints (2)

The government's current-period budget constraint:

$$G = T + B \tag{15}$$

The government's future-period budget constraint:

$$G' + (1 + r)B = T' \tag{16}$$

The Government't Present-Value Budget Constraint

Solving (16) for B:

$$B = \frac{T' - G'}{1+r} \tag{17}$$

Substitute (17) in (15):

$$G + \frac{G'}{1+r} = T + \frac{T'}{1+r} \tag{18}$$

Competitive Equilibrium

The market in which the N consumers and the government interact is the credit market, they are effectively trading future consumption goods for current consumption goods.

In a competitive equilibrium for this two-period economy, three conditions must hold:

1. Each consumer chooses first- and second-period consumption and savings optimally given the real interest rate r.
2. The government present-value budget constraint holds.
3. The credit market clears.

Credit Market Equilibrium Condition

Total private savings is equal to the quantity of government bonds issued in the current period:

$$S^p = B \tag{19}$$

Income-Expenditure Identity

Credit market equilibrium implies that the income-expenditure identity holds:

$$Y = C + G \tag{20}$$

The Ricardian Equivalence Theorem (1)

- This theorem states that a change in the timing of taxes by the government is neutral.
- Neutral means that in equilibrium a change in current taxes, exactly offset in present-value terms by an equal and opposite change in future taxes, has no effect on the real interest rate or on the consumption of individual consumers.

The Ricardian Equivalence Theorem (2)

Substitute $T = Nt$ and $T' = Nt'$ in (18):

$$G + \frac{G'}{1+r} = Nt + \frac{Nt'}{1+r} \tag{21}$$

$$t + \frac{t'}{1+r} = \frac{1}{N}\left[G + \frac{G'}{1+r}\right] \tag{22}$$

Key equation: The consumer's lifetime tax burden is equal to the consumer's share of the present value of government spending—the timing of taxation does not matter for the consumer.

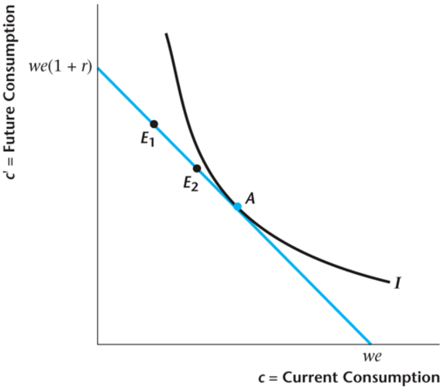
The Ricardian Equivalence Theorem (3)

Substitute (22) in (4):

$$c + \frac{c'}{1+r} = y + \frac{y'}{1+r} - \frac{1}{N}\left[G + \frac{G'}{1+r}\right] \tag{23}$$

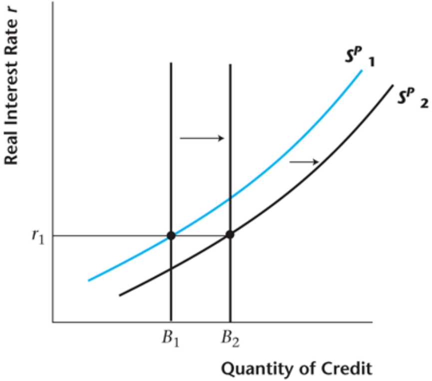
Taxes do not matter in equilibrium for the consumer's lifetime wealth, just the present value of government spending.

Ricardian Equivalence with a Cut in Current Taxes for a Borrower



A current tax cut with a future increase in taxes leaves the consumer's lifetime budget constraint unchanged, and so the consumer's optimal consumption bundle remains at A. The endowment point shifts from E_1 to E_2, so that there is an increase in saving by the amount of the current tax cut.

Ricardian Equivalence and Credit Market Equilibrium



With a decrease in current taxes, government debt increases form B_1 to B_2, and the credit supply curve shifts to the right by the same amount. The equilibrium real interest rate is unchanged, and private saving increases by an amount equal to the reduction in government saving.

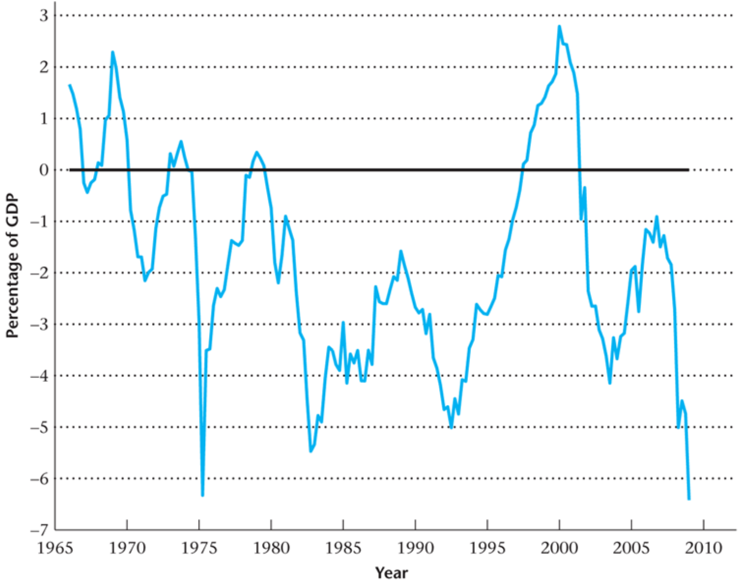
Key assumptions behind the Ricardian equivalence

- Each individual shares equal burden of taxes
- Any debt issued is paid off during the lifetime of the people alive when the debt was issued
- Taxes are lump-sum
- Perfect credit markets (same interest rate for borrowing and lending, no limit on borrowing and lending subject to the lifetime budget constraint)

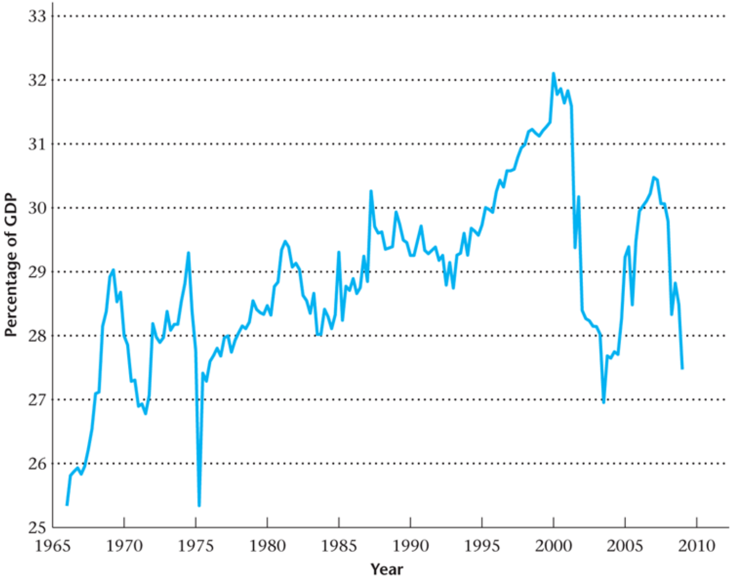
Government Deficits, Taxes, and Government Debt

- The government deficit exceeded 6% of GDP in 2009.
- Taxes have fallen due to the Bush tax cuts and the recession.
- The government debt to GDP ratio has risen to almost 80%.

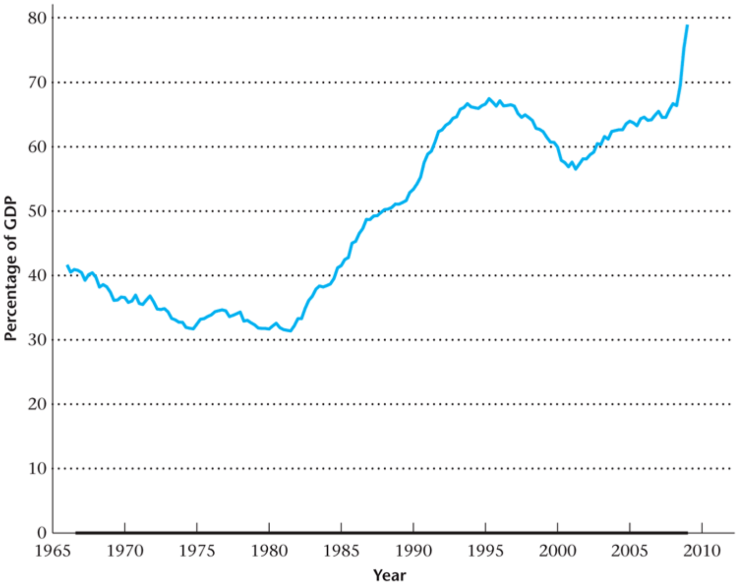
Total Government Surplus as a Percentage of GDP



Taxes as a Percentage of GDP



Federal Government Debt as a Percentage of GDP



Question

What happens if the U.S. runs government deficits of 5% to 10% of GDP forever?

Assumptions

- Suppose real GDP grows at its average rate, 3% per year, forever: $Y_t = Y_0(1+g)^t$
- Suppose the primary deficit (G+Transfers–T) is a constant fraction of GDP forever: $a \cdot Y_0(1+g)^t$ (e.g., a=–5%, or –10%)
- Suppose the real interest rate, r, is 1% per year, forever.
- Debt at time t is:
  $B_t = (1+r)B_{t-1} - aY_t = (1+r)B_{t-1} - a \cdot Y_0(1+g)^t$.

Debt to GDP ratio

$$\begin{aligned}\frac{B_t}{Y_t} &= (1+r)\frac{B_{t-1}}{Y_t} - a \\ &= (1+r)\frac{B_{t-1}}{Y_{t-1}}\frac{Y_{t-1}}{Y_t} - a \\ &= \frac{1+r}{1+g}\frac{B_{t-1}}{Y_{t-1}} - a\end{aligned}$$

It can be shown that

$$\frac{B_t}{Y_t} = -a(1+g)\frac{1-\left(\frac{1+r}{1+g}\right)^{t+1}}{g-r} \approx -\frac{a(1+g)}{g-r},$$

for large t, and $g > r$. If, e.g., $a = -5\%$, in the long run

$$\frac{B_t}{Y_t} \approx \frac{0.05(1+0.03)}{0.03-0.01} = 2.575,$$

or 257.5%.

Conclusions

- Primary deficit of 5% of GDP forever implies: Debt/GDP ratio of 257.5% in the long run (more than 3 times current ratio of 80%), with 2.6% of GDP spent on interest payments on the government debt per year in the long run.
- Primary deficit of 10% of GDP forever implies: Debt/GDP ratio of 515% in the long run (more than 6 times the current ratio), with 5.2% of GDP spent on interest payments on the government debt.

Liquidity=credit Constraints

If the consumer is a would-be-borrower but cannot borrow, i.e., is liquidity constrained, then this consumer's c will be equal to y (current consumption equals current income).

Thus, for liquidity constrained consumers current consumption is determined by current income.

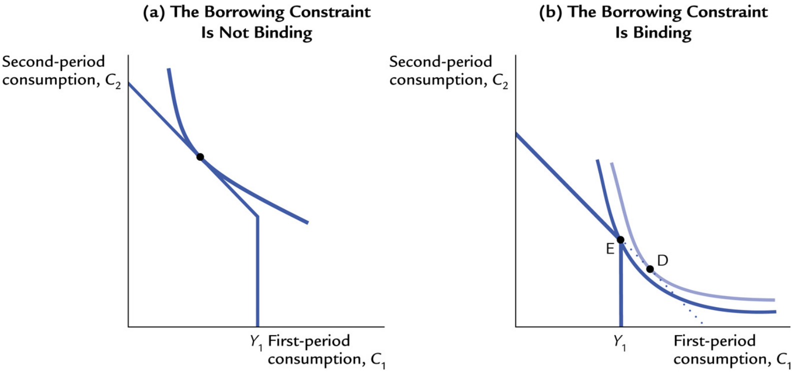
Consider first the problem without liquidity constraints. Then, (c^*, c'^*) should satisfy 2 equations. The Euler equation:

$$MU_1(c^*) = (1+r)MU_2(c'^*),$$

and the budget constraint:

$$c^* + \frac{c'^*}{1+r} = y + \frac{y'}{1+r}.$$

With liquidity (borrowing) constraints, c cannot be larger than y, that is, $c \leq y$. If the unconstrained problem gives you $c^* \leq y$, then we say the constraint is not binding—consumer is a saver anyways. Otherwise, if $c^* > y$, the maximum this consumer can have in period 1 is y. Summarizing, $c^*_{bc} = \min\{c^*, y\}$; $c'^*_{bc} = c'^*$ if $c^*_{bc} = c^*$, $c'^*_{bc} = y'$ otherwise.


(a) The Borrowing Constraint Is Not Binding
Second-period consumption, C_2
Y_1
First-period consumption, C_1
(b) The Borrowing Constraint Is Binding
Second-period consumption, C_2
E
D
Y_1
First-period consumption, C_1

Example

Let the utility function be $U(c, c') = \log(c) + \beta \log(c')$, where log is the natural logarithm. Let $y = 40$, $y' = 80$, no taxes, $r = 0.05$, $\beta = 0.90$. First, assume that consumer is unconstrained.

For this utility function, $MU_1 = \frac{1}{c}$, and $MU_2 = \beta \frac{1}{c'}$. The Euler equation tells us that $\frac{1}{c} = \beta(1+r)\frac{1}{c'}$, or $c'^* = \beta(1+r)c^*$. Plug this result into the budget constraint to obtain,
$c^* + \frac{\beta(1+r)c'^*}{1+r} = y + \frac{y'}{1+r}$, or
$c^* = \frac{1}{1+\beta}\left[y + \frac{y'}{1+r}\right] = \frac{1}{1.90}[40 + 80/(1.05)] \approx 61$. Thus,
$c'^* = 0.90 * (1.05) * 61 \approx 57.8$.

If consumer is constrained this implies that $c^*_{bc} \leq y$, and $c^*_{bc} = \min\{61, 40\} = 40$. Also, $c'^*_{bc} = y' = 80$. You can also show that the liquidity constrained consumer will be worse off.

The Life-Cycle Hypothesis

- Idea: want to smooth consumption over the life cycle. Thus, need to save during the working life to support consumption during retirement.

Assume consumer prefers a smooth consumption path; will live T more years; will work for another R years; has wealth of W; and will receive a sure income Y during the working years.

The lifetime wealth is $W + R \times Y$. Then,

$$C = (W + R \times Y)/T = W/T + (R/T) \times Y = \alpha \times W + \beta \times Y.$$

Thus, $\frac{C}{Y} = \alpha \times (W/Y) + \beta$.

In the short run, for a fixed W, an increases in Y leads to a falling APC; in the long run, W and Y grow together, and C/Y is stable.

Milton Friedman's Permanent Income Hypothesis

Milton Friedman postulated the following model of consumption:

$$Income: \quad Y = Y^T + Y^P,$$

$$Consumption: \quad C = Y^P.$$

Y^P is *the permanent income* (the component of income that persists over time); Y^T is *the transitory income* (short-lived components of income such as bonuses, overtime, windfalls from lottery etc.)

The Permanent Income Hypothesis (PIH)

Implications:

- Consumption changes by the magnitude of a change in *permanent income*. Transitory changes in income are predominantly saved.

- $APC = \frac{C}{Y} = \frac{Y^P}{Y}$. In the household studies, most of variation in $\frac{Y^P}{Y}$ comes from the transitory variation in income. Thus, if $Y > Y^P$, $C < Y$, and the APC is falling.

- In the long time series, most of variation in Y comes from the variation in Y^P, and so APC will be stable.

Hall's Formulation of the PIH

PIH: consumption depends on Y^P, and therefore on expectations of the lifetime income.

Consumption then responds only to the "news" (unexpected changes, or "surprises") about lifetime income.

Robert Hall: if the *PIH* holds, and consumers form rational expectations, then *changes in consumption* are *unpredictable*.

Importantly, under the *PIH* only *unexpected* changes in policy influence consumption.

Readings

Mankiw and Scarth. Chapter 17 (Consumption), and Section 16-4 (Ricardian equivalence).

Stephen Williamson. 2013. Macroeconomics. Fourth Canadian Edition. Chapter 9.