To Save or To Consume:
Linking Growth Theory with the Keynesian Model

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July, 2005

Abstract: In the neoclassical growth theory, higher saving rate gives rise to higher output per capita. However, in the Keynesian model, higher saving rate causes lower consumption, which may lead to a recession. Students may ask, “Should we save or should we consume?” In most of the macroeconomics textbooks, economic growth and Keynesian economics are taught in separate, sometimes unsequential, chapters. The connection between the short run and the long run is not apparent. The author builds a bridge between the neoclassical growth theory and the Keynesian model. He links the Solow diagram and the IS-LM curves and depicts the short-run to long-run transition of the economy after changes in saving and other macroeconomic policies.

Keywords: Keynesian model, medium-run adjustment, neoclassical growth theory
JEL codes: A2, E1, E2, O4

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Conventional wisdom tells us that people who save will become rich and people who spend all they have will end up poor. The neoclassical growth theory demonstrates that this is true for an economy as a whole: saving is a key determinant of the long-run steady state level of output per capita. However, we keep hearing government officials and investment bankers worry about recessions caused by insufficient consumption. These concerns stem from the Keynesian model.

In most of the current intermediate-level macroeconomics textbooks, economic growth and Keynesian economics are discussed in separate chapters (e.g., Abel and Bernanke 2001; Blanchard 2000; Dornbusch et al. 2002; Froyen 2002; Gordon 2003; Hall and Taylor 1997; and Mankiw 2003). In many cases, these chapters are not even presented successively. This creates a problem as students with a clear memory may feel that the implications of saving they have learned in earlier chapters contradict the implications in later chapters. They may ask, “Which model is correct? For the well-being of an economy, should we save or should we consume?”

Of course, macroeconomists know that the neoclassical growth model and the Keynesian model should not be viewed as alternatives. They are models focusing on economic behaviors within different time frames. Actually, most macroeconomics textbooks have already mentioned that the neoclassical growth model is a long-run model and the Keynesian model is a short-run model. Nevertheless, many students do not seem to clearly understand this distinction. The connection between the short run and the long run is not clear. In fact, the lack of connection happens not only at the undergraduate level, but also at the advanced level. As Solow has repeatedly emphasized, “One major weakness in the core of macroeconomics … is the lack of real coupling between the short-run picture and the long-run picture.” (1997, 231-32) “There must be a medium-run … at which some sort of hybrid transitional model is appropriate.” (2000, 157)

I present the relationship between the short-run model and the long-run model by placing the two models side by side. Specifically, I link the Solow diagram and the IS-LM curves. In this way, students can see clearly how the economy moves from the short-run state to the long-run state after changes in the exogenous factors, such as the saving behavior or other macroeconomic policies.

**THE TWO MODELS**

As the purpose of this article is to illustrate the linkage between the neoclassical growth model and the Keynesian model, the simplest versions of the two models are adopted (e.g., closed economy, no technological progress).

Specifically, the neoclassical growth model and the Keynesian model discussed here are the Solow model and the IS-LM model, which are the primary long-run and short-run models taught in the intermediate-level macroeconomics and are also regarded as the foundation of the usable core of macroeconomics (Solow 1997). Though the IS-LM model is not exactly Keynes (1936), it is now widely used in undergraduate macroeconomics textbooks to deliver the Keynesian ideas.

**The Long-run Model**

In the Solow model, the total output \((Y)\) of an economy is produced by the capital \((K)\) and labor \((L)\): \(Y = F(K, L)\). The production function, \(F(.)\), exhibits constant returns to scale and diminishing returns to each production factor.
Labor supply in the Solow model is determined solely by the population. That is, the long-run labor supply is perfectly inelastic with respect to the real wage. For simplicity, assume there is no population growth and the total labor force is constant at $L^*$. In the long run, full employment ensures that the labor employed equals the labor supplied ($L = L^*$). Therefore, the production function in the long run can be rewritten as $Y = F(K, L^*) = f(K)^2$.

Capital is accumulated through net investment. At this stage, it is assumed that there is no government expenditure. Output is absorbed through consumption ($C$) and investment ($I$). Let $s$ be the saving rate. $C = (1 - s)Y$ and $I = sY = sf(K)$. The change in capital over time equals investment minus depreciation: $dK/dt = sf(K) - \delta K$, where $\delta$ is the depreciation rate.

The Solow diagram is given in the Panel A of Figure 1. It presents the production curve, $f(K)$, the saving schedule, $sf(K)$, and the investment requirement line, $sY = I$. Because of the diminishing marginal product of capital, there exists a steady state at which $K = K^*$. Because the long-run labor supply is assumed to be constant at $L^*$, the steady state level of output is $Y^* = F(K^*, L^*) = f(K^*)$. (Asterisk denotes steady state values.)

The Short-run Model

In the short run, the productive capacity is given by the long-run model previously described. That is, the capital endowment is $K^*$, the labor force is $L^*$, and the potential output that can be produced is $Y^*$. If prices and wages are perfectly flexible, the economy will always be at full employment ($L = L^*$, $K = K^*$, $Y = Y^*$). Nevertheless, as prices are sticky in the short run, the economy may deviate from the full employment.

Unlike that in the long run, output in the short run is not determined by the amount of production factors available, but by the aggregate demand of the economy. Given the existing price level, the demand determined output can be derived from the IS-LM model. At the goods market equilibrium, $Y = C + I$. The consumption function and the investment function commonly used in intermediate macroeconomics textbooks are $C = (1 - s)Y$ and $I = a - bi$, where $a$ and $b$ are positive parameters and $i$ is the interest rate. The IS equation can be derived as $Y = (a - bi)/s$. At the asset market equilibrium, $M/P = kY - hi$, where $M$ and $P$ are the money supply and the general price level; $(kY - hi)$ is the money demand function commonly used; $k$ and $h$ are positive parameters. The LM equation can be derived as $hi = kY - M/P$. The IS-LM curves are drawn in the Panel A of Figure 2. Their intersection gives us the aggregate demand and the short-run demand determined output.

The short-run output in turn determines the short-run factor employment level. The short-run labor and capital employment can be expressed as $L = \rho_l L^*$ and $K = \rho_k K^*$, where $\rho_l$ and $\rho_k$ are factor utilization rates. In the long run, $\rho_l = \rho_k = 1$. But in the short run, they may deviate from one. The short-run output is $Y = F(K, L) = F(\rho_k K^*, \rho_l L^*)$. When there is a drop in the aggregate demand and the IS-LM curves intersect on the left of $Y^*$, workers will be unemployed and machines will be idled; $\rho_k$ and $\rho_l$ will drop below one.

In the Keynesian view, prices are sticky downward but not upward. The short-run aggregate supply (SRAS) curve is flat when $Y < Y^*$, but is kinked and merges with the vertical long-run aggregate supply (LRAS) curve at $Y = Y^*$. Therefore, $\rho_l$ and $\rho_k$ cannot be larger than one. However, many current textbooks (e.g., Abel and Bernanke 2001; Blanchard 2000; Dornbusch et al 2002; and Gordon 2003) have incorporated
extensions by the monetarists (imperfect information) and the new Keynesians (staggered contract, menu cost, and coordination failure). SRAS curves are drawn as either horizontal or positively sloped curves extending into the region on the right of the LRAS curve. They are drawn in such a way that expansionary policies can push the output over the potential output in the short run. If this is the case, then $\rho_k$ and $\rho_L$ can be (slightly) larger than one. That is, when the aggregate demand is pushed over the potential output and the IS-LM curves intersect on the right of $Y^*$, workers will be requested to work more intensively and machines will be kept running.

**LINKING THE SHORT RUN AND THE LONG RUN**

Inspired by Garrison (1995), who linked the Keynesian cross and the production possibility frontier (PPF) for investment and consumption, I link the Solow diagram and the IS-LM curves based on the short-run and the long-run relationships between investment and consumption. The Solow diagram indicates where the IS-LM curves should intersect in the long run. The IS-LM curves indicate how the production curve and the saving schedule in the Solow diagram fluctuate around their long-run positions.

**The Link through the Production Possibility Frontier**

We can obtain the level of potential output, $Y^*$, from the Solow diagram in Panel A of Figure 1. The corresponding income-expenditure equation, $Y^* = C + I$, can be drawn as a 45-degree downward sloping straight line on a plane of $I$ against $C$ (Panel B of Figure 1).

Based on the Solow model, the income-expenditure line (IEL) can also be interpreted as the PPF for $I$ and $C$ at a given level of output. There are two reasons for this. Firstly, the IEL imposes a supply constraint. If there is no change in the saving rate and the population growth rate, the area to the right of the line corresponds to outputs that are larger than the potential output and unattainable in the long run. Secondly, the IEL shows the instantaneous tradeoff between the current investment and the current consumption. The Solow model assumes that each instant’s output can be either consumed as consumer goods or invested as capital goods (Solow 1956). This implies that the marginal rate of transformation of $C$ for $I$ is one and the PPF is a 45-degree downward sloping straight line.

The PPF that corresponds to $Y^*$ is denoted as $PPF^*$. It is then duplicated in Panel B of Figure 2. The Solow diagram determines the level of $Y^*$ and the position of $PPF^*$. It then determines at which level of output the IS-LM curves should intersect in the long run (Panel A of Figure 2).

**The Link through the Short-run Demand Constraint**

The Solow diagram also determines the steady state level of saving, $sY^*$, and the no-growth investment level, $I^*$ (in Panel B). Then, we can obtain the corresponding steady state consumption, $C^*$, from $PPF^*$. The economy is at $(C^*, I^*)$ on $PPF^*$ in the long run. But in the short run, it may deviate from its long-run position. We can derive the short-run relationship between consumption and investment from the IS-LM model. By substituting the investment equation, $i = (a - I)/b$, and the income-expenditure equation, $Y = C + I$, in the LM
equation, we have \( h(a - I)/b = k(C + I) - M/P \). By rearranging this equation, we achieve

\[
I = \frac{b}{bk + h} \left( \frac{ah + M}{bP} \right) - \frac{bk}{bk + h} C. \tag{1}
\]

Equation (1) is the short-run demand constraint (SRDC). It shows the short-run relationship between \( C \) and \( I \) that corresponds to saving-induced movements along the LM curve. A decrease in \( C \) decreases the real money demand through \( kY \) and as a result, \( i \) decreases and \( I \) increases.

In Panel B of Figure 1 and 2, the SRDC corresponding to full employment is denoted as \( SRDC^* \). It starts from the point \((C^*, I^*)\). Because the coefficient of \( C \) in Equation (1) is negative and smaller than one in magnitude, \( SRDC^* \) is downward sloping and flatter than \( PPF^* \). The reason for this is that prices have not yet adjusted. If \( P \) had adjusted downward in response to a decrease in \( C \), \( M/P \) would have increased, the LM curve would have shifted down, and \( i \) would have dropped further. As a result, the increase in \( I \) would have been equivalent to the decrease in \( C \) (\( Y \) would stay at \( Y^* \)). Thus, if prices were perfectly flexible, \( SRDC^* \) would be identical to \( PPF^* \).

In the Keynesian view, \( SRDC^* \) will not extend to the area outside \( PPF^* \) because prices are not sticky upward. The PPF will shift rightward only in the long run when there is economic growth. But as mentioned previously, in some textbooks, the SRAS curve extends to the right of the LRAS curve and output can be pushed (slightly) over the potential output in the short run. If this is the case, then the PPF here will not be as “hard” as what we have learned in microeconomics. It can be pushed slightly rightward in the short run and \( SRDC^* \) may extend slightly to the right of \( PPF^* \).

The IS-LM diagram shows how the curves in the Solow diagram may fluctuate in the short run. When the IS curve and/or the LM curve shift, a new short-run output is obtained. Moreover, a new short-run investment level can be obtained from the SRDC curve. Then the production curve and the saving schedule in the Solow diagram will shift according to the new short-run output and short-run investment.

AN INCREASE IN THE SAVING RATE

To many students, an increase in the saving rate seems to have opposite implications under the two major models taught in intermediate macroeconomics. In the Solow diagram, an increase in the saving rate increases output. But in the IS-LM diagram, an increase in the saving rate decreases output. Students’ confusion arises from the lack of linkage between the short run and the long run. By putting the Solow and the IS-LM diagrams together, students are able to see the transition of the economy between the short run and the long run after a change in the saving rate.

The Short-run Effect

Assume that the saving rate increases from \( s \) to \( s_1 \). As a result, consumption decreases. In Panel A of Figure 2, the IS curve rotates downward from \( IS^* \) to \( IS_1 \) and the short-run output decreases from \( Y^* \) to \( Y_1 \). In Panel B of Figure 2, the decrease in the short-run output shifts the PPF leftward from its long-run position \( (PPF^*) \) to a short-run position \( (PPF_1) \). This leads the economy to move along \( SRDC^* \) from \((C^*, I^*)\) to \((C_1, I_1)\), the intersection between \( SRDC^* \) and \( PPF_1 \). Consumption decreases not only because the saving rate has increased, but also because the short-run income has decreased. Furthermore, a decrease in the interest rate (in the IS-LM diagram) leads to a rise in investment.
Panel B of Figure 2 is duplicated in Figure 3. As the vertical intercept of the PPF moves down from $Y^*$ to $Y_1$, the production curve in the Solow diagram shifts down from $f(K)$ to $\phi(K)$, where $\phi(K) = F(\rho_K K^*, \rho_L L^*)$ and $\phi(K^*) = Y_1$. In this case, both $\rho_K$ and $\rho_L$ are smaller than one. The production curve shifts down because output declines at the given value of capital stock available ($K^*$).

When the saving rate increases, the saving schedule, $sf(K)$, in the Solow diagram shifts. However, unlike the conventional Solow model, the saving schedule does not shift up to $s_1f(K)$ immediately. Instead, it shifts to a short-run position, $s_1\phi(K)$. Because $s_1 > s$ whereas $\phi(K) < f(K)$, we cannot tell from the Solow model if the saving schedule will shift up or shift down in the short run; this must be derived from the IS-LM model. From Panel B of Figures 2 and 3, we can see that investment increases from $I^*$ to $I_1$. As $s_1\phi(K^*) = I_1$ and $sf(K^*) = I^*$, we know that the saving schedule will shift up in the short run, though not as much as in the conventional Solow model. (This may not be the case sometimes; see the following discussion of the paradox of thrift.)

In the original Solow model, consumption decreases when the saving rate increases; but the output level does not change. This is because prices will adjust accordingly such that any output not being consumed will be invested and any capital and labor no longer needed for producing consumer goods will be reallocated to produce capital goods. Under this model, no worker will be unemployed and no physical capital will be idled. Hence, a decrease in consumption is balanced by an equivalent increase in investment, leading the economy to move along the PPF. However, this is not true in the short run.

In the Keynesian model, when consumption decreases, a portion of the capital and labor originally employed in the consumer goods sector will be released into the factor market. The economy will have an excess of productive capacity. However, as prices are sticky, the excess productive capacity cannot be cleared. Although the investment increases because of the decrease in interest rate, it cannot cover the decrease in consumption. Only some of the released capital and labor will be reallocated into the capital goods sector; others will be unemployed. The economy moves along the SRDC.

The Medium-run and the Long-run Effects

Following the common time frame definition of macroeconomic behaviors used in many intermediate macroeconomics textbooks, the medium run is defined as the time frame for price adjustment and the long run is defined as the time frame for capital accumulation and convergence to a steady state. (Some textbooks label the former time frame as the long run and the later time frame as the very long run.)

Under this definition of time frame, I assume the economy will not start accumulating capital stock before prices have been fully adjusted. That is, the economy will not move along the $s_1\phi(K)$ schedule to the intersection point of $s_1\phi(K)$ and the investment requirement line $\delta K$. This assumption is not based on any empirical reasons. It is just because capital accumulation is defined as a long-run behavior and price adjustment is defined as a medium-run behavior. Of course, there is no reason to believe that long-run behaviors and medium-run behaviors cannot take place simultaneously; however, maintaining this assumption significantly simplifies the dynamics without any loss of generality and avoids complication and confusion to students.
In the medium run, the general price level decreases and the LM curve in Figure 2 shifts downward to $LM_1$. Following this, output goes back to $Y^*$ (the economy has not started accumulating capital yet and the capital stock is still $K^*$) and full employment is restored ($\rho_K = \rho_L = 1$). The PPF shifts rightward from $PPF_1$ back to $PPF^*$. In the Solow diagram, the production curve shifts back up from $f(K)$ to $\phi(K)$; the saving schedule shifts further up from $s_1\phi(K)$ to $s_1f(K)$.

From Equation (1), we can see that when $P$ decreases, the SRDC curve shifts up. The exact magnitude of this shift is indicated by the Solow diagram. As the new saving is $s_1f(K^*) = s_1Y^*$, the SRDC should shift from $SRDC^*$ up to a position, $SRDC_1$, that cuts the $PPF^*$ at $I = I_2 = s_1Y^*$ (Panel B of Figure 3).

In the long run, the original Solow model is incorporated. As $s_1f(K^*) > \delta K^*$, the saving is higher than the investment required to maintain the capital stock; capital stock is accumulated (Panel A of Figure 3). The economy will converge slowly to a new steady state, at which the new saving schedule, $s_1f(K)$, intersects the investment requirement line, $\delta K$.

Figure 3 is duplicated in Figure 4 for the long run. At the new steady state, $K = K^{**}$ and $Y = f(K^{**}) = Y^{**}$. Consequently, the PPF shifts out from $PPF^*$ to $PPF^{**}$. In Panel A of Figure 2, the potential output increases from $Y^*$ to $Y^{**}$. Because it is in the long run, prices are adjustable. As the new potential output is larger than the output at which $IS_1$ and $LM_1$ intersect, prices will decrease. As a result, the LM curve shifts further down to $LM^{**}$. Also, as prices decline, the SRDC curve shifts further up. As indicated by the Solow diagram, the new saving is $s_1Y^{**}$; therefore, the SRDC will shift to $SRDC^{**}$, which cuts $PPF^{**}$ at $I = I^{**} = s_1Y^{**}$.

From the discussion above, students can see clearly that when the saving rate increases, output decreases in the short run, returns to its original level in the medium run, and rises in the long run. The neoclassical growth model and the Keynesian model do not contradict each other; instead, they are just illustrating different stages of the whole picture.

Although the short-run and the long-run models do not contradict each other, macroeconomists do disagree on the actual duration of the time frames. If the short run is very short, then we need not worry too much about the short-run decrease in output. If, however, the actual duration of the short run is very long, then the long-run increase in output becomes irrelevant.

**The Paradox of Thrift**

The paradox of thrift occurs when “every such attempt to save more by reducing consumption will so affect incomes that the attempt necessarily defeats itself” (Keynes 1936, 84). This may happen when investment depends not only negatively on the interest rate, but also positively on the total output (e.g., Blanchard 2000). Let the investment function in this case be $I = a - bi + \beta Y$. To ensure a stable condition and achieve a normal downward sloping IS curve, we should assume $s > \beta$. The equation for SRDC in this case is

$$I = \frac{b}{bk + h(1 - \beta)} \left( \frac{ah + M}{b + P} \right) - \frac{bk - h\beta}{bk + h(1 - \beta)} C. \tag{2}$$

Unlike the SRDC curve given by Equation (1), which is downward sloping, the SRDC curve given by Equation (2) can be either upward or downward sloping. It depends on the sign of $bk - h\beta$. In the previous case, when investment depends only on the interest rate, consumption affects investment only through its influence on the
interest rate. However, in this case, consumption affects investment through two channels. First, a decrease in consumption decreases the output and, consequently, decreases the investment by a factor of $\beta$. Define this channel as the “output channel.” The responsiveness of investment to consumption through the output channel depends on $\beta$. Second, the decline in output reduces the money demand. As a result, the interest rate falls. The responsiveness of interest rate to output is captured by $k/h$. The decrease in interest rate increases the investment by a factor of $b$. Define this channel as the “interest rate channel.” The responsiveness of investment to consumption through the interest rate channel depends on $bk/h$.

If the effect of consumption on investment through the interest rate channel is larger than the effect through the output channel, then $bk/h > \beta$ and $bk – h\beta > 0$. Hence, the SRDC curve will still be downward sloping. Nonetheless, if the effect of consumption through the interest rate channel is smaller than that through the output channel, then the SRDC curve will be upward sloping.

When the SRDC curve is either horizontal or upward sloping, the paradox of thrift occurs. Suppose it is upward sloping. When the saving rate increases, the IS curve rotates down, the PPF shifts leftward, and the economy moves along the SRDC curve to a position at which the investment is reduced. This implies that the short-run saving schedule in the Solow diagram shifts down (the production curve drops even further because the investment decreases in this case as opposed to an increase in the previous case). In brief, if $bk/h \leq \beta$, when the saving rate increases, the actual saving will be either unchanged or reduced. This is the paradox of thrift. Society intends to increase saving; however, this intention decreases the output. The saving rate increases only because the output decreases. The total saving is not increased.

Nevertheless, in the medium run, prices will decrease and the economy will go back to full employment. The total saving will rise and be higher than the original saving level. In the long run, saving will further increase as the higher saving rate leads to capital accumulation. Therefore, the paradox of thrift is only a short-run phenomenon. It disappears in the medium run. When prices are fully adjusted, an increase in the saving rate will always increase the total saving.

**MACROECONOMIC POLICIES**

The graphical illustrations above can also be used to demonstrate the short-run and the long-run impacts of monetary and fiscal policies.

Suppose the central bank increases the money supply. The LM curve shifts down. This decreases the interest rate and increases output. Consequently, investment and consumption increase and the PPF shifts out. According to Equation (1), when $M$ increases, the SRDC curve shifts upward. The new SRDC curve and the new PPF intersect at a point at which both $I$ and $C$ are higher than before. As a result, both the production curve and the saving schedule in the Solow diagram shift up. If the economy was originally in recession, then an increase in money supply can push output back to its long-run potential. But if output is pushed against its long-run potential, then prices will increase in the medium run and the LM curve will shift back up. Output, consumption, and investment will all decrease and the SRDC, PPF, production curve, and the saving schedule will all shift back down to their long-run position.

For simplicity, fiscal policies have been excluded in previous sections. But adding government spending and income tax will not require much extra effort. In fact, there are models that incorporate fiscal policies in the Solow model.
models, fiscal policies shift the saving schedule and affect the long-run steady state (Heijdra and van der Ploeg, 2002). However, in those extensions, changes in fiscal policies do not shift the production curve in the Solow diagram. This means they ignore the short-run impacts of fiscal policies mentioned in the Keynesian model. In essence, they are extended long-run Solow models, but are not models that link the long-run and the short-run macroeconomic mechanisms.

There will only be two major changes after we add the government expenditure ($G$) and the income tax rate ($t$). First, $I = Y - (1 - s)(1 - t)Y - G$. Saving in the Solow model will be $s(1 - t)f(K) + tf(K) - G$, which is the private saving plus the government saving. The saving schedule in the Solow diagram will no longer start from the origin; instead, it will start from a negative vertical intercept, $-G$. Second, the variable $C$ in the equations for PPF and SRDC shall be replaced by $(C + G)$. In the meantime, the horizontal axis of the PPF diagram shall be relabeled as $C + G$ instead of just $C$. (The slope and the intercepts of the IS curve will change, but that will not enter our discussion here unless we are going to study the effectiveness of the policies.)

An increase in the government spending shifts the IS curve rightward. Both output and the interest rate increase. The PPF shifts out. By replacing $C$ by $(C + G)$ in Equation (1), an increase in $G$ shifts the SRDC curve downward. Consequently, consumption increases whereas investment decreases. As a result, in the Solow diagram, the production curve shifts up whereas the saving schedule shifts down. Investment is crowded out by consumption and government expenditure. (In the case of paradox of thrift, the positive influence of output on investment is so large that there will be no crowding out.)

Again, if the economy was originally in recession, then an increase in government spending will push output back to its long-run potential. But if output is pushed against its long-run potential, then prices will increase and the LM curve will shift up. In the medium run, output will drop back to its long-run potential while the interest rate will increase further. The PPF and the production curve will shift back down to their long-run position; the SRDC and the saving schedule will shift down further. Consumption will return to its long-run level whereas investment will be crowded out by the increased government spending. In the long run, because the investment is lower than the depreciation, capital stock will decrease and the economy will move down to a steady state with a lower level of output per capita.

The effect of a reduction in the income tax rate is similar to that of a decrease in the saving rate and can be left to students as an exercise.

**CONCLUSION**

Although most intermediate-level macroeconomics textbooks have acknowledged that the Solow model is a long-run model and the IS-LM model is a short-run model, the two models have not been put together and presented as a complete picture to students. The transition from the short run to the long run has not been properly demonstrated in the undergraduate macroeconomics curriculum.

By placing the Solow diagram and the IS-LM diagram side by side, students can see the whole picture and understand that the two models’ views about saving are in fact not contradicting each other: an increase in the saving rate will first lead to a short-term recession, but this will be followed by a long-term growth. In addition to analyzing the impacts of saving, this integrated approach can also be used to demonstrate the short-run and the long-run effects of macroeconomic policies.
NOTES

1. This assumption is not far from the truth in the long run. In the past century, labor productivity and real wages have risen dramatically, but people are still working roughly the same number of hours.

2. The standard Solow model focuses on output per capita. As the IS-LM model focuses on aggregate output, in this article, I do not convert variables in the Solow model into per worker units.

3. For simplicity, I assume the expected inflation rate is zero such that the real interest rate is just the nominal interest rate.

4. Although the long-run labor supply is assumed to be perfectly inelastic, the short-run labor supply may increase because of reasons such as imperfect information and/or contracts and long-term relationships. However, this short-run increase in labor supply cannot last long.

5. PPF is defined as the limits to production given the resources available. Here, a given level of output is the “resources” available for investment and consumption.

6. Note that the tradeoff between current investment and current consumption should not be confused with the relationship between current investment and future consumption.

7. The Solow model is actually a one-sector model. The production of aggregate output, which includes both consumer goods and capital goods, is represented by a single aggregate production function. Expressing the production relationship of both consumer goods and capital goods with a single production function is valid under either of the following conditions. First, the aggregate output is “only a single, homogeneous good” (Jones 2002, 20). Second, the factor intensity of consumer goods on average is the same as the factor intensity of capital goods on average and the production factors are perfectly mobile across industries. If there are some consumer goods that cannot be used as capital goods or vice versa, or if the tradeoff between consumer goods and capital goods is not one-for-one, then the Solow model cannot be applied and must be replaced by multi-sector growth models.

8. This corresponds to the special case mentioned in Garrison (1995, 126) that the slope of the PPF is negative one.

9. The SRDC in Garrison (1995) is upward sloping because Garrison focused only on the Keynesian cross, in which investment is autonomous rather than depending on interest rate.

REFERENCES


FIGURE 1: The Solow diagram and the investment-consumption relationship.
FIGURE 2: The IS-LM diagram and the investment-consumption relationship.
FIGURE 3: An increase in the saving rate (short run and medium run).
FIGURE 4: An increase in the saving rate (long run).