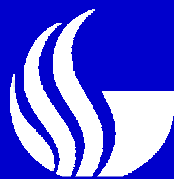


# International Studies Program

Working Paper 04-09  
September 2004

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**Henry Thompson**



Georgia State  
University

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# Economic Growth with Imperfect Foreign Investment

Henry Thompson \*

## 1. Introduction

Foreign investment has proven essential for economic growth and the present paper connects it explicitly to the capital stock in the neoclassical growth model. The assumption in the literature of perfect foreign investment implies no distinction between domestic and foreign capital. In the applied growth literature, the working assumption is that foreign investment shifts technology. The present paper introduces imperfect foreign investment as a function of the difference between domestic and foreign capital returns. The foreign capital stock is then separate and the small open economy may be a steady state foreign investment host (or source). Convergence is incomplete in the two country model.

The assumption that foreign investment shifts technology is summarized by Barro and Sala-i-Martin (1999) and exemplified by Blomström, Lipsey and Zejan (1992), De Gregorio (1992), Berthelemey and Demurger (2000), and Bengoa and Sánchez-Robles (2003). Separating technology from capital input is difficult, however, both in theory and

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practice. Empirical evidence on technology transfer due to foreign investment remains mixed: Aitken, Harrison, and Lipsey (1996) find positive technology spillovers from foreign ownership while Aitken and Harrison (1999) do not. The present model takes an alternative approach that allows foreign investment to augment capital in a host country holding technology constant.

The model assumes perfect substitution between domestic and foreign capital as inputs but foreign investment is imperfectly responsive to the international difference in capital returns. The steady state for a host involves perpetual foreign investment with a capital return above and wage below the rest of the world. For a steady state source country, investment abroad continues with a relatively low capital return and high wage. Incomplete convergence in the two country model may contribute to explaining the lack of convergence noted in the empirical literature.

## 2. Domestic and foreign capital in a neoclassical growth model

The underlying constant returns neoclassical production function  $Y = Y(K, L)$  of Solow (1956) and Swan (1956) reduces to

$$y = y(k) \tag{1}$$

where  $y$  is per capita income and  $k$  is the capital/labor ratio,  $k \equiv K/L$ . The first derivative  $y'$  equals the capital return  $r$ , and the wage is  $w = y - y'k$ .

Total capital input  $K$  is composed of domestic and foreign capital, and changes in the capital/labor ratio are

$$\dot{K} = \dot{K}_D + \dot{K}_F \tag{2}$$

where the dot  $\dot{\phantom{x}}$  represents a time derivative  $d/dt$ . If  $\dot{K}_F > 0$  foreign investment augments the capital stock along with domestic saving, and if  $\dot{K}_F < 0$  foreign investment goes abroad. The present paper focuses on a capital scarce country that attracts foreign investment, and analysis is similar for a source country.

In autarky, a capital dear country has a higher capital return  $r$  than the exogenous foreign return  $r^*$ . Introducing a perfectly integrated international capital market, foreign investment would move the economy to  $k^*$  where  $y'(k^*) = r^*$ . In the present model of imperfect capital mobility, domestic firms hire all domestic capital  $K_D$  along with constrained foreign capital  $K_F$  and the domestic return  $r$  remains above  $r^*$ . The

capital/labor ratio  $k$  remains below  $k^*$  and  $r = y'(k) > r^*$ . Home capital owners keep their capital at home and there is insufficient foreign investment to lower  $r$  to  $r^*$ .

The saving rate  $\sigma$  can be the result of optimal saving in an overlapping-generations model with maximization of homothetic utility over two lifetime periods, along the lines of Ramsey (1928), Cass (1965), and Koopmans (1965). Homotheticity implies  $\sigma$  is invariant with respect to income, holding the capital return  $r$  constant. The positive substitution effect of a fall in  $r$  outweighs the negative income effect, leading to a positive first order effect for  $\sigma(r)$ . With growth,  $k$  rises and  $r$  falls implying a lower saving rate. The dynamics of foreign investment and growth do not depend on this saving behavior, and the present results are robust to a negative first order effect or constant saving rate.

Aggregate saving per capita  $\sigma y$  may rise or fall with growth since  $d(\sigma y)/dk = y'\sigma + \sigma'y''y$ ,  $y' > 0$  with positive marginal product of capital, and  $y'' < 0$  with diminishing marginal productivity. At higher levels of  $y$ , the positive  $y'$  diminishes leading to the possibility of a downward sloping saving schedule as pictured in Figure 1.

\* Figure 1 \*

Domestic capital  $K_D$  grows with saving  $\sigma(r)Y$  and depreciates at rate  $\delta$ ,

$$K_D^* = \sigma(r)Y - \delta K_D. \quad (3)$$

Foreign investment  $\Phi$  is a positive function of the difference between the domestic and foreign capital returns, and the stock of foreign capital changes according to

$$K_F^* = \Phi(r - r^*) - \delta K_F \quad (4)$$

where  $r^*$  is exogenous for the small open economy. An increase in the exogenous foreign capital return  $r^*$  lowers  $\Phi$ . The two types of capital are perfect substitutes in production and depreciate at the common rate  $\delta$ , although these assumptions can be relaxed without necessarily altering results of the model.

With a higher domestic capital return, there is incoming foreign investment but not enough to bring it down to the foreign level. As the capital/labor ratio rises, there is a decline in the difference between  $r$  and  $r^*$  but the steady state may be reached before (or after) they equalize depending on the foreign investment function and model parameters.

Combining (3) and (4), the capital stock in the economy evolves according to

$$\dot{K} = \sigma(r)Y + \Phi(r - r^*) - \delta K, \quad (5)$$

and the capital/labor ratio  $k$  adjusts according to

$$\dot{k} = (\dot{K}L - L\dot{K})/L^2 = \sigma(r)y + \varphi(r - r^*) - (n + \delta)k \quad (6)$$

where  $n \equiv \dot{L}/L$  is the constant growth rate of labor and  $\varphi \equiv \Phi/L$  is the per capita foreign investment function. This first order differential equation in  $k$  adds foreign investment to the dynamics of the familiar neoclassical growth model.

The foreign investment function  $\varphi = \varphi(r - r^*)$  has a positive first derivative and can be written  $\varphi(k, r^*)$ . The first order effect  $d\varphi/dk < 0$  is sufficient for present purposes and  $\varphi(k, r^*)$  is convex in  $k$  since  $r(k) = y'(k)$  is concave. By assumption,  $\varphi(0) = 0$  when  $r = r^*$ . The sign of  $\varphi$  is the same as the sign of  $r - r^*$ . An economy is a source country if  $r < r^*$  and  $\varphi < 0$  in the steady state.

The steady state is defined as  $\dot{k} = 0$  implying

$$\sigma(r^S)y^S + \varphi(r^S - r^*) = (n + \delta)k^S \quad (7)$$

where superscript <sup>S</sup> refers to steady state levels of endogenous  $k$ ,  $y(k)$ , and  $r(k)$ . The steady state in (7) with  $\varphi^S > 0$  holds for the foreign investment host country in Figure 1. The negative current account  $-\varphi$  implies a steady state trade deficit, and it is possible to develop net interest payments and the balance of payments in the present framework.

Foreign investment  $\varphi$  is the distance between the saving schedule  $\sigma(r)y$  and its sum with foreign investment  $\sigma(r)y + \varphi(r - r^*)$  as in Figure 1. As  $k$  increases,  $r$  falls and  $\varphi$  decreases. Note that as  $k \rightarrow 0$ , the positive level of foreign investment eliminates the curious “start up” problem of neoclassical growth theory because a stranded island of workers without capital would attract foreign investment.

The  $\sigma y$  and  $\sigma y + \varphi$  schedules intersect at  $k^*$  where  $\varphi = 0$  and  $r = r^*$  along the production function (not shown) at the point  $y(k^*)$ . The assumption of perfect foreign investment implies the economy must produce where  $r = r^*$  and  $\sigma^*y^* = (n + \delta)k^*$  making it impossible to separate foreign capital.

### 3. Source versus host countries

The steady state in Figure 1 occurs where the  $\sigma y + \varphi$  schedule intersects  $(n + \delta)k$  at  $k^S$ . This economy is a steady state foreign investment host with  $\varphi^S > 0$ , implying  $r^S > r^*$  and  $w^S < w^*$ , with a steady state capital account surplus and current account deficit.

Autarky would occur where the  $\sigma(r)y$  curve intersects  $(n + \delta)k$  at  $k^A$  implying  $r^A > r^S$  and  $w^A < w^S$ . Moving from autarky to free foreign investment, wages rise but do not catch up with the rest of the world. Per capita income increases with foreign investment but domestic capital owners never do as well as when their resource is scarce.

Figure 2 pictures a foreign investment source country. Although it is not critical, the saving schedule is declining in the steady state. For a source country,  $\varphi^S < 0$  implying  $r^A < r^S < r^*$  and  $w^A > w^S > w^*$ . There is a steady state foreign investment deficit and current account surplus. Workers in a source country are best off in autarky as are capital owners in host countries but the net gains from foreign investment suggest autarky may not be politically feasible. Per capita income falls in a source country with foreign investment.

A country is more likely a foreign investment host with

- a higher rate of labor force growth  $n$
- a higher depreciation rate  $\delta$
- a lower saving schedule  $\sigma(r)$
- a lower foreign investment schedule  $\varphi(r - r^*)$ .

An increase in the exogenous foreign interest rate  $r^*$  lowers foreign investment, making the country less of a host or more of a source. An increase in  $r^*$  lowers  $k^S$ , raises  $r^S$ , and lowers  $w^S$ , lowering the capital account and raising the current account.

Introducing exogenous shift variables into the saving and foreign investment functions offers a framework for application. For instance, a change in the exogenous saving propensity  $\zeta$  would shift the saving schedule  $\sigma(r, \zeta)$  affecting foreign investment and other endogenous variables in the steady state. An increase in  $\zeta$  raises  $k^S$  and lowers  $\varphi$ , making the economy less of a host (more of a source) with  $r^S$  falling and  $w^S$  rising. A change in foreign investment “openness”  $\omega$  shifts the  $\varphi(r - r^*, \omega)$  schedule. An increase in  $\omega$  raises the  $\sigma y + \varphi$  schedule leaving  $\sigma y$  in place, leading to increases in  $\varphi^S$ ,  $k^S$ , and  $w^S$ , and a decrease in  $r^S$ . For the host country in Figure 1, there is an  $\omega^*$  where  $\sigma y + \varphi$

intersects the capital depletion line  $(n + \delta)k^*$  and  $r = r^*$ . With perfect foreign investment, there is no  $\phi$  schedule.

#### 4. Stability and trends in the relative capital stock

The growth model without foreign investment is stable due to properties of the neoclassical production function  $y(k)$  as  $k$  evolves according to  $\dot{k} = \sigma(r) - (n + \delta)k$  with  $dk^*/dk = \sigma y' - (n + \delta)$  and  $d^2k^*/dk^2 = \sigma y'' < 0$ . This concave phase line implies monotonic convergence to the autarky steady state  $k_A^S = \sigma^S_A / (n + \delta)$ .

The slope of the phase line with foreign investment from (6) is  $dk^*/dk = \sigma y' + \sigma' y y'' - (n + \delta)$  which is everywhere less than the slope without foreign investment since  $\sigma' > 0$  and  $y'' < 0$ . Concavity follows since  $d^2k^*/dk^2 = \sigma y'' + 2\sigma' y' y'' + (y\sigma'' + \phi'')y''^2 < 0$  assuming concavity  $\sigma'' < 0$  and  $\phi'' < 0$ , with  $y''' = 0$ . The model converges monotonically to the steady state  $k^S$  consistent with Figures 1 and 2.

The ratio of foreign to domestic capital  $\kappa \equiv k_F/k_D$  rises iff  $\kappa < \phi/\sigma y$ . Suppose a capital host opens to foreign investment starting at the domestic equilibrium  $k^A$  with  $k_F = \kappa = 0$  and  $\dot{\kappa} > 0$ . With growth,  $\phi/\sigma y$  falls and  $\kappa$  converges to its steady state level  $\phi^S/\sigma^S y^S$ . There is similar convergence in a source country with  $\phi < 0$  and  $k_F < 0$ . If  $\phi = 0$  and  $r = r^*$ ,  $\kappa$  and  $k_F$  converge to 0.

The steady state ratios  $\phi/\sigma y$  in Figures 1 and 2 are ratios of foreign to domestic capital stocks. For the host country in Figure 1, the positive ratio  $\phi/\sigma y$  is the steady state ratio of foreign to domestic capital and the share of foreign capital in the economy is  $\phi/(\sigma y + \phi)$ . For the source country in Figure 2,  $-\phi/\sigma y$  is the ratio of capital abroad, and  $\sigma y/(-\phi + \sigma y)$  is the share of capital at home.

#### 5. The two country model with imperfect foreign investment

Consider a world with two countries, north N and south S. The steady state for the two phase lines

$$\dot{k}_N = \sigma_N(r_N)y_N(k_N) + \phi_N(r_N - r_S) - (n_N + \delta_N)k_N \text{ and} \quad (8a)$$

$$\dot{k}_S = \sigma_S(r_S)y_S(k_S) + \phi_S(r_S - r_N) - (n_S + \delta_S)k_S \quad (8b)$$

occurs where  $\dot{k}_N = \dot{k}_S = 0$  and  $\phi_N = -\phi_S$  implying

$$\sigma_N y_N - (n_N + \delta_N)k_N = (n_S + \delta_S)k_S - \sigma_S y_S . \quad (9)$$

The excess supply of investment from one country must match excess demand in the other.

Figure 3 shows an example of the steady state assuming country N is the source country. Curve N is the “excess supply” of per capita investment  $\sigma_N y_N - (n_N + \delta_N)k_N$  from (9), the difference between per capita saving and capital erosion in country N. The curve labeled S is “excess demand”  $(n_S + \delta_S)k_S - \sigma_S y_S$ , the difference between capital erosion and saving in country S. Note that country N has a higher autarky steady state capital/labor ratio,  $k_N^A > k_S^A$ . In autarky, abundance implies cheapness:  $r_S > r_N$  and  $w_N > w_S$ .

Figure 3 \*

With perfect foreign investment, the steady state occurs where the two curves intersect at  $k^E$  with investment from N to S. Due to concavity in production, the curves only intersect once (other than the origin). If the two countries share the same production function, the country with higher saving function, lower labor growth, and lower depreciation would tend to be the source.

Wages and capital returns are equal across countries at  $k^E$  as familiar from factor proportions trade theory, assuming the countries have the same production function. Capital mobility along with free trade in one of the products would be sufficient for factor price equalization. In the present model, the price (cost) of output is identical across countries since wages and capital returns are equal across countries.

In the steady state, the capital abundant country defined in terms of home capital ownership is the source country. Let  $F$  represent the positive stock of foreign investment. The capital/labor ratio in the source country is  $(K_N - F)/L_N$  and in the host  $(K_S + F)/L_S$  where  $K_j$  represents home owned capital. Using these two capital/labor ratios,  $F = (K_N L_S - K_S L_N)/(L_N + L_S)$  implying  $K_N/L_N > K_S/L_S$ .

With imperfect foreign investment, the two capital returns will not equalize and  $r_S - r_N$  will remain positive. The steady state occurs where  $\phi_N = -\phi_S$  at  $k_N^S$  and  $k_S^S$  as in Figure 3, and convergence is incomplete with  $r_S^S > r_N^S$  and  $w_N^S > w_S^S$ . The present

model may explain in part the partial convergence noted empirical growth studies such as Rassekh (2004).

Define the difference between steady state capital returns as  $\gamma \equiv r_S^S - r_N^S$  and suppose  $\gamma$  is the increasing function  $\gamma(k_S^A - k_N^A)$ . Foreign investment levels  $\varphi_N = -\varphi_S$  in Figure 3 can then be derived. Various theoretical motivations might account for a nonzero  $\gamma$ . For instance, a larger difference between autarky capital/labor ratios might increase the difficulty or success of foreign investment as suggested by Lucas (1990). As another example, Borensztein, De Gregorio, and Lee (1998) find that the level of human capital affects FDI productivity. Legal systems, property rights, infrastructure, and so on might account for a foreign investment wedge  $\gamma$ . As in the applied literature, explicit parameters can test various hypotheses in the present theoretical framework.

## 6. Conclusion

The present model offers an alternative foundation to include foreign investment in growth theory. The typical theoretical assumption of perfect international capital mobility implies instantaneous movement to the steady state and equal capital/labor ratios across countries. In the empirical growth literature, the assumption that foreign investment shifts technology requires further assumptions of imperfect competition. The present model introduces a competitive model of imperfect foreign investment that allows growth with perfect competition and incomplete convergence.

The empirical literature notes that increasing per capita income over the decades is difficult to explain if all countries approach the same steady state, motivating models with technological improvement. In the present model, increasing per capita incomes would occur with increasing global capital abundance.

Models of technology innovation play a role but separating improved technology from increased capital input is a challenge as in the applied production literature. The present model provides a framework to analyze and anticipate impacts of increased foreign investment. Slowly, governments are losing control over their economic borders due to free trade agreements and foreign investment, which remains imperfect and critical for economic growth.

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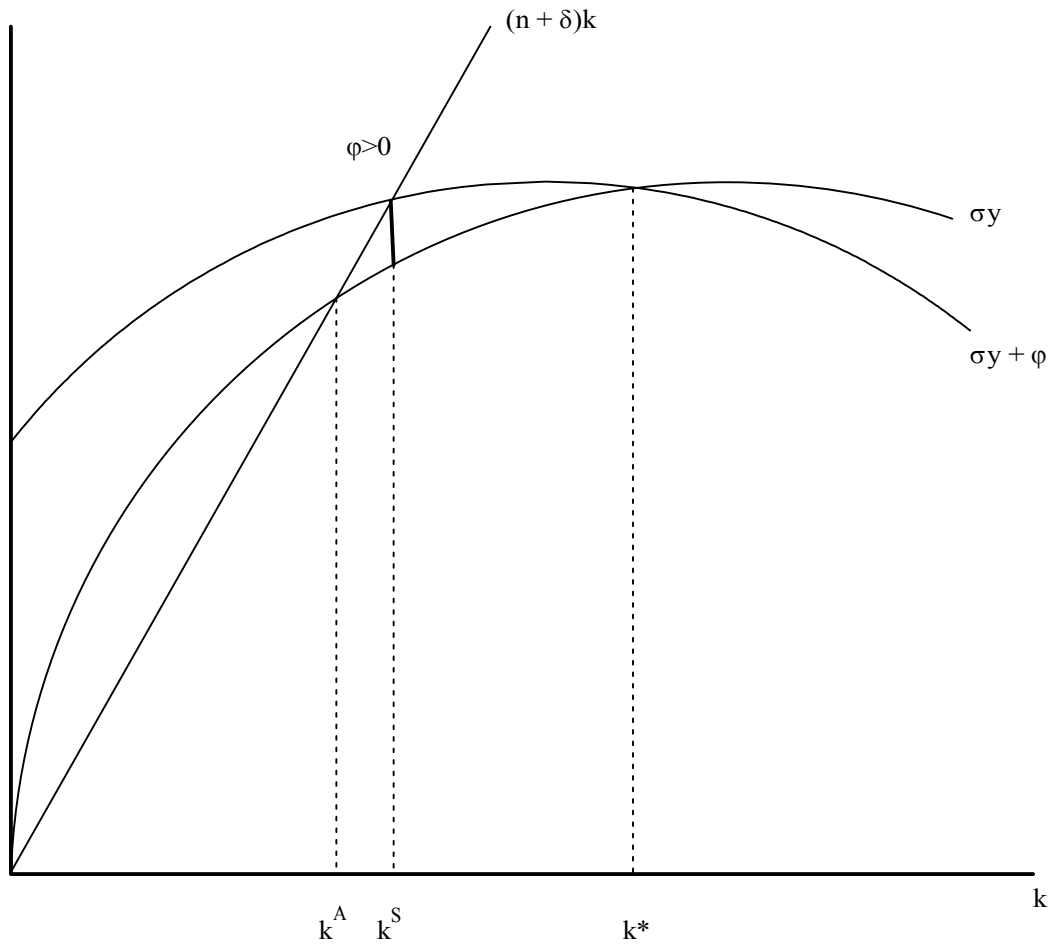


Figure 1. Foreign investment host

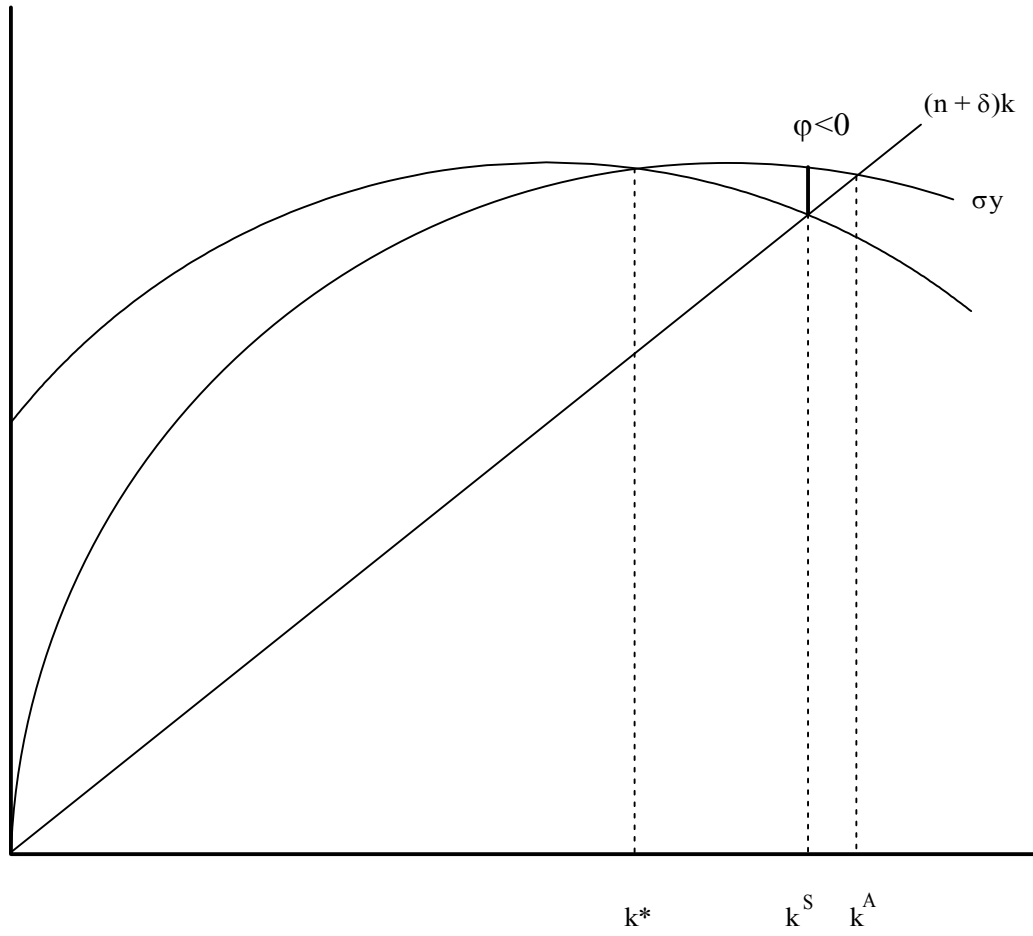


Figure 2. Foreign investment source

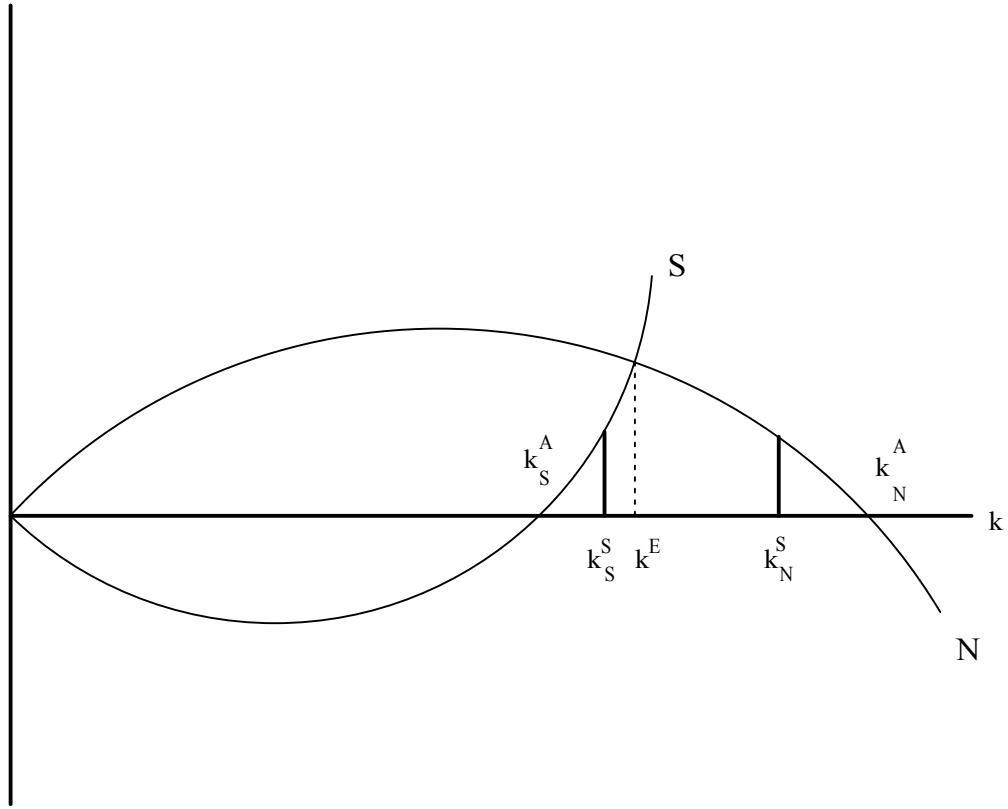


Figure 3. The two country model