



ATHENS UNIVERSITY OF ECONOMICS AND BUSINESS
DEPARTMENT OF ECONOMICS

WORKING PAPER SERIES

7-2014

**Financial Openness versus Autarky in a Neoclassical
Growth Model**

George Alogoskoufis

76 Patission Str., Athens 104 34, Greece
Tel. (++30) 210-8203911 - Fax: (++30) 210-8203301
www.econ.aueb.gr

Financial Openness versus Autarky in a Neoclassical Growth Model

George Alogoskoufis*

June 2014

Abstract

This paper compares financial openness with autarky in a neoclassical growth model, with adjustment costs for investment. We analyse the relation between growth and the current account in the transition towards the balanced growth path, and derive the implications of the two financial regimes for the balanced growth path. For an economy with an initial capital stock which is lower than the rest of the world, output (GDP) per capita on the balanced growth path is the same under financial openness and autarky. However, Gross National Product (GNP) and consumption per capita are lower under financial openness than under autarky. The reason is that the economy has to pay interest on the foreign debt it has accumulated during the transition. During the transition, the economy runs current account deficits and accumulates net foreign debt. The opposite applies to an economy, whose initial capital stock is higher than the rest of the world. There are benefits from financial openness and inter-temporal trade for either type of economy, as, during the transition, the path of the world real interest rate differs from the path of autarky real interest rates for either type of economy.

Keywords: neoclassical growth, external balance, interest rates, financial openness, financial autarky

JEL Classification: F43 F34 O11 D91 D92

* Department of Economics, Athens University of Economics and Business, 76, Patission street, GR-10434, Athens, Greece. The author would like to acknowledge financial support from a departmental research grant of the Athens University of Economics and Business.

Email: alogoskoufis@me.com Web Page: www.alogoskoufis.gr/?lang=EN .

The neoclassical growth model is the workhorse of both growth theory and, in its stochastic version, real business cycle theory. Yet its use in international economics has been relatively limited, due to the assumption of the standard neoclassical growth model that investment is determined by domestic savings. In order to determine the current account in an intertemporal model one needs an investment function which is independent of the savings function. It is only in this case that one can analyse the difference between savings and investment in growing open economies and thus analyse the adjustment of the current account during the convergence process.

This paper compares financial openness with autarky in an augmented neoclassical growth model, in which investment is subject to adjustment costs. Households choose individually optimal consumption plans, and firms choose individually optimal investment (and employment) plans, as postulated by the q theory of investment. We analyse the model under the two alternative regimes of financial autarky and openness. Under financial autarky domestic savings are continuously equal to domestic investment. Under financial openness they can differ, and their difference determines the current account. We analyse the relation between growth and the current account in the transition towards the balanced growth path, and derive the implications of the two alternative financial regimes for the balanced growth path.¹

Obstfeld (1998) and Henry (2007) survey the literature on the pros and cons of financial openness. Obstfeld concludes that “Despite periodic crises, global financial integration holds significant benefits and probably is, in any case, impossible to stop—short of a second great depression or third world war. The challenge for national and international policymakers is to maintain an economic and political milieu in which the trend of increasing economic integration can continue.” (p. 28). Henry concludes that “There is little evidence that economic growth and capital account openness are positively correlated across countries. But there is lots of evidence that opening the capital account leads countries to temporarily invest more and grow faster than they did when their capital accounts were closed.” (pp. 928-929).

The analysis of the augmented neoclassical model in this paper suggests that on the balanced growth path both capital and *domestic output* (GDP) per capita are the same under financial autarky and openness. So is the steady state real wage and the real interest rate.

¹ The closed economy neoclassical growth model of Ramsey (1928), Cass (1965) and Koopmans (1965), augmented by the q theory of investment, has been analysed by Abel and Blachard (1983). For a small open economy version see Blanchard (1983) and Blanchard and Fischer (1989). Miller (1968), Sachs (1981), as well as the papers surveyed in Svensson (1984), are early applications of the intertemporal approach to the current account, but rely mainly on two period Fisher (1930) models. Barro, Mankiw and Sala-i-Martin (1995) examine capital mobility in a neoclassical growth model with human and non-human capital, but without adjustment costs for investment. The advanced textbooks of Obstfeld and Rogoff (1996) and Vegh (2013) survey and present alternative open economy models based on the intertemporal approach that have been developed since the 1980s.

However, there are significant differences under the two alternative regimes for the adjustment path to the steady state and for steady state *national income* (GNP) and *consumption per capita*. These differences arise because of the dynamics of the current account and the accumulation of net foreign assets along the adjustment path to the steady state.

We show that the dynamics of the current account under financial openness depend on the initial capital stock. An initially capital poor economy will run current account deficits during the transition to the balanced growth path under financial openness, thus accumulating foreign debt. In the steady state it returns to external balance, but the interest payments on the external debt it has accumulated will result in lower national income and consumption compared to financial autarky. The opposite will apply to an initially capital rich economy. During the transition to the balanced growth path it will run current account surpluses under financial openness, thus accumulating positive net foreign assets. In the steady state it returns to external balance, but the interest payments on the external assets it has accumulated will result in higher national income and consumption compared to financial autarky. Thus, the initial capital stock has implications for steady state consumption and the relationship between gross domestic product (GDP) and gross national income (GNI) per capita along the balanced growth path.

The analysis of the paper is in two parts.

We first analyse a small economy, whose initial capital stock is below its steady state equilibrium, under the assumption that the rest of the world is on a balanced growth path. For this economy, real interest rates under financial openness will be at their steady state value, and below the corresponding path of real interest rates under autarky. As a result, under financial openness, there will be full consumption smoothing and both per capita consumption and investment will be higher during the adjustment process than under autarky.

During the transition to the balanced growth path, this financially open economy runs current account deficits and accumulates foreign debt. As it approaches the balanced growth path, the process of foreign debt accumulation slows down, and the economy converges to a position of external balance. On the balanced growth path, output per capita is the same as under autarky, but consumption per capita is lower than under autarky, as domestic residents have to pay interest on the foreign debt they have accumulated during the transition.

Financial openness is beneficial to this economy, despite lower steady state consumption, because it allows it to engage in beneficial inter-temporal trade, and have higher consumption and investment during the adjustment path towards the steady state.

Financial openness is also beneficial for an economy whose initial capital stock is above its steady state value. For this economy, the path of real interest rates under financial openness will be above the corresponding path under autarky. As a result, per capita

consumption and investment will be lower during the adjustment process under financial openness than under autarky. During the transition, such an economy runs current account surpluses and accumulates net foreign assets. In the steady state the process of foreign asset accumulation gradually stops and the economy returns to external balance. However, steady state consumption per capita will be higher under financial openness than under autarky, as the economy receives interest on the foreign assets that it has accumulated during the transition. Consumers are again better off, because of the consumption smoothing that they can achieve under financial openness.

In the second part of the analysis we abandon the small open economy assumption and analyse the process of adjustment in a two country world, in which two otherwise similar economies have different initial capital stocks. One economy is assumed to have a relatively lower initial capital stock than the other. We demonstrate that if the two economies establish inter-temporal trade, the world real interest rate will be determined between the initial autarky real interest rates in the two economies. In the economy with the lower initial capital stock real interest rates will fall compared to autarky, causing an increase in both investment and consumption, and thus a current account deficit. In the economy with the higher initial capital stock real interest rates will rise compared to autarky, causing a fall in both investment and consumption, and a corresponding current account surplus. In the steady state, both economies will converge to the same GDP per capita with external balance, but the initially “capital poor” economy will be a net debtor vis-a-vis the rest of the world, i.e. vis-a-vis the initially “capital rich” economy. Steady state GNP per capita and steady state consumption will be lower compared to the initially capital rich economy, which as a net creditor to the initially capital poor economy receives income from its positive net asset holdings.

Although both economies derive benefits from financial openness, financial openness cannot neutralise the economic head start of the initially capital rich economy.

The paper is organised as follows: In section 1 we present the basic representative household model and characterise its optimal consumption plan. In section 2 we analyse the optimal production, employment and investment decisions of firms, under the assumption of competitive markets and convex (quadratic) adjustment costs for investment. Equilibrium under financial autarky is analysed in section 3. In section 4 we analyse a small open economy under financial openness and present our main conclusions for a small open economy. In section 5 we present the model of a two country world, with otherwise similar economies that differ only in their initial capital stocks. In section 6 we present numerical simulations of both the small open economy and the two country world economy cases, which corroborate our theoretical results. In section 7 we discuss various generalisations and extensions of the basic model, while the last section summarises our conclusions.

1. Optimal Consumption in the Representative Household Model

We assume an economy populated by infinitely lived identical households. Each household has a growing number of members, each of which supplies one unit of labor.

Household j chooses a consumption path to maximise,

$$U_j = \int_{t=0}^{\infty} e^{-(\rho-n)t} \ln c_j(t) dt \quad (1)$$

subject to the instantaneous budget constraint,

$$\dot{a}_j(t) = (r(t) - n)a_j(t) + w_j(t) - c_j(t) \quad (2)$$

and the household's solvency (no-Ponzi game) condition,

$$\lim_{t \rightarrow \infty} e^{-\int_{s=0}^t (r(s)-n)ds} a_j(t) = 0 \quad (3)$$

$\rho > 0$ is the pure rate of time preference, $n > 0$ is the exogenous rate of growth of household members (and population), $c_j(t)$ is the per capita consumption of household j at instant t , $a_j(t)$ is the per capita non-human wealth of household j at instant t , and $w_j(t)$ is per capita non asset (labor) income of household j at instant t . $r(t)$ is the real interest rate.

Instantaneous utility is assumed logarithmic, implying that the elasticity of inter-temporal substitution is equal to unity. We also assume that $\rho - n > 0$, which is necessary for (1) to be finite.

Integrating (2), using the solvency condition (3), and assuming that the initial per capital non-human wealth of the household is equal to $a_j(0)$, yields the familiar inter-temporal budget constraint, that the present value of per capita consumption must equal the present value of per capita labor income plus initial per capita non-human wealth.

$$a_j(0) + \int_{t=0}^{\infty} w_j(t) e^{-\int_{s=0}^t (r(s)-n)ds} dt = \int_{t=0}^{\infty} c_j(t) e^{-\int_{s=0}^t (r(s)-n)ds} dt \quad (4)$$

Maximisation of (1) subject to (2) and (3) yields the familiar Euler equation for consumption,

$$\dot{c}_j(s) = (r(s) - \rho)c_j(s) \quad (5)$$

We can aggregate the first order condition (5) to derive aggregate consumption, as,

$$\dot{C}(t) = (r(t) - \rho + n)C(t) \quad (6)$$

where C is aggregate consumption of goods and services.

2. Production, Employment and the Investment Decisions of Firms

Producers are competitive firms, employing capital and labor to produce a homogeneous commodity. The production function of firm i at time t is assumed Cobb Douglas with constant returns to scale, and is given by,

$$Y_i(t) = AK_i(t)^\alpha (h(t)L_i(t))^{1-\alpha} \quad (7)$$

where Y is output, K physical capital, L the number of employees and h the efficiency of labor. The efficiency of labor is the same for all firms. $A > 0$, which measures total factor productivity, and $0 < \alpha < 1$ are exogenous technological parameters.

We assume that the efficiency of labor grows at an exogenous rate g , which measures the rate of technological process. We thus assume that,

$$h(t) = e^{gt} \quad (8)$$

where g is the rate of exogenous (labor augmenting) technical progress and the efficiency of labor at time 0 has been normalised to unity.

Substituting (8) in (7) and aggregating across firms, we have,

$$Y(t) = AK(t)^\alpha (e^{gt} L(t))^{1-\alpha} \quad (9)$$

In order to determine the production, employment and investment decisions of firms we first define the instantaneous profit function of firm i . This is given by,

$$Y_i(t) - w(t)L_i(t) - \left[1 + \frac{\phi}{2} \left(\frac{I_i(t)}{K_i(t)} \right) \right] I_i(t) \quad (10)$$

where w is the real wage and ϕ is a positive constant measuring the intensity of the marginal adjustment cost of gross investment I . The relation between gross and net investment is given by,

$$I_i(t) = \dot{K}_i(t) + \delta K_i(t) \quad (11)$$

Each firm thus chooses an employment and an investment plan to maximise,

$$\int_{s=t}^{\infty} e^{-\int_{z=t}^s r(z)dz} \left(Y_i(s) - w(s)L_i(s) - \left[1 + \frac{\phi}{2} \left(\frac{I_i(s)}{K_i(s)} \right) \right] I_i(s) \right) ds \quad (12)$$

subject to the production function (7) and the accumulation equation,

$$\dot{K}_i(s) = I_i(s) - \delta K_i(s) \quad (13)$$

Since firms are competitive, they take the path of real wages and real interest rates as exogenously given.

From the first order conditions for the maximisation of (12) subject to the production function (7) and the capital accumulation equation (13), we get,

$$w(t) = (1 - \alpha) A \left(\frac{K_i(t)}{L_i(t)} \right)^{\alpha} h(t)^{1-\alpha} \quad (14)$$

$$q_i(t) = 1 + \phi \left(\frac{I_i(t)}{K_i(t)} \right) = 1 + \phi \left(\frac{\dot{K}_i(t)}{K_i(t)} + \delta \right) \quad (15)$$

$$\left(r(t) + \delta - \frac{\dot{q}_i(t)}{q_i(t)} \right) q_i(t) = \alpha A \left(\frac{K_i(t)}{L_i(t)} \right)^{\alpha-1} h(t)^{1-\alpha} + \frac{\phi}{2} \left(\frac{\dot{K}_i(t)}{K_i(t)} + \delta \right)^2 \quad (16)$$

where q is the shadow price of installed physical capital.

These first order conditions have well known interpretations. (14) states that firms will hire labor until the marginal product of labor is equal to the real wage. (15) is the condition linking the shadow price of installed capital to the gross investment rate. (16) states that the user cost of capital (on the left hand side) is equal to the marginal product capital, which consists of the marginal product of capital in current production, plus the reduction of future investment costs.

The path of investment and capital must also satisfy the transversality condition,

$$\lim_{s \rightarrow \infty} e^{-\int_{z=t}^s r(z)dz} q_j(s) K_j(s) = 0 \quad (17)$$

Note that firms take the efficiency of labor as exogenously given. Also note that because the real wage is the same for all firms, and all firms share the same technology, all firms will choose the same capital labor ratio. Since the real interest rate is the same for all firms,

and all firms share the same technology, all firms will also share the same gross investment rate.

Aggregating (14)-(16) across firms, and using (8), the aggregate first order conditions are given by,

$$w(t) = (1 - \alpha)Ak(t)^\alpha e^{gt} \quad (18)$$

$$q(t) = 1 + \phi \left(\frac{\dot{k}(t)}{k(t)} + g + n + \delta \right) \quad (19)$$

$$\left(r(t) + \delta - \frac{\dot{q}(t)}{q(t)} \right) q(t) = \alpha Ak(t)^{-(1-\alpha)} + \frac{\phi}{2} \left(\frac{\dot{k}(t)}{k(t)} + g + n + \delta \right)^2 \quad (20)$$

where,

$$k(t) = \frac{K(t)}{h(t)L(t)} = \frac{K(t)}{e^{(g+n)t}} \quad (21)$$

k is defined as capital per efficiency unit of labor.

3. The Adjustment Path and the Steady State under Financial Autarky

We define as *financial autarky*, the regime under which the economy cannot borrow or lend internationally. Under financial autarky, equilibrium in the goods market requires that domestic consumption plus investment are continuously equal to total domestic output. Thus, financial autarky is a regime in which the economy behaves as a closed economy, and domestic investment is always equal to domestic savings.

The properties of the model under financial autarky are well known from the standard Ramsey-Cass-Koopmans model with adjustment costs for investment (see Abel and Blanchard 1983).

From the production function (13), output per efficiency unit of labor is given by,

$$y(t) = Ak(t)^\alpha \quad (22)$$

$$\text{where, } y(t) = \frac{Y(t)}{h(t)L(t)} = \frac{Y(t)}{e^{(g+n)t}} .$$

From the aggregate consumption function (5), consumption per efficiency unit of labor evolves according to,

$$\dot{c}(t) = (r(t) - \rho - g)c(t) \quad (23)$$

Under financial autarky, the economy must satisfy,

$$y(t) = Ak(t)^\alpha = c(t) + q(t) \left(\dot{k}(t) + (g + n + \delta)k(t) \right) \quad (24)$$

(24) can be rewritten as,

$$\dot{k}(t) = \frac{1}{q(t)} (Ak(t)^\alpha - c(t)) - (g + n + \delta)k(t) \quad (25)$$

Under the assumption that $0 < \alpha < 1$, the model possesses a steady state.

We can use the model to analyse the balanced growth path under financial autarky as well as the adjustment process towards the balanced growth path.

3.1 The Balanced Growth Path

The balanced growth path (steady state) under autarky is defined as the vector $(y_E, k_E, c_E, q_E, r_E, w_E)$ that simultaneously satisfies (18), (19), (20), (22), (23) and (25), for,

$$\dot{q}(t) = \dot{k}(t) = \dot{c}(t) = 0$$

The steady state turns out to be a function of a single state variable, namely k .

From (23), in steady state, the real interest rate must satisfy,

$$r_E = \rho + g \quad (26)$$

From (19), the steady state shadow price of installed capital must satisfy,

$$q_E = 1 + \phi(g + n + \delta) \quad (27)$$

Equation (27) determines the steady state investment rate.

From (20), the equality between the user cost of capital and the marginal product of capital, must hold for the steady state investment rate, the steady state real interest rate and the steady state capital stock. Substituting (26) in (20), this implies that,

$$q_E = \frac{1}{\rho + g} \left(\alpha A k_E^{-(1-\alpha)} + \frac{\phi}{2} (g + n + \delta)^2 \right) - \delta \quad (28)$$

(27) and (28) determine the steady state capital stock per efficiency unit of labor as,

$$k_E = \left(\frac{aA}{\rho + g + \delta + \phi(\rho - n)(g + n + \delta) + (\phi/2)(g + n + \delta)^2} \right)^{\frac{1}{1-\alpha}} \quad (29)$$

Note from (29) that the steady state capital stock is lower than the steady state capital stock in the absence of adjustment costs for investment ($\phi=0$). Adjustment costs for investment result in a lower steady state capital stock.

Once the steady state capital stock per efficiency unit of labor is determined, steady state output follows from (22), the steady state real wage follows from (18) and steady state consumption per efficiency unit of labor follows from (25).

From (18), the real wage per efficiency unit of labor, ω , is given by,

$$\omega_E = e^{-gt} w_E = (1 - \alpha) A k_E^\alpha \quad (30)$$

Finally, from (25), steady state consumption per efficiency unit of labor satisfies,

$$c_E = A k_E^\alpha - (g + n + \delta) q_E k_E \quad (31)$$

3.2 Dynamic Adjustment to the Steady State

The dynamic behavior of the full model is determined by the evolution of three variables. The capital stock k , which is the only state (backward looking) variable in this model, q , which determines the investment rate and is a control (forward looking) variable, and c , private consumption, which is also a control variable. The behavior of the real wage ω and the real interest rate r follow directly from the paths of these three variables.

The process of adjustment to the steady state for this model has been studied formally by Abel and Blanchard (1983). The equilibrium is a stable manifold and the adjustment process is governed by three roots, one negative (stable) which corresponds to the capital stock k , and two positive (unstable), which correspond to the forward looking variables q and c .

In what follows, we provide a heuristic description of the dynamic adjustment paths using a pair of interdependent phase diagrams, which help describe the adjustment process for investment, consumption and the capital stock. Without loss of generality we focus on the case of an economy with an initial capital stock which is lower than the steady state capital stock.

Assume that the economy in time 0 possesses a capital stock per effective unit of labor which is smaller than the steady state capital stock, say $k_0 < k_E$. With a low initial capital stock, the real interest rate r , as well as q (the investment rate) will be higher than in the steady state. As the economy accumulates capital, both the real interest rate and the investment rate are declining along the adjustment path. Since along the adjustment path the real interest rate is higher than in the steady state, consumption per efficiency unit of labor will be rising as the economy is adding to its stock of capital per effective unit of labor. The growth rate will be higher than the steady state growth rate, and the economy will gradually converge to its balanced growth path. On the other hand, during the convergence process, q and the investment rate will be on a declining path and consumption per effective unit of labor on a rising path. This adjustment process is depicted in Figure 1.

The dynamics of investment (q) and the capital stock (k) are qualitatively similar to the dynamics of the standard q model with an exogenous real interest rate. However, in our case the real interest is endogenous, as it simultaneously satisfies (20) and (23). Thus, the adjustment path of q would lie above the corresponding path in the constant real interest rate case (dotted line), as the real interest rate is declining along the adjustment path in this model.

The dynamics of consumption and the capital stock are qualitatively similar to the dynamics of the standard Ramsey-Cass-Koopmans model, without adjustment costs for investment. However, the adjustment path of consumption is steeper as, outside the steady state, the path of real interest rates lies above the corresponding path in the absence of adjustment costs for investment.

In Figure 2 we depict the time paths of output and consumption in the case of financial autarky. Both start below their steady state values and gradually converge towards them. Consumption converges at a faster rate, as the investment rate is declining along the adjustment path. Initially, the real interest rate will be higher than the steady state real interest rate and the real wage rate lower than in the steady state, but growing at a rate higher than g . In the steady state the real interest rate will converge to $\rho + g$ (see eq. 26), while wages per effective unit of labor will be increasing, due to the accumulation of capital, which causes an increase in the marginal product of labor (see eq. 30).

It is straightforward to deduce from Figure 1 the nature of the dynamic adjustment of an economy whose initial capital stock is above its steady state value. With a high initial capital stock, the real interest rate r , as well as q and the investment rate will be lower than in the steady state. As the economy gradually decumulates capital, the real interest rate and the investment rate are rising along the adjustment path. Since along the adjustment path the real interest rate is lower than in the steady state, consumption per efficiency unit of labor will be falling, as the economy is subtracting from its stock of capital per effective unit of labor. The growth rate will be lower than the steady state growth rate, and the economy will gradually converge to its balanced growth path.

4. Equilibrium Adjustment under Financial Openness in a Small Open Economy

We next turn to an analysis of the model under financial openness. We define financial openness as a regime in which the economy can borrow and lend freely at the world real interest, and is not constrained to finance domestic investment through domestic savings.

We shall assume for simplicity that the world real interest rate is equal to the steady state real interest rate under autarky. Essentially, this means that the rest of world is already on a balanced growth path, that consumers in the rest of the world have the same rate of time preference as domestic consumers, and that the exogenous rate of increase of productivity is the same in the rest of the world.

We shall thus assume that the world real interest rate is given by,²

$$r^* = \rho + g \quad (32)$$

4.1 Consumption under Financial Openness

Under financial openness, consumption per effective unit of labor will jump immediately to its relevant steady state level, as consumers will be able to fully smooth their consumption path.

Substituting (32) in the Euler equation for consumption (23), we get,

$$\dot{c}(t) = (r^* - \rho - g)c(t) = 0 \quad (33)$$

Since households are assumed to satisfy their inter-temporal budget constraint, it must also follow from (4), that,

$$k(0) + \int_{t=0}^{\infty} w(t) e^{-\int_{s=0}^t (r(s)-n)ds} dt = \int_{t=0}^{\infty} c(t) e^{-\int_{s=0}^t (r(s)-g-n)ds} dt \quad (34)$$

In (34) we have assumed that the initial wealth of the representative household is in the form of domestic capital. Recall that $w(t)$ is the real wage per worker and $c(t)$ is consumption per effective unit of labor. With a constant real interest rate as in (32), (34) can be rewritten as,

² This assumption simplifies the analysis but involves little loss of generality. To confirm this, see our two country analysis below, where the world real interest rate is allowed to be different from its steady state value.

$$k(0) + \int_{t=0}^{\infty} w(t)e^{-(\rho+g-n)t} dt = \int_{t=0}^{\infty} c(t)e^{-(\rho-n)t} dt = \bar{c} \int_{t=0}^{\infty} e^{-(\rho-n)t} dt = \frac{\bar{c}(k_0)}{\rho-n} \quad (35)$$

where \bar{c} denotes the constant (smoothed) consumption per effective unit of labor. Solving (35) for consumption, we get,

$$\bar{c}(k_0) = (\rho - n) \left(k(0) + \int_{t=0}^{\infty} w(t)e^{-(\rho+g-n)t} dt \right) \quad (36)$$

Equation (36) suggests that under financial openness, and with the world real interest rate at its steady state value, domestic consumption per effective unit of labor will be determined as postulated by the permanent income hypothesis. Domestic consumers will be consuming their permanent income, which is a constant fraction of their total wealth.³

Note that consumption per effective unit of labor will be constant and a positive function of the initial capital stock k_0 . The higher is the initial capital stock, the higher will be the permanent income of the representative household, since both its original non-human wealth (k_0) and its human wealth will be higher. Its human wealth will be higher because with a higher initial capital stock, the path of real wages will also be higher, and thus the present value of the stream of labor income in (35) will be higher when evaluated at the world real interest rate.

Also note that with $k_0 < k_E$ savings under openness will be lower than savings under autarky, since consumption will be equal to permanent income and not current (low) income minus investment.

4.2 Investment under Financial Openness

With the world real interest constant at its steady state value, investment will be determined by (19) and the equality between the user cost of capital and the marginal product of capital.

$$\left(r^* + \delta - \frac{\dot{q}(t)}{q(t)} \right) q(t) = \left(\rho + g + \delta - \frac{\dot{q}(t)}{q(t)} \right) q(t) = \alpha A k(t)^{-(1-\alpha)} + \frac{\phi}{2} \left(\frac{\dot{k}(t)}{k(t)} + g + n + \delta \right)^2 \quad (20')$$

Whereas in steady state (20) and (20') will coincide, (20') will lie above (20) for economies with an initial capital stock below the steady state capital stock, and below (20) in the opposite case. This means, that an economy with a low initial capital stock will experience higher investment under financial openness than under autarky, and will as a result converge more rapidly to the steady state. This is because world interest rates are lower

³ Note, however, that although consumption per effective unit of labor will be constant, consumption per head will be rising at a constant rate g .

compared to this economy's initial autarky interest rate. An economy with a high initial capital stock, i.e one that exceeds its steady state level, will also experience faster convergence, as it will have a higher disinvestment rate, since the world interest rate will be higher than its initial autarky rate.

The difference between autarky and openness is depicted in Figure 3. The saddle path under openness is steeper than under autarky (the dotted line), and as a result convergence is faster.

We have thus demonstrated that, for an economy with a low initial capital stock relative to its steady state value and the rest of the world, savings are lower and investment is higher under financial openness, than in the case of autarky. As a result, the current account will initially move into deficit after financial liberalisation.

4.3 The Current Account and External Balance

The evolution of the current account will be determined by the difference between national savings and domestic investment. Thus, instead of (25), which in the case of autarky required the equality of domestic savings and investment, we shall have,

$$\dot{f}(t) = ((r^* - g - n)f(t) + Ak(t)^\alpha - c(t)) - q(t) \left(\dot{k}(t) + (g + n + \delta)k(t) \right) \quad (25')$$

where f denotes net financial assets from the rest of world. To the extent that national savings exceed domestic investment, the economy accumulates net financial assets from the rest of the world. In the opposite case, it accumulates net foreign debt.

The trade balance, will be determined by the difference between domestic savings and investment, and will be given by,

$$Ak(t)^\alpha - c(t) - q(t) \left(\dot{k}(t) + (g + n + \delta)k(t) \right)$$

We shall again concentrate on a small economy that starts with a low initial capital stock and will additionally assume that net financial assets from the rest of the world are initially zero.

We have already demonstrated that under financial openness this economy will initially have lower savings and higher investment compared to the case of autarky. Thus, its trade balance and the current account will move into deficit and the economy it will start accumulating foreign debt. Substituting (31) and (33) into (25'), the process of debt accumulation will be determined by,

$$\dot{f}(t) = (\rho - n)f(t) + Ak(t)^\alpha - \bar{c}(k_0) - q(t) \left(\dot{k}(t) + (g + n + \delta)k(t) \right) \quad (36)$$

As the economy converges towards the steady state, savings increase, since national output increases and consumption is constant, while investment gradually falls, as q falls due to the gradual increase of the stock of physical capital. In the steady state, national savings will be equal to domestic investment, and the stock of equilibrium net foreign assets per effective unit of labor will be negative, because of the accumulated current account deficits during the adjustment process. Equilibrium net foreign assets will be given by,

$$\bar{f}(k_0) = \frac{-1}{(\rho - n)} \left(Ak_E^\alpha - \bar{c}(k_0) - q_E k_E (g + n + \delta) \right) \quad (37)$$

Note from (37) that the steady state GDP per effective unit of labor is the same as under autarky. The same applies to q and the capital stock. Steady state investment is thus the same as under autarky. The reason is that under autarky the steady state domestic real interest rate is equal to the world real interest rate.

In Figure 4, we present the adjustment process. Note that we consider a small economy, whose initial capital stock is below its steady state value, under the assumption that the rest of the world is on a balanced growth path. For this economy, the path of real interest rates under financial openness will be below the corresponding path under autarky. As a result, both per capita consumption and investment will be higher during the adjustment process under financial openness than under autarky. Lower interest rates and higher investment imply higher real wages and a higher present value of labor income under openness than under autarky. Thus, both the present value of consumption and the welfare of the representative household will be higher under financial openness than under autarky.

During the transition, the small open economy in question runs current account deficits and accumulates foreign debt. As the economy approaches the steady state, the process of foreign debt accumulation slows, and the economy returns to external balance. However, steady state consumption per capita is lower under financial openness than under autarky, as under openness, the economy has to pay interest on the foreign debt that it has accumulated during the transition.

Consider Figure 4. At time 0, because of the low initial capital stock, consumption is higher than output net of investment. Thus, there is a trade deficit, which is equal to the difference between the high consumption and the low output net of domestic investment. As output gradually rises and investment gradually declines along the adjustment path, the trade deficit narrows and after a point becomes a surplus. From then on the economy is running trade surpluses in order to service the foreign debt that it has accumulated. In steady state the economy returns to external balance, servicing a constant foreign debt per effective unit of labor.

Although steady state GDP per capita is the same under financial autarky and openness, GNP per capita is smaller than GDP per capita under openness, as the country has to pay interest on the debt it has accumulated vis-a-vis the rest of the world.

It is also worth noting that along the balanced growth path the economy runs a trade surplus, but a current account deficit. Foreign debt per effective unit of labor is constant, meaning that foreign debt is rising at a rate $g+n$, the same as the rate of growth of GDP.

For an economy with an initial capital stock that exceeds the steady state capital stock, the opposite would apply. Under financial openness it will initially experience trade and current account surpluses, and in the steady state it will end up with positive net foreign assets rather than foreign debt. Consumption per effective unit of labor will be higher than under autarky in the steady state, because the country receives interest payments on the foreign assets it has accumulated. Although steady state GDP per capita is the same under financial autarky and openness, GNP per capita is higher than GDP per capita under openness, as the country receives interest on the assets it has accumulated in the rest of the world.

The dependence of steady state consumption on the initial capital stock under openness can be directly deduced from (35). The higher the initial capital stock, the higher will be the permanent income of the representative household, since both its original non-human wealth (k_0) and its human wealth will be higher. Its human wealth will be higher because with a higher initial capital stock, the path of real wages will be higher, and thus the present value of the stream of labor income in (35) will be higher when evaluated at the world real interest rate.

5. *Equilibrium under Financial Openness in a Two-Country World*

We now abandon the small open economy assumption, in order to analyse the case of a two country world of interdependent economies.

We assume a world economy consisting of two economies that are similar in every respect, apart from their initial per capita capital stocks. Both economies are competitive, they have access to the same production technology and their consumers have exactly the same preferences. We shall assume that economy 1 has a higher initial capital stock than economy 2 .

The two country world is described by the following model, where subscript $i=1,2$ refers to the two countries.

$$y_i(t) = Ak_i(t)^\alpha \quad (38.1)$$

$$\dot{c}_i(t) = (r(t) - \rho - g)c_i(t) \quad (38.2)$$

$$q_i(t) = 1 + \phi \left(\frac{\dot{k}_i(t)}{k_i(t)} + g + n + \delta \right) \quad (38.3)$$

$$\left(r_i(t) + \delta - \frac{\dot{q}_i(t)}{q_i(t)} \right) q_i(t) = \alpha A k_i(t)^{-(1-\alpha)} + \frac{\phi}{2} \left(\frac{\dot{k}_i(t)}{k_i(t)} + g + n + \delta \right)^2 \quad (38.4)$$

$$\omega_i(t) = w_i(t) e^{-gt} = (1 - \alpha) A k_i(t)^\alpha \quad (38.5)$$

$$\dot{f}_i(t) = \left((r(t) - g - n) f_i(t) + A k_i(t)^\alpha - c_i(t) \right) - q_i(t) \left(\dot{k}_i(t) + (g + n + \delta) k_i(t) \right) \quad (38.6)$$

$$f_1(t) = -f_2(t) \quad (38.7)$$

$$k_E > k_1(0) > k_2(0) \quad (38.8)$$

Under financial autarky, net foreign assets f are equal to zero for all t . Under financial openness, the two economies have the same real interest rate $r(t)$, the world real interest rate, which is determined by the equality of savings and investment in the world economy. It is straightforward to show that the world real interest rate will lie between the autarky real interest rates of the two economies. It will be higher than the autarky real interest rate for economy 1 (the DC) and lower than the autarky real interest for economy 2 (the LDC). Thus, economy 1 will have lower investment and higher savings than in the case of autarky, and economy 2 will have higher investment and lower savings than in the case of autarky.

It follows from our previous analysis of a single economy, that in the transition path economy 1 will have a lower growth rate of GDP per capita than in the case of autarky, while economy 2 will have a higher growth rate. More importantly, in the transition path, economy 1 will be accumulating net foreign assets, through current account surpluses, while economy 2 will be accumulating foreign debt, through current account deficits.

The transition paths for investment and the capital stock for the two economies are depicted in Figure 5, under the additional assumption that the initial capital stock of both economies is below its steady state equilibrium. Because the path of the world real interest rate will lie between the paths of the autarky real interest rates in the two economies, the path of investment will be lower than under autarky for economy 1 (the capital rich economy) and higher than under autarky for economy 2 (the capital poor economy). However, both economies will converging towards the same balanced growth path for capital and output.

Where things differ qualitatively from our previous analysis is in the paths of private consumption and the current account. Unlike the small open economy case that we analysed in the previous section, the world real interest rate is above its steady state value $\rho+g$, and it is not constant but declining along the transition path. Thus, consumption smoothing will not be absolute, as in the case of a constant equilibrium real interest rate, but relative.

As depicted in Figure 6, consumption will be increasing in both economies, as they accumulate capital and the world real interest rate is higher than in steady state, and on a downward path towards its steady state value. In economy 2 (the capital poor economy), consumption will be initially above the difference between output and investment, and as a result economy 2 will be experiencing current account deficits. In economy 1 (the capital rich economy), consumption will be below the difference between output and investment, and economy 1 will be experiencing current account surpluses. As consumption and output are rising in both economies, there will be a gradual narrowing of the trade imbalances, which after some time will be reversed. Economy 2 will start experiencing trade (but not current account) surpluses, in order to service the foreign debt that it has accumulated, while economy 1 will start experiencing trade (but not current account) deficits. As the economies converge towards the balanced growth path, external balance is restored.

In the steady state, both economies will have converged to the same GDP per effective unit of labor, but steady state consumption (and GNP) will be higher in economy 1, which is a net lender vis-a-vis the rest of the world (economy 2), and lower in economy 2, which is a net borrower from the rest of the world (economy 1).

We have thus demonstrated the following four results:

1. On the balanced growth path, output (GDP) per capita is the same as under autarky for both economies.
2. On the balanced growth path Gross National Product (GNP) and consumption per capita is lower for economy 2 (the capital poor economy), since the economy has to pay interest on the foreign debt it has accumulated during the transition. The opposite applies to economy 1 (the capital rich economy).
3. During the transition, the capital rich economy 1 runs current account surpluses and accumulates net foreign assets, while the capital poor economy 2 runs current account deficits and accumulates net foreign debt.
4. There are benefits from inter-temporal trade for both types of economies, as, during the transition path, the real interest rate under autarky differs from the world real interest rate for either of them.

In what follows we present numerical simulations of both the small open economy and two country models. This will allow us to get a quantitative feel of the significance of the differences between financial openness and autarky.

6. A Numerical Simulation of the Adjustment Paths under Autarky and Openness

The results of a dynamic simulation of both the small open economy model and the two country model are presented in Table 1 and Figures 7, 8 and 9.⁴

We consider first the case of a small “poor” economy which, under openness, can borrow at the steady state world real interest rate, as in the analysis of section 4. We assume that the initial GDP (per effective unit of labor) of this economy is at 70% of its steady state value. The steady state results are summarised in the first two columns of Table 1, while the adjustment paths are depicted in Figure 7.

Compared to autarky, financial openness results in an immediate rise in the investment rate and absolute consumption smoothing (see Figure 7). The adjustment of the capital stock and GDP (per effective unit of labor) towards the balanced growth path is thus faster than under financial autarky. However, the economy initially runs trade and current account deficits. Gradually, the trade deficits are transformed into surpluses and the stock of foreign debt stabilises.

As suggested by the theoretical analysis, the steady state capital stock, steady state GDP per capita, the steady state shadow price of capital and the steady state real interest rate are the same under autarky and openness, although their adjustment paths differ under the two regimes. However, as the theoretical analysis has also concluded, steady state consumption is lower under openness than under autarky, and GNP is lower than GDP. Because of the large initial gap between the autarky real interest rate and the world real interest rate, and the resulting fast accumulation of external debt, the steady state difference between GNP and GDP is about 18% of GDP in this example, while the steady state difference in consumption between autarky and openness is 5.5% of GDP (see Table 1).

We next consider the case of a symmetric two country world economy. We assume, as in the analysis of section 5, that the only difference between the two countries is in their initial capital stock and the resulting per capita GDP. The initial GDP (per effective unit of labor) of economy 1 is at 90% of its steady state value, while the initial GDP (per effective unit of labor) of economy 2 is at 70% of its steady state value. The steady state results are summarised in the last four columns of Table 1, while the adjustment paths are depicted in Figures 8 and 9.

As suggested by the theoretical analysis, the steady state capital stock, steady state GDP per capita, the steady state shadow price of capital and the steady state real interest rate are the same under autarky and openness, for both economies, although their adjustment paths differ under the two regimes.

⁴ The simulations were carried out in MATLAB, using the DYNARE pre-processor (see Adjemian et al (2011)). The parameter values used were, $\rho=2\%$, $n=1\%$, $g=1.5\%$, $\delta=3.5\%$, $A=2$, $\alpha=0.33$ and $\phi=6$. The qualitative nature of the simulation results does not depend on the exact parameter values.

Compared to autarky, for economy 1 (the capital rich economy) financial openness results in a fall in the investment rate and an initial fall in private consumption (see Figure 8). This is because the real interest rate rises compared to autarky. The adjustment of the capital stock and GDP (per effective unit of labor) towards the balanced growth path is thus slower than under financial autarky. As a result of the higher savings and the lower investment, the economy initially runs trade and current account surpluses. Gradually, the trade surpluses are transformed into deficits and the stock of foreign assets stabilises. As the theoretical analysis has concluded, steady state consumption is higher under openness than under autarky, and GNP is higher than GDP.

The opposite happens in economy 2 (the capital poor economy). Both investment and consumption rise, because of the fall of the real interest rate compared to autarky (see Figure 9). Consumption smoothing is not absolute (as in our small economy example) but relative, since the world real interest rate is initially above the steady state real interest rate and declining. In all other respects, the adjustment path of economy 2 resembles the adjustment path of the small open economy that we have already analysed. In this case, because of the smaller initial gap between the autarky real interest rate and the world real interest rate, and the resulting slower accumulation of external debt, the steady state difference between GNP and GDP is about 7.3% of GDP, while the steady state difference in consumption between autarky and openness is 2.6% of GDP (see Table 1).

7. Potential Extensions and the Time Consistency Problem

Our analysis of the neoclassical growth model, augmented for adjustment costs for investment, has demonstrated that financial openness affords an economy the opportunity to engage in beneficial inter-temporal trade, as long as the path of the world real interest rate differs from the path of its real interest rates under autarky. We have demonstrated that this will be the case during the adjustment path to a balanced growth path, as long as the initial capital stock of an economy differs from the initial capital stock in the rest of the world, even if the economy is characterised by the same technology and preferences as the rest of the world.

The analysis has a number of potentially important implications both for the growth process of less developed economies and macroeconomic interdependence between developed and less developed economies. It suggests that financial openness can be beneficial for LDCs and DCs. For LDCs it can facilitate consumption smoothing and it can speed up the growth process, but at the same time it will result in external deficits and accumulation of foreign debt, which in the steady state will result in lower GNP and private consumption per capita than under financial autarky.

Introducing a government that finances a path of government consumption through lump sum taxes, debt or money would not affect the conclusions in this representative household model, as the model is characterised by Ricardian equivalence. The path of government consumption will affect private consumption, but not the investment and

growth rates or total domestic savings, which jointly determine the path of the current account. In addition, the choice between government debt and lump taxes will not have any effects. On the other hand, the impact of distortionary taxes under the two regimes of financial autarky and openness would be an interesting avenue for future research.

Another avenue for future research would be to extend the analysis to the case of a neoclassical growth model with overlapping generations (Diamond (1965), Blanchard (1985), Weil (1989)). In such a model, government consumption, debt and money would have real effects, as Ricardian equivalence would not hold.⁵

However, what is potentially more problematic for the analysis is the issue of time consistency. We have assumed throughout that the economies in question respect their inter-temporal budget constraints and do not repudiate on the foreign debt that they accumulate. This is equivalent to assuming an international commitment mechanism that stops households, or governments, from re-optimising after they have accumulated foreign debt. In the absence of such international commitment mechanisms, an economy that has accumulated foreign debt may find that it can increase its ex post welfare, by repudiating on its foreign debt. Foreign lenders will anticipate such incentives, and the economy may not be able to borrow freely in international debt markets.⁶ The prevalence of international debt crises in the era of financial openness since the 1970s suggests that this problem is potentially serious, and that time consistency problems may undermine financial openness and the concomitant benefits of inter-temporal trade. Thus, the results of this paper must be treated with caution, as they rely on commitment and do not incorporate an analysis of potential repudiation problems.⁷

One recent case in point is the experience of the economies in the periphery of the euro area (Greece, Portugal, Spain and Ireland). These economies opted for full financial openness when they entered the euro area in the late 1990s. As a result, for almost ten years they experienced lower real interest rates, higher investment and growth rates and lower national savings rates. Their current account deficits soared and they were the first to be hit in the international financial crisis of 2008. They have since returned to high real interest rates and some were excluded from international financial markets, effectively returning to a regime of financial autarky.

⁵ Alogoskoufis (2014) analyses the effects of budgetary policies on external balance in an endogenous growth overlapping generations model of a small open economy.

⁶ Obstfeld and Rogoff (1996), Chapter 6.2 discuss this problem in a two period Fisherian economy. They show that in the absence of international commitment mechanisms, there exists a debt ceiling beyond which international lenders are not willing to lend, as lending beyond the debt ceiling will create incentives for a country to repudiate on its foreign debt.

⁷ These problems have been studied since the 1980s in the important contributions of Eaton and Gersovitz (1981), Cohen and Sachs (1986) and Bulow and Rogoff (1989) among others. An important recent contribution that also surveys the more recent literature is Arellano (2008). However, the models used in this literature are simple compared to the neoclassical growth model. They are either two period Fisherian models or endowment economies without capital. An exception is Cohen and Sachs (1986) who, however, use a linear (endogenous growth) production technology.

8. *Conclusions*

In this paper we have compared financial openness with autarky in a neoclassical growth model, augmented with adjustment costs for investment.

We have analysed the relation between growth and the current account both in the balanced growth path and in the process of adjustment towards the balanced growth path.

For an economy, whose initial capital stock is lower than in the rest of the world, the path of real interest rates under financial openness will be below the corresponding path of real interest rates under autarky. As a result, under financial openness, both per capita consumption and investment will be higher during the adjustment process. During the transition to the balanced growth path, such an economy thus runs current account deficits and accumulates foreign debt. As it approaches the balanced growth path, the process of foreign debt accumulation slows down, and the economy approaches a position of external balance.

On the balanced growth path, output (GDP) per capita is the same as under autarky, but Gross National Product (GNP) and consumption per capita are lower under financial openness than under autarky, since the economy has to pay interest on the foreign debt it has accumulated during the transition.

The opposite applies to an economy, whose initial capital stock is higher than the rest of the world. During the transition, the economy runs current account surpluses and accumulates net foreign assets. Steady state consumption per capita will be higher under financial openness than under autarky, as the economy receives interest on the foreign assets that it has accumulated during the transition.

There are benefits from inter-temporal trade for both types of economies, as, along the transition path, world real interest rates differ from autarky real interest rates for both economies.

The analysis has been conducted under the assumption of commitment to the originally optimal plans, and has not incorporated the problem of time inconsistency and the incentives to repudiate on foreign debt. In the absence of international commitment mechanisms financial openness may not be an easily implementable regime and the benefits from inter-temporal trade not easily available to economies that cannot pre-commit not to repudiate on their foreign debt.

References

- Abel A. and Blanchard O. (1983), "An Intertemporal Equilibrium Model of Saving and Investment", *Econometrica*, 51, pp. 675-692.
- Adjemian S., Bastani H., Juillard M., Karamé F., Mihoubi F., Perendia G., Pfeifer J., Ratto M. and Villemot S. (2011), "Dynare: Reference Manual, Version 4," *Dynare Working Papers*, 1, CEPREMAP.
- Alogoskoufis G. (2014), "Endogenous Growth and External Balance in a Small Open Economy", *Open Economies Review*, 25, pp. 571-594.
- Arellano C. (2008), "Default Risk and Income Fluctuations in Emerging Economies", *American Economic Review*, 98, pp. 690-712.
- Barro R., Mankiw G. and Sala-i-Martin X. (1995), "Capital Mobility in Neoclassical Models of Growth", *American Economic Review*, 85, pp. 103-115.
- Blanchard O. (1983), "Debt and the Current Account Deficit in Brazil", in Arnella P., Dornbusch R. and Obstfeld M. (eds), *Financial Policies and the World Capital Market: The Problem of Latin American Countries*, Chicago Ill., University of Chicago Press.
- Blanchard O. (1985), "Debts, Deficits and Finite Horizons", *Journal of Political Economy*, 93, pp. 223-247.
- Blanchard O. and Fischer S. (1989), *Lectures on Macroeconomics*, Cambridge Mass., MIT Press.
- Bulow J. and Rogoff K. (1989), "Sovereign Debt: Is to Forgive to Forget?", *American Economic Review*, 79, pp. 43-50.
- Cass D. (1965), "Optimum Growth in an Aggregative Model of Capital Accumulation", *Review of Economic Studies*, 32, pp. 233-240.
- Cohen D. and Sachs J. (1986), "Growth and External Debt under Risk of Debt Repudiation", *European Economic Review*, 30, pp. 529-560.
- Diamond P. (1965), "National Debt in a Neoclassical Growth Model", *American Economic Review*, 55, pp. 1126-1150.
- Eaton J. and Gersovitz M. (1981), "Debt with Potential Repudiation: Theoretical and Empirical Analysis", *Review of Economic Studies*, 67, pp. 289-309.
- Fisher I. (1930), *The Theory of Interest*, New York, Macmillan.
- Henry P. (2007), "Capital Account Liberalization: Theory, Evidence and Speculation", *Journal of Economic Literature*, 45, pp. 887-935.
- Koopmans T. (1965), "On the Concept of Optimal Economic Growth", in *The Econometric Approach to Development Planning*, Amsterdam, Elsevier.
- Metzler L. (1960), "The Process of International Adjustment under Conditions of Full Employment: A Keynesian View.", paper read before the Econometric Society, reprinted in Caves R. and Johnson H. (eds), (1968), *Readings in International Economics*, Homewood Ill., Irwin.
- Miller N. (1968), "A General Equilibrium Theory of International Capital Flows", *The Economic Journal*, 78, pp. 312-320.
- Obstfeld M. (1998), "The Global Capital Market: Benefactor or Menace.", *Journal of Economic Perspectives*, 12, pp. 9-30.
- Obstfeld M. and Rogoff K. (1996), *Foundations of International Macroeconomics*, Cambridge Mass., MIT Press.

- Ramsey F. (1928), "A Mathematical Theory of Saving", *The Economic Journal*, 38, pp. 543-559.
- Sachs J. (1981), "The Current Account and Macroeconomic Adjustment in the 1970s", *Brookings Papers on Economic Activity*, 1, pp. 201-268.
- Svensson L. (1984), "Oil Prices, Welfare and the Trade Balance", *The Quarterly Journal of Economics*, 99, pp. 649-672.
- Vegh C. (2013), *Open Economy Macroeconomics in Developing Countries*, Cambridge Mass., MIT Press.
- Weil P. (1989), "Overlapping Families of Infinitely lived Households", *Journal of Public Economics*, 38, pp. 183-198.

Figure 1
Dynamic Adjustment under Financial Autarky

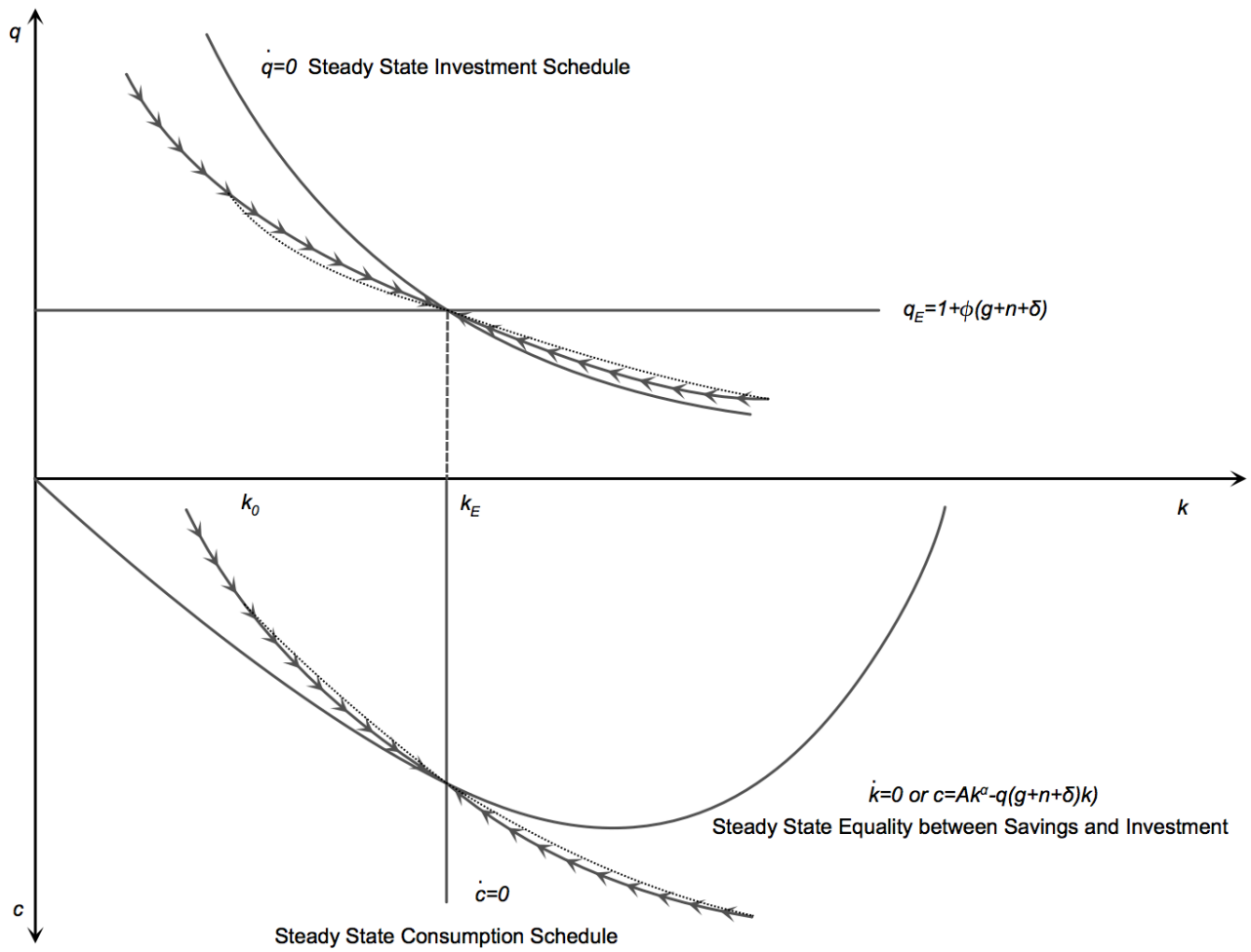


Figure 2
The Time Paths of Output and Consumption under Financial Autarky

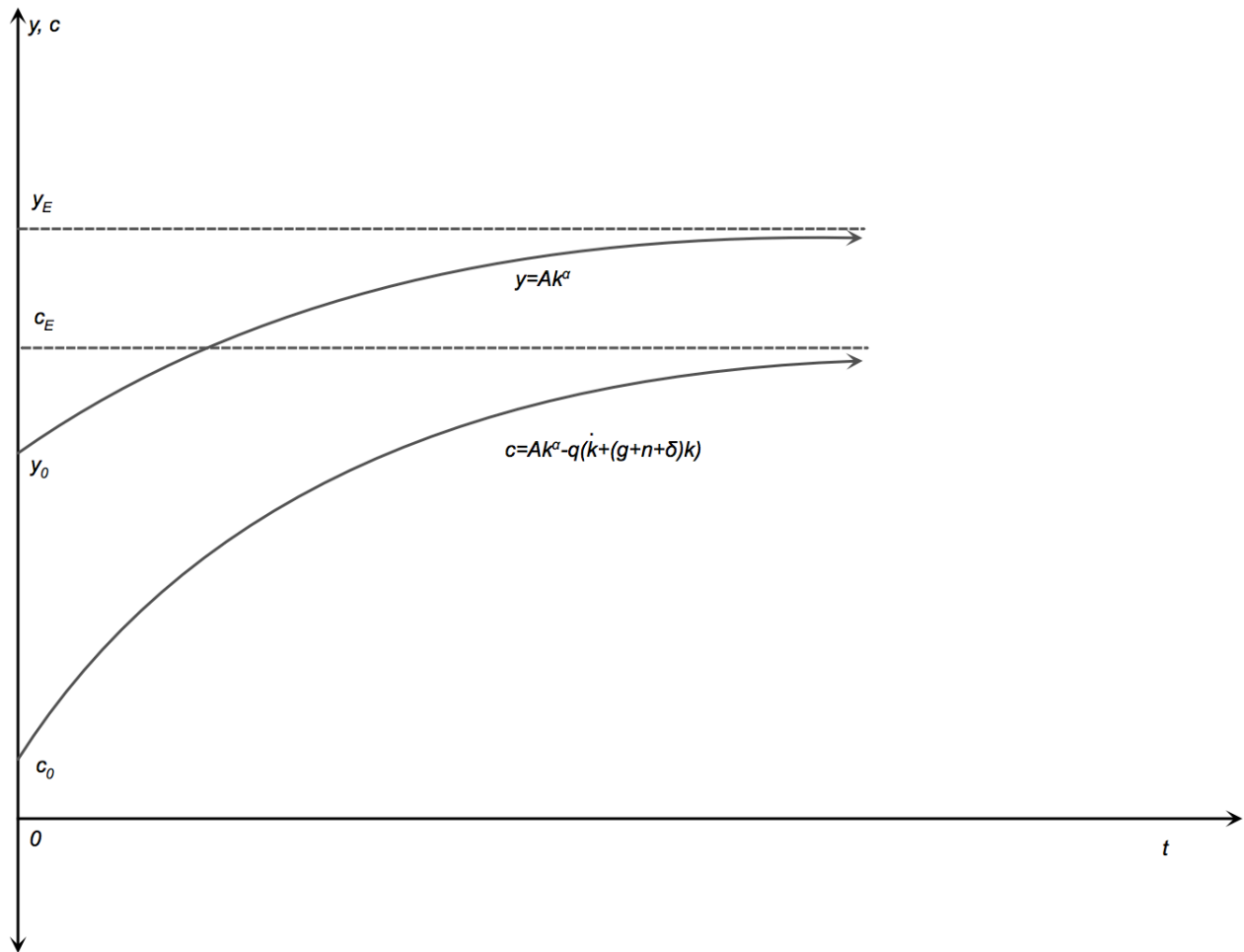


Figure 3
The Dynamic Adjustment of Investment and Capital
under Financial Openness

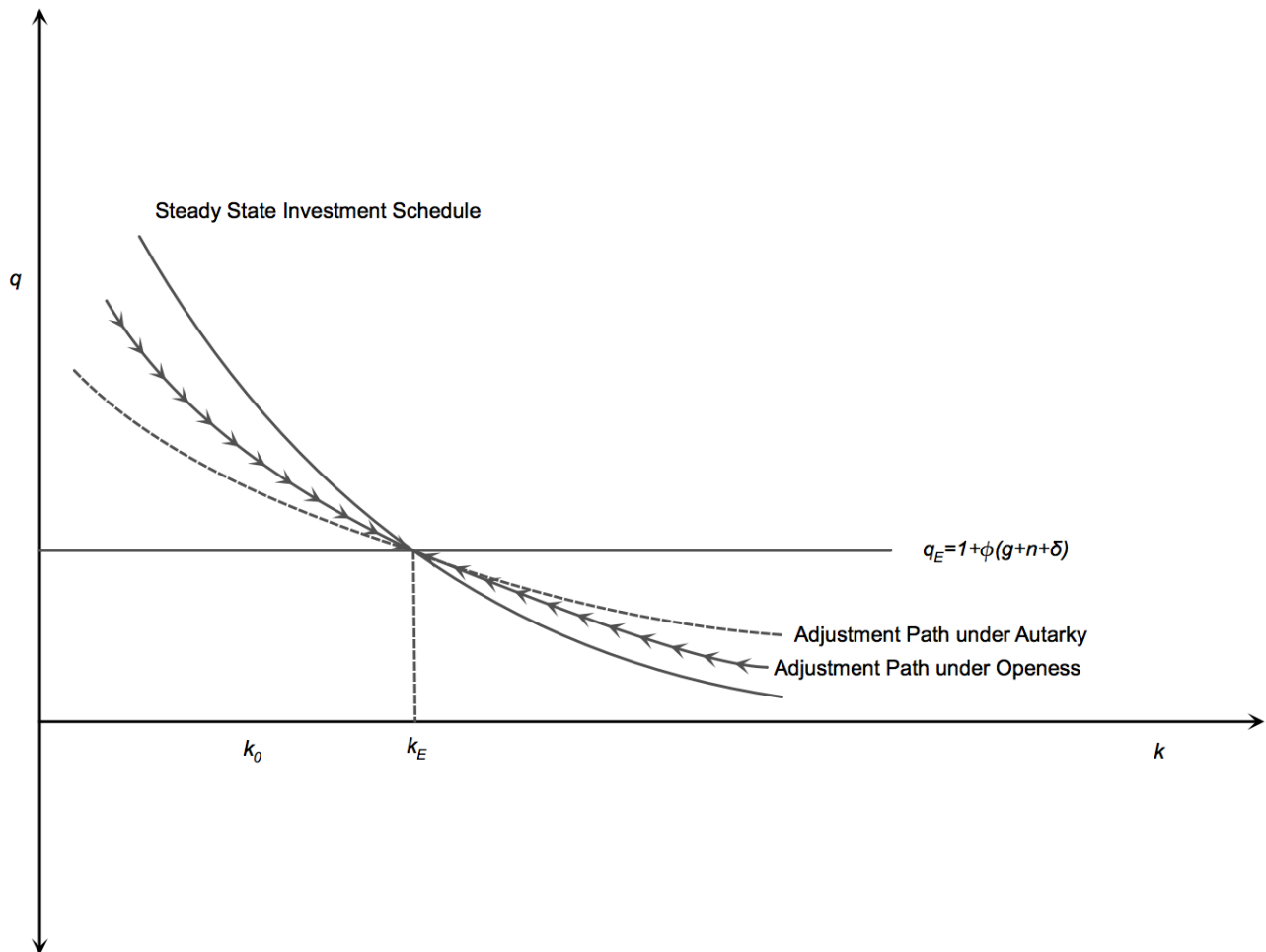


Figure 4
Consumption and the Trade Balance
in a Small Open Economy

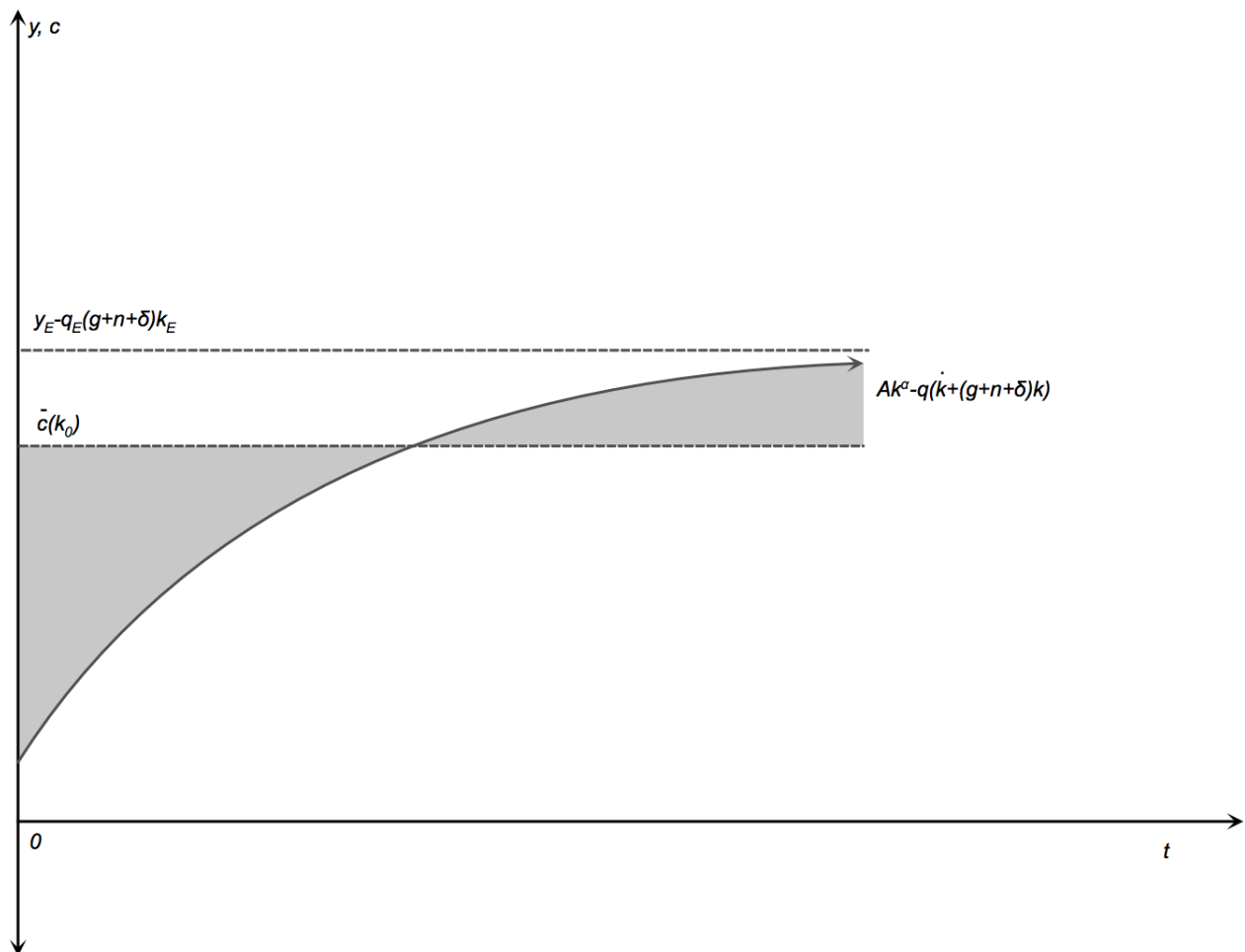


Figure 5
The Dynamic Adjustment of Investment and Capital in a Two Country World

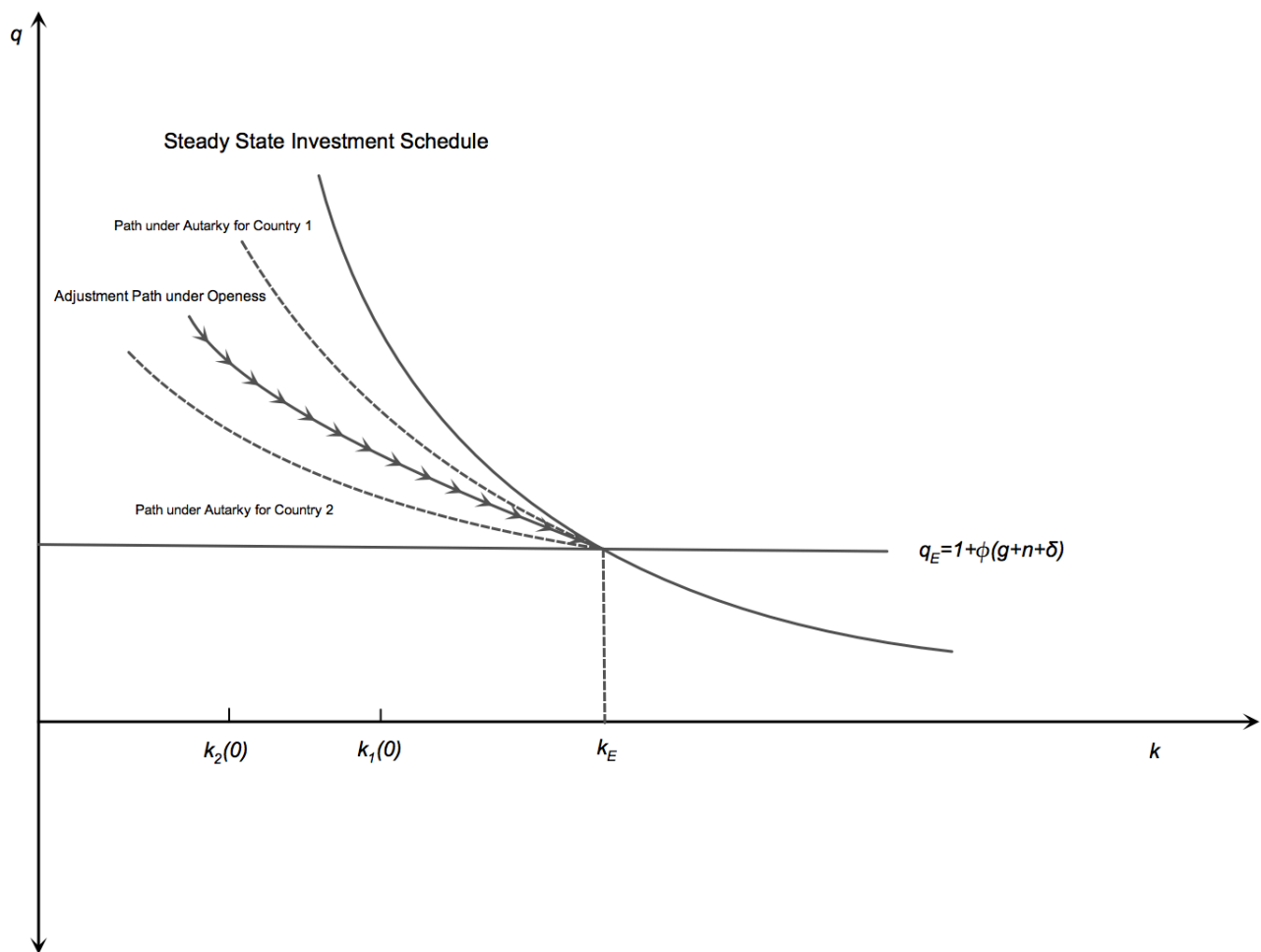


Figure 6
Consumption and Trade Balances in a Two Country World

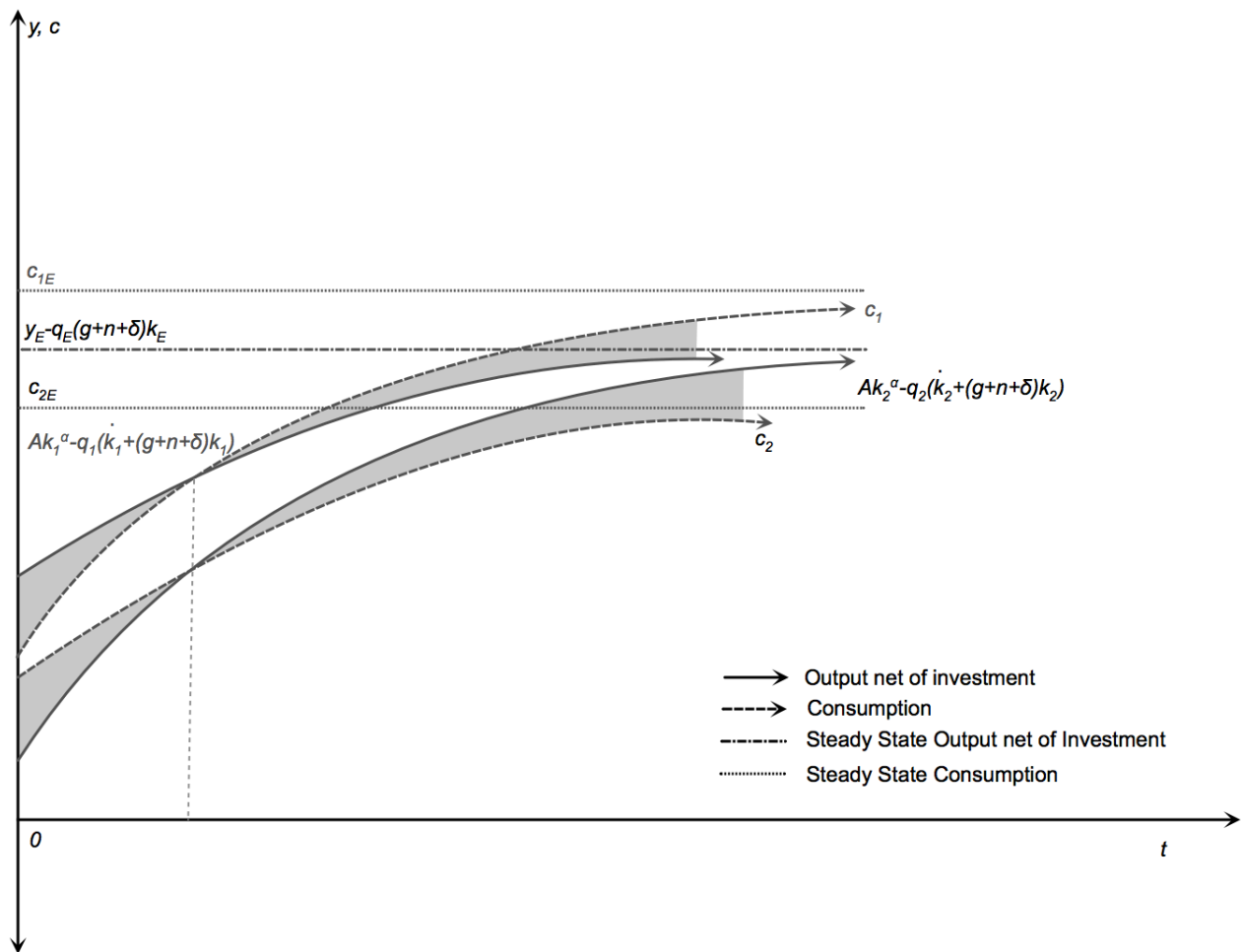
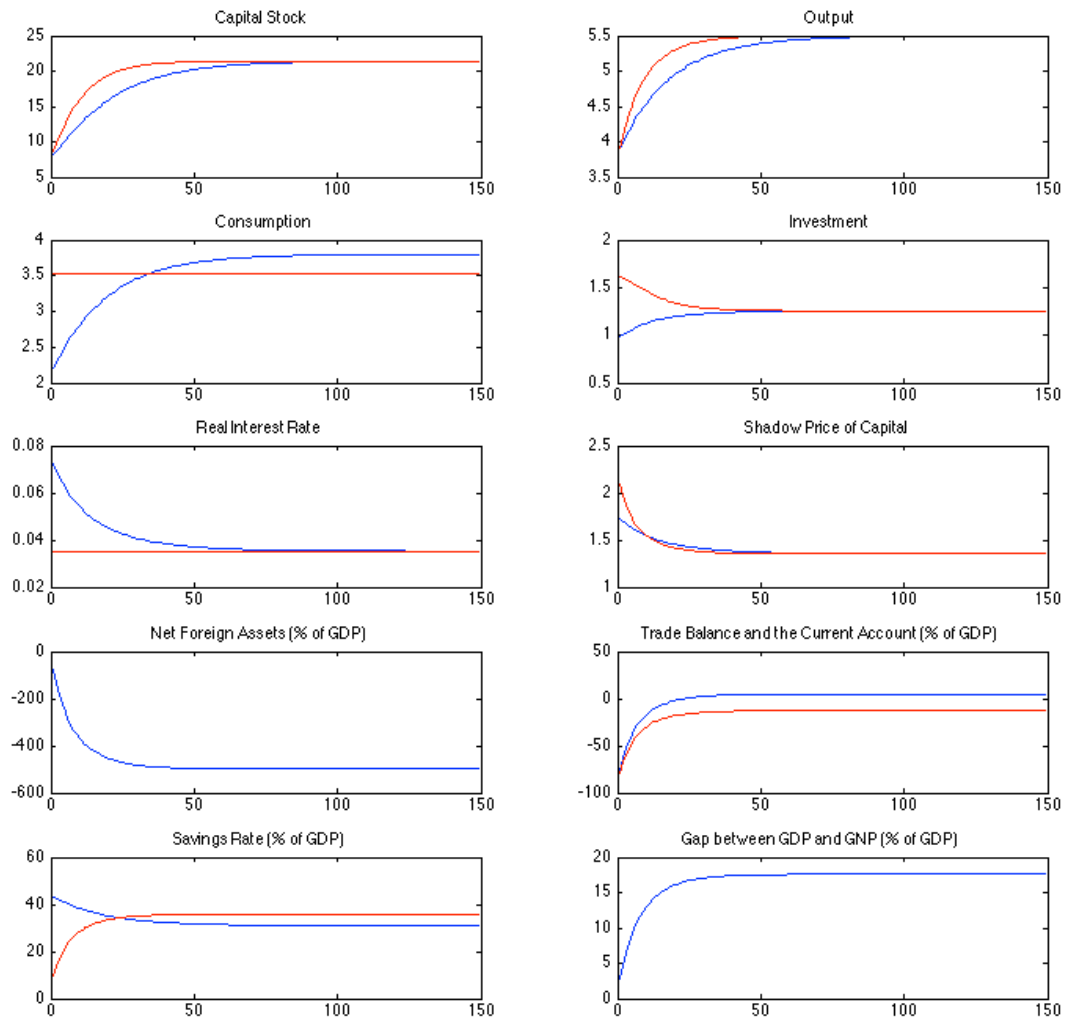
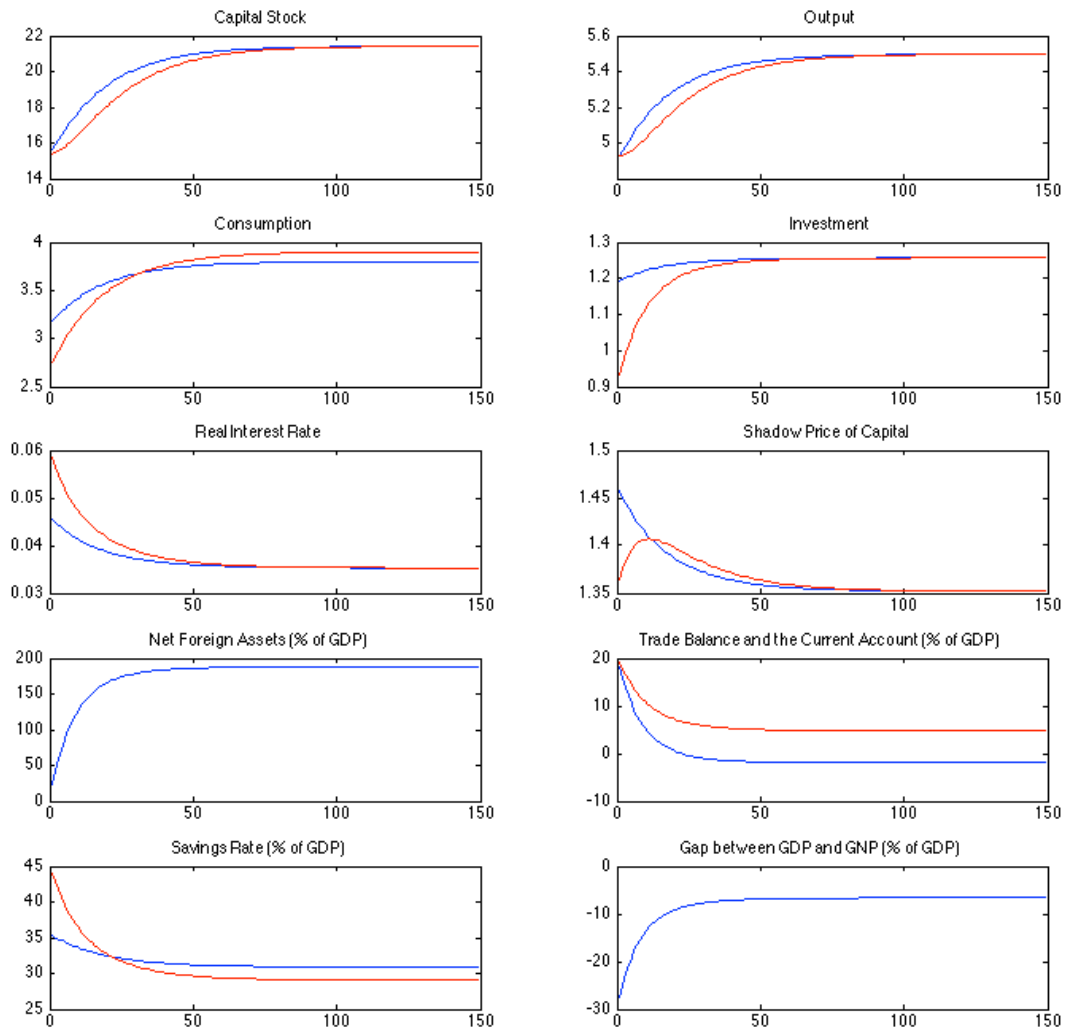


Figure 7
The Adjustment Path of a Capital Poor Small Economy
under Financial Autarky and Openness



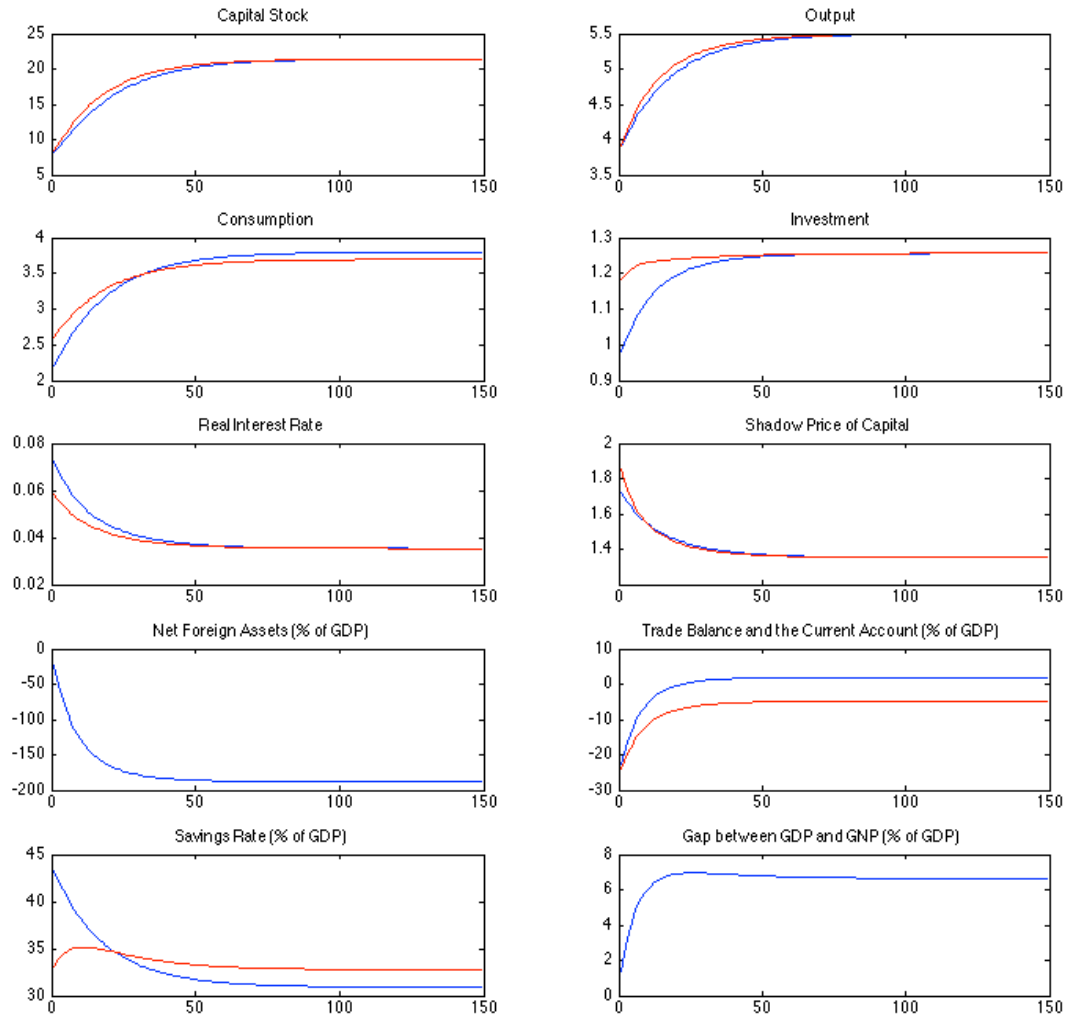
Note: The blue line depicts the adjustment path under financial autarky and the red line the adjustment path under financial openness. In the panel on the Trade Balance and the Current Account, the trade balance is depicted by the blue line and the current account by the red line. See the text and the notes to Table 1 for the simulation details.

Figure 8
The Adjustment Path of Economy 1 (Rich) in a Two Country Model,
under Financial Autarky and Openness



Note: The blue line depicts the adjustment path under financial autarky and the red line the adjustment path under financial openness. In the panel on the Trade Balance and the Current Account, the trade balance is depicted by the blue line and the current account by the red line. See the text and the notes to Table 1 for the simulation details.

Figure 9
The Adjustment Path of Economy 2 (Poor) in a Two Country Model,
under Financial Autarky and Openness



Note: The blue line depicts the adjustment path under financial autarky and the red line the adjustment path under financial openness. In the panel on the Trade Balance and the Current Account, the trade balance is depicted by the blue line and the current account by the red line. See the text and the notes to Table 1 for the simulation details.

Table 1
Simulation Results for the Small Economy and Two Country Models

	Small Economy Autarky	Small Economy Openness	Economy 1 (rich) Autarky	Economy 1 (rich) Openness	Economy 2 (poor) Autarky	Economy 2 (poor) Openness
k_E	21.4	21.4	21.4	21.4	21.4	21.4
y_E	5.5	5.5	5.5	5.5	5.5	5.5
c_E	3.8	3.5	3.8	3.9	3.8	3.7
q_E	1.4	1.4	1.4	1.4	1.4	1.4
r_E	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%
i_E	1.3	1.3	1.3	1.3	1.3	1.3
f_E		-27.4		10.3		-10.3
y_E^n		4.5		5.9		5.1
s_E	31%	36%	31%	29%	31%	33%
tb_E		4.9%		-1.9%		1.9%
ca_E		-12.7%		4.8%		-4.8%
y_0	3.9	3.9	4.9	4.9	3.9	3.9

Note: The simulations have been carried out in MATLAB, using the DYNARE pre-processor (see Adjemian et al (2011)). The parameter values used were, $\rho=2\%$, $n=1\%$, $g=1.5\%$, $\delta=3.5\%$, $A=2$, $\alpha=0.33$, $\phi=6$. y^n is Gross National Income (per effective unit of labor), s is the savings rate (% of GDP), tb is the trade balance (% of GDP) and ca is the current account (per cent of GDP). Subscript E refers to the steady state (balanced growth path). y_0 is the initial GDP (per effective unit of labor). It was set at 70% of steady state GDP for the small economy model and the poor economy in the 2 country model, and at 90% of steady state GDP for the rich economy in the 2 country model.