Global Imbalances, Exchange Rates and Economic Growth

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March 24, 2012

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Abstract

Some emerging countries manipulate their exchange rates to promote an export-led growth policy and manage their current account. This has contributed to creating a "global saving glut" (Bernanke 2005) and increasing global current account imbalances since the end of the 1990s. This paper proposes a two-country overlapping generations model, in which a country can intervene on the foreign exchange market in order to grow without relying on foreign saving. When time preferences and development levels are different across countries, the effects of foreign exchange intervention on current accounts, income growth and the interest rates are consistent with observed facts. In particular, we show that there can be a tradeoff between current account management and growth.

Keywords: balance of payments, exchange rate, global imbalances, growth, overlapping generations
JEL Classification numbers: E20, F21, F31, F43, O16, O41

*L. Artige acknowledges the financial support of the Banque Nationale de Belgique.

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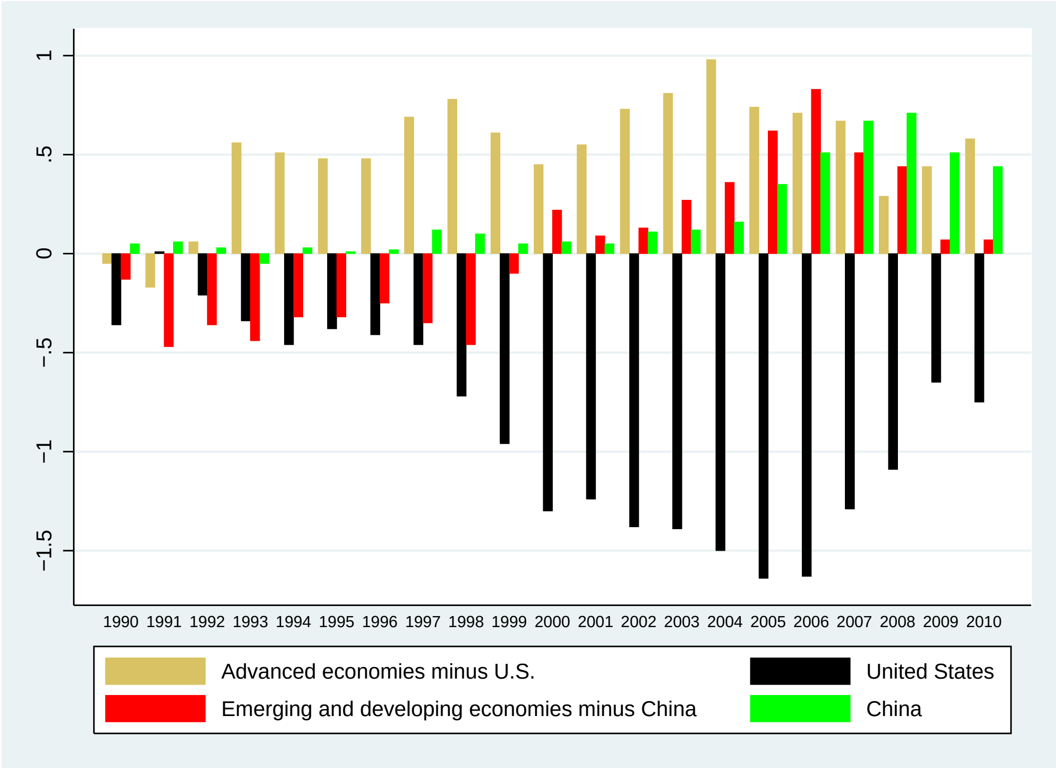
1 Introduction

Global current account imbalances have been a major concern before and after the financial crisis of 2007-2008. Before the crisis, the U.S. current account deficit which kept increasing at a high pace since the end of the 1990s was considered by some observers as unsustainable and could lead to severe adjustments in the foreign exchange market and turbulence in the financial markets at large.[1] In fact, the currency market was not at the origin of the financial crisis in the summer of 2007 although global imbalances have probably paved the way for this crisis by contributing to the underpricing of credit risk in the U.S. financial markets (Obstfeld and Rogoff (2009) and Blanchard and Milesi-Ferretti (2010)). At the height of the crisis in the fall 2008, the U.S. dollar even appreciated and global imbalances reduced. Since then, global imbalances have started to widen again and cause worry as before.

In addition, global imbalances are not a new phenomenon as the U.S. current account deficit was already deep in the 1980s but these imbalances were experienced among advanced countries. The peculiarity of global imbalances nowadays is that they involve advanced and emerging economies. When the Soviet bloc collapsed, many countries joined the international goods and asset markets. This event contributed to enlarging substantially these markets and increasing the opportunities to move production factors across borders. By opening their economies and taking advantage of the globalization of financial markets the emerging countries used foreign saving to invest and grow. They therefore ran current account deficits until a series a financial crises hit them in the 1990s. These financial crises proved that a development strategy financed by foreign saving was vulnerable to liquidity risk in case of an increase in the level of uncertainty in the financial markets. Since then, these countries have resumed fast growth but have adopted economic policies capable of generating current account surpluses and, hence, sizeable foreign exchange reserves to stave off balance-of-payments crises. One of these policies has consisted in intervening in the foreign exchange market in order to yield a depreciation of the real exchange rate or to prevent it from appreciating. Some consider that currency manipulation and other appropriate economic policies have contributed to reversing the current account balances in these economies and to creating a "global saving glut" (Bernanke 2005). As a consequence, large global imbalances have been recorded in the recent past between the fast-growing emerging economies and the developing countries, on the one hand, and the slow-growing advanced economies, on the other hand. The former have been financing the current account deficits and the credit-led growth of the latter.

Global imbalances nowadays are again mainly a current account imbalance between the United States and the rest of the world, of which China has become a dominant player (Figure 1). Its source is less an overwhelming U.S. appetite for foreign goods than an ever-increasing demand by the rest of the world for dollar-denominated assets, even the low-yield ones. This demand can be explained by the financial buffer the crisis-averse emerging

[1]See, among others, the papers by Obstfeld and Rogoff (2000), Obstfeld and Rogoff (2007), Obstfeld and Rogoff (2005), and Blanchard, Giavazzi, and Sa (2005).



Source: IMF, World Economic Outlook, April 2010
Country groups information: see IMF 2010 WEO database.

Figure 1: Current account balances as a percentage of world GDP (1990-2010)

countries want to build but also, as Caballero, Farhi, and Gourinchas (2008) argue, by the lack of supply of sound financial assets in these countries. Both explanations lead to the same conclusion: the United States are likely unable to correct their large current account deficit alone, especially with the countries manipulating their exchange rate. Global imbalances have certainly allowed to diminish world real interest rates at historical low levels and spurred economic growth everywhere. However, the abundance of liquidity and the creditors' chase for U.S. assets have probably encouraged U.S. financial institutions to develop too complex and unsound assets, which eventually led to the financial crisis of 2007-2008 (Bernanke (2009), BIS (2009) and Obstfeld and Rogoff (2009)).

The export-driven growth strategy and the risk of disruptive adjustment in the foreign exchange market have led the emerging countries to use the exchange rate as a tool to manage the current account balance and its financial counterpart. Even creditor countries such as China have also pegged their currency to the U.S. dollar in order to foster growth of exports but also to eliminate the instability inherent to free-floating and its disturbing effects on trade and asset returns.

This paper adopts Bernanke's hypothesis that global imbalances are the result of the emerging countries' decision not to depend on foreign saving. Artige and Cavenaile (2010) show that government policy in these countries resulted in forced saving, which contributed to financing the current account deficits of the advanced economies. In this framework in which purchasing power parity is verified at all times, the growth effects were positive for both the developed and the developing countries as the saving glut reduced world interest rates. The present paper considers a two-country overlapping generations (OLG) model with exchange rates in which currency manipulation can be used instead of forced saving to generate current account surpluses. We further show that foreign exchange intervention implies a tradeoff between current account management and income growth.

Gourinchas and Rey (2007) emphasize that currency changes have a valuation and a trade effect.

The paper is organized as follows. Section 2 defines the two-country overlapping generations model with exchange rates and presents the dynamic equilibrium in an open economy. Section 3 analyzes the steady-state current account balances when tastes and population growth rates differ across countries and when the exchange rate is manipulated. Section 4 examines global imbalances in the two-country model, and studies the existence of an intertemporal equilibrium with exchange rate and different time preferences. The effect on interest rates is discussed. Finally, section 5 concludes.

2 A Two-Country Model

2.1 Setup

We consider a discrete-time deterministic model of an economy consisting of two countries, country A and country B, producing the same good under perfect competition from date $t = 0$ to infinity. We assume that country A is an emerging economy (for instance China) and country B is an advanced economy (for instance the United States). The model builds on Buiter (1981). Each country is populated by overlapping generations living for two periods. We assume that the population grows at a constant rate n_A in country A and at a constant rate n_B in country B. When young, individuals supply inelastically one unit of labor to the firms, receive a wage and allocate this income between consumption and saving. When old, they retire and consume the return on their saving. The labor market is perfectly competitive within the national borders while physical capital moves freely across countries. The representative firm in each country produces a single aggregate good using a Cobb-Douglas technology of the form

$$Y_{i,t} = A_i K_{i,t}^{\alpha} L_{i,t}^{1-\alpha}, \quad i = A, B, \tag{1}$$

where $K_{i,t}$ is the stock of capital, $L_{i,t}$ is the labor input, and A_i is a technological parameter of country i at time t. We assume that physical capital fully depreciates after one period.

At time t, the representative firm of country i has an installed stock of capital $K_{i,t}$, chooses the labor input paid at the competitive wage $w_{i,t}$, equal to the marginal product of labor, and maximizes its profits

$$\pi_{i,t} = \max_{L_{i,t}} A_i K_{i,t}^{\alpha} L_{i,t}^{1-\alpha} - w_{i,t} L_{i,t}, \tag{2}$$

where $\pi_{i,t} = R_{i,t} K_{i,t}$ are the profits distributed to the owners of the capital stock and $R_{i,t}$ the real interest factor, which is equal to the marginal product of capital. Since returns to scale are constant, the production function can be written in intensive form:

$$y_t = A_i k_{i,t}^{\alpha}, \tag{3}$$

where $k_{i,t} \equiv K_{i,t}/L_{i,t}$ is the capital-labor ratio.

The representative agent of country i maximizes a logarithmic additively separable utility function

$$U_i = \ln c_{i,t} + \beta_i \ln d_{i,t+1} \tag{4}$$

subject to the nominal budget constraints

$$c_{i,t} + s_{i,t} + \;=\; w_{i,t} \tag{5}$$

$$d_{i,t+1} \;=\; R_{i,t+1} s_{i,t}, \tag{6}$$

where $w_{i,t}$ is the wage at time t, $c_{i,t}$ is consumption when young, $s_{i,t}$ is the individual saving. When old, the individuals spend the gross return on saving on consumption $d_{i,t+1}$. The parameter $\beta_i > 0$ is the psychological discount factor of country i.

The maximization of (4) with respect to (5) and to (6) yields the optimal level of individual nominal saving:

$$s_{i,t} = \frac{\beta_i}{1+\beta_i}(1-\alpha) A_i k_{i,t}^{\alpha}. \tag{7}$$

Individual saving depends only on the wage and the preference parameter β_i.

2.2 The Open-Economy Equilibrium

In this two-country world economy, there is no trade in the consumption good and labor is immobile across countries. However, physical capital can be traded from one country to another in a frictionless international capital market. The equilibrium in the national labor market is given by the equality between the national supply and demand for labor. Since the labor supply is inelastic and the production function exhibits constant returns to scale, the national equilibrium wage is equal to the marginal product of labor. The equilibrium in the world goods market at period t is given by the world income accounts identity:

$$Y_{A,t} + Y_{B,t} = L_{A,t}c_{A,t} + L_{A,t-1}d_{A,t} + I_{A,t} + L_{B,t}c_{B,t} + L_{B,t-1}d_{B,t} + I_{B,t}, \tag{8}$$

where the world output is equal to the aggregate consumption of the young and the old generations and the aggregate investment in both countries. Full depreciation of the current capital stock in each country implies $I_{A,t} = K_{A,t+1}$ and $I_{B,t} = K_{B,t+1}$. It is assumed that the owners of the capital stock at date $t = 0$ in both countries cannot move this stock from one country to the other. The integration of capital markets thus occurs at date $t = 1$. The equilibrium in the international capital market, once capital is mobile across countries, derives from (8) and yields:

$$K_{A,t+1} + K_{B,t+1} = L_{A,t}s_{A,t} + L_{B,t}s_{B,t}, \tag{9}$$

The perfect mobility on the international capital market makes domestic and foreign assets perfect substitutes provided that the countries do not manipulate the nominal exchange rate. At the world level, total investment must equal total saving. The equilibrium in the capital market requires real interest parity:

$$\frac{R_{B,t+1}}{R_{A,t+1}} = \frac{\epsilon_{t+1}}{\epsilon_t}, \tag{10}$$

where ϵ_t is the real exchange rate between country A and country B at time t. We assume that $0 < \frac{\epsilon_{t+1}}{\epsilon_t} < \infty$ to eliminate uninteresting degenerate capital market equilibria. If the foreign exchange market is perfect and without country intervention, the ratio $\frac{\epsilon_{t+1}}{\epsilon_t}$ equals 1. Let us define that an increase in ϵ_t corresponds to a real appreciation of the currency of country A and a real depreciation of the currency of country B. The equilibrium condition in the capital market is therefore:

$$\frac{k_{A,t+1}}{k_{Bt+1}} = \left(\frac{\epsilon_{t+1}}{\epsilon_t}\frac{A_A}{A_B}\right)^{\frac{1}{1-\alpha}}. \tag{11}$$

If the law of one price applies for all periods the equilibrium condition in the capital market is the same as in the nonmonetary economy. If the real exchange rate, ϵ_t, decreases over time (i.e. if country A's currency depreciates in real terms) then the real return on capital in country B gets higher. Interest parity is reestablished either if capital moves from country A to country B, which raises the interest rate in country A and reduces it in country B, or if there is an adjustment of the nominal exchange rate (i.e. a nominal depreciation of country A's currency), or a combination of the two.

By using Equations (7), (9) and (11), we can compute the intertemporal equilibrium with perfect foresight in each country:

$$k_{A,t+1} = \frac{(1-\alpha)\left(\frac{\beta_A}{1+\beta_A}A_A L_{A,t}k_{A,t}^{\alpha} + \frac{\beta_B}{1+\beta_B}A_B L_{B,t}k_{B,t}^{\alpha}\right)}{L_{A,t+1} + L_{B,t+1}\left(\frac{\epsilon_t}{\epsilon_{t+1}}\frac{A_B}{A_A}\right)^{\frac{1}{1-\alpha}}} \tag{12}$$

$$k_{B,t+1} = \frac{(1-\alpha)\left(\frac{\beta_A}{1+\beta_A}A_A L_{A,t}k_{A,t}^{\alpha} + \frac{\beta_B}{1+\beta_B}A_B L_{B,t}k_{B,t}^{\alpha}\right)}{L_{A,t+1}\left(\frac{\epsilon_{t+1}}{\epsilon_t}\frac{A_A}{A_B}\right)^{\frac{1}{1-\alpha}} + L_{B,t+1}}, \tag{13}$$

Proposition 1 *In a two-country model with overlapping generations living for two periods with integrated capital markets, the intertemporal equilibrium admits a unique globally stable interior steady state provided that* $\frac{\epsilon_{t+1}}{\epsilon_t}$ *is constant over time.*

Proof: $\bar{k}_i$ is stationary if and only if $\frac{\epsilon_{t+1}}{\epsilon_t}$ is a constant.
The steady state is characterized by:

$$\bar{k}_A = \left[\frac{(1-\alpha)\left(\frac{\beta_A}{1+\beta_A}A_A L_{A,t} + \frac{\beta_B}{1+\beta_B}A_B L_{B,t}\left(\frac{\epsilon_t}{\epsilon_{t+1}}\frac{A_B}{A_A}\right)^{\frac{\alpha}{1-\alpha}}\right)}{L_{A,t+1} + L_{B,t+1}\left(\frac{\epsilon_t}{\epsilon_{t+1}}\frac{A_B}{A_A}\right)^{\frac{1}{1-\alpha}}}\right]^{\frac{1}{1-\alpha}} \tag{14}$$

$$\bar{k}_B = \left[\frac{(1-\alpha)\left(\frac{\beta_A}{1+\beta_A}A_A L_{A,t}\left(\frac{\epsilon_{t+1}}{\epsilon_t}\frac{A_A}{A_B}\right)^{\frac{\alpha}{1-\alpha}} + \frac{\beta_B}{1+\beta_B}A_B L_{B,t}\right)}{L_{A,t+1}\left(\frac{\epsilon_{t+1}}{\epsilon_t}\frac{A_A}{A_B}\right)^{\frac{1}{1-\alpha}} + L_{B,t+1}}\right]^{\frac{1}{1-\alpha}} \tag{15}$$

At the steady state, the capital stock per worker and hence the income per capita remains constant.
The transition dynamics in the two countries are governed by the following two equations:

$$\begin{aligned} dk_{A,t+1} &= \frac{\alpha(1-\alpha)\frac{\beta_A}{1+\beta_A}A_A L_{A,t}k_{A,t+1}^{\alpha-1}}{L_{A,t+1} + L_{B,t+1}\left(\frac{\epsilon_t}{\epsilon_{t+1}}\frac{A_B}{A_A}\right)^{\frac{1}{1-\alpha}}}\,dk_{A,t} \\ &+ \frac{\alpha(1-\alpha)\frac{\beta_B}{1+\beta_B}A_B L_{B,t}k_{B,t+1}^{\alpha-1}}{L_{A,t+1} + L_{B,t+1}\left(\frac{\epsilon_t}{\epsilon_{t+1}}\frac{A_B}{A_A}\right)^{\frac{1}{1-\alpha}}}\,dk_{B,t} \\ &+ \frac{\left(\frac{\beta_A}{1+\beta_A}A_A L_{A,t}k_{A,t}^{\alpha} + \frac{\beta_B}{1+\beta_B}A_B L_{B,t}k_{B,t}^{\alpha}\right)L_{B,t+1}\left(\frac{A_B}{A_A}\right)^{\frac{1}{1-\alpha}}\left(\frac{\epsilon_t}{\epsilon_{t+1}}\right)^{\frac{2-\alpha}{1-\alpha}}}{\left[L_{A,t+1} + L_{B,t+1}\left(\frac{\epsilon_t}{\epsilon_{t+1}}\frac{A_B}{A_A}\right)^{\frac{1}{1-\alpha}}\right]^2}\,d\left(\frac{\epsilon_{t+1}}{\epsilon_t}\right) \end{aligned} \tag{16}$$

$$
\begin{aligned}
dk_{B,t+1} &= \frac{\alpha(1-\alpha)\frac{\beta_A}{1+\beta_A}A_A L_{A,t}k_{A,t+1}^{\alpha-1}}{L_{A,t+1}\left(\frac{\epsilon_{t+1}}{\epsilon_t}\frac{A_A}{A_B}\right)^{\frac{1}{1-\alpha}}+L_{B,t+1}}\,dk_{A,t} \\
&+ \frac{\alpha(1-\alpha)\frac{\beta_B}{1+\beta_B}A_B L_{B,t}k_{B,t+1}^{\alpha-1}}{L_{A,t+1}\left(\frac{\epsilon_{t+1}}{\epsilon_t}\frac{A_A}{A_B}\right)^{\frac{1}{1-\alpha}}+L_{B,t+1}}\,dk_{B,t} \\
&- \frac{\left(\frac{\beta_A}{1+\beta_A}A_A L_{A,t}k_{A,t}^{\alpha}+\frac{\beta_B}{1+\beta_B}A_B L_{B,t}k_{B,t}^{\alpha}\right)L_{A,t+1}\left(\frac{A_A}{A_B}\right)^{\frac{1}{1-\alpha}}\left(\frac{\epsilon_{t+1}}{\epsilon_t}\right)^{\frac{\alpha}{1-\alpha}}}{\left[L_{A,t+1}\left(\frac{\epsilon_{t+1}}{\epsilon_t}\frac{A_A}{A_B}\right)^{\frac{1}{1-\alpha}}+L_{B,t+1}\right]^2}\,d\left(\frac{\epsilon_{t+1}}{\epsilon_t}\right).
\end{aligned}
\tag{17}
$$

The capital stock per worker in both countries at time $t+1$ is a positive function of $k_{A,t}$ and $k_{B,t}$. An increase in the real exchange rate over time has a positive effect on the level of the capital stock per worker of country A and a negative effect on that of country B.

3 The Balance of Payments

In an open two-country world, a country can finance domestic investment by foreign saving. The difference between domestic investment and domestic saving is equal to the current account balance. In other words, a country can spend more or less than it produces. The national income accounts identity of country i in this two-country economy is

$$Y_{i,t} + R_t\left(L_{i,t-1}s_{i,t-1} - K_{i,t}\right) = L_{i,t}c_{i,t} + L_{i,t-1}d_{i,t} + G_{i,t} + K_{i,t+1}, \tag{18}$$

where $Y_{i,t}$ and $R_t(L_{i,t}s_{i,t} - K_{i,t+1})$ are the Gross Domestic Product (GDP) and the net factor income from abroad respectively, and the sum of the two is the Gross National Income (GNI) of country i at time t. On the right hand side of the identity, $G_{i,t}$ is the difference between domestic spending on foreign capital and foreign spending on domestic capital. In this model of one single good in each country, where there is no trade in consumption goods and there are no unilateral transfers, $G_{i,t}$ is the current account balance of country i at time t. This is simply the difference between the factor income from abroad and the factor income payments to the foreign country. In intensive form, taking into account the fact that $y_{i,t} = w_{i,t} + R_t k_{i,t}$, the current account balance is equal to

$$g_{i,t} = w_{i,t} + \frac{L_{i,t-1}}{L_{i,t}}R_t s_{i,t-1} - c_{i,t} - \frac{L_{i,t-1}}{L_{i,t}}d_{i,t} - \frac{L_{i,t+1}}{L_{i,t}}k_{i,t+1}, \tag{19}$$

or, equivalently, since $d_{i,t} = R_t s_{i,t-1}$,

$$g_{i,t} = s_{i,t} - \left(\frac{L_{i,t+1}}{L_{i,t}}\right) k_{i,t+1}. \tag{20}$$

Without loss of generality, we focus on country A. The current account balance per worker of country A is

$$g_{A,t} = (1-\alpha)\left[\frac{L_{B,t+1}\frac{\beta_A}{1+\beta_A}A_A k_{A,t}^{\alpha}\left(\frac{A_B\epsilon_t}{A_A\epsilon_{t+1}}\right)^{\frac{1}{1-\alpha}} - \frac{L_{A,t+1}}{L_{A,t}}\frac{\beta_B}{1+\beta_B}L_{B,t}A_B k_{B,t}^{\alpha}}{L_{A,t+1} + L_{B,t+1}\left(\frac{A_B\epsilon_t}{A_A\epsilon_{t+1}}\right)^{\frac{1}{1-\alpha}}}\right], \tag{21}$$

and the signs of its derivative with respect to ϵ_{t+1} are respectively:

$$\frac{\partial g_{A,t}}{\partial \epsilon_{t+1}} \ < \ 0. \tag{22}$$

The conditions on the current account balance per worker are as follows:

$$g_{A,t} \lesseqqgtr 0 \ \texttt{if} \ \frac{k_{A,t}}{k_{B,t}} \lesseqqgtr \left[\frac{L_{A,t+1}L_{B,t}}{L_{A,t}L_{B,t+1}}\left(\frac{\epsilon_{t+1}}{\epsilon_t}\right)^{\frac{1}{1-\alpha}}\frac{\beta_B(1+\beta_A)}{\beta_A(1+\beta_B)}\left(\frac{A_A}{A_B}\right)^{\frac{\alpha}{1-\alpha}}\right]^{\frac{1}{\alpha}}. \tag{23}$$

The current account balance of country A is an increasing function of $k_{A,t}$, β_A, the population growth rate of country B, and a decreasing function of $k_{B,t}$, β_B and the population growth rate of country A. When capital is free to move from one country to another,

$$g_{A,t} \lesseqqgtr 0 \ \texttt{if} \ \frac{\beta_A}{1+\beta_A}\left(\frac{L_{A,t}}{L_{A,t+1}}\right) \lesseqqgtr \left(\frac{\epsilon_{t+1}}{\epsilon_t}\right)^{\frac{1}{1-\alpha}}\left(\frac{\epsilon_{t-1}}{\epsilon_t}\right)^{\frac{\alpha}{1-\alpha}}\frac{\beta_B}{1+\beta_B}\left(\frac{L_{B,t}}{L_{B,t+1}}\right). \tag{24}$$

Condition (24) is also the condition for $g_A \lesseqqgtr 0$ at the steady state with $\frac{\epsilon_{t+1}}{\epsilon_t} = \frac{\epsilon_t}{\epsilon_{t-1}}$. From this condition we now establish the following three propositions:

Proposition 2 *In a two-country model with overlapping generations living for two periods with integrated capital markets, country A experiences a current account deficit (surplus) at time t if, for identical population growth rates across countries and* $\epsilon_{t+1} = \epsilon_t = \epsilon_{t-1}$ *for all t, the preference parameter* β_A *is lower (higher) than* β_B*.*

Proof: From condition (24) it is straightforward to show that $g_{A,t} \lesseqqgtr 0$ if $\left(\frac{\beta_A}{1+\beta_A}\right) \lesseqqgtr \left(\frac{\beta_B}{1+\beta_B}\right)$, the growth rates of population are identical and $\epsilon_{t+1} = \epsilon_t = \epsilon_{t-1}$ for all t.

Under autarky, the level of the capital stock per worker at time t is an increasing function of β, the psychological discount factor[2]. Assuming that two countries are identical in all respects except in the preference parameter β, a country populated with more impatient consumers (lower β) will have a lower k_t and a higher capital return at time t than the country populated with more patient consumers. If capital markets are integrated, the country with impatient consumers will attract foreign investment owing to a higher capital return up to the point where capital returns are equal. Therefore, this country will have a current account deficit at time t.

In the next two propositions, we rewrite condition (24) as a function of the real exchange rates only off the steady state and at the steady state respectively. By assuming identical tastes and population growth rates we establish the condition on the real exchange rates for a positive, balanced or negative current account.

Proposition 3 *In a two-country model with overlapping generations living for two periods with integrated capital markets, identical population growth rates and identical tastes across countries, country A's current account balance, for any $t > 0$,*

$$g_{A,t} \lesseqqgtr 0 \quad \boldsymbol{if} \quad \frac{\epsilon_{t+1}}{\epsilon_t} \gtreqqless \left(\frac{\epsilon_t}{\epsilon_{t-1}}\right)^{\alpha}. \tag{25}$$

Proof: This result derives from condition (24).

If $\frac{\epsilon_t}{\epsilon_{t-1}} = 1$ for all t, then the real exchange rate is constant over time and $g_{A,t} = 0$ for all t. If $\frac{\epsilon_t}{\epsilon_{t-1}} = 1$ at period t, any appreciation (any depreciation) of the real exchange rate from t to $t+1$, i.e. $\frac{\epsilon_{t+1}}{\epsilon_t} > 1$ ($\frac{\epsilon_{t+1}}{\epsilon_t} < 1$) leads to a current account deficit (surplus). If $\frac{\epsilon_t}{\epsilon_{t-1}} < 1$, a depreciation of the real exchange rate from t to $t+1$, i.e. $\frac{\epsilon_{t+1}}{\epsilon_t} < 1$, does not necessarily generate a current account surplus. A surplus is reached if the depreciation from t to $t+1$ satisfies $\frac{\epsilon_{t+1}}{\epsilon_t} < \left(\frac{\epsilon_t}{\epsilon_{t-1}}\right)^{\alpha}$. Likewise, if $\frac{\epsilon_t}{\epsilon_{t-1}} > 1$, an appreciation does not necessarily lead to a current account deficit. At the steady state, the rate of variation in the real exchange rates must be constant over time. Condition (24) allows to determine the relationship between the sequence of the real exchange rates and the sequences of the current accounts:

Proposition 4 *In a two-country model with overlapping generations living for two periods, country A experiences a current account deficit (surplus) at the steady state if, for identical population growth rates and identical tastes across countries, the real exchange rate increases (decreases) at a constant rate over time.*

[2]See Artige and Cavenaile (2010) for more details.

Proof: The existence of a steady state requires $\frac{\epsilon_t}{\epsilon_{t-1}}$ constant over time (see Proposition 1). Hence, this implies $g_A \lesseqqgtr 0$ at the steady state if $\frac{\epsilon_t}{\epsilon_{t-1}} \gtreqqless 0$ for all t (see Proposition 3).

This result implies that a sequence of positive or negative current account balances with a steady state can be reached through exchange rate manipulation while the market outcome would yield a sequence of balanced current accounts. Assuming that two countries are identical in all respects, the real appreciation of country A's currency over time implies a move of capital from country B to country A when the integration of capital market is realized. This increases the steady-state level of $\bar{k}_A$ and reduces the real interest factor R_A while it decreases the steady-state level of $\bar{k}_B$ and increases the real interest factor R_B. The result is a current account deficit in country A at the steady state. The manipulation of the nominal exchange rate or the violation of the law of one price have real effects on the economies of both countries and their balance of payments.

Let us now assume that the two countries have the same population growth rate but country A has a lower preference parameter than country B. If country A has a sufficiently higher preference parameter, this country will have a current account surplus at the steady state even if the real exchange rate appreciates over time at a constant rate.

Proposition 5 *In a two-country model with overlapping generations living for two periods with integrated capital markets, and identical population growth rates, country A experiences a current account balance*

$$g_{A,t} \lesseqqgtr 0 \quad \textit{if} \quad 0 < \beta_A \lesseqqgtr \frac{1}{\left(\frac{1+\beta_B}{\beta_B}\right)\left(\frac{\epsilon_t}{\epsilon_{t+1}}\right)^{\frac{1}{1-\alpha}}\left(\frac{\epsilon_t}{\epsilon_{t-1}}\right)^{\frac{\alpha}{1-\alpha}} - 1}, \tag{26}$$

with $\frac{\beta_B}{1+\beta_B} \neq \left(\frac{\epsilon_{t+1}}{\epsilon_t}\right)^{\frac{1}{1-\alpha}}\left(\frac{\epsilon_{t-1}}{\epsilon_t}\right)^{\frac{\alpha}{1-\alpha}}$.

Proof: This result derives easily from condition (24).

This result holds true off the steady state and at the steady state provided that capital markets are integrated. In particular, if $\epsilon_t = 1$ for all t, Proposition 5 reduces to the main result of Buiter (1981). The negative effect on the current account of the real appreciation of country A's currency can be offset if β_A is sufficiently higher than β_B. If β_A is lower than β_B, then the resulting current account deficit can be corrected by a real depreciation of the country A's currency.

4 A Two-Country Model with Global Imbalances

This model builds on Buiter (1981), in which exchange rates are introduced. Capital movements across countries are then realized at the prevailing exchange rate. In this two-country economy, country A is less developed than country B but grows at a higher pace along the transition path to the steady state. The development gap is captured by the differences in the technological parameters or/and in the initial capital stocks per worker: $A_A < A_B$ or/and $k_{A,0} < k_{B,0}$. If purchasing power parity is verified at all times, then the present model reduces exactly to the model of Buiter (1981). In this paper, we will consider two departures from purchasing power parity due to currency manipulation. First, whenever the market outcome yields a current account deficit, we will assume that the government of country A sets the real exchange rate, through the manipulation of the nominal exchange rate, so as to generate a current account balance positive or null. Second, even though the market outcome yields a current account surplus, country A's government can nevertheless intervene on the foreign exchange market to increase its current account surplus and its foreign exchange reserves.[3] Before examining these two cases, we define an intertemporal equilibrium with global imbalances:

4.1 Intertemporal Equilibrium with Global Imbalances: Definition

Given $A_A < A_B$ or/and $k_{A,0} < k_{B,0}$, an intertemporal equilibrium with global imbalances is a sequence of temporary equilibria that satisfies $g_{A,t} \geqslant 0$ for all $t \geqslant 0$.

4.2 Country A's Government Intervention in the Foreign Exchange Market

Artige and Cavenaile (2010) identify nine potential trajectories for g_A, the current account balance per worker in the developing economy. Assuming that international capital integration is achieved at $t = 1$, the government of country A can intervene in the foreign exchange market at the initial date to avoid the current account deficit yielded by the market. If the current account balance is negative only at $t = 0$, the government will intervene temporarily. If the current account balance is negative at all times, the government will always intervene. If the current account balance is positive at all times, the government of country A can nevertheless manipulate the exchange rate to increase the current account surplus.

4.3 Existence of an Intertemporal Equilibrium with Global Imbalances

We now study the existence condition of an intertemporal equilibrium with global imbalances and determine the foreign exchange policy response of the government to ensure

[3]Our model is deterministic and does not consider currency risk. A country could in fact manipulate its currency to avoid exchange rate volatility and the associated speculation. Xiao (2010) claims that this is the main reason why the renminbi is pegged to the U.S. dollar.

nonnegative current account balances. The model is identical to the one defined in Section 2 with an integrated international capital market. If $g_{A,t} < 0$, the government acts on the real exchange rate through the nominal exchange rate to guarantee $g_{A,t} \geqslant 0$. If $g_{A,t} \geqslant 0$ is verified at each period, the government can nevertheless intervene.

Proposition 6 *In a two-country model with overlapping generations living for two periods, an intertemporal equilibrium with global imbalances exists if and only if, for all $t \geqslant 0$,*

$$\frac{\epsilon_{t+1}}{\epsilon_t} \leqslant \left[\left(\frac{k_{A,t}}{k_{B,t}} \right)^{\alpha} \frac{L_{A,t} L_{B,t+1}}{L_{A,t+1} L_{B,t}} \left(\frac{A_B}{A_A} \right)^{\frac{\alpha}{1-\alpha}} \frac{\beta_A(1+\beta_B)}{\beta_B(1+\beta_A)} \right]^{1-\alpha} . \tag{27}$$

Proof: $g_{A,t} \geqslant 0$ for all $t \geqslant 0$ if condition (23) is verified. The necessary value for $\frac{\epsilon_{t+1}}{\epsilon_t}$ derives from this condition.

Proposition 6 establishes that, with a perfect integrated capital market, global imbalances are an intertemporal equilibrium result. This intertemporal equilibrium leads to a steady state if and only if $\frac{\epsilon_{t+1}}{\epsilon_t}$ is constant for all t.

4.4 Economic Growth and Interest Rate

An intervention on the foreign exchange market has an impact on both the growth rate and the interest rate.

Proposition 7 *In a two-country model with overlapping generations living for two periods, the growth rate in country A decreases and the growth rate in country B increases, ceteris paribus, when country A's government intervenes to depreciate its currency.*

Proof: Equations 12 and 13 show that $k_{A,t+1}$ is an increasing function of ϵ_{t+1} and the reverse for $k_{b,t+1}$.

If the government of country A depreciates its currency in order to ensure non-negative current account balance, it slows down country A's growth and speeds up country B's growth. This means that there exists a tradeoff between using exchange rate policy for current account management and economic growth for country A. However, this tradeoff between current account surplus and economic growth can be eliminated if the country experiences an increase in its propensity to save which can offset the impact the negative impact of exchange rate depreciation on economic growth (Artige and Cavenaile (2010)). This increase in saving rate has been observed in many emerging countries since the end of the 1990's.

The (gross) interest rate $R_{i,t+1}$ is the rental rate of capital of country i at time $t+1$. When the capital markets are integrated, $R_{B,t+1} = \frac{\epsilon_{t+1}}{\epsilon_t} R_{A,t+1}$.

Proposition 8 *In a two-country model with overlapping generations living for two periods, the interest rate in country A increases and the interest rate in country B decreases, ceteris paribus, when country A's government intervenes to depreciate its currency.*

Proof: The interest rate of country A at time $t+1$, $R_{A,t+1} = \alpha A_A k_{A,t+1}^{\alpha-1}$, is a decreasing function of $k_{A,t+1}$. Equation (17) shows that $k_{A,t+1}$ is an increasing function of the intertemporal variation in the real exchange rate. Therefore, a decrease in $\frac{\epsilon_{t+1}}{\epsilon_t}$ leads to an increase in $R_{A,t+1}$. It can be checked that a decrease in $\frac{\epsilon_{t+1}}{\epsilon_t}$ leads to a decrease in $R_{B,t+1}$ (see Proposition 7).

Proposition 8 establishes the link between global imbalances and the interest rates in the world economy. If condition (27) is not satisfied, country A's government intervenes and the real exchange rate depreciates over time. Capital in country A is less attractive and moves to country B up to the point where real interest parity is again satisfied. The capital stock per worker in country A decreases and its real interest factor increases while the capital stock per worker increases in country B and its rental rate of capital decreases. Therefore, the global imbalances allow for a lower interest rate in the advanced economy (country B).

4.5 Discussion

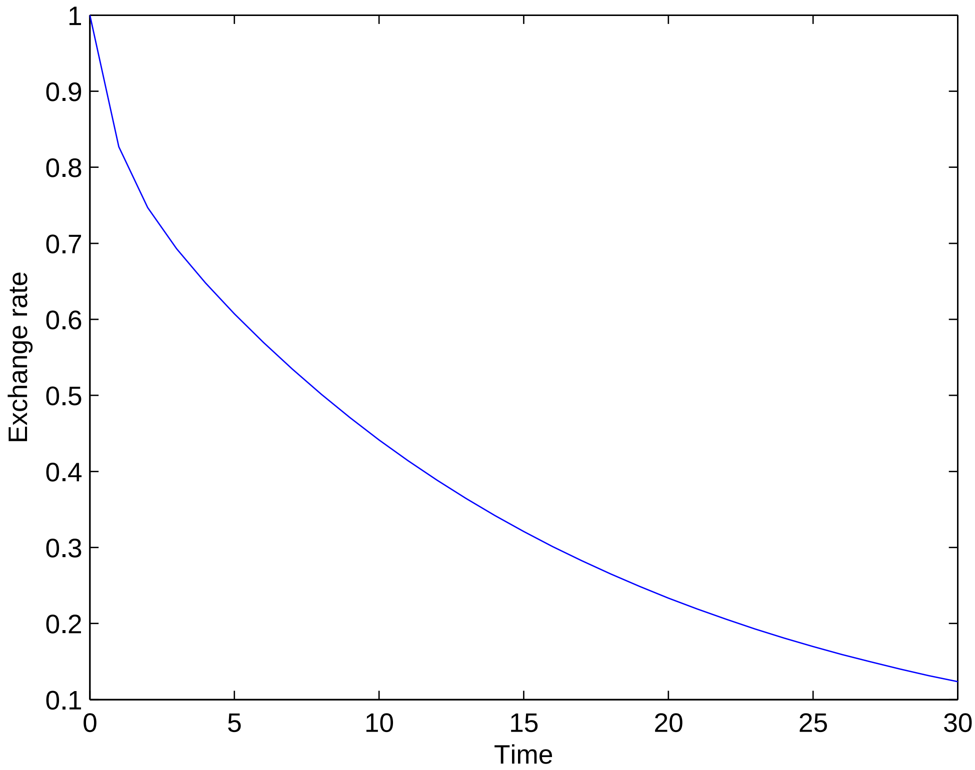
Country A's government manipulates its exchange rate according to (27) either to avoid current account deficits or to increase its current account surpluses. Both cases yield global imbalances. To simplify the discussion of these two cases, let us assume identical population growth rates, identical technological parameters, $A_A = A_B$, and that country B does not manipulate the nominal bilateral exchange rate. The current account balance of country A, g_A, thus depends on the values of β_A and β_B, on the initial conditions, $k_{A,0}$ and $k_{B,0}$, and the intertemporal variation of real exchange rates $\frac{\epsilon_{t+1}}{\epsilon_t}$.

4.5.1 Exchange rate manipulation to avoid current account deficits

In this case, the initial conditions and the parameters yield a current account deficit in country A in the first period ($t = 0$) before any government intervention. This case corresponds to a fast-growing emerging economy, which attracts foreign capital. Therefore, the government has to manipulate the exchange rate to ensure $g_{A,t}|_{\,t>\,0} = 0$. For a given $k_{A,0}/k_{B,0} < 1$, the government's intervention of country A on the foreign exchange market will depend on the relative values of β_A and β_B (see Appendix 6.1):

i) If $\beta_A < \beta_B$, consumers in country A are more impatient than in country B. In order to reach non-negative current accounts in the first and the subsequent periods, country A's government has to manipulate the nominal exchange rate so as to generate a real exchange rate depreciation of its currency in every period. The larger the difference between the preference parameters across countries, the larger the real exchange rate depreciation must be. In this case, the exchange rate is increasingly distant from 1 (PPP).

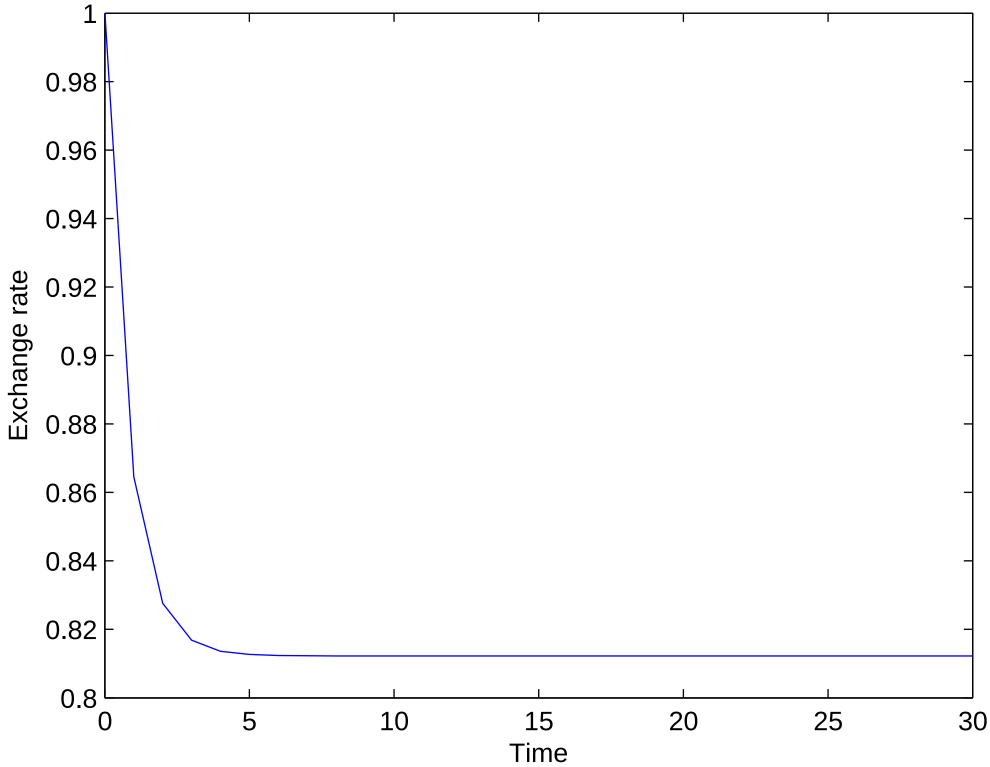
Figure 2: Sequence of ϵ_t such that $g_{A,t} = 0$ with $k_{A,0} = 0.5k_{B,0}$, $\beta_A = 0.8$, $\beta_B = 0.9$ and $\alpha = 0.3$



ii) If $\beta_A = \beta_B$, tastes are identical across countries. The condition to reach non-negative current accounts in the first and subsequent periods imposes an intervention at each period. At some point in time, the required exchange becomes constant but different from 1 (see Figure 3). We can nevertheless emphasize that the market outcome (i.e. if purchasing power parity holds) could result in a negative current account balance only at $t = 0$.

iii) If $\beta_A > \beta_B$, non-negative current accounts obtain if country A's government has to decrease the nominal exchange rate of its currency in the first period in order that the real exchange rate verifies condition (27). The magnitude and the time length of the foreign exchange intervention will depend on the differential in the preference parameters. Once the government does not intervene any longer, the real exchange rate goes back to unity (see Figure 4).

Figure 3: Sequence of ϵ_t such that $g_{A,t} = 0$ with $k_{A,0} = 0.5k_{B,0}$, $\beta_A = \beta_B = 0.8$ and $\alpha = 0.3$



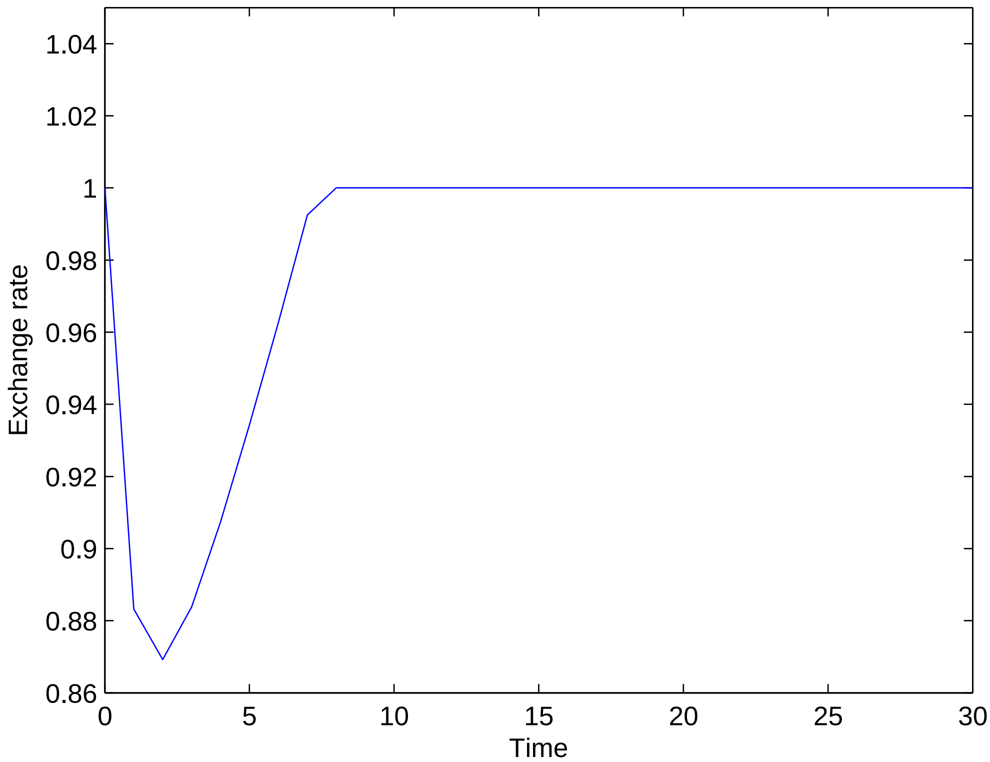
4.5.2 Exchange rate manipulation to increase current account surpluses

The initial conditions and the parameters yield a current account surplus in country A in the first period. Country A's government does not need intervene in the foreign exchange market. However, a country may decide to manipulate its nominal exchange rate to promote its foreign trade performance or to create a precautionary financial buffer by accumulating foreign exchange reserves. For a given $k_{A,0}/k_{B,0}$ and $k_{A,0} < k_{B,0}$, the effect of the exchange rate manipulation on the current account balance will depend on the relative values of β_A and β_B.

If $\beta_A > \beta_B$[4], the difference in preference parameters yields current account surpluses at every period. A constant depreciation of the exchange rate (condition for the existence of a steady state) will increase country A's current account surplus and, hence, will deepen global imbalances with respect to the situation without intervention.

[4]If $\beta_A < \beta_B$, $g_{A,t}$ cannot be positive without intervention since we assume that $k_{A,0} < k_{B,0}$.

Figure 4: Sufficient condition on ϵ_t for $g_{A,t} \geq 0$ with $k_{A,0} = 0.5k_{B,0}$, $\beta_A = 0.9$, $\beta_B = 0.85$ and $\alpha = 0.3$



5 Conclusion

In this paper, we investigate the existence of global imbalances within a two-country growth model. We extend the two-country overlapping generation model proposed by Buiter (1981) and Artige and Cavenaile (2010) by introducing the possibility of government intervention on the exchange rate. We show that a country experiencing a current account deficit can create a current account surplus (and hence global imbalances) through a real depreciation of its currency. The required magnitude and time length of the intervention is a function of both the relative time preferences of individual in the two countries and of the relative degree of development of the two countries before capital market integration. We show that the existence of global imbalances coincides with an intertemporal equilibrium and that, provided that the depreciation rate is constant over time, it corresponds to a steady state in both countries. We further show that a country's decision to depreciate its currency negatively impacts its economic growth rate and increases the foreign country growth creating a trade-off between growth and current account management. The intervention also leads to an increase in the domestic interest rate and a decrease in the foreign interest rate.

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6 Appendix

6.1 Appendix A: Time length and magnitude of exchange rate intervention as a function of initial conditions and psychological discount factor differentials

The magnitude and time length of exchange rate intervention in order to ensure non-negative current account balance can be determined as a function of the differential in psychological discount factors and initial conditions. For simplicity and without loss of generality, we assume that $A_A = A_B$, that $\frac{L_{A,t}}{L_{A,t+1}} = \frac{L_{B,t}}{L_{B,t+1}}$ and that country A intervenes on the exchange rate to have $g_{A,t} = 0$ whenever $g_{A,t} < 0$ without intervention. Given our assumptions, we know from Equation 27 that $g_{A,t} < 0$ if $\frac{\epsilon_{t+1}}{\epsilon_t} > \left[\left(\frac{k_{A,t}}{k_{B,t}}\right)^{\alpha} \frac{\beta_A(1+\beta_B)}{\beta_B(1+\beta_A)}\right]^{1-\alpha}$.

Let us first define $C = \frac{k_{A,0}}{k_{B,0}} < 1$ and $B = \frac{\beta_A(1+\beta_B)}{\beta_B(1+\beta_A)}$ and recall that $\epsilon_t = 1$ for any t without intervention. At time $t = 0$, country A intervenes on the exchange rate provided that:

$$1 > (C^{\alpha} B)^{1-\alpha} \tag{28}$$

with $\epsilon_0 = 1$.

If country A has to intervene, it sets ϵ_1 such as to ensure that $g_{A,0} = 0$:

$$\epsilon_1 = (C^{\alpha} B)^{1-\alpha} \tag{29}$$

At $t = 1$ with integrated capital market and intervention at $t = 0$, country A has to intervene provided that:

$$\frac{1}{\epsilon_1} > \left[\left(\frac{k_{A,1}}{k_{B,1}}\right)^{\alpha} B\right]^{1-\alpha} \tag{30}$$

or alternatively, using Equations 11 and 29, provided that:

$$\begin{aligned} &(C^{\alpha} B)^{\alpha-1} > \left[(C^{\alpha} B)^{\alpha} B\right]^{1-\alpha} \\ &\Leftrightarrow 1 > \left[C^{\alpha(1+\alpha)} B^{2+\alpha}\right]^{1-\alpha} \end{aligned} \tag{31}$$

If country A has to intervene, it sets:

$$\epsilon_2 = \left[C^{\alpha+\alpha^2} B^{2+\alpha}\right]^{1-\alpha} \tag{32}$$

We can repeat the procedure at $t = 2$. Using Equations 11, 29 and 32, country A has to intervene provided that:

$$1 > \left[C^{\alpha+\alpha^2+\alpha^3} B^{3+2\alpha+\alpha^2}\right]^{1-\alpha} \tag{33}$$

If country A has to intervene, it sets:

$$\epsilon_3 = \left[C^{\alpha+\alpha^2+\alpha^3} B^{3+2\alpha+\alpha^2}\right]^{1-\alpha} \tag{34}$$

We can easily generalize this results and states that country A keeps on intervening on the exchange rate at time t as long as:

$$1 > \left[C^{\sum_{i=1}^{t+1}\alpha^i} B^{\sum_{j=1}^{t+1}\sum_{i=0}^{j-1}\alpha^i}\right]^{1-\alpha} \tag{35}$$

If country A has to intervene, it sets:

$$\epsilon_{t+1} = \left[C^{\sum_{i=1}^{t+1}\alpha^i} B^{\sum_{j=1}^{t+1}\sum_{i=0}^{j-1}\alpha^i}\right]^{1-\alpha} \tag{36}$$

With $C < 1$, it is easy to see that intervention is always required when $\beta_A \leq \beta_B$ since Equation 35 is always satisfied. If $\beta_A > \beta_B$, intervention is at most temporary[5] since $C^{\sum_{i=1}^{t+1}\alpha^i} \rightarrow$ *positive constant* and $B^{\sum_{j=1}^{t+1}\sum_{i=0}^{j-1}\alpha^i} \rightarrow +\infty$ with $\alpha < 1$ and $t \rightarrow +\infty$ but the required time length of intervention depends on the initial condition C and the psychological discount factor differential B.

Lastly, it is easy to show that if country A has stopped intervening at time $t-1$, it does not have to intervene for any subsequent time period. Indeed, if country A does not intervene at time $t-1$, $\epsilon_t = 1$. Hence, we simply have to show that:

$$\frac{\epsilon_{t+1}}{\epsilon_t} = 1 \leq \left[\left(\frac{1}{\epsilon_{t-1}}\right)^{\frac{\alpha}{1-\alpha}} B\right]^{1-\alpha}, \tag{37}$$

which is obvious since country A can stop intervening only if $B > 1$ and since $\frac{1}{\epsilon_{t-1}} > 1$ due to intervention at $t-2$.

In general, the dynamics of ϵ_t such that $g_{A,t} = 0$ for all t is given by:

$$\epsilon_{t+1} = \left[C^{\alpha^{t+1}} B^{\sum_{i=0}^{t}\alpha^i}\right]^{1-\alpha} \epsilon_t \tag{38}$$

[5] Intervention may even not be required if initial conditions do not imply a negative current account at $t = 0$.