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Boom-and-bust Cycles, External Imbalances and the Real Exchange Rate

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1. INTRODUCTION

DURING the last half-century, many countries have opened up their financial accounts by removing restrictions on cross-border capital flows. As a consequence, the volume of international financial transactions and the associated stocks of foreign assets and liabilities have increased substantially. Regardless of their economic benefits, capital flows can have destabilising effects, particularly when they cause so-called boom-and-bust cycles. In the past, there have been many episodes in all parts of the world in which countries experienced strong capital inflows and rapid growth, yet subsequently had to endure serious economic recessions and financial crises.

Boom-and-bust cycles share a number of common characteristics (Calvo et al., 1994, 1996, 2005; Conley and Maloney, 1995; McKinnon and Pill, 1996, 1997; Gourinchas et al., 2001; Tornell and Westermann, 2002; Hernández and Landerretche, 2003, Aizenman and Jinjarak, 2009, Reinhart and Reinhart, 2009; Jordà et al., 2011). The boom phase can be described as follows. First, returns on real investment, whether actual or perceived, rise above the international average. Often this is the result of changes in the country's internal conditions – such as, for example, domestic economic reforms, moves towards more financial openness, technological innovations or natural resource discoveries – that create an optimistic atmosphere and make the country attractive in the eyes of foreign investors. However, in many cases external factors play a role, too. Second, the country starts to receive large sums of foreign investment, causing a boom in asset markets. Third, the country experiences accelerated growth and a strong surge in domestic investment. Private consumption also rises, putting a brake on national saving. Fourth, the current account, defined as the gap between saving and investment, deteriorates steadily. Fifth, despite the deficit on the current account, the real exchange rate tends to appreciate strongly.

After reaching a peak, however, the country enters a downward spiral. First, domestic residents and foreign investors realise that their expectations were too optimistic, making stock and real estate markets plummet. Second, foreign investors turn their back on the country,

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pulling out their stakes. Third, the country enters recession and may also be confronted with a financial crisis. Domestic investment falls, and so does consumption. Fourth, the current account improves, not so much, however, as to undo the previous fall in the net foreign asset position. Fifth and finally, the real exchange rate falls, often considerably below its original level.

The described causes and effects of capital inflows are not unexpected. It is relatively straightforward, for instance, to explain the first four features of each of the two respective phases, the boom and the bust, using a model of intertemporal consumption and saving in an open economy with capital mobility (see Calvo et al., 1996). However, this paper goes one step further. While constructing a model that is capable to explain the main macroeconomic fluctuations during temporary booms in foreign lending, it offers an entirely new theoretical explanation of the fifth feature, the initial rise and subsequent decline of the real exchange rate.

This paper is based on the simple, yet realistic notion that the nominal exchange rate (defined here as the foreign-currency price of the domestic money) is driven by the demand and supply conditions in the foreign exchange market. An excess supply of, say, the domestic currency implies a low current exchange rate and thus an expected future appreciation, providing an incentive to hold that currency. An excess demand has the opposite effect. Through the nominal exchange rate, the demand and supply conditions affect the real exchange rate, too.

The key question is why people hold certain amounts of different currencies. This paper shows that the answer is straightforward as long as one avoids a very common economic fallacy that affects much of the research and teaching in international finance. The balance of payments is an accounting identity, meaning that the current account and the financial account sum up to zero.[1] Many economists wrongly take this to mean that the current account, net capital inflows and net sales of official reserves would also have to add up to zero. The truth is that the sum of these three items generally differs from zero because a country's financial account does not only include capital flows and official reserve changes, but also monetary payments.

Accepting that international payment flows exist and that they are important for exchange rates implies the need to model the current account and capital flows independently. This is what is done in this paper and what sets this paper apart from almost all theoretical models in international macroeconomics since these models generally assume, explicitly or implicitly, that capital flows follow the movements of the current account or *vice versa*.

This paper builds a model of optimal consumption and portfolio choice in an open economy. Among other assets, the representative consumer–investor holds money. However, the amount of domestic and foreign money she or he holds depends on the accumulated money flows between her or his country and the rest of the world – and thus on all present and past current account balances, capital flows and reserve interventions. The model is used to study the macroeconomic dynamics of a country whose investment returns initially rise and subsequently fall back to their original levels. It is shown how at the beginning capital inflows rise and the current account deteriorates (the latter due to the boom in domestic consumption and real investment) and how, later on, capital inflows slow down and the current account recovers. For the exchange rate, the movements of the different balance of payments components

[1] For simplicity, we ignore here the capital account, which records non-market and other special transactions, as well as the errors and omissions category of the balance of payments.

imply an appreciation during the upswing, followed by an even greater depreciation during the downswing.

It is important to stress that boom-and-bust cycles such as those studied in this paper come close to a natural experiment as they are associated with abnormally high returns on real and financial assets. Whereas in tranquil times the current account and net capital outflows can move in the same or different directions depending on the economic forces at work, the model simulation of Section 4 and the case studies of Section 5 show that countries going through boom-and-bust cycles experience simultaneous surges in real investment and in the foreign demand for domestic equity. As a result, virtually all those countries face burgeoning current account deficits and massive capital inflows. When there are no restrictions on the financial account, capital inflows tend to exceed the deficit on current account initially, pushing up the currency. Yet since those inflows are of a temporary nature, sooner or later a slump in the exchange rate becomes inevitable.

The paper is structured as follows: Section 2 reviews the literature. Section 3 presents the model of optimal consumption and investment and explains how the nominal and real exchange rates are determined by the movements of the balance of payments. Section 4 simulates the behaviour of the model during a typical boom-and-bust cycle. Section 5 provides case studies that show that the model can be applied to many different historical episodes. Finally, Section 6 provides conclusions.

2. LITERATURE REVIEW

The theoretical model and empirical evidence of this paper are related to a number of research areas. The literature on boom-and-bust cycles has already been cited in the introduction. Recent contributions that have linked exchange rate movements to balance of payments fluctuations are those by Hau and Rey (2006) and Müller-Plantenberg (2006, 2010). One may regard balance of payments flows as the origin of order flows in the foreign exchange market, which the literature on foreign exchange (FX) market microstructure has shown to be strongly correlated with exchange rate changes (Lyons, 2001). As regards the balance of payments itself, the influential intertemporal approach to the current account holds that positive income shocks lead to increased savings and current account surpluses (Obstfeld and Rogoff, 1995). This paper shows, however, that the expansionary phase of boom-and-bust cycles tends to be mostly investment-driven and thus associated with a massive deterioration of the current account – the exact opposite of what the intertemporal approach to the current account suggests. Finally, it should be noted that this paper offers an entirely new explanation for currency crises. Unlike traditional approaches, which identify fiscal deficits, domestic credit growth or high unemployment as the fundamental causes of exchange rate crises (for a comprehensive review of the literature, see Müller-Plantenberg, 2015), this paper argues that currency crises are simply due to the drain of foreign exchange resulting from large and protracted current account deficits.

3. MODEL

a. Theory, Definitions and Accounting Identities

In the model that is to be developed in this section, the exchange rate is essentially driven by balance of payments flows. The key here is to model the current account and the financial account independently; international currency flows can then be deduced from the balance of payments identity. To model the current account, which by definition is the gap between aggregate saving and investment, it is necessary to specify how income, consumption and real investment are determined. The financial account, on the other hand, requires a specification of the determinants of cross-border financial investments. Hence, a standard model of optimal consumption and financial investment is set up that, together with some intuitive assumptions on output and real investment and in conjunction with the national income accounting identity, allows us to derive all the variables needed to explain the current and financial accounts and thus exchange rate movements.

For ease of exposition, in the following we will work backwards, explaining first how consumption and investment decisions are made, then how the balance of payments components are determined and finally how the exchange rate is set in the foreign exchange market. Moreover, Section 3*b* outlines some general rules regarding the notation adopted in the model.

b. Notation

The model is in continuous time. A subscript 0 is used to indicate a stock variable (e.g. k_0, the capital stock) and a subscript 1 to indicate its first time derivative (k_1, instantaneous investment):

$$k_{0,t} = \int_{-\infty}^{t} k_{1,\tau} \mathrm{d}\tau. \tag{1}$$

As regards price levels and exchange rates, the subscripts 0 and 1 refer to the levels and changes of the respective variables. Thus, P_0^{H} is the domestic price level, p_0^{H} its natural logarithm and p_1^{H} domestic inflation. Likewise, S_0^{HF}, or simply S_0, is the nominal exchange rate of the home country *vis-à-vis* the foreign country (that is, the foreign-currency price of the domestic currency), s_0 its natural logarithm and s_1 the rate of nominal appreciation of the domestic currency.

There are two identical countries, a home and a foreign one. As already shown, the home country is indexed by H, the foreign country by F. Single superscripts indicate whether a variable belongs to the home or the foreign country; for example, a_0^{H}, z_1^{H}, c_1^{H} and k_0^{H} are, respectively, wealth, the current account, consumption and the real capital stock of the home country. Double superscripts are used for financial assets in such a way that the first superscript indicates the owner of an asset and the second superscript the asset's location. For instance, e_0^{HH} and e_0^{HF} represent, respectively, domestic and foreign equity held by the domestic consumer-investor; b_0^{HF} represents her or his foreign bonds (or loans granted to the foreign agent).

The domestic and foreign central banks are indexed by $\bar{\mathrm{H}}$ and $\bar{\mathrm{F}}$. They intervene by buying and selling domestic and foreign bonds. Domestic credit made available by the domestic and foreign central banks is given by, respectively, $b_0^{\bar{\mathrm{H}}\mathrm{H}}$ and $b_0^{\bar{\mathrm{F}}\mathrm{F}}$, and their official reserves are $b_0^{\bar{\mathrm{H}}\mathrm{F}}$ and $b_0^{\bar{\mathrm{F}}\mathrm{H}}$. Correspondingly, $m_0^{\mathrm{H}\bar{\mathrm{H}}}$ $(= b_0^{\bar{\mathrm{H}}\mathrm{H}})$ is money held by the domestic consumer–investor that is issued by the domestic central bank, $m_0^{\mathrm{H}\bar{\mathrm{F}}}$ $(= b_0^{\bar{\mathrm{F}}\mathrm{H}})$ her or his money issued by the foreign central bank and so on. Since not only central banks can create money, there is a variable of net cross-border money holdings, m_0^{HF}, which represents the difference between the domestic agent's holdings of money issued by the foreign agent and the foreign agent's holdings of money issued by the domestic agent.

The index T can have two meanings. When it is the first superscript of a financial asset, it indicates the total holdings of that asset by all its holders. For instance, the value of the domestic stock market is given by $e_0^{\mathrm{TH}} = e_0^{\mathrm{HH}} + e_0^{\mathrm{FH}}$ and the value of all domestically issued bonds by $b_0^{\mathrm{TH}} = b_0^{\mathrm{FH}} + b_0^{\mathrm{\bar{H}H}} + b_0^{\mathrm{\bar{F}H}}$ (note that b_0^{HH} does not exist since debt obligations of the domestic consumer–investor to herself or himself are offset by the corresponding claims). It is understood that the return of an asset is the same regardless of the holder of the asset; hence, $\pi_{e^{\mathrm{TH}}} = \pi_{e^{\mathrm{HH}}} = \pi_{e^{\mathrm{FH}}}$ and $\pi_{b^{\mathrm{TH}}} = \pi_{b^{\mathrm{FH}}} = \pi_{b^{\mathrm{\bar{H}H}}} = \pi_{b^{\mathrm{\bar{F}H}}}$.

However, when the index T is the second superscript of a variable, it indicates the total asset holdings of a particular agent. For instance, the value of all the bonds held by the domestic central bank is given by $b_0^{\mathrm{\bar{H}T}} = b_0^{\mathrm{\bar{H}H}} + b_0^{\mathrm{\bar{H}F}}$.

All asset holdings are measured in terms of the world currency, whose value is the weighted geometric average of the domestic and foreign monies. Hence, $S_0 = S_0^{\mathrm{HW}} \times S_0^{\mathrm{WF}}$, where $S_0^{\mathrm{HW}} = S_0^{\upsilon}, S_0^{\mathrm{WF}} = S_0^{1-\upsilon}$ and $\upsilon \in [0,1]$. Currency holdings are indicated by the indices :HC and :FC. Thus, $m_0^{\mathrm{H:FC}}$ is the amount of foreign currency the domestic consumer–investor holds and $m_0^{\mathrm{F:HC}}$ the amount of domestic currency her or his foreign counterpart holds.

Since both countries are identical, equations and formulae are generally only to be stated for the home country. The corresponding equations and formulae of the foreign country can be derived analogously or be obtained by simply interchanging the superscripts H and F of all variables.

A summary of the notation used in this article is given in Table 1.

c. *Optimal Consumption and Financial Investment*

The representative agent of the home country – and analogously the one of the foreign country – decides in each infinitesimal period how much to save and consume and how to distribute her or his stock of wealth among alternative assets. The objective is to maximise the expected present discounted value of consumption:

$$E\left(\int_0^{\infty} e^{-\rho t} \frac{\left(c_{1,t}^{\mathrm{H}}\right)^{1-\gamma}}{1-\gamma} \mathrm{d}t\right), \tag{2}$$

where γ is the degree of relative risk aversion (with $\gamma > 0$) and $\lim_{\gamma \to 1}\left(c_{1,t}^{\mathrm{H}}\right)^{1-\gamma}/(1-\gamma) = \ln\left(c_{1,t}^{\mathrm{H}}\right)$ by l'Hôpital's rule.

The stocks of wealth of the domestic and foreign agents are given by the following equations:

$$\begin{aligned} a_0^{\mathrm{H}} &= e_0^{\mathrm{HH}} - b_0^{\mathrm{\bar{H}H}} + m_0^{\mathrm{H\bar{H}}} + e_0^{\mathrm{HF}} - e_0^{\mathrm{FH}} + b_0^{\mathrm{HF}} - b_0^{\mathrm{FH}} + m_0^{\mathrm{HF}} - b_0^{\mathrm{\bar{F}H}} + m_0^{\mathrm{H\bar{F}}} \\ &= e_0^{\mathrm{HH}} - b_0^{\mathrm{\bar{H}H}} + m_0^{\mathrm{H\bar{H}}} + z_0^{\mathrm{H}} - b_0^{\mathrm{\bar{H}F}} + m_0^{\mathrm{F\bar{H}}}, \end{aligned} \tag{3a}$$

$$\begin{aligned} a_0^{\mathrm{F}} &= e_0^{\mathrm{FF}} - b_0^{\mathrm{\bar{F}F}} + m_0^{\mathrm{F\bar{F}}} - e_0^{\mathrm{HF}} + e_0^{\mathrm{FH}} - b_0^{\mathrm{HF}} + b_0^{\mathrm{FH}} + m_0^{\mathrm{FH}} - b_0^{\mathrm{\bar{H}F}} + m_0^{\mathrm{F\bar{H}}} \\ &= e_0^{\mathrm{FF}} - b_0^{\mathrm{\bar{F}F}} + m_0^{\mathrm{F\bar{F}}} + z_0^{\mathrm{F}} - b_0^{\mathrm{\bar{F}H}} + m_0^{\mathrm{H\bar{F}}}, \end{aligned} \tag{3b}$$

where $m_0^{\mathrm{H\bar{H}}} = b_0^{\mathrm{\bar{H}H}}$, $m_0^{\mathrm{H\bar{F}}} = b_0^{\mathrm{\bar{F}H}}, m_0^{\mathrm{F\bar{F}}} = b_0^{\mathrm{\bar{F}F}}, m_0^{\mathrm{F\bar{H}}} = b_0^{\mathrm{\bar{H}F}}, m_0^{\mathrm{FH}} = -m_0^{\mathrm{HF}}$ and $z_0^{\mathrm{F}} = -z_0^{\mathrm{H}}$.

The domestic agent chooses among three risky assets, e_0^{HH}, e_0^{HF} and b_0^{HF}, and (risk-free) money, $m_0^{\mathrm{H\bar{H}}} + m_0^{\mathrm{HF}} + m_0^{\mathrm{H\bar{F}}}$. Similarly, the foreign agent chooses among the remaining three risky assets, e_0^{FF}, e_0^{FH} and b_0^{FH}, and (risk-free) money, $m_0^{\mathrm{F\bar{F}}} + m_0^{\mathrm{FH}} + m_0^{\mathrm{F\bar{H}}}$. The domestic central bank sets $b_0^{\mathrm{\bar{H}H}}$ and $b_0^{\mathrm{\bar{H}F}}$ and the foreign central bank $b_0^{\mathrm{\bar{F}F}}$ and $b_0^{\mathrm{\bar{F}H}}$.

We assume that the risk and return properties of equity and bonds can be represented by yield-less assets whose prices follow geometric Brownian motions:

TABLE 1
Notation by Examples

Variable	*Description*	*Variable*	*Description*
a_0^{H}	Wealth	a_1^{H}	Change in wealth
		c_1^{H}	Consumption
k_0^{H}	Capital stock	k_1^{H}	Real investment
		$\tilde{y}_1^{\mathrm{H}}$	Gross domestic product
		y_1^{H}	Gross national income
e_0^{HH}	Holdings of domestic equity	e_1^{HH}	Net acquisition of domestic equity
$b_0^{\mathrm{\bar{H}H}}$	Domestic credit	$b_1^{\mathrm{\bar{H}H}}$	Change in domestic credit
$m_0^{\mathrm{H\bar{H}}}$	Holdings of money issued by the domestic central bank	$m_1^{\mathrm{H\bar{H}}}$	Net acquisition of money issued by the domestic central bank
z_0^{HF}	Cumulative current account balance	z_1^{HF}	Current account balance
f_0^{HF}	Net foreign asset position	f_1^{HF}	Minus the financial account
e_0^{HF}	Holdings of foreign equity	e_1^{HF}	Net acquisition of foreign equity ('net capital outflow')
b_0^{HF}	Holdings of foreign bonds	b_1^{HF}	Net acquisition of foreign bonds ('net capital outflow')
m_0^{HF}	Net money claims against the foreign agent	m_1^{HF}	Change in net money claims against the foreign agent ('net money inflow')
$b_0^{\mathrm{\bar{H}F}}$	Stock of official reserves	$b_1^{\mathrm{\bar{H}F}}$	Net official reserve purchases
$m_0^{\mathrm{H\bar{F}}}$	Holdings of money issued by the foreign central bank	$m_1^{\mathrm{H\bar{F}}}$	Net acquisition of money issued by the foreign central bank ('net money inflow')
x_0^{H}	Cumulative international cash flow $(= z_0^{\mathrm{H}} - e_0^{\mathrm{HF}} + e_0^{\mathrm{FH}} - b_0^{\mathrm{HF}} + b_0^{\mathrm{FH}})$	x_1^{H}	International cash flow
$m_0^{\mathrm{H:FC}}$	Holdings of foreign currency	$m_1^{\mathrm{H:FC}}$	Net acquisition of foreign currency
$\tilde{m}_0$	Currency market pressure $(= m_0^{\mathrm{H:FC}} - m_0^{\mathrm{F:HC}})$	$\tilde{m}_1$	Change in currency market pressure
e_0^{TH}	Value of the domestic stock market $(= e_0^{\mathrm{HH}} + e_0^{\mathrm{FH}})$	e_1^{TH}	Change in the value of the domestic stock market
b_0^{TH}	Value of all domestically issued bonds $(= b_0^{\mathrm{FH}} + b_0^{\mathrm{\bar{H}H}} + b_0^{\mathrm{\bar{F}H}})$	b_1^{TH}	Change in the value of all domestically issued bonds
$b_0^{\mathrm{\bar{H}T}}$	Value of all bonds held by the domestic central bank $(= b_0^{\mathrm{\bar{H}H}} + b_0^{\mathrm{\bar{H}F}})$	$b_1^{\mathrm{\bar{H}T}}$	Change in the value of all bonds held by the domestic central bank

Notes:
(i) All variables in this table refer to the representative agent of the home country (H) or to the domestic central bank ($\bar{\mathrm{H}}$).
(ii) The notation for price levels and exchange rates is explained in the text.

$$dP_{i,t} = P_{i,t}\pi_i \mathrm{d}t + P_{i,t}\zeta_i d\omega_{i,t}, \tag{4}$$

where $i \in \{e^{\mathrm{HH}}, e^{\mathrm{FF}}, b^{\mathrm{\bar{H}H}}, b^{\mathrm{\bar{F}F}}, e^{\mathrm{HF}}, e^{\mathrm{FH}}, b^{\mathrm{HF}}, b^{\mathrm{FH}}, b^{\mathrm{\bar{H}F}}, b^{\mathrm{\bar{F}H}}\}$, $\omega_{i,t}$ is a Wiener process and π_i and ζ_i are, respectively, the percentage drift and percentage volatility of the price process of asset i.

It can be shown that the domestic consumer's budget equation is (see Merton, 1971):

$$\begin{aligned} a_1^{\mathrm{H}}\mathrm{d}t = {} & \left(\sum_i (\pi_i - r)i_0 - \sum_j (\pi_j - r)j_0 + ra_0^{\mathrm{H}} - c_1^{\mathrm{H}}\right)\mathrm{d}t \\ & + \sum_i i_0\zeta_i d\omega_i - \sum_j j_0\zeta_j d\omega_j, \end{aligned} \tag{5}$$

where $i \in \{e^{\mathrm{HH}}, e^{\mathrm{HF}}, b^{\mathrm{HF}}\}$, $j \in \{e^{\mathrm{FH}}, b^{\mathrm{TH}}\}$ and $b_0^{\mathrm{TH}} = b_0^{\mathrm{FH}} + b_0^{\mathrm{\bar{H}H}} + b_0^{\mathrm{\bar{F}H}}$.

To find the optimal consumption and investment rules, consider the Bellman equation for this problem:

$$\begin{aligned}\rho V(a_0^{\mathrm{H}}) = \max_{c_1^{\mathrm{H}}, e_0^{\mathrm{HH}}, e_0^{\mathrm{HF}}, b_0^{\mathrm{HF}}} \Bigg\{ & u(c_1^{\mathrm{H}}) \\ & + \left(\sum_i (\pi_i - r) i_0 - \sum_j (\pi_j - r) j_0 + r a_0^{\mathrm{H}} - c_1^{\mathrm{H}} \right) V'(a_0^{\mathrm{H}}) \\ & + \frac{1}{2} \Bigg(\sum_i \sum_{i'} i_0 i'_0 \zeta_i \zeta_{i'} \eta_{ii'} - 2 \sum_i \sum_j i_0 j_0 \zeta_i \zeta_j \eta_{ij} \\ & \qquad + \sum_j \sum_{j'} j_0 j'_0 \zeta_j \zeta_{j'} \eta_{jj'} \Bigg) V''(a_0^{\mathrm{H}}) \Bigg\}, \end{aligned} \tag{6}$$

where $i, i' \in \{e^{\mathrm{HH}}, e^{\mathrm{HF}}, b^{\mathrm{HF}}\}$, $j, j' \in \{e^{\mathrm{FH}}, b^{\mathrm{TH}}\}$ and $\eta_{..}$ represents the correlation between the returns of the assets shown in the subindices.

The domestic consumer–investor solves the first-order conditions with respect to c_1^{H}, e_0^{HH}, e_0^{HF} and b_0^{HF}:

$$u'(c_1^{\mathrm{H}}) = V'(a_0^{\mathrm{H}}), \tag{7}$$

$$i_0 = \frac{\pi_i - r}{\zeta_i^2} \left[-\frac{V'(a_0^{\mathrm{H}})}{a_0^{\mathrm{H}} V''(a_0^{\mathrm{H}})} \right] a_0^{\mathrm{H}} - \frac{1}{\zeta_i^2} \left(\sum_{i' \neq i} i'_0 \zeta_i \zeta_{i'} \eta_{ii'} - \sum_j j_0 \zeta_i \zeta_j \eta_{ij} \right), \tag{8}$$

where $i, i' \in \{e^{\mathrm{HH}}, e^{\mathrm{HF}}, b^{\mathrm{HF}}\}$ and $j \in \{e^{\mathrm{FH}}, b^{\mathrm{TH}}\}$. Note that the term in squared brackets is the reciprocal of the Arrow-Pratt relative risk aversion of the indirect utility function.

Equation 7 says that consumption is so chosen that, in current values, the marginal utility of consumption equals the marginal utility of wealth, which is a standard result. Equation 8 determines the optimal asset holdings of the domestic consumer–investor. The investment in asset i depends positively on the asset's excess return over the risk-free asset (money) and negatively on the asset's variance; the more risk-averse the investor is, the weaker will be the first effect and the stronger will be the second effect. Finally, optimal diversification requires the investor to adjust her or his holdings of asset i according to the asset's correlation with other assets (i') as well as financial obligations (j).

As shown in the online Appendix S1, the assumption of isoelastic utility implies a value function of the following form:

$$V(a_0^{\mathrm{H}}) = \frac{A^{-\gamma}}{1-\gamma} (a_0^{\mathrm{H}})^{1-\gamma}, \tag{9}$$

where A is a constant to be determined. The first-order condition for consumption in equation 7 reduces to $c_1^{\mathrm{H}} = A a_0^{\mathrm{H}}$; that is, the agent consumes a stable fraction of her or his wealth. Given the form of the value function, the formula for the optimal asset holdings in equation 8 can also be simplified since the degree of relative risk aversion of the indirect utility function, $\gamma(a_0^{\mathrm{H}})$, is constant and equal to γ:

$$\gamma(a_0^{\mathrm{H}}) = -\frac{a_0^{\mathrm{H}} V''(a_0^{\mathrm{H}})}{V'(a_0^{\mathrm{H}})} = \gamma. \tag{10}$$

d. Real Investment

As far as physical investment is concerned, it is assumed here that such activity is associated with a quadratic adjustment cost. Due to its tractability, this modelling approach is popular in both theoretical and empirical research.

In every infinitesimal period, entrepreneurs can invest into k_1^{H} units of capital and sell them for $k_1^{\mathrm{H}} \times e_0^{\mathrm{TH}}/k_0^{\mathrm{H}}$ at the stock market. Suppose the adjustment cost of a given investment rate depends on the square of the deviation of the investment rate from the steady-state growth rate of domestic wealth. Then, the entrepreneurs are solving the following maximisation problem:

$$\max_{k_1^{\mathrm{H}}} \frac{e_0^{\mathrm{TH}}}{k_0^{\mathrm{H}}}\frac{k_1^{\mathrm{H}}}{k_0^{\mathrm{H}}} - \frac{k_1^{\mathrm{H}}}{k_0^{\mathrm{H}}} - \frac{1}{2\lambda'}\left(\frac{k_1^{\mathrm{H}}}{k_0^{\mathrm{H}}} - \hat{a}_0^{\mathrm{H}}\right)^2, \tag{11}$$

where $\lambda' = \lambda(1 + \hat{a}_0^{\mathrm{H}})$, λ is a parameter inversely proportional to the adjustment cost faced by the entrepreneurs and $\hat{a}_0^{\mathrm{H}}$ is the steady-state growth rate of domestic wealth. By solving this problem, it is found that real investment, k_1^{H}, is governed by the following differential equation:

$$k_1^{\mathrm{H}} = \hat{a}_0^{\mathrm{H}} k_0^{\mathrm{H}} + \lambda'(e_0^{\mathrm{TH}} - k_0^{\mathrm{H}}). \tag{12}$$

Real investment is therefore driven by an error-correction mechanism that causes investment to rise gradually when the stock market is overvalued and to fall when the stock market is undervalued. Stock market overvaluation refers to the situation where the value of e_0^{TH} exceeds that of k_0^{H}, stock market undervaluation to the opposite situation. The online Appendix S2 shows how λ is chosen and how the solution k_0^{H} of equation 12 is found.

e. Output and National Income

(i) Output

It follows from the national income identity that world output is equal to the world's consumption and investment spending:

$$\sum_i \tilde{y}_1^i = \sum_i (c_1^i + k_1^i), \qquad i \in \{\mathrm{H}, \mathrm{F}\}. \tag{13}$$

Countries are presumed to import a share α of their consumption and investment from abroad so that the output of the home country is determined by the consumption and investment spending of both countries as follows:

$$\tilde{y}_1^{\mathrm{H}} = (1-\alpha)c_1^{\mathrm{H}} + \alpha c_1^{\mathrm{F}} + (1-\alpha)k_1^{\mathrm{H}} + \alpha k_1^{\mathrm{F}}. \tag{14}$$

(ii) National Income

The national income of the home country is equal to the country's output (GDP) plus the net income from financial investments abroad:

$$y_1^{\mathrm{H}} = \tilde{y}_1^{\mathrm{H}} + \sum_i \pi_i i_0 - \sum_j \pi_j j_0 + r(m_0^{\mathrm{HF}} + m_0^{\mathrm{H\bar{F}}} - m_0^{\mathrm{F\bar{H}}}), \tag{15}$$

where $i \in \{e^{\mathrm{HF}}, b^{\mathrm{HF}}, b^{\mathrm{\bar{H}F}}\}$ and $j \in \{e^{\mathrm{FH}}, b^{\mathrm{FH}}, b^{\mathrm{\bar{F}H}}\}$.

f. Balance of Payments

The net foreign asset position and the balance of payments identity of the home country are given by the following two equations:

$$z_0^{\mathrm{H}} = f_0^{\mathrm{H}}, \qquad z_1^{\mathrm{H}} = f_1^{\mathrm{H}}. \tag{16}$$

The net foreign asset position can be broken down into the following components:

$$f_0^{\mathrm{H}} = e_0^{\mathrm{HF}} - e_0^{\mathrm{FH}} + b_0^{\mathrm{HF}} - b_0^{\mathrm{FH}} + m_0^{\mathrm{HF}} + b_0^{\bar{\mathrm{H}}\mathrm{F}} - m_0^{\mathrm{F}\bar{\mathrm{H}}} - b_0^{\bar{\mathrm{F}}\mathrm{H}} + m_0^{\mathrm{H}\bar{\mathrm{F}}} = -f_0^{\mathrm{F}}. \tag{17}$$

When we differentiate this equation with respect to time, we obtain the financial account and its components. In terms of published balance of payments statistics, $e_1^{\mathrm{HF}} - e_1^{\mathrm{FH}}$ captures net FDI outflows (part of the foreign direct investment balance) and net equity investment outflows (part of the portfolio balance); $b_1^{\mathrm{HF}} - b_1^{\mathrm{FH}}$ includes net bond inflows (part of the portfolio balance) and net lending outflows such as loans and trade credits (part of the other investment balance); $m_1^{\mathrm{HF}} + m_1^{\mathrm{H}\bar{\mathrm{F}}} - m_1^{\mathrm{F}\bar{\mathrm{H}}}$ captures net money inflows such bank transfers (part of the other investment balance); and finally, $b_0^{\bar{\mathrm{H}}\mathrm{F}} - b_0^{\bar{\mathrm{F}}\mathrm{H}}$ represents net reserve inflows (part of the reserve balance).

The current account is the difference between national income on the one hand and consumption and investment on the other:

$$\begin{aligned} z_1^{\mathrm{H}} &= y_1^{\mathrm{H}} - c_1^{\mathrm{H}} - k_1^{\mathrm{H}} \\ &= \alpha(c_1^{\mathrm{F}} + k_1^{\mathrm{F}}) - \alpha(c_1^{\mathrm{H}} + k_1^{\mathrm{H}}) \\ &\quad + \sum_i \pi_i i_0 - \sum_j \pi_j j_0 + r(m_0^{\mathrm{HF}} + m_0^{\mathrm{H}\bar{\mathrm{F}}} - m_0^{\mathrm{F}\bar{\mathrm{H}}}) \\ &= -\left(y_1^{\mathrm{F}} - c_1^{\mathrm{F}} - k_1^{\mathrm{F}}\right) \\ &= -z_1^{\mathrm{F}}, \end{aligned} \tag{18}$$

where $i \in \{e^{\mathrm{HF}}, b^{\mathrm{HF}}, b^{\bar{\mathrm{H}}\mathrm{F}}\}$ and $j \in \{e^{\mathrm{FH}}, b^{\mathrm{FH}}, b^{\bar{\mathrm{F}}\mathrm{H}}\}$.

g. Exchange Rate Determination

(i) Nominal Exchange Rate

The nominal exchange rate, s_0, is defined here as the value of the domestic currency in terms of the foreign currency and is set in the foreign exchange market. The foreign exchange market consists of a foreign exchange trader whose task it is to exchange the foreign currency of the domestic consumer–investor with the domestic currency of the foreign consumer–investor. Since the foreign and domestic currency holdings of both agents measured in terms of the world currency are not equal in general, the FX trader is forced to hold open currency positions. However, she or he will only be willing to do so as long as the expected future movement of the exchange rate makes a value gain on the abundant currency likely.

More specifically, assume the FX trader solves the following maximisation problem:

$$\max_{s_0} -\frac{1}{2}\left[(s_0 + p_0^{\mathrm{H}} - p_0^{\mathrm{F}}) - \xi(m_0^{\mathrm{H:FC}} - m_0^{\mathrm{F:HC}})\right]^2. \tag{19}$$

Equation 19 shows that the FX trader faces a trade-off between risk and return. The foreign currency holdings of the domestic agent, $m_0^{\mathrm{H:FC}}$, and the domestic currency holdings of the foreign agent, $m_0^{\mathrm{F:HC}}$, are generally different from each other since both are determined independently as a result of balance of payments transactions. This implies a disutility for the FX trader since she or he would want, at least to start with, to close currency positions at the end of each infinitesimal period so as to minimise exchange rate risk. However, since the trader can set the nominal exchange rate freely, she or he can fix it at a level that favours the currency which is in excess supply. If, say, the FX trader holds more foreign than domestic money, so that $m_0^{\mathrm{H:FC}} > m_0^{\mathrm{F:HC}}$, she or he will choose a nominal exchange rate above its PPP-consistent level since this implies an expected appreciation of the (depreciated) foreign currency, making it possible to offset the utility loss arising from the large position in that currency.

The optimisation in equation 19 leads to the following nominal exchange rate equation:

$$s_0 = -(p_0^{\mathrm{H}} - p_0^{\mathrm{F}}) + \xi \tilde{m}_0, \tag{20}$$

where $\tilde{m}_0 = m_0^{\mathrm{H:FC}} - m_0^{\mathrm{F:HC}}$. The determination of the nominal exchange rate is thus quite simple. First of all, the nominal exchange rate depends on the purchasing powers of both currencies, in such a way that one could refer to $-(p_0^{\mathrm{H}} - p_0^{\mathrm{F}})$ as the 'fundamental', or PPP-consistent, level of the exchange rate in the absence of added currency market pressure. In addition, however, the supply and demand conditions in the foreign exchange market can push the exchange rate below or above its 'fundamental' level. For this reason, the variable $\tilde{m}_0$ is referred to here as currency market pressure.[2]

Currency market pressure measures the scarcity of the domestic money relative to the foreign one and is defined as the difference between the amount of foreign currency the domestic agent holds and the amount of domestic currency the foreign agent holds. The net foreign currency holdings of the domestic agent and the net domestic currency holdings of the foreign agent are (for the approximation, see the online Appendix S3):

$$m_{0,t}^{\mathrm{H:FC}} = S_{0,t}^{-(1-\upsilon)} \int_{-\infty}^{t} S_{0,\tau}^{1-\upsilon} (b_{1,\tau}^{\bar{\mathrm{F}}\mathrm{H}} + \phi x_{1,\tau}^{\mathrm{H}}) d\tau \approx b_{0,t}^{\bar{\mathrm{F}}\mathrm{H}} + \phi x_{0,t}^{\mathrm{H}}, \tag{21a}$$

$$m_{0,t}^{\mathrm{F:HC}} = S_{0,t}^{\upsilon} \int_{-\infty}^{t} S_{0,\tau}^{-\upsilon} (b_{1,\tau}^{\bar{\mathrm{H}}\mathrm{F}} - (1-\phi) x_{1,\tau}^{\mathrm{H}}) d\tau \approx b_{0,t}^{\bar{\mathrm{H}}\mathrm{F}} - (1-\phi) x_{0,t}^{\mathrm{H}}. \tag{21b}$$

Here, the values of both currency holdings are stated in terms of the world currency, so as to make them comparable. The variable x_0^{H} stands for the cumulative international cash flow of the home country. This variable measures the sum of all past and present current account balances and net capital inflows and is defined as follows:

$$x_0^{\mathrm{H}} = z_0^{\mathrm{H}} - e_0^{\mathrm{HF}} + e_0^{\mathrm{FH}} - b_0^{\mathrm{HF}} + b_0^{\mathrm{FH}}. \tag{22}$$

The parameter ϕ, with $\phi \in [0,1]$, measures the part of international cash flow denominated in the foreign currency; the remaining part, $1-\phi$, is denominated in the domestic currency.

Using equations 16 and 17, we obtain the following:

$$\tilde{m}_0 = m_0^{\mathrm{H:FC}} - m_0^{\mathrm{F:HC}} \approx x_0^{\mathrm{H}} - b_0^{\bar{\mathrm{H}}\mathrm{F}} + b_0^{\bar{\mathrm{F}}\mathrm{H}} = m_0^{\mathrm{HF}} + m_0^{\mathrm{H}\bar{\mathrm{F}}} - m_0^{\mathrm{F}\bar{\mathrm{H}}}. \tag{23}$$

Equations 20 and 23 tell us (in their flow versions) that the net appreciation of the domestic currency against the foreign currency is the stronger: the lower domestic inflation is and the higher foreign inflation is, the higher the current account balance is, the higher net FDI and equity investment inflows into the home country are, the higher net lending inflows

[2] A similar way of determining the exchange rate is implicit in assumption 3 of Hau and Rey (2006).

(bonds, loans, trade credits, etc.) into the home country are and the more official reserves the domestic central bank is selling and the foreign central bank is buying.

In Section 3*h*, it will be assumed that the central banks use sterilisation measures to completely stabilise the price levels P_0^{H} and P_0^{F} at a normalised level of one; hence, $p_0^{\mathrm{H}} = p_0^{\mathrm{F}} = 0$. This assumption rules out the typical link between money supply changes and exchange rate movements as it is known from monetary models, which helps in getting a clear idea of how balance of payments flows by themselves influence the exchange rate.

(ii) Real Exchange Rate

The simple model of nominal exchange rate determination in Section 3*g(i)* implies that the real exchange rate is driven solely by the movements of the currency market pressure variable:

$$q_0 = s_0 + p_0^{\mathrm{H}} - p_0^{\mathrm{F}} = [-(p_0^{\mathrm{H}} - p_0^{\mathrm{F}}) + \xi\tilde{m}_0] + p_0^{\mathrm{H}} - p_0^{\mathrm{F}} = \xi\tilde{m}_0. \tag{24}$$

h. Monetary Policy

The aim of this article is to show how balance of payments imbalances bring about large exchange rate movements even if central banks are successful in their efforts to achieve price stability. Suppose that the quantity theory of money holds, so that:

$$\begin{aligned}
&(S_0^{\mathrm{HW}})^{-1}(m_0^{\mathrm{H\bar{H}}} + m_0^{\mathrm{H\bar{F}}} + m_0^{\mathrm{HF}})v \\
&\quad = (S_0^{\mathrm{HW}})^{-1}(b_0^{\mathrm{\bar{H}H}} + b_0^{\mathrm{\bar{F}H}} + x_0^{\mathrm{H}})v \\
&\quad = \frac{P_0^{\mathrm{H}}(1-\alpha) + S_0^{-1}P_0^{\mathrm{F}}\alpha}{P_0^{\mathrm{W}}}(c_1^{\mathrm{H}} + k_1^{\mathrm{H}}),
\end{aligned} \tag{25}$$

where $m_0^{\mathrm{H\bar{H}}} + m_0^{\mathrm{H\bar{F}}} + m_0^{\mathrm{HF}}$ is the domestic effective money supply (i.e. the amount of money the domestic consumer–investor actually holds), v the velocity of money (assumed here to equal 0.5), P_0^{H} the domestic price level, P_0^{F} the foreign price level and P_0^{W} a weighted average of the domestic and foreign price levels. Suppose that the domestic and foreign central banks sterilise all money inflows and outflows to keep their respective price levels, P_0^{H} and P_0^{F}, at a normalised value of one. To simplify things further, a first-order Taylor series approximation around $S_0 = S_0^{\mathrm{HW}} = 1$ and $m_0^{\mathrm{H\bar{H}}} + m_0^{\mathrm{H\bar{F}}} + m_0^{\mathrm{HF}} = 0$ is applied to equation 25. Hence, it must hold that:

$$b_0^{\mathrm{\bar{H}H}} = \frac{c_1^{\mathrm{H}} + k_1^{\mathrm{H}}}{v} - b_0^{\mathrm{\bar{F}H}} - x_0^{\mathrm{H}}. \tag{26}$$

We assume that no official intervention takes place and that the central banks merely maintain a stable ratio of official reserves to domestic wealth, such that $b_0^{\mathrm{\bar{H}F}} = \kappa a_0^{\mathrm{H}}$ and $b_0^{\mathrm{\bar{F}H}} = \kappa a_0^{\mathrm{F}}$. Note that in the empirical part of this paper, we will set $\kappa = 0.005$. Hence, all the values on the right-hand side of equation 26 are known, and all the central banks do is to raise or lower domestic credit, $b_0^{\mathrm{\bar{H}H}}$ and $b_0^{\mathrm{\bar{F}F}}$, as is necessary to maintain price stability.

As long as they possess the necessary reserves, the central banks could of course buy and sell each other's bonds to depreciate or appreciate the exchange rate. Such intervention certainly plays a role in practice, particularly during episodes in which fixed exchange rate regimes are maintained that later collapse (see Section 5*b*), yet its effects within the model are rather obvious. So to keep the analysis simple, the possibility of active official intervention is ignored in this paper.

4. SIMULATION OF BOOM-AND-BUST CYCLES

a. Generation of Boom-and-bust Cycles

Boom-and-bust cycles are thought of here as periods of great economic optimism and are modelled as a temporary rise and fall of the expected return on domestic capital, k_0^{H}. This section simulates the reaction of the model to the exogenous shift in the return on domestic capital and interprets the findings economically.

b. Parameter Choices

According to the first-order conditions in equation 8, the optimal portfolio shares $w_i\,(=i_0/a_0^{\mathrm{H}}),\ i\in C,\ C=\{e^{\mathrm{HH}},e^{\mathrm{HF}},b^{\mathrm{HF}}\}$, and $w_j\,(=j_0/a_0^{\mathrm{F}}),\ j\in D,\ D=\{e^{\mathrm{FF}},e^{\mathrm{FH}},b^{\mathrm{FH}}\}$, are functions of asset returns $\pi_k,\ k\in E,\ E=C\cup D$, asset return volatilities $\zeta_k,\ k\in E$ and asset return correlations $\eta_l,\ l\in F,\ F=E\times E\backslash\{(e^{\mathrm{HH}},e^{\mathrm{FF}}),(e^{\mathrm{FF}},e^{\mathrm{HH}})\}$. The rise and fall of the return on domestic capital during boom-and-bust cycles leads to transitory adjustments of the portfolio weights.

Initially, both countries are in an identical position, so their portfolio compositions match each other. We assume that each agent holds the same amount of foreign equity and foreign bonds and that the total sum of foreign assets amounts to half her or his wealth; that is, $w_{e^{\mathrm{HF}}}=w_{e^{\mathrm{FH}}}=w_{b^{\mathrm{HF}}}=w_{b^{\mathrm{FH}}}=0.25$. Since international financial assets and obligations cancel each other out, the domestic consumer–investor's net initial wealth, a_0^{H}, consists only of equity, e_0^{HH}; see equation 3.

The formula for optimal portfolio shares in equation 8 for both the domestic and the foreign agent can now be used to derive the initial returns π_k, $k\in E$, provided ζ_k, $k\in E$, and η_l, $l\in F$, are known. Specifically, we use for the volatility parameters:

$$\zeta_{e^{\mathrm{HH}}}=\zeta_{e^{\mathrm{FF}}}=0.275,\qquad \zeta_{e^{\mathrm{HF}}}=\zeta_{e^{\mathrm{FH}}}=0.392,\qquad \zeta_{b^{\mathrm{HF}}}=\zeta_{b^{\mathrm{FH}}}=0.164. \tag{27}$$

The correlations are chosen as follows:

$$\eta_{j_1}=0.25,\quad j_1\in F\backslash\{(e^{\mathrm{HH}},e^{\mathrm{FH}}),(e^{\mathrm{FF}},e^{\mathrm{HF}})\}, \tag{28}$$

$$\eta_{j_2}=1.00,\quad j_2\in\{(e^{\mathrm{HH}},e^{\mathrm{FH}}),(e^{\mathrm{FF}},e^{\mathrm{HF}})\}. \tag{29}$$

Hence, we obtain:

$$\pi_{e^{\mathrm{HH}}}=\pi_{e^{\mathrm{FF}}}=5.5\%,\qquad \pi_{e^{\mathrm{HF}}}=\pi_{e^{\mathrm{FH}}}=5.5\%,\qquad \pi_{b^{\mathrm{HF}}}=\pi_{b^{\mathrm{FH}}}=1.6\%. \tag{30}$$

The parameter choices are calibrations based on what is known about stock and bond returns. Dimson et al. (2011) have constructed 19-country world indices for equities and long-term government bonds. The countries included in their study covered 89 per cent of the global stock market in 1900 and 83 per cent of its market capitalisation by the start of 2011. Over the 111 years from 1900 to 2011, they find that the real value of equities, with income reinvested, grew by a factor of 374.8; the same factor for bonds was 6.1. This translates into an annual real return on the world equity index of 5.5 per cent and of the world bond index of 1.6 per cent. They further show that the world equity index had a volatility of 17.7 per cent per year and the world bond index a volatility of 10.4 per cent, yielding a volatility ratio of 1.70, which is close to the ratios of $\zeta_{e^{\mathrm{HH}}}/\zeta_{b^{\mathrm{HF}}}$ and $\zeta_{e^{\mathrm{HF}}}/\zeta_{b^{\mathrm{HF}}}$ of the present model, which are 1.71 and 2.38, respectively. For the correlation between stocks and bonds, Dimson et al. (2011) find that it is generally positive in the 19 countries they consider, with an average of +0.24 over the period from 1900 to 2011. As Figure 6 in Obstfeld and Taylor (2003) shows, the correlation of equity returns in US dollars for the G7 and up to 22 stock markets was also positive during the period from 1800 to 2000, with an average somewhere between 0.20 and 0.40 (with considerable fluctuations though). For simplicity, equation 28 sets all correlations to 0.25; the only exception is the correlation between the returns on equity shared by the domestic and the foreign investors, which is assumed to equal one (see equation 29).

Regarding the other parameters of the model, the following choices are made. The degree of relative risk aversion, γ, is one, implying that utility is logarithmic and that optimal consumption is given by $c_1^{\mathrm{H}} = \rho a_0^{\mathrm{H}}$. The return on money, r, is zero. The discount factor, ρ, is 0.04. The import factor of both countries, α, is 0.3. Finally, starting values for wealth at home and abroad, the state variables, are needed. Here, we set $a_{0,0}^{\mathrm{H}} = a_{0,0}^{\mathrm{F}} = 1{,}000$.

c. Macroeconomic Effects of a Rise in the Return on Domestic Capital

The simulation of a typical boom-and-bust cycle is based on a discretised version of the model of Section 3; to focus on the main dynamics of the model, shocks are set to zero. Time is measured in years, and each year consists of n observations (here, n = 50). We assume that both the boom and the bust phase last for four years (this is a simplification, of course, since in reality the duration of lending booms varies). Moreover, to get an idea of the behaviour of the variables in tranquil times, we allow for a warming-up and a cooling-off period, each of which lasts four years as well. Altogether therefore, the four different phases – warming-up, boom, bust and cooling-off – span a period of 16 years.

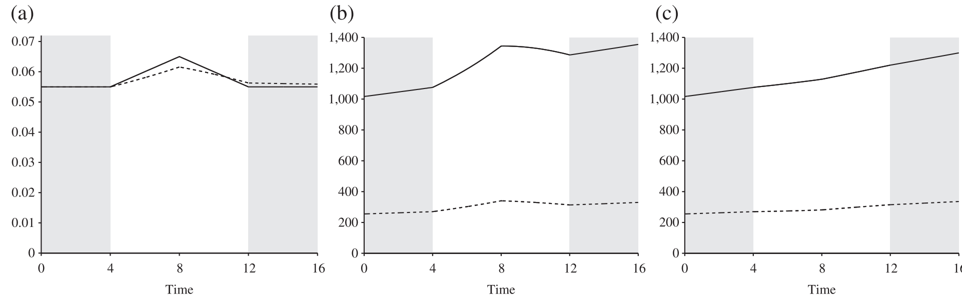
If ρ is not too high, the model of Section 3 exhibits growth of wealth, consumption, investment, output and national income over time. The boom phase is characterised by an exogenous linear rise in the return on domestic capital, $\pi_{k^{\mathrm{H}}}$, by one percentage point; during the subsequent bust, the return on domestic capital falls linearly back to its original level. This is shown in Figure 1a. The return on domestic equity, $\pi_{e^{\mathrm{TH}}}$, also rises, though by a bit less (for reasons that become clear shortly). The returns on all other assets remain unchanged.

The optimal portfolio allocation of the domestic and foreign investors are determined by equation 8. Panels b, c and d of Figure 1 show that the rise in the return on domestic capital leads agents to increase the share of domestic equity and to reduce the shares of all other assets in their portfolios. The positive asset correlations in equations 28 and 29 imply that both agents need to reduce their stakes in bonds and foreign equity in order to strike the right balance between the overall return and risk.

As a consequence of the rise of $\pi_{e^{\mathrm{TH}}}$ and the shift towards domestic equity, the stocks of wealth of both agents, particularly of the domestic consumer–investor, rise more rapidly. This is shown in Figure 1e.

Uncertainty, large sunk costs and the opportunity to wait associated with investments in real estate, plants and machinery imply that aggregate investment adjusts to changing investment opportunities more slowly than the stock market. The more gradual adjustment of real investment is captured by equation 12. As panels a and b of Figure 2 show, the rise in the return on domestic capital leads to an acceleration of domestic real investment and a modest deceleration of foreign real investment. However, since equity investments react more promptly and strongly, the domestic stock market becomes overvalued and the foreign stock market slightly undervalued. The stock market over- and undervaluations are measured by the ‘bubble’ factors $\beta^{\mathrm{H}} (= e_0^{\mathrm{TH}}/k_0^{\mathrm{H}})$ and $\beta^{\mathrm{F}} (= e_0^{\mathrm{TF}}/k_0^{\mathrm{F}})$, which are plotted in Figure 2c. Of course, similar asset price movements will be observed in the real estate market, too; see Aizenman and Jinjarak (2009) and Tillmann (2013).

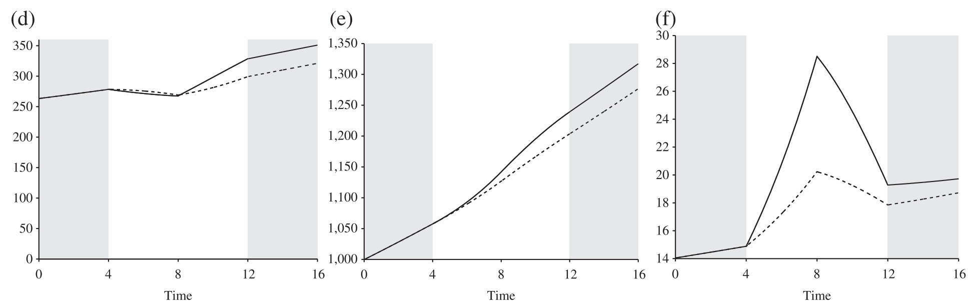
FIGURE 1
Asset Returns and Portfolio Allocation: Asset Returns, Portfolio Holdings of Domestic and Foreign Investors and Domestic and Foreign Wealth



(a) Return on Domestic Real Capital (π_{k^H}: solid line) and on Domestic Equity ($\pi_{e^{TH}}$: dashed line)

(b) Domestic Equity Held by Domestic Residents (e_0^{HH}: solid line) and Foreign Residents (e_0^{FH}: dashed line)

(c) Foreign Equity Held by Foreign Residents (e_0^{FF}: solid line) and Domestic Residents (e_0^{HF}: dashed line)



(d) Foreign Bonds Held by Domestic Residents (b_0^{HF}: solid line) and Domestic Bonds Held by Foreign Residents (b_0^{FH}: dashed line)

(e) Domestic Wealth (a_0^H: solid line) and Foreign Wealth (a_0^F:dashed line)

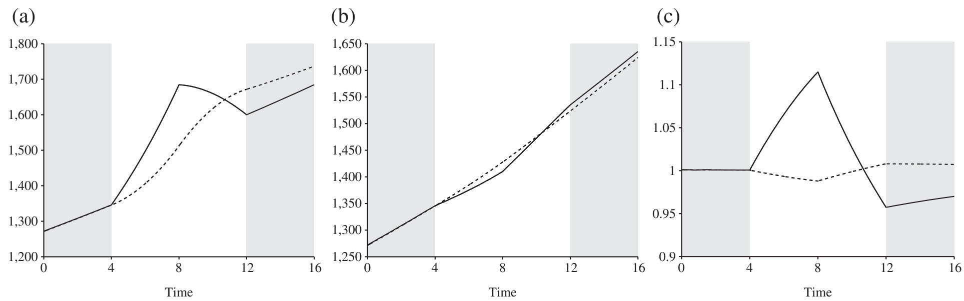
(f) Absolute Growth of Domestic Wealth (a_1^H: solid line) and Foreign Wealth (a_1^F: dashed line)

Since the total return on capital, $\pi_{k^H}k_0^H$, has to be distributed among all holders of domestic equity, the return on domestic equity, $\pi_{e^{TH}}$, is given by π_{k^H}/β^H (similarly, $\pi_{e^{TF}} = \pi_{k^F}/\beta^F$). This explains why, as mentioned above, the return on domestic equity rises a little less than the return on domestic capital (see Figure 1a).

During the boom, consumption and real investment rise in both countries. This is shown in panels a, b, d and e of Figure 3. The increase in domestic consumption is modest in the present model, as the domestic consumer–investor chooses to consume a constant fraction of her or his wealth (in line with the permanent income theory of consumption, see equation 7). However, domestic real investment, being driven by the higher expected returns, goes up very strongly. Abroad, both consumption and investment rise only little. As equation 12 shows, foreign real investment could in fact even fall, depending on which of its determinants, the accelerated growth of foreign wealth or the underperformance of the foreign equity market, has a stronger impact.

The implications for national income and saving are shown in Figure 3, too. The fact that part of the consumption and investment demands of both countries falls on imports means that

FIGURE 2
Stock Market Overvaluations: Domestic and Foreign Capital Stocks, Stock Market Values and Stock Market Overvaluations

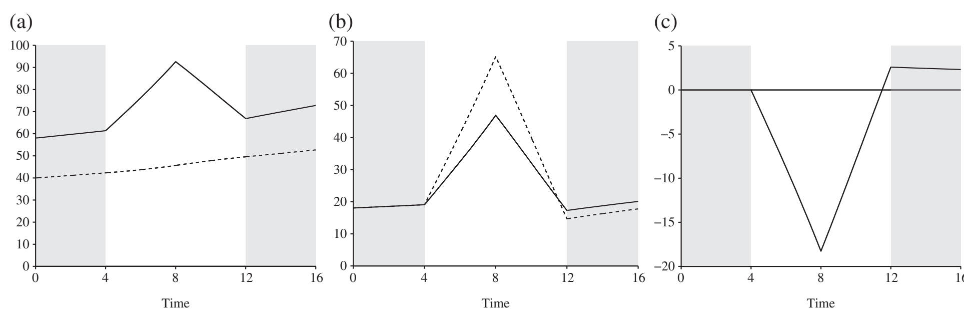


(a) Domestic Stock Market Value (e_0^{TH}: solid line) and Capital Stock (k_0^{H}: dashed line)

(b) Foreign Stock Market Value (e_0^{TF}: solid line) and Capital Stock (k_0^{F}: dashed line)

(c) Overvaluation of the Domestic Stock Market (β^{H}: solid line) and the Foreign Stock Market (β^{F}: dashed line)

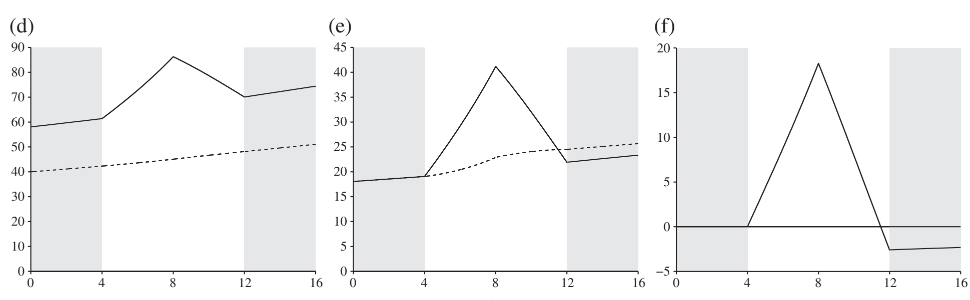
FIGURE 3
National Income and Spending: National Income, Consumption, Saving, Investment and Current Account Balance at Home and Abroad



(a) Domestic National Income (y_1^{H}: solid line) and Consumption (c_1^{H}: dashed line)

(b) Domestic Saving ($y_1^{H} - c_1^{H}$: solid line) and Investment (k_1^{H}: dashed line)

(c) Domestic Current Account (z_1^{H})

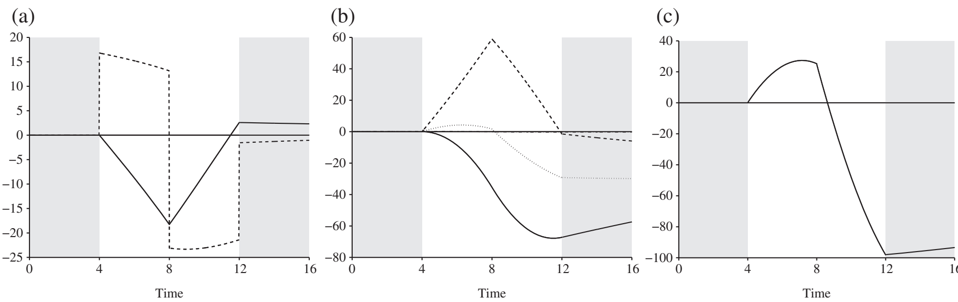


(d) Foreign National Income (y_1^{F}: solid line) and Consumption (c_1^{F}: dashed line)

(e) Foreign Saving ($y_1^{F} - c_1^{F}$: solid line) and Investment (k_1^{F}: dashed line)

(f) Foreign Current Account (z_1^{F})

FIGURE 4
Currency Market Pressure: Comparison of the Current Account Balance with Capital Inflows as well as Currency Market Pressure and its Components



Domestic Current Account (z_1^{H}: solid line) and Net Capital Inflows ($e_1^{\mathrm{FH}} - e_1^{\mathrm{HF}} + b_1^{\mathrm{FH}} - b_1^{\mathrm{HF}}$: dashed line)

Components of Currency Market Pressure: z_0^{H} (solid line), $e_0^{\mathrm{FH}} - e_0^{\mathrm{HF}}$ (dashed line), $b_0^{\mathrm{FH}} - b_0^{\mathrm{HF}}$ (dotted line) and $b_0^{\bar{\mathrm{F}}\mathrm{H}} - b_0^{\bar{\mathrm{H}}\mathrm{F}}$ (dash-dotted line)

Currency Market Pressure ($\tilde{m}_0$)

both countries' outputs and incomes benefit from the boom (see equations 14 and 15). Most of the increased incomes is saved, rather than consumed.

Now consider the behaviour of the current account balance. From equation 14, we can see that since investment rises so much more at home than abroad, it must be the case that output, and hence saving, increases less than real investment at home and more than real investment abroad, a result that is independent of the exact import shares one chooses. Given that the current account is defined as the gap between saving and investment, this implies that the home country has to run a current account deficit and the foreign country a current account surplus (see panels c and f of Figure 3). Note that the result is in stark contrast to traditional intertemporal models of the current account, according to which positive income shocks lead to current account surpluses rather than deficits.

Figure 4a shows that the home country experiences large capital inflows during the expansionary phase, followed by large outflows during the economic downturn. The plot also shows that the volume of the capital inflows exceeds that of the gradually emerging current account deficit. The preponderance of the equity flows is not mere coincidence, but a necessary consequence of the assumption of Section 3*d* that cross-border finance reacts to rising investment opportunities more rapidly than real investment.

Panel b of Figure 4 considers the cumulative balance of payments flows, which according to equations 22 and 23 are the driving force behind the currency market pressure variable, $\tilde{m}_0$. Panel c then shows the resulting rise, and even greater fall, of $\tilde{m}_0$ during a typical boom-and-bust episode.

The plots reveal several interesting things. First, the real appreciation of the home currency results entirely from the shift of both agents' equity holdings towards domestic equity and the reduction of the domestic agent's foreign bond holdings. Second, the overall real depreciation of the currency at the end of the boom-and-bust cycle is caused by the decline of the cumulative current account balance, or net foreign asset position.

Third, the fall of the real exchange rate is in part also due to the fall in the domestic bond holdings by foreigners and the rise in the foreign bond holdings by domestic residents. These developments are a consequence of the sterilisation measures carried out by the two central banks (see equation 26). During the boom, the central banks are faced with money flows from the foreign economy to the domestic economy, inducing the domestic central bank to reduce and the foreign central bank to increase their stocks of domestic credit. During the subsequent bust, however, both central banks are confronted with even greater money flows in the opposite direction. To stabilise the money supply, the domestic central bank thus has to boost its domestic bond holdings; the foreign central bank, on the other hand, has to do the exact opposite. As a result, foreign investors are driven out of the domestic bond market and domestic investors into the foreign bond market.

Fourth, Figure 4b shows that equity flight does *not* explain the eventual collapse of the real exchange rate (i.e. the fall below its original level). As the simulated time series shows, the volume of initial equity inflows is equal to that of the subsequent outflows, leaving the net cumulative equity inflow balance around zero in the end. Indeed, in many of the episodes studied in Section 5, capital inflows do not even cease during the economic slump.

Finally, fifth, as a result of the simplifying assumption that central banks do not engage in active official intervention, the effect of the foreign exchange purchases carried out by the two central banks is negligible. However, it should be noticed that cumulative official interventions, as represented by $b_0^{\bar{\mathrm{H}}\mathrm{F}}$ and $b_0^{\bar{\mathrm{F}}\mathrm{H}}$, enter the exchange market equation 23 with the expected sign; thus if, for example, the domestic central bank wants to defend a currency peg amidst a current account deficit and weak or negative capital inflows, what it needs to do is to sell foreign bonds.

5. CASE STUDIES

Having analysed the macroeconomic dynamics of boom-and-bust cycles in Sections 3 and 4, we now turn to case studies to examine the empirical validity of the theoretical predictions. As we shall see, overborrowing can be observed in different economic contexts, the examples considered here being the Latin American debt crisis of the 1980s, the currency crises of the 1990s as well as countries' macroeconomic reactions to natural resource discoveries. Interestingly, even the two large upswings and downswings of the US dollar since the breakdown of the Bretton Woods system can be explained within the proposed theoretical framework.[3]

[3] Each case study in this section is accompanied by a figure containing time series of the volume of private consumption and investment, the volume of GDP, net capital inflows, the current account and the real exchange rate. Note that published balance of payments statistics do not permit the exact calculation of capital flows between countries. The reason is that these statistics generally do not provide disaggregated data on the 'other investment' category of the financial account, which contains both capital flows (loans and trade credits) and money transfers. The solution adopted here is to plot only the sum of net foreign direct investment and portfolio investment inflows in the figures, so as to at least get an idea of the likely direction of capital flows.

Note that all time series are taken from the International Financial Statistics of the IMF, the only exception being the data on GDP, consumption and investment of Mongolia, which are from the World Development Indicators of the World Bank. Years start at the axis ticks of the corresponding year. All logarithms in the article are to the base 2. The GDP volume indices are all equal to 100 in the base year 2005, and their base 2 logarithms thus equal to 6.63 in that year. Quarterly data of the current account and capital flow series are multiplied by 4 to allow easy comparison with countries where only annual data are available.

a. Debt Crisis of the 1980s

The international debt crisis of the 1980s broke out in August 1982 when Mexico announced that it could not service its international debt any longer. Other countries in Latin America and other developing regions soon followed suit. Here we examine the case of Mexico as well as that of Chile.

The origins of the Latin American debt crisis are usually traced back to the two oil shocks in 1973–74 and 1979–80, which led to a surge in export revenues of the countries of the OPEC cartel. These petrodollars were in large part deposited in western commercial banks, who went on to invest, or 'recycle', them by granting long-term loans to governments of developing countries with good growth prospects. In the late 1970s, not least because of rising inflation, real interest rates were very low and in some cases even turned negative.

However, in late 1979 the appointment of Paul Volcker as chairman of the Federal Reserve marked a turning point. Aiming to tighten the money supply to reduce inflation in the United States, he immediately set out to raise dollar interest rates to historically high levels, causing a worldwide recession. As a consequence, the by now highly indebted countries in Latin America and other regions of the world not only faced higher interest payments and lower export demands, but also lower terms of trade due to the fall in commodity prices. The economic booms that most of these countries were experiencing as a result of the heavy foreign lending thus came to a sudden stop.

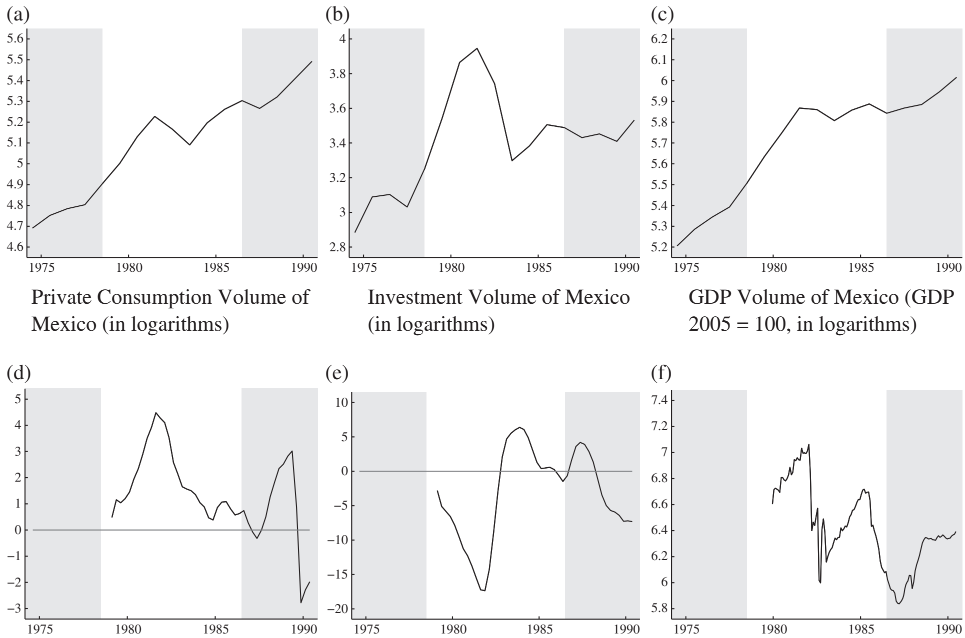
(i) Mexico – 1982

Mexico experienced strong growth following a model of import substitution industrialisation from 1930 to 1970, a period referred to as the 'Mexican miracle'. In the 1970s, its presidents Luis Echeverría Álvarez (1970–76) and José López Portillo (1976–82) pursued policies of economic and social development, for instance through the nationalisation of the mining and electrical industries, the redistribution of land and increased spending on health, housing construction, education and food subsidies. The boosts in public spending were facilitated by the discovery in 1974 of vast oil fields and the surge in the price of oil. Towards the end of the 1970s, Mexico started to borrow heavily from international capital markets to invest in the state-owned oil firm Petróleos Mexicanos (Pemex).

Figure 5 gives an impression of how strongly consumption, real investment, output and external debt rose up until 1982. From 1977 to 1981, Mexico's private consumption rose in real terms by 7.6 per cent annually, real investment by 17.2 per cent and GDP by 8.6 per cent. As a consequence of the surge in investment, Mexico was running the largest current account deficit in the world in 1981 (of 135 countries). Nevertheless, the moratorium on foreign debt of August 1982 and the economic and financial crisis that followed implied substantial cutbacks in foreign lending and domestic investment, with the latter falling in real terms by 36.2 per cent between 1981 and 1983. The upshot was an impressive turnaround of the current account, which by 1983 was already recording the world's second-largest surplus (of 139 countries).

As our model predicts, the Mexican peso rose in real terms during the boom of the late 1970s yet had to be devalued several times after the 1982 debt default. Although foreign capital in the form of direct and portfolio investment kept on flowing into Mexico after 1982, it did so at a much reduced rate (due to the already mentioned lack of data, we cannot say anything definite about the sign and volume of lending flows to and from Mexico). Albeit a brief relief in 1984–85, the Mexican real effective exchange rate fell by 50.3 per cent between 1981 and 1987.

FIGURE 5
Case Study: Mexico – 1982



(a) Private Consumption Volume of Mexico (in logarithms)

(b) Investment Volume of Mexico (in logarithms)

(c) GDP Volume of Mexico (GDP 2005 = 100, in logarithms)

(d) Net Direct and Portfolio Investment Inflows of Mexico (in billions of US dollars, annual moving average)

(e) Current Account of Mexico (in billions of US dollars, annual moving average)

(f) Real Effective Exchange Rate of Mexico (CPI-based, in logarithms)

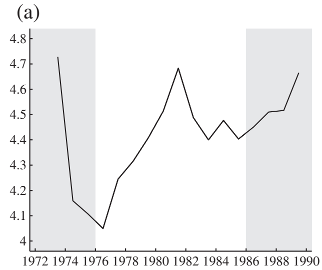
(ii) Chile – 1982

In 1973, the Chilean general Augusto Pinochet Ugarte overthrew the democratically elected socialist government of Salvador Allende Gossens, setting the stage for a 17-year military dictatorship in Chile. In 1975, Pinochet appointed a group of economists, many of whom had been trained at the University of Chicago under Milton Friedman and Arnold Harberger or at its affiliate at the Catholic University of Chile, to implement market-oriented economic reforms. Given financial and ideological support from the United States and international financial institutions, the so-called Chicago Boys introduced a bundle of measures aimed to privatise the pension system as well as many state-owned companies and banks, to open up the country's current and financial accounts, to consolidate public finances (while cutting taxes) and to stabilise inflation.

Although these changes are said to have worsened the already high income inequality in Chile, they set in motion a remarkable country-wide economic boom. According to the data underlying Figure 6, Chile's private consumption rose by 9.2 per cent per annum in real terms between 1976 and 1981, real investment by 15.2 per cent and GDP by 7.5 per cent. Conley and Maloney (1995) provide a vivid account of the 'triumphalist' mood of those years. There was a wide-spread conviction that Chile had overcome a decade of stagnation and 'in 10 years would be a developed nation [...] where 70 per cent of the population would have colour TVs' (labour minister José Piñera Echenique, quoted by Conley and Maloney, 1995).

FIGURE 6
Case Study: Chile – 1982

(a)

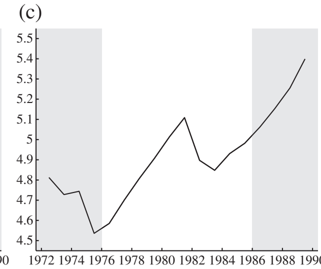


Private Consumption Volume of Chile (in logarithms)

(b)

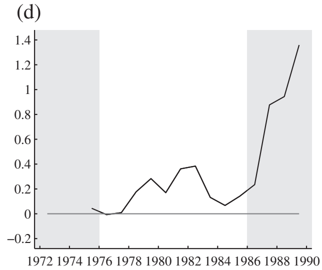
Investment Volume of Chile (in logarithms)

(c)



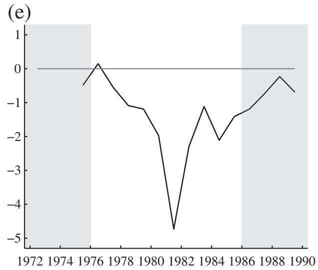
GDP Volume of Chile (GDP 2005 = 100, in logarithms)

(d)



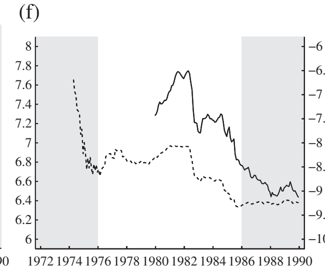
Net Direct and Portfolio Investment Inflows of Chile (in billions of US dollars)

(e)



Current Account of Chile (in billions of US dollars)

(f)



Real Effective Exchange Rate of Chile (CPI-based, in logarithms, solid line, left scale) and Bilateral Real Exchange Rate Between Chile and the United States (CPI-based, in logarithms, dashed line, right scale)

With national savings declining (as a percentage of GDP) and national investment soaring, the current account deficit reached a staggering 14.5 per cent of GDP at the peak in 1981. Households and firms took on great debts, often in the form of foreign loans which were easily available and cheaper than the domestic ones. Figure 6d shows that inflows of foreign direct and portfolio investment were sizeable; however, there is little doubt that overall capital flows including foreign loans were much larger still and that they exceeded the deficit on current account during the boom years.

Yet in 1982, not least because of the hike in international interest rates and the overvaluation of the local currency, the boom collapsed. Between 1981 and 1983, real GDP dropped by 16.5 per cent. The private sector found itself deep in debt. Banks were renationalised and the up to now healthy-looking public finances deteriorated precipitously when the public sector began to assume large amounts of foreign-denominated private sector debt. This left the government with the largest *per capita* debt in Latin America (Conley and Maloney, 1995).

Not long before the crash, Chile had introduced a fixed exchange rate regime, which it now had to abandon. What is striking is how much the behaviour of the real exchange rate in those volatile years, which is shown in Figure 6f, resembles that predicted by our model, which is depicted in Figure 4c. Not only did the real exchange rate rise during the boom and fall during the bust, the eventual fall was also much larger than the initial rise: between 1980Q1 and 1982Q1, the real effective exchange rate rose by 30.0 per cent, yet between 1982Q1 and the end of the decade, it fell by 58.4 per cent.

b. Currency Crises of the 1990s

According to most theoretical models of currency crises, the origin of such crises can be traced back to excessive money growth or to fiscal indiscipline (see Section 2). It is with regard to the immediate causes that these models normally differ (discrete changes in exchange rate expectations, self-fulfilling prophecies, balance-sheet effects, etc.). In contrast, the model presented in this paper suggests that external imbalances accompanying episodes of large economic expansions and contractions are key to understanding the incidence and severity of exchange rate crises. In the two case studies that follow, we will see that balance of payments imbalances played an all-important role in the collapse of the Mexican peso in 1994 and the Korean won in 1997.

(i) Mexico – 1994

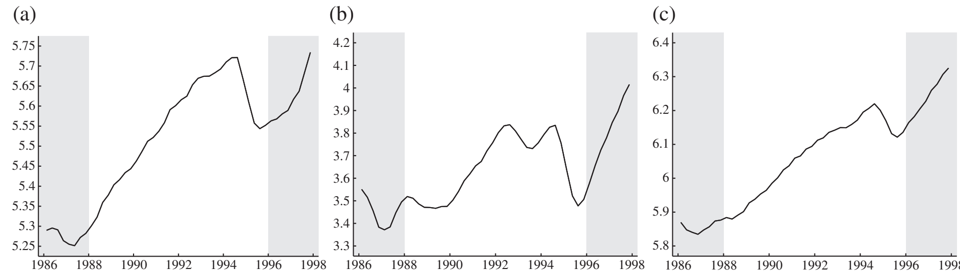
Mexico's 'tequila crisis' of 1994–95 was preceded by a period of good macroeconomic performance, which followed the implementation of a stabilisation programme, privatisation policies and structural reforms in the mid-1980s. Capital inflows, which had been very low or negative since the crash of 1982, resumed in 1988 and intensified following the Brady debt reduction agreement in 1989 (Dabós and Juan-Ramón, 2000). Between 1988 and 1994, consumption rose by 4.9 per cent per year in real terms, investment by 4.7 per cent and GDP by 3.9 per cent. The downside was a burgeoning current account deficit, which hit 6.8 per cent of GDP two years before the crisis. In 1993–94, Mexico's current account deficit was the second-largest in the world (of 157–159 countries). All this can be seen from Figure 7, which also shows that the country, which was operating a crawling peg with respect to the dollar, saw its real exchange rate almost double in the years leading up to the crisis.

Yet in 1994, despite the coming into force of the North American Free Trade Agreement between Canada, Mexico and the United States, problems mounted. A series of political events throughout the year – such as a rebellion in the southern province of Chiapas and the assassination of the ruling party's presidential candidate – raised doubts about Mexico's political and economic stability (Whitt, 1996). To make things worse, US interest rates started to rise in early 1994. Mexico's central bank found it increasingly difficult to keep the peso within the specified bands. Interest rates rose sharply, while official reserves dwindled. Eventually, in December 1994, the peso was allowed to float, initiating a 50 per cent nominal depreciation over the next six months. During the ensuing recession, GDP fell by 6.2 per cent in real terms in 1995. The situation was exacerbated by the large debts of the private and public sectors and the fact that a large part of the government's debts were denominated in dollars. Although the real exchange rate recovered fairly quickly after about a year, Figure 7f shows clearly its rise during the boom from 1988 to 1994 and its subsequent fall during the bust from 1994 to 1995.

(ii) Korea – 1997

Korea experienced a boom-and-bust cycle before and during the Asian crisis of 1997–98. Korea's economic growth had already been strong and stable since the 1960s, when the country was one of the poorest countries in the world, yet in the late 1980s it gained even more pace, thanks to a boom in consumption and investment encouraged by strong capital inflows.

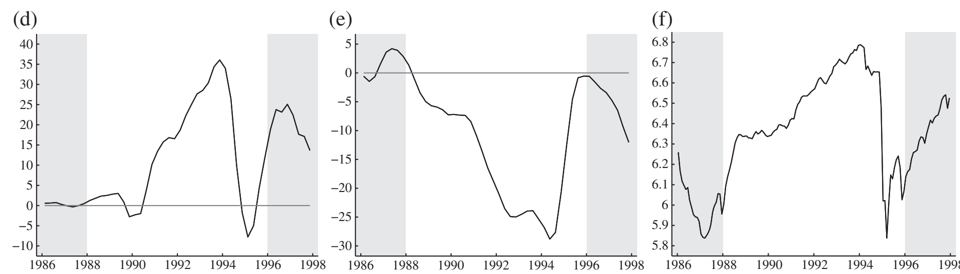
FIGURE 7
Case Study: Mexico – 1994



(a) Private Consumption Volume of Mexico (in logarithms, annual moving average)

(b) Investment Volume of Mexico (in logarithms, annual moving average)

(c) GDP Volume of Mexico (GDP 2005 = 100, in logarithms, annual moving average)



(d) Net Direct and Portfolio Investment Inflows of Mexico (in billions of US dollars, annual moving average)

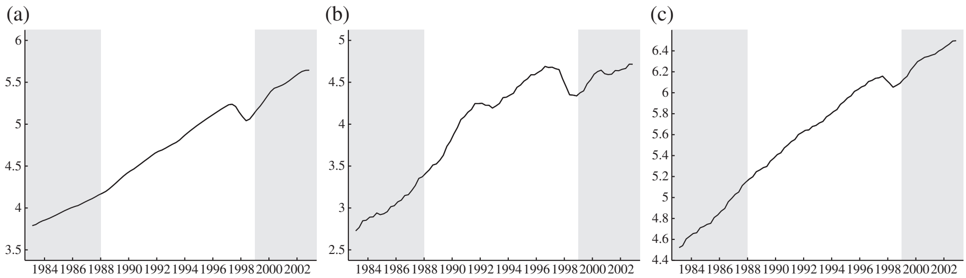
(e) Current Account of Mexico (in billions of US dollars, annual moving average)

(f) Real Effective Exchange Rate of Mexico (CPI-based, in logarithms)

Between 1988 and 1996, private consumption of households grew at an annualised rate of 8.5 per cent in real terms, investment by firms by 10.9 per cent and overall production by 7.8 per cent (see Figure 8). Over the same period, Korea's current account moved from a surplus of 7.7 per cent of GDP to a deficit of 4.3 per cent. From around 1991, however, Korea started to receive capital inflows on an unprecedented scale, allowing the country to finance its external deficit with relative ease and to prop up its foreign exchange reserves at the same time.

The surge in capital inflows, which was experienced similarly by other South-East Asian economies and emerging markets elsewhere at the time, had its origins in internal and external factors (Calvo et al., 1994, 1996; Grenville, 1998). On the one hand, the Korean government had recently introduced a series of measures aimed at liberalising the country's financial account (for details, see Wang, 2002) and, given its high growth rates, the country seemed to offer good investment opportunities. On the other hand, interest rates in the developed world were low in the early 1990s, with US short-term interest rates reaching their lowest level since the early 1960s. Moreover, the importance of institutional investors and mutual funds had increased substantially during the 1980s and early 1990s, as had their willingness to diversify their portfolios towards emerging market economies. Last but not least, banks were in a process of opening up internationally and ready to lend large sums of money to the Asian economies (see table 3 in Grenville, 1998).

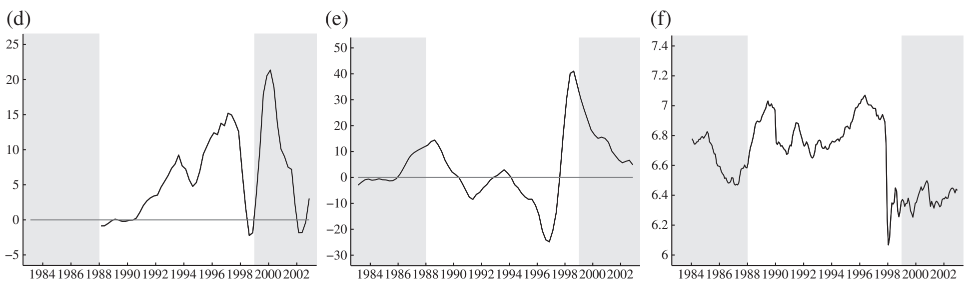
FIGURE 8
Case Study: Korea – 1997



(a) Private Consumption Volume of Korea (in logarithms, annual moving average)

(b) Investment Volume of Korea (in logarithms, annual moving average)

(c) GDP Volume of Korea (GDP 2005 = 100, in logarithms, annual moving average)



(d) Net Direct and Portfolio Investment Inflows of Korea (in billions of US dollars, annual moving average)

(e) Current Account of Korea (in billions of US dollars, annual moving average)

(f) Real Effective Exchange Rate of Korea (ULC-based, in logarithms)

As capital mobility increased, the Korean government found it increasingly difficult to maintain a pegged exchange rate and thus adopted a managed floating exchange rate regime in 1990 (Wang, 2002). Consistent with the theory presented here, the large-scale foreign investments in the first half of the 1990s strengthened the Korean won, which appreciated in real terms by 41.7 per cent between 1986 and 1996. Nevertheless, the large current account deficit meant that eventually the currency had to come down. And in fact, the dollar exchange rate of the won dropped by half in 1997, contributing to a trade-weighted real depreciation of the Korean currency of 39.5 per cent between 1996 and 1998. Finally, it should be noted that the strong improvement of the current account, which our theory predicts as a consequence of turning from boom to bust (see Figure 3c), is born out by the data, too. After all, Korea was running the world's third-largest current account deficit in 1996 (of 160 countries), yet only two years later, in 1998, it was running the world's second-largest surplus (of 162 countries, equivalent to 10.2 per cent of GDP).

c. *Movements of the US Dollar Since 1973*

In the first years after the breakdown of the Bretton Woods system, the US current account and real exchange rate stayed relatively stable. It is since the beginning of the 1980s that both variables show large fluctuations. The current account has been in deficit twice, first during the

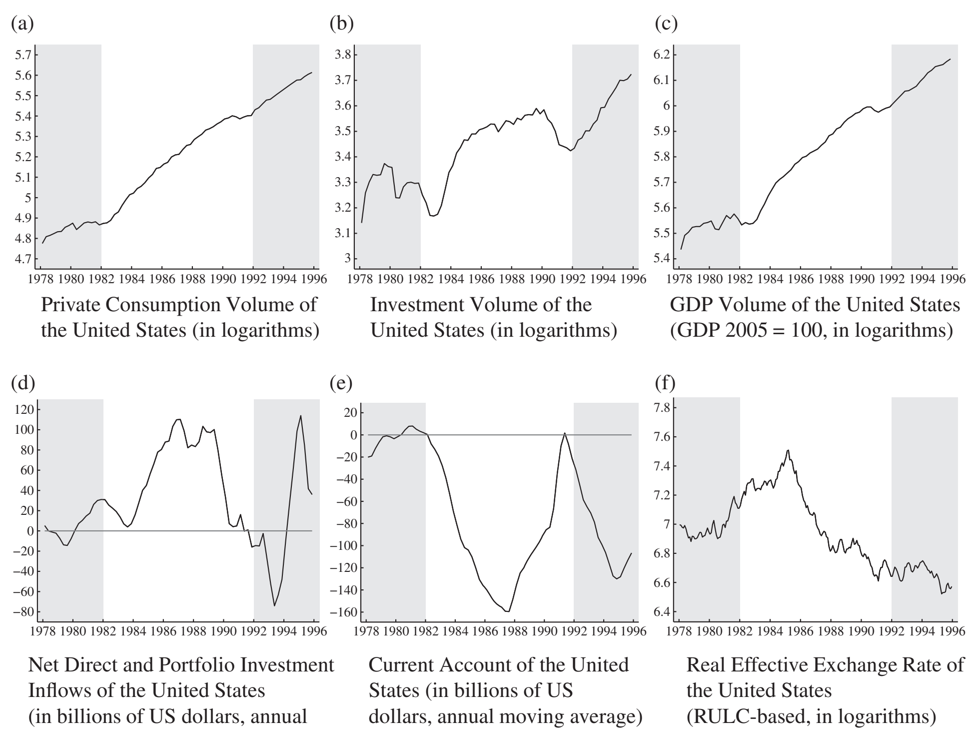
1980s and then during the 1990s and 2000s, and in both instances the dollar experienced a large appreciation, followed by an even larger depreciation. We now look at each episode in turn.

(i) United States – 1980s

In the early 1980s, the United States lived through a severe recession. The recession was primarily the result of a contractionary monetary policy pursued by the Federal Reserve under its chairman Paul Volcker until the summer of 1982. The aim was to control inflation, which had risen to double-digit levels in the wake of the 1970s oil crises. After the official end of the recession in late 1982, the United States experienced a strong economic expansion that lasted for the rest of the decade. Between 1982 and 1989, private consumption in the US rose at an average annual rate of 4.7 per cent in real terms, investment by 3.7 per cent and output by 4.3 per cent (see Figure 9). The stock market also went up, with the real US stock market return from 1980 to 1989 totalling 184 per cent (*The Economist,* 2011a). There is debate over the question whether Ronald Reagan's economic policies – which were based on supply-side economics and a laissez-faire philosophy, yet nevertheless led to large budget deficits due to tax cuts and public spending increases – were responsible for the boom. While many think they are, critics argue that '[the] secret of the long climb after 1982 was the economic plunge that preceded it' (Krugman, 2004).

The model developed in Sections 3 and 4 predicts a large current account deficit during the expansionary phase, followed by a significant improvement during the slump (see

FIGURE 9
Case Study: United States – 1980s



(a) Private Consumption Volume of the United States (in logarithms)

(b) Investment Volume of the United States (in logarithms)

(c) GDP Volume of the United States (GDP 2005 = 100, in logarithms)

(d) Net Direct and Portfolio Investment Inflows of the United States (in billions of US dollars, annual moving average)

(e) Current Account of the United States (in billions of US dollars, annual moving average)

(f) Real Effective Exchange Rate of the United States (RULC-based, in logarithms)

Figure 3c). This is what happened in the United States. From 1983 to 1990, the country run the largest current account deficit in the world (of 139–146 countries); at its worst, in 1987, the deficit amounted to 3.4 per cent of GDP. In 1991, however, the United States had the world's eighth-largest current account surplus in the world (of 147 countries).

What is more, the model offers an intriguingly simple and coherent explanation of the 'dazzling' (Frankel, 1985) movements of the dollar during the 1980s. The US real exchange rate rose by about a third between 1980 and 1985, only to fall by two-fifths from its peak value between 1985 and 1992. In fact, it is instructive to put Figure 9f showing the actual track of the real exchange rate during the 1980s next to Figure 4c showing the predicted movements of the dollar; the two look almost identical.

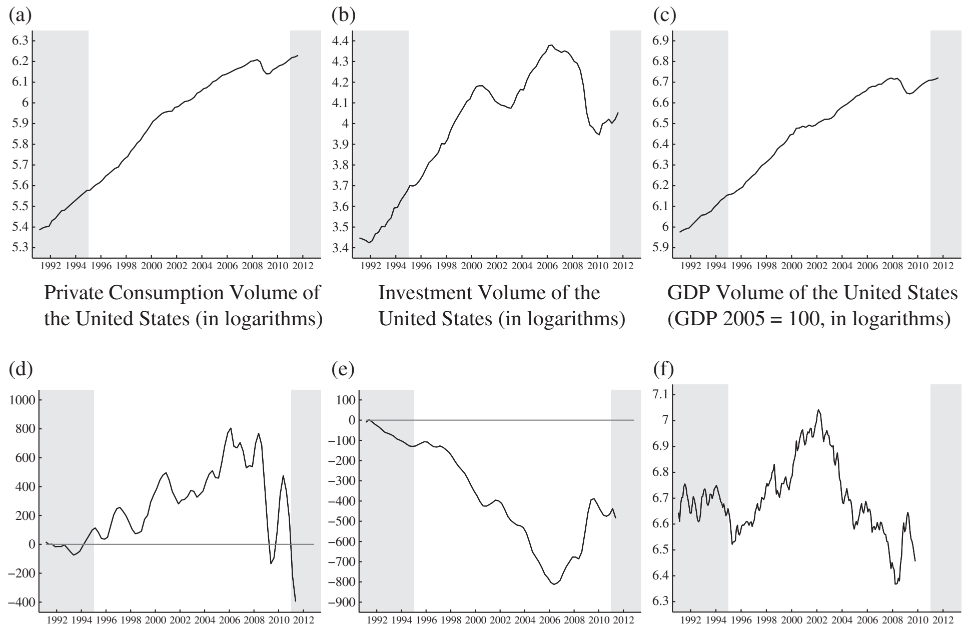
The dollar's behaviour during the 1980s was exceptional in that a steep and monotone appreciation during half a decade was followed by a steep and monotone depreciation during a similarly long period. At the time, these movements were widely interpreted as a speculative bubble, brought to an end by a secret meeting at New York's Plaza Hotel in September 1985 where G5 finance ministers and central bank governors agreed to cooperate to bring about an 'orderly appreciation of the non-dollar currencies' (Eichengreen, 1996, p. 149). However, there are reasons to believe that the Plaza Accord was much less consequential than generally assumed. For one, the dollar had already started to decline six months earlier. And, moreover, 'no change in monetary and fiscal policies had been discussed at the Plaza, much less undertaken' (Eichengreen, 1996, p. 149). This paper, by contrast, suggests that the sudden turnaround of the dollar in 1985 had to do with the economic boom of the time, which implied that at some point the cumulative capital inflows the United States received had to fall short of its cumulative current account deficit, making a trend reversal inevitable. Economic policy may have played a role insofar as the restrictive monetary policy of the early 1980s and the rising budget deficit of the Reagan administration drove US real interest rates above those of other countries (Frankel, 1985; Isard and Stekler, 1985; Sachs, 1985).

(ii) United States – 1990s and 2000s

In the 1990s, the United States' external imbalances re-emerged. Since 1992, the country has been running the largest current account deficit in the world (of 151–173 countries). In 2006, the deficit-to-GDP ratio peaked at 6.0 per cent. Between 1992 and 2006, private consumption rose on average by 3.5 per cent per year in real terms, investment by 4.5 per cent and GDP by 3.2 per cent. Capital inflows were strong, with net direct and portfolio inflows by themselves (i.e. without other lending flows) being roughly sufficient to finance the deficit on the current account. Considering the graphs in Figure 10, it appears that the economic expansion from March 1991 to March 2001, the longest in US history, was followed by another, more moderate expansion in the 2000s. In other words, the early 2000s recession was more a temporary setback than the end of a boom; in particular, consumption and investment remained above their respective trends and capital inflows kept on rising in 2002 after a small correction in 2001. Yet the boom definitely ended in 2007–08 as the global financial crisis unfolded.

There has been considerable debate over the causes of this long period of economic prosperity in the United States. An important question is whether the rapid growth of output and wealth was due to accelerated productivity growth (especially in the IT sector) or whether it was simply the result of a speculative bubble, facilitated by the easy-money policies of the Federal Reserve during Alan Greenspan's tenure. What is certain, however, is that investing in the United States was lucrative during those years. Between 1990 and 1999, for instance, the real stock market

FIGURE 10
Case Study: United States – 1990s and 2000s



(a) Private Consumption Volume of the United States (in logarithms)

(b) Investment Volume of the United States (in logarithms)

(c) GDP Volume of the United States (GDP 2005 = 100, in logarithms)

(d) Net Direct and Portfolio Investment Inflows of the United States (in billions of US dollars, annual moving average)

(e) Current Account of the United States (in billions of US dollars, annual moving average)

(f) Real Effective Exchange Rate of the United States (RULC-based, in logarithms)

return in the United States was 279 per cent, compared to 188 per cent in Britain, 148 per cent in Germany, −42 per cent in Japan and 114 per cent in the world as a whole (*The Economist*, 2011a).

As far as the exchange rate is concerned, we can observe a strong rise of the dollar up until early 2002, followed by a gradual and deep decline thereafter. The US real exchange rate appreciated by roughly a quarter between 1992 and 2002, but fell by an even greater amount until the end of the 2000s. To be sure, the evolution of the actual exchange rate in Figure 10f is again very similar to that of the hypothetical exchange rate shown in Figure 4c.

d. Natural Resource Discoveries

We have already seen in Section 5*a(i)* how natural resource discoveries can lead to a rise and fall of the real exchange rate. The observation is not new, after all it forms the basis of the Dutch disease, which links the exploitation of natural resources to the decline of the manufacturing sector (*The Economist*, 1977). The idea behind the Dutch disease phenomenon is similar to the one presented in this paper. The discovery of natural resources in a country, so the argument goes, will lead to a large inflow of foreign currency due to increased foreign investments and larger exports, up to the point where the appreciation of the real exchange rate hampers the international competitiveness of the manufacturing industry. What this paper shows, however, is that although the real exchange rate rises initially after a resource discovery, it is set to fall with the passage of time as foreign debt rises.

(i) Mongolia – Since 2006

Mongolia is a country with vast reserves of copper, coal, gold, silver, uranium, molybdenum and other minerals, many of which have been discovered just a few years ago. Since around 2006, it is experiencing a boom in the mining sector. This has led to a steep increase in private consumption, real investment and output, which between 2006 and 2012 grew, respectively, by 9.7, 18.4 and 8.9 per cent per year in real terms (see Figure 11). Buiter and Rahbari (2011) of Citigroup recently identified Mongolia as one of 11 global growth generators, or 3Gs, countries with the most promising growth prospects for 2010–50.

Mongolia's biggest development site is Oyu Tolgoi, or 'Turquoise Hill', in the Gobi desert, a copper-and-gold mine attracting large sums of foreign investment. It is estimated that by 2013, some \$10 billion had been spent on it (*The Economist*, 2012). For comparison, Mongolia's current GDP is about \$6 billion. By 2020, when production will be fully under way, Oyu Tolgoi should account for one-third of Mongolia's GDP.

Figure 11 shows how the rise in consumption and investment resulted in a burgeoning current account deficit. At its peak in 2012, the current account deficit was equivalent to 32.6 per cent of GDP. Yet capital inflows were still stronger. Even if we consider only direct investment and portfolio investment and ignore foreign loans and trade credits, net capital inflows were equal to 65.2 per cent of GDP in 2012. In 2013, there were the first signs of a turnaround. In that year, investment fell by 5.0 per cent, the current account deficit fell slightly to 27.7 per cent of GDP and capital inflows slumped to 17.0 per cent of GDP.

Mongolia provides a good example of how capital inflows first exceed the deficit on current account and later on fall short of it. Whereas the gap between capital inflows and the current account deficit averaged 19.2 per cent of GDP between 2006 and 2012, this gap turned into a shortfall equivalent to 10.8 per cent of GDP in 2013. The exchange rate reacted to the shifting external imbalances as predicted here. In 2012M5, the bilateral real exchange rate between Mongolia and the United States was up by 64.3 per cent since 2006M1 and by 78.7 per cent since 2004M1, yet it then fell by 14.8 per cent between 2012M5 and 2014M7 (see Figure 11f).

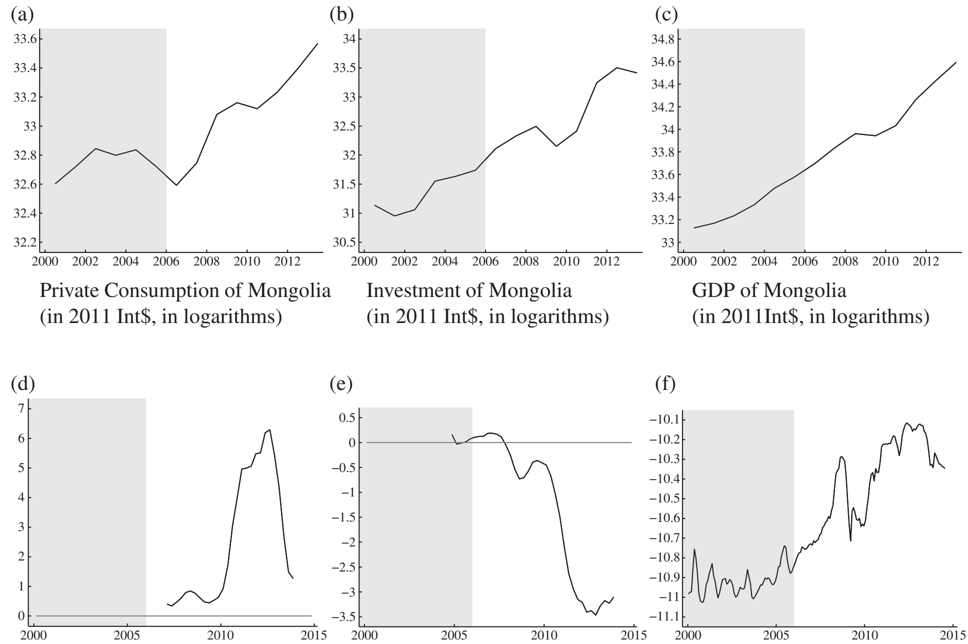
(ii) Brazil – Since 2007

In 2007, Brazil's state-controlled energy corporation Petrobras and other oil companies started to discover vast oil reserves in the so-called presalt ('below the salt') layer off the coast of Brazil. Before the finds, Brazil's total proven and probable oil reserves were 20 billion barrels. According to conservative estimates, however, total recoverable presalt oil amounts to at least 50 billion barrels. Hence, it is likely that the country, which currently ranks 11th among the world's oil producers, is in the top five by 2020. The development of the presalt oil fields is forecast to cost a trillion dollars over the first 10 years, around half Brazil's 2010 GDP. Petrobras itself is set to spend \$45 billion a year for the next five years, the largest investment programme of any oil firm in the world.[4]

Even before the oil bonanza, Brazil's economy was vibrant and fast-growing. Yet as the time series in Figure 12 show, domestic investment and foreign lending have soared right after the oil finds. Between 2006 and 2010, inflation-adjusted investment grew by 9.1 per cent

[4] Data in this paragraph are taken from *The Economist* (2011b, 2011c).

FIGURE 11
Case Study: Mongolia – Since 2006



(a) Private Consumption of Mongolia (in 2011 Int$, in logarithms)
(b) Investment of Mongolia (in 2011 Int$, in logarithms)
(c) GDP of Mongolia (in 2011Int$, in logarithms)
(d) Net Direct and Portfolio Investment Inflows of Mongolia (in billions of US dollars, annual moving average)
(e) Current Account of Mongolia (in billions of US dollars, annual moving average)
(f) Bilateral Real Exchange Rate Between Mongolia and the United States (CPI-based, in logarithms)

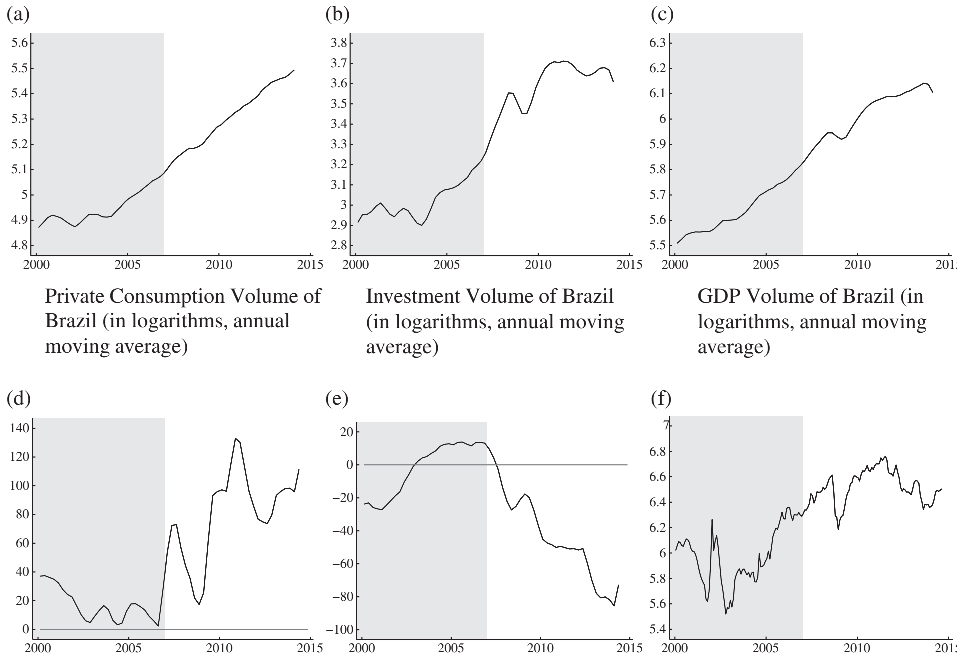
per year, consumption by 4.3 per cent and GDP by 4.6 per cent. Afterwards, the boom seems to have lost pace. Between 2010 and 2013, investment stayed flat, consumption grew by 3.8 per cent annually and GDP only by 2.1 per cent.

Brazil’s current account, which recorded a surplus between 2003 and 2007, entered into deficit in 2008. The IMF predicts the Brazilian current account deficit in dollar terms to be the world’s third highest from 2013 to 2017 and the world’s second highest in 2018 and 2019 (of 184–185 countries). Between 2007 and 2010, capital inflows were about three times as high as the deficit on current account, yet until 2013 this ratio fell steadily to a value near one. As a consequence, Brazil’s official reserves increased about sevenfold between the 2005 and 2012 (and more than tenfold between 2001 and 2012) and fell only in 2013 for the first time in more than a decade. The real exchange rate for its part reached a peak in 2011M7, when it was up by 40.9 per cent from its 2006M1 level and by 136.5 per cent from its 2002M10 level. Coinciding with the economic slowdown, the real exchange rate depreciated by 25.3 per cent between 2011M7 and 2013M8.

e. Conclusions from Case Studies

This section has come up with eight different historical episodes of economic booms and crashes. It has documented that during such episodes countries experience strong capital

FIGURE 12
Case Study: Brazil – Since 2007



(a) Private Consumption Volume of Brazil (in logarithms, annual moving average)

(b) Investment Volume of Brazil (in logarithms, annual moving average)

(c) GDP Volume of Brazil (in logarithms, annual moving average)

(d) Net Direct and Portfolio Investment Inflows of Brazil (in billions of US dollars, annual moving average)

(e) Current Account of Brazil (in billions of US dollars, annual moving average)

(f) Real Effective Exchange Rate of Brazil (CPI-based, in logarithms)

inflows followed by capital outflows, a burgeoning current account deficit and an initial rise and subsequent collapse of the real exchange rate. The empirical evidence presented here contradicts current macroeconomic thinking in two very important respects. First, the economic booms considered here led to the world's largest (or almost largest) current account deficits due to the accompanying surges in real investment. This finding stands in stark contrast to the intertemporal approach to the current account that predicts a rise in the current account balance in periods of economic prosperity (see Section 2). And second, the theoretical prediction that the real exchange rate of a country has to appreciate substantially while its current account deficit is rising (due to the concomitant rise in capital inflows) and to depreciate only much later when the deficit has started to fall again is borne out by the facts, contradicting the widespread belief among macroeconomists that current account deficits translate directly into exchange rate depreciations.

6. CONCLUSIONS

The objective of this article has been to explain the macroeconomic dynamics of boom-and-bust cycles and in particular the movements of the real exchange rate during such episodes. A model of optimal consumption and portfolio choice has been used to demonstrate how national income and spending as well as the balance of payments respond to an economic boom provoked by a temporary rise in the return on domestic capital. The model predicts a moderate rise in consumption and a strong surge in investment during the initial expansion, accompanied by strong capital inflows and a steady deterioration of the current account. When the return on domestic capital reverts to its original level, however, domestic investment slows down and foreign investors pull out their stakes, too. Although the current account enters into surplus and the net foreign asset position improves, the latter variable ends up at a lower level than at the beginning.

The explanation of the real exchange rate behaviour during boom-and-bust cycles is thus straightforward. During the initial economic expansion, capital inflows exceed the deficit on the current account, pushing the exchange rate up. During the subsequent downturn, however, foreign capital is drawn back, and together with the fall of the net foreign asset position this implies a sharp real depreciation. Such dynamics can be observed not only in countries with fixed exchange rates, which often experience outright currency crises during the economic downturn, but also in countries that let their exchange rates float.

Although simple, realistic and intuitive, the idea that real exchange rates are driven by currency movements originating from balance of payments fluctuations is a no-no in the theoretical literature on exchange rates, which – despite the empirical criticism put forward by Engel (1999) – still relies on the relative price of non-traded goods as the main determinant of real exchange rate changes.

SUPPORTING INFORMATION

Additional Supporting Information may be found in the online version of this article:

Appendix S1. Solution details.

Appendix S2. Real investment dynamics.

Appendix S3. Approximation of currency market pressure.

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