

# An Asset-Pricing View of External Adjustment\*

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## Abstract

Recent literature has argued that conventional measures of external sustainability—the trade balance and current account—are misleading because they omit capital gains on net foreign asset positions. We adjust the definition of the current account to include the capital gains and discuss how this may affect our thinking about external adjustment and sustainability. We do so in the context of a two-country macro-finance model of Pavlova and Rigobon (2008) that allows to explore the interconnections between equilibrium portfolios and external accounts' dynamics. We calibrate the model and find that it generates several testable implications, some of which have already been validated empirically. First, we establish dynamic properties of the capital-gains adjusted current account and show that they are fundamentally different from those of the conventional current account. Second, we find that capital gains have a stabilizing effect on the trade balance and the current account. Third, we demonstrate that in response to a shock, the conventional and the capital-gains adjusted current accounts may move in opposite directions. Finally, we explore the implications of our analysis for sustainability of the US economy and conclude that the current state of external imbalances is too large to be justified as a valid equilibrium (sustainable) path.

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# 1. Introduction

In the last 15 years large, persistent, and growing trade balance and current account deficits in the US have captured the attention of policymakers, practitioners, and academics. The central question is whether or not the current path of consumption, investment and fiscal expenditure in the US is sustainable. Although the research of this matter has been intense, opinions differ dramatically: some are expecting a sizeable recession or a large adjustment of the exchange rate, while others are arguing that additional sources of income not accounted for in the conventional external accounts, can finance and have been financing US consumption.<sup>1</sup> One conclusion, however, is undisputed: the growth of gross asset holdings that has taken place in the last couple of decades<sup>2</sup> should change significantly our understanding of how measures of sustainability have to be defined, and how the adjustment process needs to take place.

In this paper we respond to the critique of the conventional definition of the current account and define a *capital-gains adjusted current account*—a measure that explicitly accounts for capital gains on net foreign asset positions of a country. We investigate the properties of this measure in the context of a two-country macro-finance model of Pavlova and Rigobon (2008) and compare it to other measures of external accounts. The model is solved in closed-form, which allows us to examine several analytical properties that link the external accounts and financial asset holdings. Moreover, because asset prices and portfolio holdings are all endogenous, it is possible to study the interconnections between external sustainability and portfolio decisions.

To evaluate the stochastic properties of the external measures of sustainability, we calibrate our model to reflect the current state of the US economy. In particular, through our parameter selection, we attempt to match the magnitudes of the trade balance and current account deficits in the US, home bias in asset holdings, net foreign debt of the US, and average cross-country correlations of consumption expenditure. We choose the parameters assuming that the current situation is one of equilibrium (as in our economy). In this environment, we first analyze separately the two elements that are missing from the conventional current account: the *expected* and the *unexpected* capital gains. We show that the former have a stabilizing property, offsetting the fluctuations in

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<sup>1</sup>The former view is advocated by e.g., Edwards (2005), Frankel (2006), Obstfeld (2004), Obstfeld and Rogoff (2007), Roubini and Setser (2004). Arguments supporting the latter view have been put forward by Gourinchas and Rey (2007b). See also Hausmann and Sturzenegger (2006) and Tille (2003) for related points.

<sup>2</sup>As documented in e.g., Gourinchas and Rey (2007a), Lane and Milesi-Ferretti (2001), Lane and Milesi-Ferretti (2007), Tille (2003), and Tille (2008).

the trade balance and the traditional current account. Gourinchas and Rey (2007b) document a similar effect occurring in their dataset. It is the *unexpected* part of the capital gains, however, that is key to the dramatic differences in the dynamic properties of the traditional and the capital-gains adjusted current account in our model. The traditional current account follows a persistent process, while the capital-gains adjusted current account is highly volatile and serially uncorrelated. This is consistent with the evidence presented in Kollmann (2006) and Lane and Shambaugh (2007). In other words, the capital-gains adjusted current account behaves much like asset returns, whose short-term dynamics are also dominated by unexpected capital gains.

In order to understand the effects of capital gains (valuation effects) on the external adjustment mechanism, we study impulse responses of our economy. The standard model of external adjustment is the one based on the canonical intertemporal approach to the current account. In that model, when a shock occurs, we first study its implications for output and consumption, and given those implications, we can trace their impact on the trade balance, the current account, the savings decisions, and ultimately on international positions. Our view in this paper is different. It starts by recognizing that agents already have wealth invested internationally. Therefore, the starting point—even before the shock shows up—is to determine the distribution of wealth and how it is invested (i.e, the composition of international portfolios). When a shock takes place, the first step is to track its impact on production and asset prices. Once these impacts are understood, we can track how the net foreign asset positions are going to be affected by the shock. That in turn will allow us to compute a new wealth distribution in the world economy. Agents' wealth will determine their consumption patterns, and given output, we can track the implications for the external accounts. Guided by this view of external adjustment, we do not find it surprising that our impulse responses show that following a shock, the conventional current account and the capital-gains adjusted current account may move in opposite directions.

The model we are using is one in which the economy is in a stochastic steady state; all shocks are permanent, and all transitory dynamics have been shut down.<sup>3</sup> Such a steady state has to possess two properties that link the external accounts with the financial asset holdings: there is a one-to-one relationship (i) between the conventional current account and the stock of international debt, and (ii) between the trade balance and the stock of net foreign assets. If any of these two properties is violated, then one country's intertemporal budget constraint is not satisfied—and so

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<sup>3</sup>In the old system dynamics literature language, we are dealing with a pure extrinsic dynamics model, and the intrinsic dynamics have been closed.

we use them as our definitions of sustainability. We confront these properties with the recent US data and reject them. We conclude that either the US economy’s consumption is unsustainable, or the economy has been in transitional dynamics for the past two decades. The second exercise we perform is to analyze the terms of trade adjustment and portfolio recomposition that needs to take place to achieve a reduction of current account deficit in the stochastic steady state by three percent of GDP. We find that such a reduction has to be accompanied by a 20 percent adjustment of the terms of trade. This is the case irrespectively of which shock triggers the adjustment process. This result is interesting because in the model, as in the data, capital gains play a significant role—and still the final message is very much in line with the “traditional” open economy calibrations offered by Obstfeld and Rogoff (2007) and Roubini and Setser (2004).

Our work is related to the growing theoretical macro-finance literature that incorporates portfolio choice and asset pricing into models of open economy macroeconomics. Similarly to our approach here, Devereux and Sutherland (2008), Evans and Hnatkowska (2007), Ghironi, Lee, and Rebucci (2006), Kollmann (2006), and Tille and van Wincoop (2007) all base their analyses of external accounts on stochastic portfolio models with incomplete markets.<sup>4</sup> These papers employ various approximation techniques to study the behavior of their models around their steady states. By contrast, we base our analysis on an exact closed-form characterization of our equilibrium. Moreover, the steady state in our economy is stochastic.

The rest of the paper is organized as follows. Section 2 briefly describes the model and defines the capital-gains adjusted current account. Section 3 studies dynamic properties of the capital-gains adjusted current account, contrasting them to those of the conventional current account, and explores the implications of the model for external sustainability. Section 4 discusses external adjustment and estimates the economic impact of a current account correction within our model. Section 6 offers some concluding remarks and directions for future research.

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<sup>4</sup>Also related, but, unlike ours, cast in the context of production economies, are elegant analyses of Devereux and Saito (2006), and Kraay and Ventura (2000). Coeurdacier, Kollmann, and Martin (2008) primarily focus on equity home bias, but do also report implications for NFA dynamics similar to ours. Other important contributions to this literature, but with a different focus than ours, include Engel and Matsumoto (2006) and Mendoza, Quadrini, and Rios-Rull (2007).

## 2. The Model

### 2.1. The Economic Setting

For the purposes of our investigation, we adopt the model from Pavlova and Rigobon (2008). We briefly review it here for completeness.

We work with a pure-exchange finite-horizon continuous-time economy populated by two countries: Home and Foreign. The Home country represents a large industrialized country, while Foreign stands for the rest of the world. Each country is endowed with a Lucas tree producing a strictly positive amount of a country-specific perishable good:

$$dY(t) = \mu_Y(t) Y(t) dt + \sigma_Y(t) Y(t) dw(t) \quad (\text{Home}), \quad (1)$$

$$dY^*(t) = \mu_{Y^*}(t) Y^*(t) dt + \sigma_{Y^*}(t) Y^*(t) dw^*(t) \quad (\text{Foreign}), \quad (2)$$

where  $w$  and  $w^*$  are the (independent) Brownian motions representing Home and Foreign output shocks, respectively, and  $\mu_Y, \mu_{Y^*}, \sigma_Y > 0$ , and  $\sigma_{Y^*} > 0$  are the mean growth rates and volatilities of output. The prices of the Home and Foreign goods are denoted by  $p$  and  $p^*$ , respectively. We fix the world numeraire basket to contain  $a \in (0, 1)$  units of the Home good and  $(1-a)$  units of the Foreign good, and normalize the price of this basket to be equal to unity. The terms of trade,  $q$ , are defined as the price of the Home good relative to that of the Foreign good:  $q \equiv p/p^*$ . Our modeling of financial markets is standard. The Home and Foreign stocks  $S$  and  $S^*$ , are claims to the Home and Foreign trees, respectively. They are available for trade by all investors and are in fixed supply of one share each. There is also the “world” bond  $B$  in zero net supply, which is a money market account locally riskless in units of the numeraire.

The initial shareholdings of a representative consumer-investor of each country consist of no shares of the bond and a total supply of the stock market of his country. Thus, the initial wealth of the Home resident is  $W_H(0) = S(0)$  and that of the Foreign resident is  $W_F(0) = S^*(0)$ . Each consumer  $i, i \in \{H, F\}$ , chooses nonnegative consumption of each good  $(C_i(t), C_i^*(t))$  and a portfolio of the available securities  $s_i(t) \equiv (s_i^S(t), s_i^{S^*}(t))$ , where  $s_i^j$  the number of shares of asset  $j$  held by consumer  $i$ . The dynamic budget constraint of each consumer has the standard form

$$\begin{aligned} dW_i(t) = & s_i^B(t) dB(t) + s_i^S(t) (dS(t) + p(t)Y(t)dt) + s_i^{S^*}(t) (dS^*(t) + p^*(t)Y^*(t)dt) \\ & - p(t)(C_i(t) - e_i(t)) dt - p^*(t)(C_i^*(t) - e_i^*(t)) dt, \end{aligned} \quad (3)$$

where  $W_i(T) \geq 0$ ,  $i \in \{H, F\}$ . Preferences of consumer  $i$ , are represented by a time-additive utility function defined over consumption of both goods:

$$E \left[ \int_0^T e^{-\rho t} u_i(C_i(t), C_i^*(t)) dt \right], \quad \rho > 0, \quad i \in \{H, F\}, \quad (4)$$

where

$$\begin{aligned} u_H(C_H(t), C_H^*(t)) &= \alpha_H(t) \log C_H(t) + \beta_H(t) \log C_H^*(t), \\ u_F(C_F(t), C_F^*(t)) &= \beta_F \log C_F(t) + \alpha_F \log C_F^*(t). \end{aligned}$$

Stochastic processes  $\alpha_H$  and  $\beta_H$  in the utility of the Home country represent preference shifts toward the Home and Foreign good, respectively. For generality, the innovations to  $\alpha_H$  and  $\beta_H$  are given by a combination of supply shocks  $w$  and  $w^*$  as well as two independent standard Brownian motions  $w^\alpha$  and  $w^\beta$ . Without the last two Brownian motions, financial markets are complete. But if the preference shifters display nontrivial dependence on  $w^\alpha$  and  $w^\beta$ , the existing investment opportunity cannot span the uncertainty in the model, and hence the possibilities of hedging against the preference shifts is impaired and risk sharing in the world economy becomes imperfect. The main focus of this paper is on the Home country, which is why we assume away any preference shifts at Foreign and concentrate on the effects of domestic preference shifts at Home.

The preference shifts or *demand shocks* are important ingredients of our model, for two reasons. First, in the absence of the demand shocks, free trade in goods makes stock prices perfectly correlated and financial markets irrelevant (Helpman and Razin (1978), Cole and Obstfeld (1991), Zapatero (1995)). Second, empirical evidence indicates that demand shocks are important for reproducing the real-world dynamics; supply shocks alone are typically not sufficient. For example, Stockman and Tesar (1995) calibrate preference shocks to be roughly 85% of the size of supply shocks, while of Pavlova and Rigobon (2007) estimate a similar model and conclude that they have approximately the same volatility as supply shocks.

## 2.2. Characterization of Equilibrium

An equilibrium in this economy is defined in a standard way: it is a collection of goods and asset prices  $(p, p^*, S, S^*, B)$  and consumption-investment policies  $(C_i(t), C_i^*(t), x_i^S(t), x_i^{S^*}(t))$ ,  $i \in \{H, F\}$  such that (i) each consumer-investor maximizes his utility (4) subject to the budget constraint (3) and (ii) goods, stock, and bond markets clear.

In this incomplete markets economy, the usual construction of a representative agent's (planner's) utility as a weighted sum, with constant weights, of individual utility functions is not possible. However, as we explain in Pavlova and Rigobon (2008), one can still solve for the equilibrium allocations in this economy using an analogue of the central planning approach in which the weights in the fictitious world representative agent utility are stochastic. This fictitious representative agent maximizes his utility subject to the resource constraints:

$$\begin{aligned} \max_{\{C_H, C_H^*, C_F, C_F^*\}} \quad & E \left[ \int_0^T e^{-\rho t} (u_H(C_H(t), C_H^*(t)) + \lambda(t) u_F(C_F(t), C_F^*(t))) dt \right] \\ \text{s. t.} \quad & C_H(t) + C_F(t) = Y(t), \\ & C_H^*(t) + C_F^*(t) = Y^*(t), \end{aligned}$$

where we have normalized the weight on the Home consumer to be equal to one and assigned the weight  $\lambda$  to the Foreign consumer. The possibly stochastic weighting process  $\lambda$  will be linked to the wealth distribution in the economy and is to be determined as part of the equilibrium.

The consumption allocations and the corresponding good and asset prices supporting these allocations are derived in Pavlova and Rigobon (2008). We do not reproduce the full equilibrium characterization here and just report the expressions that are relevant for our discussion in this paper.

The equilibrium terms of trade and stock prices are given by:

$$q(t) = \frac{\alpha_H(t) + \lambda(t)\beta_F}{\beta_H(t) + \lambda(t)\alpha_F} \frac{Y^*(t)}{Y(t)} \quad (5)$$

and

$$S(t) = \frac{1 - e^{-\rho(T-t)}}{\rho} \frac{q(t)}{aq(t) + 1 - a} Y(t), \quad (6)$$

$$S^*(t) = \frac{1 - e^{-\rho(T-t)}}{\rho} \frac{1}{aq(t) + 1 - a} Y^*(t) \quad (7)$$

The wealth of Home and Foreign is, respectively,

$$W_H(t) = \frac{\alpha_H(t) + \beta_H(t)}{\alpha_H(t) + \lambda(t)\beta_F} S(t), \quad W_F(t) = \frac{\lambda(t)(\alpha_F + \beta_F)}{\beta_H(t) + \lambda(t)\alpha_F} S^*(t). \quad (8)$$

The above expressions yield a simple interpretation of the stochastic weight  $\lambda$ . One can see that

$$\lambda(t) = \frac{W_F(t)(\alpha_H(t) + \beta_H(t))}{W_H(t)(\alpha_F + \beta_F)}. \quad (9)$$

That is, incomplete markets enrich the dynamics of the economy with an additional state variable  $\lambda$ , which is related to the wealth distribution, but not given exactly by the wealth distribution unless  $\alpha_H(t) + \beta_H(t)$  is constant. The dynamics of  $\lambda$  are derived as part of the equilibrium characterization.

### 2.3. The Current Account

Before we turn to investigating equilibrium behavior of our economy and making a link between portfolio rebalancing and external adjustment mechanisms, we highlight the model's implications for the current account and its dynamics. We first start with the textbook definition of the current account and then consider the definition based on changes in a country's net foreign asset position.

In principle, the two definitions should yield similar measures. However, once expected and realized capital gains are accounted for, the differences between the two measures, and especially their dynamic properties, can be striking, as we demonstrate below.

#### 2.3.1. The Conventional Current Account

Let us concentrate on the Home country. The conventional measure of the current account, employed in international finance textbooks and used in the national accounts, is

$$CA = \text{Trade Balance} + \text{Net Dividend Payments} + \text{Net Interest Payments.}$$

In our economy, the trade balance is given by

$$TB_H(t) = p(t)(Y(t) - C_H(t)) - p^*(t)C_H^*(t),$$

and the current account by

$$CA_H(t) = \left[ TB_H(t) + s_H^{S^*}(t)p^*(t)Y^*(t) - s_F^S(t)p(t)Y(t) + s_H^B(t)B(t)r(t) \right] dt. \quad (10)$$

The second and the third terms in (10) are dividend receipts from foreign assets minus dividend payments to Foreign, and the last term is net interest payments. Recall that each of the above quantities in our model is defined as a rate (e.g., the export rate, the dividend rate, etc.) and hence need to be scaled by a time increment. This is the reason behind the term “dt” appearing in (10).

### 2.3.2. The Capital-Gains Adjusted Current Account

Defining the current account as the change in the net foreign asset (NFA) position of a country, we have

$$CGCA_H(t) = d \left[ s_H^{S^*}(t) S^*(t) - s_F^S(t) S(t) + s_H^B(t) B(t) \right], \quad (11)$$

where the first two terms in the square brackets are Home's investment in the Foreign stock minus Foreign' investment in the Home stock, and the last term is Home's balance on the bond account. The label "CGCA" stands for "capital-gains adjusted current account," the rationale for which will become clear shortly. Note that, by market clearing,  $s_F^S(t) = 1 - s_H^S(t)$  and that, by definition, Home's financial wealth equals its portfolio value,  $W_H(t) = s_H^S(t) S(t) + s_H^{S^*}(t) S^*(t) + s_H^B(t) B(t)$ . Hence, we can rewrite (11) as

$$CGCA_H(t) = dW_H(t) - dS(t) \quad (12)$$

To simplify the exposition below, let us introduce some new notation. Let us summarize all the Brownian motions driving the economy in the vector  $\vec{w} \equiv (w, w^*, w^\alpha, w^\beta)$  and represent the dynamics of the bond and the stocks as follows

$$dB(t) = B(t)r(t)dt, \quad (13)$$

$$dS(t) + p(t)Y(t)dt = S(t)[\mu_S(t)dt + \sigma_S(t)d\vec{w}(t)], \quad (14)$$

$$dS^*(t) + p^*(t)Y^*(t)dt = S^*(t)[\mu_{S^*}(t)dt + \sigma_{S^*}(t)d\vec{w}(t)], \quad (15)$$

where the interest rate  $r$ , the stocks expected returns  $\mu_S$  and  $\mu_{S^*}$  and their volatilities  $\sigma_S$  and  $\sigma_{S^*}$  are determined in equilibrium (e.g., from (6)–(7)). Armed with this notation, we can rewrite the budget constraint of Home (3) as follows:

$$\begin{aligned} dW_H(t) &= \left[ s_H^B(t) B(t) r(t) + s_H^S(t) S(t) \mu_S(t) + s_H^{S^*}(t) S^*(t) \mu_{S^*}(t) \right] dt \\ &+ \left[ s_H^S(t) S(t) \sigma_S(t) + s_H^{S^*}(t) S^*(t) \sigma_{S^*}(t) \right] d\vec{w}(t) + \left[ TB_H(t) - p(t)Y(t) \right] dt. \end{aligned}$$

Substituting it into (12) and then using (14) and the stock market clearing, we arrive at the following expression:

$$\begin{aligned} CGCA_H(t) &= \left[ TB_H(t) + s_H^{S^*}(t) S^*(t) \mu_{S^*}(t) - s_F^S(t) S(t) \mu_S(t) + s_H^B(t) B(t) r(t) \right] dt \\ &+ \left[ s_H^{S^*}(t) S^*(t) \sigma_{S^*}(t) - s_F^S(t) S(t) \sigma_S(t) \right] d\vec{w}(t). \end{aligned} \quad (16)$$

The first difference between the conventional and the capital-gains adjusted current account revealed by equation (16) is the presence of the diffusion ( $d\vec{w}$ ) component in (16) and its absence in (10). This component is the *unexpected* part of the realized capital gains on Home's net foreign assets. A shock  $d\vec{w}$  typically has a differential impact on the stock portfolios of Home and Foreign. The capital-gains adjusted current account of Home improves if its return on foreign asset holdings exceeds the return the Foreign country makes on its holdings of Home's assets. Equation (16) assumes, however, that all capital gains are marked to market. This aspect makes *CGCA* different from book-value based measures of current account such as the one in (10), commonly employed in practice.

It is important to note that the two measures of the current account have fundamentally different dynamic properties. The conventional current account is a persistent process, in line with the results in the existing literature. In contrast, the capital-gains adjusted current account features additionally an increment of a random walk ( $d\vec{w}$ ) process, and therefore it bears a closer resemblance to the dynamics of a stock market rather than a persistent macroeconomic series such as dividends or the conventional current account. It is amply documented by the proponents of the efficient markets hypothesis in finance that stocks' capital gains are large, volatile, and serially uncorrelated. And so should be the fluctuations in a NFA position of a country, captured here by *CGCA*.

The second difference between the two measures of the current account stems from the differences in the *expected* ( $dt$ ) component. Comparing equations (10) and (16), we find two elements that are common to the conventional and the capital-gains adjusted current account measures: the trade balance and net interest payments on the (locally) riskless bond. The remaining terms, due to holdings of the risky stocks, are different. To better highlight the differences, note from (14)–(15) that

$$S(t) \mu_S(t) dt = E_t[dS(t)] + p(t)Y(t)dt \quad \text{and} \quad S^*(t) \mu_{S^*}(t) dt = E_t[dS^*(t)] + p^*(t)Y^*(t)dt,$$

where  $E_t[\cdot]$  is a shortcut for  $E[\cdot|\mathcal{F}_t]$ . The first term on the right-hand side of these expressions is the expected capital gains and the second one is the dividends per share. Denoting the expected capital gains on holding a share of stocks  $S$  and  $S^*$  by  $ECG_S$  and  $ECG_{S^*}$ , respectively, we can express the difference between the expected capital-gains adjusted current account and the conventional one as

$$E_t[CGCA_H(t)] - CA_H(t) = -s_F^S(t) ECG_S(t) + s_H^{S^*}(t) ECG_{S^*}(t). \quad (17)$$

This simple formula describes what Hausmann and Sturzenegger (2006) label “the missing dark

matter” in the measurement the current account. This “dark matter” accumulates due to the fact that the countries hold risky assets which are issued at home as well as abroad, and these risky assets have different expected capital gains. The expected capital gain on an asset, of course, reflects its risk and return tradeoff. If domestic assets are safer and have lower expected returns than foreign, a country earns a higher expected return on its assets than it owes on its liabilities. In this scenario, the difference between the capital-gains adjusted and the conventional current account is expected to be positive. We expect such pattern to be occurring in the US whose gains on domestic assets have been lower than gains on assets abroad (Gourinchas and Rey (2007b)).

The sum of net expected capital gains and net unexpected capital gains is what has been typically labeled as “valuation effects” in the current account adjustment literature. Empirically, it is very hard to disentangle the two individual components. However, as we will point out below, their stochastic properties are very distinct.

One may wonder why the terms of trade were mentioned nowhere in this discussion. After all, the original arguments highlighting valuation effects stress primarily the fact that the values of a country’s asset and liabilities change in response to fluctuations in the exchange rate (or the terms of trade), and these fluctuations need to be taken into account when evaluating the NFA position of a country. This argument definitely applies in our model—in fact, as will become clear below, the terms of trade play a key role in our intuitions. The terms of trade are embedded in the prices of stocks and their dynamics.

It is worth mentioning that in our derivations in this section we did not need to specialize consumer preferences to be log-linear. The expressions for both the current account in equation (10) and the capital-gains adjusted current account in equation (16) are valid for a general utility function. The log-linear form of the preferences is needed only for obtaining a closed-form characterization of the inputs into the formulas, namely the stock prices and the countries’ portfolios.

### **3. Dynamic Implications**

In this section, we calibrate our model to match several key aspects of the data and investigate its dynamic properties. The Home country in our calibration represents the US economy and the Foreign country the rest of the world. First, we contrast different measures of external accounts and examine the extent of discrepancies across the measures. Then we look at our model’s implications

for the sustainability of the US economy and conclude that the current state of external imbalances is too large to be justified as a valid equilibrium (sustainable) path.

### 3.1. Calibration

In our choice of parameter values we have tried to match several important statistics of the US economy. Where directly observable, we set the parameters equal to their average values in the data. Where not observable (e.g., the preference shifters), we calibrate the parameters so that the model implies that the Home country (i) runs a trade deficit and a (conventional) current account deficit of the sizes roughly matching those of the US economy, and (ii) so that the countries have positive cross-holdings and their portfolios exhibit a home bias of a reasonable magnitude. Table 1 lists the ensuing parameter values.

Parameter	Value	Parameter	Value	Parameter	Value
$Y(0)$	1	$\alpha_H(0)$	0.7	$\sigma_Y$	0.01
$Y^*(0)$	2	$\alpha_F$	0.7	$\sigma_{Y^*}$	0.01
$\mu_Y$	0.02	$\beta_H(0)$	0.3	$\sigma_{\alpha_H}$	$(z_1, 0, z_2, 0)$
$\mu_{Y^*}$	0.02	$\beta_F$	0.3	$\sigma_{\beta_H}$	$(0, z_1, 0, z_2), z_1 \in [0, 0.006],$
$\rho$	0.05	$a$	0.5		$z_2 \in [0.002, 0.014]$

Table 1: Parameter choices.

According to this parametrization, the countries' output processes are geometric Brownian motions (since both the drift and diffusion are constant). This is a specification most commonly assumed in the literature. We chose the mean growth rate of 2% and the volatility of 1% for realism, but the results do not change much as we vary them. The literature provides little guidance for the form of preference shifts, and so we simply assume that the parameters  $\sigma_{\alpha_H}$  and  $\sigma_{\beta_H}$  are constant. This creates a potential problem that  $\alpha_H(t)$  and  $\beta_H(t)$  may become negative, but we guard against this possibility in our simulations. The results are qualitatively the same if  $\alpha_H(t)$  and  $\beta_H(t)$  follow geometric Brownian motions with no drift. Furthermore, motivated by the estimated dynamics of demand shocks in Pavlova and Rigobon (2007), we posit that  $\alpha_H$  loads positively on the Home output shock  $w$  and  $\beta_H$  loads positively on the Foreign output shock  $w^*$ . The presence of demand shocks allows us to attain realistic values for the consumption (expenditure) correlations across countries and for a home bias in portfolios. Otherwise, as has been well-documented in the IRBC literature, the cross-country correlation of consumption is too high, and definitely higher than the output correlation. Moreover, with no demand shocks, the countries' portfolios in our model are indeterminate (for the same reason as in Cole and Obstfeld (1991)), and hence no meaningful

matching of international portfolio compositions is possible. As a sensitivity exercise, we vary the relative sizes of the demand and supply shocks (from 0.05 to 1.85) by varying the volatility of the demand shocks and keeping that of the supply shocks fixed, as well as vary the instantaneous correlation between the demand and supply shocks (from 0 to 45 percent).<sup>5</sup> The ensuing ranges of  $\sigma_{\alpha_H}$  and  $\sigma_{\beta_H}$  are specified in Table 1. The implied cross-country consumption (expenditure) correlations are mainly sensitive to the parameter controlling the relative sizes of the supply and demand shocks, while the portfolio compositions also to the parameter controlling the correlation of the shocks.

We first simulate our economy for a number of periods to reduce the dependence on the initial conditions. Then we set all shocks equal to zero for the remainder of the horizon—and define the resulting path as a steady state path reached by our economy. Figure 3 reports the steady-state values of the key variables in our model. Unless stated otherwise, all variables are for the Home country. We plot the number of shares of the Home stock held by the Home residents (panel (a)), the number of shares of the Foreign stock held by Home residents (panel (b)), the value of their bondholdings (panel (c)), the annualized trade balance and conventional current account measured as fractions of GDP (panels (d) and (e)), and the capital-gains adjusted current account as a fraction of GDP (panel (f)). In all figures, the x-axis measures the instantaneous correlation between the demand and supply shocks and the y-axis the relative size of the demand and supply shocks, as captured by the ratio of their volatilities.

Our choice of parameters implies a home bias in portfolios, whereby Home holds more than 65 percent of the supply of Home shares, and between 40 to 55 percent of that of Foreign shares. When the correlations between demand and supply shocks are zero and their relative variance is small, this ratio is close to 65/40. When demand and supply shocks are uncorrelated, bond holdings are exactly zero. When the correlation increases, Home’s bondholdings become negative.<sup>6</sup> Home demands more of both the Home and Foreign stock, ending up owning more shares of the Foreign

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<sup>5</sup>The former is formally defined as  $\sqrt{\|\sigma_{\alpha_H}\|^2}/\sigma_Y$  and the latter as  $\sigma_Y i_1 \sigma_{\alpha_H}^\top / (\sigma_Y \sqrt{\|\sigma_{\alpha_H}\|^2})$ , where  $i_1 = (1, 0, 0, 0)$ . That is, the supply shock is represented by the Home output shock and the demand shock by a preference shift towards the Home good. We could have defined these quantities using the output shock at Foreign and the demand shift towards the Foreign good—the results below would be essentially the same. We bound the volatility of the demand shocks from below because values close to zero produce a lot of variation in the countries’ portfolios, with portfolios becoming indeterminate in the limit of zero volatility (Cole and Obstfeld).

<sup>6</sup>It is important to highlight that whether bondholdings are positive or negative depends on the sign of the correlation between the demand shocks and the supply shocks. In our case, home supply shocks are positively correlated with the agents’ demand for the Home good, and therefore, the Home stock is a good hedge against that correlation.

stock than foreigners own abroad, and finances these stock purchases not by selling domestic shares (rebalancing), but by borrowing. The selling of the bond by Home implies a current account deficit, as shown in panel (e) and implied by Property 1. In our steady state, the current account deficit varies from zero up to 40 percent of GDP, while the trade deficit is constant at 3.1 percent (panel (d)). Note that CGCA comes out positive, at around 3.1 percent of GDP (panel (f)).

### 3.2. Unconditional responses

In this simulation we generate 500 histories, each of 95 periods (we set the shocks to be zero in the first five periods), by randomly drawing all four shocks. Each period corresponds to one hundredth of a year.

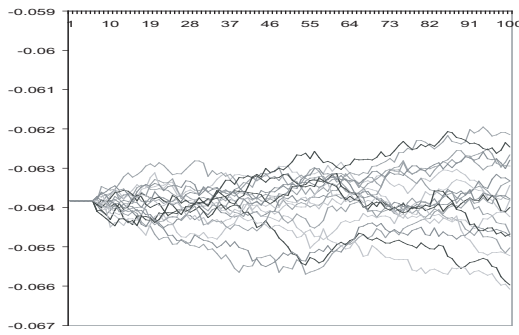
We start by examining the serial correlation of the conventional current account and the serial correlation of the capital-gains adjusted current account. To provide an illustration, Figure 1 depicts a variety of sample paths of the trade balance and the current accounts emerging from the Monte-Carlo simulations. The difference in the dynamic behavior of the two series in the top panels and the one in the bottom is striking. Both the trade balance and the conventional current account are clearly highly persistent series, while the capital-gains adjusted current account is not. The main reason why the latter does not exhibit much persistence is the fact that much of its variation is explained by the *unexpected* capital gains, which are not serially correlated. The series in panel (c) looks much like a return on a financial asset: very volatile and largely unpredictable. Table 2 validates these observations and reports the serial correlations of each of the three measures of external accounts. We estimate a simple AR(1) and average the coefficients across all simulations, for the entire parameter space. One can see that irrespectively of the parameters chosen for a

	AR(1) Serial Correlation			Standard Error
	Average	Max	Min	
$TB_H$	94.8%	94.8%	94.7%	3.9%
$CA_H$	95.05%	96.42%	94.33%	3.45%
$CGCA_H$	-0.52%	-0.29%	-0.68%	10.54%

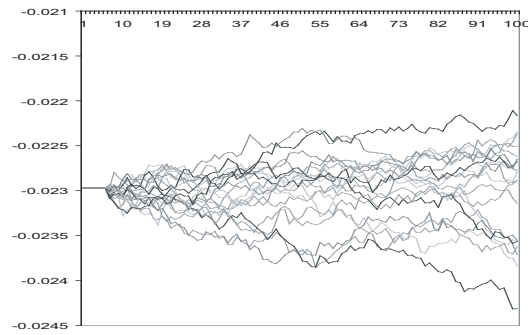
Table 2: AR(1) serial correlation of the simulated trade balance, conventional current account, and capital-gains adjusted current account (in fractions of GDP). The average is computed as the simple average of the estimates across our parameter space, and the standard error is for that average.

simulation, the current account is highly serially correlated. CGCA, however, does not exhibit much serial correlation.<sup>7</sup> Its dynamics closely resembles those of asset returns.

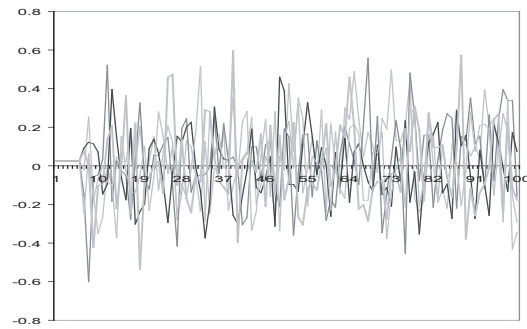
<sup>7</sup>This is consistent with the evidence presented in Kollmann (2006) and Lane and Shambaugh (2007).



(a) Trade balance



(b) Conventional current account



(c) Capital-gains adjusted current account

Figure 1: Simulated sample paths of the trade balance, conventional current account, and capital-gains adjusted current account (these series have not been scaled by GDP). Each sample path corresponds to one simulated history.

### 3.3. US economy: Sustainable or not?

The recent swelling of the US current account deficit has long been fueling the debate among policymakers and academics alike whether the current situation is sustainable or whether a significant correction must take place. We can address this question in the context of our model. In our model, existence of equilibrium is equivalent to sustainability, which means precisely that the budget constraint is not violated in any state of the world. Any equilibrium that exists in our economy has to possess two simple and readily testable properties that we list below.<sup>8</sup> Violation of these properties in the recent data may suggest that the current situation is unsustainable.

**Property 1:** *The relationship between the Home country's net debt position and its current account is as follows:*

$$CA_H(t) = \left( r(t) - \frac{\rho}{1 - e^{-\rho(T-t)}} \right) s_H^B(t) B(t) dt. \quad (18)$$

**Property 2:** *The relationship between the Home country's net foreign asset position and its trade balance is given by*

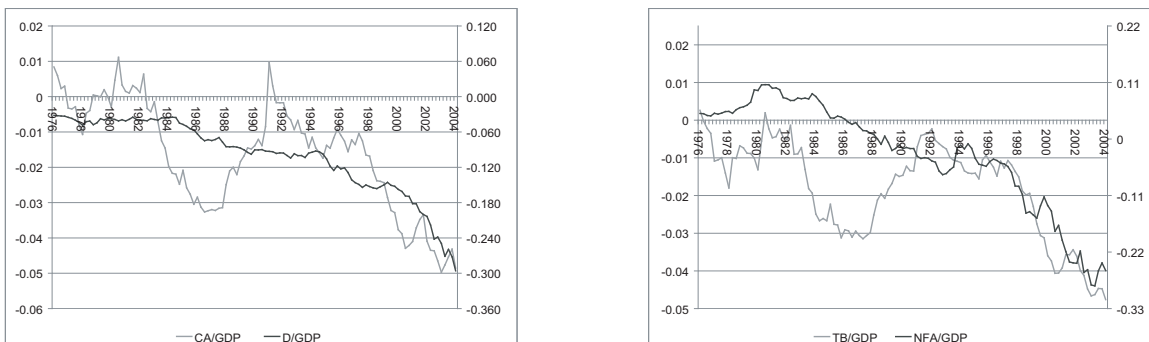
$$TB_H(t) = - \frac{\rho}{1 - e^{-\rho(T-t)}} NFA_H(t). \quad (19)$$

The first implication that can be derived from the two properties are their sign implications: (i) in an economy in which the interest rate is higher than the discount rate, a country with a negative net debt position should be running a current account deficit, and (ii) a country with a negative NFA position should be having a trade surplus. The second implication of the two properties concerns the relative magnitudes of the external accounts and the financial asset holdings. In particular, Property 1 implies that the ratio between the conventional current account measure and the net foreign debt is of the order of magnitude of the interest rate minus the discount rate. Similarly, for  $T$  large enough, the ratio between the NFA positions and the trade balance is also of the order of magnitude of the discount rate (Property 2). We here test these implications on a sample of US data over the past 30 years. We split our data into two different subsamples: the 90s and the previous 15 years. As will become evident, in some dimensions, both periods are inconsistent with the predictions of the model. However, it is the most recent 15 years that encompass alarmingly large deviations from equilibrium, and not the earlier period.

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<sup>8</sup>These properties are, of course, model-specific. Nonetheless, we believe that establishing their empirical validity is a useful exercise. For a proof of the properties see Pavlova and Rigobon (2008).

Figure 2 plots our data. In panel (a), we present the conventional current account and net foreign debt of the US. Both variables in fractions of GDP. The current account is measured on the left vertical axis, while the debt is measured on the right axis. In panel (b), we plot the trade balance and the NFA positions, also measured as fractions of GDP. As before, the external account (TB) is measured on the left axis while the financial variable (NFA) on the right axis.



(a) Current account and net debt

(b) Trade balance and NFA

Figure 2: External accounts and financial assets. All variables are in fractions of GDP. In panel (a), the current account is measured on the left axis and the net foreign debt of the US on the right axis. In panel (b), the trade balance is measured on the left axis and the NFA position of the US on the right axis. The data are from the IMF.

Several aspects of the figures are worth highlighting. Let us first concentrate on the period between 1976 and 1990. The average debt during this period is 5.43 percent of GDP and the average current account deficit is 1.12 percent. Our theory predicts that these variables are positively correlated, and indeed the correlation is positive (59 percent). The magnitude of the correlation, however, is smaller than 100 percent, contrary to our theory. In this dimension, the model is not able to fully capture the co-movement that we observe in the data. Furthermore, the ratio of the average current account to the average debt is 0.21. According to Property 1, this ratio should be equal to the difference between the interest rate and the discount rate, which is in the neighborhood of 2 to 5 percent and definitely less than 20 percent.

Now consider the relationship between the NFA and the trade balance (Property 2). Between 1976 and 1990, the US ran an average trade deficit of 1.51 percent of GDP, while the NFA were positive, equal on average to 4.74 percent. Consistent with our theory, the trade balance and the net foreign assets are negatively related. The magnitude of their ratio, however, is significantly different from what the theory predicts. The absolute value of the ratio is close to one, when the

theory says that it should be equal to the discount rate.

In summary, the signs of the correlations between the external accounts and financial assets during 1976–1990 are consistent with the theory. However, the external accounts constitute a much larger fraction of the assets than what the theory predicts. In other words, either the financial variables are downward biased, or the external accounts were excessively large.<sup>9</sup> Nevertheless, this period is very interesting because the US has indeed corrected a relatively large current account deficit, and that correction happened within an environment in which external holdings—both debt and equity—moved significantly. Interestingly, this behavior is captured by the main implications of the theory.

In the recent 15 years in our data, the behavior of the external accounts in relation to the financial assets has changed dramatically. First, the theory predicts that in equilibrium, on each path, the current account and net debt are positively correlated. This implication still holds over the last 15 years—the correlation in levels is 87.88 percent. Interestingly, this correlation drops to almost zero when measured in changes (-1.48 percent). Our theory and simulations show that they should be very large both in levels and in first differences.<sup>10</sup>

Second, although the relationship between the current account and the net debt is somewhat consistent with the predictions of the model, the relationship between the trade balance and the net foreign assets is rejected strongly in the data. As opposed to being negatively correlated, as the theory predicts, the variables are highly positively correlated, which is easy to see in Figure 2b. In levels, the correlation is 92.39 percent, although it becomes essentially 0.74 percent in first differences. The fact that the variables are so highly and positively correlated in levels suggests a strong rejection.<sup>11</sup>

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<sup>9</sup>Another alternative that we are not exploring in this paper is that in reality countries trade claims to just a fraction of their output—i.e., only the part of GDP that is capitalizable. In this case, it may be possible to make the observed external accounts and the external asset holdings consistent with the theory. This form of incompleteness has been studied by Caballero, Farhi, and Gourinchas (2008) in a model without uncertainty. In future research, it would be interesting to extend our framework to include this possibility.

<sup>10</sup>One possible explanation for this drop in the correlation is that the NFA and external debt are mismeasured. For example, Curcuru, Dvorak, and Warnock (2008) have argued that significant problems exist in the procedure used for computation of the NFA in the US that lead to their mismeasurement at high frequencies. Over the long run, though, these measurement problems average out. This is why it is possible that the correlation exists in levels and not in first differences. Another possibility is that the variables simply contain a trend and the correlation in levels is spurious.

<sup>11</sup>The only two ways the current path can be deemed sustainable within our framework is to assume that either the economy is in some transitional dynamic for the last 15 years, or that every observation in the path in Figure 2b is a different equilibrium, where the parameters changing are not the supply and demand shocks that govern the evolution of uncertainty in our model. For instance, a transfer of wealth not explained by our shocks (e.g., a movement in  $\lambda$  not due to supply or demand shocks) will shift the equilibrium and therefore, it may be possible to find a shift in

In addition to the simple correlations, we report concurrence measures for the variables in first differences. A *concurrence* between two variables is defined as the frequency with which the variables are moving in the same direction. For the net debt and the current account, we found that in 47 percent of the quarters the two variables are shifting in the same direction. For the NFA and the trade balance, this number is 51 percent. In both cases, these frequencies are not statistically different from 1/2, which would be the outcome if the variables were completely independent in first differences. Again, this is a strong indication that the fundamental properties of an equilibrium path are violated in the data.

Third, even if we do not pay attention to the sign implications, the data offer strong rejections of equilibrium behavior based on the relative magnitudes of the external accounts and the financial asset holdings. For instance, according to the theory (and confirmed in the simulations) the ratio of the current account to the net debt should be equal to the difference between the interest rate and the discount rate. In the data for the 90s, the interest rate has fluctuated, but assuming a reasonable discount rate (e.g., 2 percent), this difference has been around 5 percent. The average ratio of the current account to the net debt in the data is 13.4 percent. Surprisingly, this ratio has been remarkably stable. Over the past 15 years, the standard deviation of the ratio is only 7.3 percent. This suggests that either the current account is too large, or the US has not borrowed enough. Similarly, the ratio of the NFA to the trade balance is excessively large. According to our theory, this ratio should be equal to the discount rate. In the data, it is 25.6 percent and extremely unstable—ranging from 5 percent up to 150 percent! The standard deviation of the ratio in the sample is 24 percent. Again, this suggests that the trade balance is too large to be justified by the country's NFA position.

## 4. External Adjustment Process

Properties 1 and 2 establish strong links between a country's asset positions and its external accounts. For example, Property 2 says that any gains and losses on financial assets comprising the country's portfolio must be compensated with an offsetting change to the trade balance. As we have highlighted, part of these gains/losses is unexpected. The mechanism through which countries in our economy respond in the event of experiencing a gain (loss) is to increase (reduce) their trade deficits. So the trigger in this trade balance adjustment mechanism is the fluctuations in asset

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which the trade balance and the net foreign assets are moving in the same direction.

prices—and the trade balance then responds accordingly. This is the chain of reasoning we have in mind when we talk about an “asset-pricing” view of external adjustment. In this section, we discuss the propagation of shocks in our model and assess the size of the adjustment that needs to take place in order to shrink the US account deficit.

#### 4.1. Impact responses

We start our analysis by investigating the propagation of shocks in our economy. More specifically, we examine two types of shocks: a permanent shift in preferences toward the home good (a demand shock) and a permanent increase in productivity at Home (a supply shock). Our model also allows for an investigation of the effects of a preference shift towards the Foreign good and a productivity shock at Foreign, but for brevity we omit that discussion. We emphasize that the shocks that we study are permanent.<sup>12</sup> That is, we have chosen to close all the intrinsic dynamics and concentrate on the extrinsic dynamics of the model (see Obstfeld and Stockman (1985) for a discussion of these two types of dynamics). Following a shock, our economy moves directly into a new steady state. That is why it is sufficient to look at impact responses to the shocks—impulse responses (over many periods) do not contain any significant information beyond that already captured by the impact responses.

For each shock we present a sequence of figures that capture the impact responses of the real side of the economy, of the financial side of the economy and then highlight the resulting response of the current account of the Home country. To compute the impact responses, we start from our steady state (illustrated in Figure 3) and then introduce one shock (of one standard deviation). Then, for each pertinent variable, we subtract the steady-state series for this variable from the one with the shock, and report the impact of the shock—the resulting change at the time of the shock.

Figure 4 presents impact responses to a shock  $dw^\alpha$ . Recall that by construction, such a shock has no effect on the Home or Foreign output, and the only change in the primitives of our model that takes place in response to the shock is a preference shift at Home towards the domestic good ( $\alpha_H$  increases). The direction in which the terms of trade and stock prices move following the shock can be easily derived from equations (5)–(7). The economic intuition behind these responses is even

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<sup>12</sup>Our focus on permanent shocks is motivated largely by the limitations of the model: while productivity shocks can be modeled as transitory, preference shifts have to be permanent (recall that, for tractability, we have assumed that  $\alpha_H$  and  $\beta_H$  are martingales). The analysis of transitory shocks is thus beyond the scope of this paper, and we leave it for future research.

simpler. A pure demand shock of the type we are considering here creates an excess demand for the Home good. This pushes its price up and therefore improves Home’s terms of trade. This is why panel (a) of Figure 4 reports an increase in  $q$  for all parameter values. Output in both countries stays the same, but because of the movement in the terms of trade, the value of the output increases at Home and decreases at Foreign. Hence the increase in the stock market values at Home (panel (b)) and the decrease at Foreign (panel (c)). It is now easy to understand why the Home country suffers an net unexpected capital loss (panel (d)). Remember that our parameters imply positive steady state holdings of both stocks by both countries. The increase in the stock price at Home thus implies a capital gain for foreigners, while the decline in foreign stock prices implies a loss for Home agents. Both effects act in the same direction, against the Home residents. The capital loss at Home induces the “planner” to reassign weights to the countries in its objective function—in favor of Foreign (panel (e)). Such an outcome is often loosely referred to as an (unexpected) wealth transfer from Home to Foreign, but we caution the reader that such a statement is not entirely accurate, as can be seen from equation (9):  $\lambda(t) = \frac{W_F(t)}{W_H(t)} \times \frac{\alpha_H(t) + \beta_H(t)}{\alpha_F + \beta_F}$ . Indeed, a part of a change in the relative weight  $\lambda$  coincides with a change in the wealth distribution (a pure wealth transfer), but the remaining part is due to imperfect demand risk sharing: under complete markets,  $\lambda$  does not move in response to any shock, but it does respond to shocks under incomplete markets because the shocks cannot be perfectly hedged. For our parametrization, the wealth transfer effect dominates, but this need not be the case in general.

As shown in panel (f), the trade balance improves for all parameter values. This improvement of the trade balance is simply the flip side of the deterioration of the NFA position due to the unexpected net capital loss (Property 2). According to our model, the current trade balance has to adjust to absorb the capital loss. For all parameters, except the ones under which the demand and supply shocks are uncorrelated, Home purchases the bond. (For the case of zero correlation, the gross holdings of the bond are zero). These bond purchases decrease the deficit in the current account according to Property 1—and indeed an improvement in the current account is evident from panel (h). Finally, note that the movements in the net unexpected capital gains dominate the dynamics of the NFA position. The response of the capital-gains adjusted current account mimics that of the net unexpected capital gains—CGCA is negative for all parameter values (panel (i)). Note that the direction of the response of the conventional current account is just the opposite (panel (h)).

In Figure 5 we provide the impact responses to a shock to the Home output  $dw$ . This case is more complex than the one above because a positive Home output shock also causes an increase in  $\alpha_H$  through our choice of parametrization (see Table 1 and the surrounding discussion). Again, the direction in which the terms of trade and stock prices move following the shock can be formally derived from (5)–(7). The intuition behind the responses is as follows. A positive shock to the Home output  $Y_H$  increases the value of its stock market (panel (b)). At the same time, the Home good becomes less scarce and hence its price drops relative to that of the Foreign good—or in other words, Home’s terms of trade deteriorate. The Foreign’s terms of trade therefore improve, which increases the value of its output and benefits its stock market (panel (c)). These responses are somewhat mitigated by the increase in  $\alpha_H$  that occurs contemporaneously. As we have seen in the previous figure, a positive shock to  $\alpha_H$  improves Home’s terms of trade, boosts the stock market at Home, while decreasing the stock market abroad. We can see that this confounding effect becomes more pronounced when the demand shocks have a high loading on the supply shock  $dw$ —i.e., when both the correlation between the demand and supply shocks and the relative variance of the demand and supply shocks is high.

Furthermore, we find that Home enjoys a net unexpected capital gain in response to the supply shock (panel (d)). The intuition of this result is complicated because it depends on how prices and portfolio choices interact. A capital gain at Home causes a wealth transfer from Foreign to Home, or, more accurately, the weight  $\lambda$  of Foreign in the “planner’s” problem falls, increasing the allocation to the Home country (panel (e)). Since the NFA position of Home has improved, it can afford to deteriorate its trade balance, which is what we see in panel (f). Part of the financing of the increased purchases of the two stocks comes from selling the bond (panel (g)), which according to our Property 1 deteriorates the conventional current account (panel (h)). The capital-gains adjusted current account, however, moves in the opposite direction—the same direction as the net unexpected capital gains, which are positive here (panel (i)).

## 4.2. US economy: The impact of a 3% current account correction

Our discussion of the adjustment process thus far has been purely qualitative. We finish this section by supplementing this discussion with some quantitative analysis. One common question that policymakers want to know the answer to is “What is the size of the exchange rate or the terms of trade movement required to cut the current account deficit by a certain amount?”, “How

big of a reduction of the consumption of the foreign goods is required for such correction?”. We seek to find the answers to these questions in the context of our model. Our goal is to quantify the movement in wealth, consumption, and the terms of trade that is required to cut the current account deficit by three percentage points (as a fraction of GDP).

In our model, we cannot have a terms of trade (or an exchange rate) movement that is unrelated to the primitive shocks. That is why we need to start from the primitive shocks and calibrate them so as to generate the desired correction of the current account. We consider the same two types of shocks that we focused on in the previous subsection: (i) a Home output shock ( $dw$ ) and (ii) a pure demand shock that shifts Home’s preference towards its own good ( $dw^\alpha$ ). We keep the same parametrization of the economy as that presented in Table 1, and in particular, we continue to assume that the demand shocks are instantaneously positively correlated with the output shocks. We consider a range of possible parameter values—we again vary the relative importance of demand and supply shocks, as well as their correlation. To summarize the results, we report the average, the median, maximum, and minimum across our simulations.

Table 3 reports the required adjustments needed to generate a 3 percent current account correction. Our exercise is to move the economy from the initial steady state to one in which the current account deficit is on average 3 percent lower (with both steady states being sustainable). We evaluate the ensuing drop in wealth of the home country, the drop in (real) consumption of domestic and foreign goods, the fall in the total consumption expenditure, and the terms of trade adjustment. We measure all the adjustments as a percentage change relative to the original steady state.

The top panel in Table 3 report the results for the case when the shock is to home output. Remember that given our parameters, a typical movement in the home output also implies a shift in the expenditure shares (because  $\alpha_H$  loads positively on  $w$ ). The bottom panel is for a pure demand shock—the shock that does not affect production and alters only the expenditure shares (a change in  $w^\alpha$ ). To evaluate the impact of these two shocks, we concentrate on wealth and consumption variables. It is important to point out that in our framework it is more appropriate to consider the required adjustment of wealth or consumption rather than output. The correction of the current account may occur without any output change at all (as in the bottom panel), but this does not mean that the welfare of the home consumers does not drop.

As is evident from panel (a), if the adjustment comes from the income side, the reductions in

(a) via output reduction ( $dw < 0$ )				
<i>Required Adjustment</i>	Average	Median	Min	Max
Wealth	-21.9%	-20.8%	-28.4%	-18.7%
Consumption of Home Good	-30.8%	-29.3%	-40.3%	-26.3%
Consumption of Foreign Good	-0.7%	-0.6%	-1.1%	-0.5%
Total Consumption Expenditure	-22.5%	-21.3%	-30.1%	-19.0%
Terms of Trade	18.1%	16.9%	9.3%	30.7%

(b) via demand shift towards the home good ( $dw^\alpha > 0$ )				
<i>Required Adjustment</i>	Average	Median	Min	Max
Wealth	0.3%	0.1%	-0.2%	2.4%
Consumption of Home Good	2.7%	2.5%	1.4%	5.1%
Consumption of Foreign Good	-10.8%	-10.0%	-21.6%	-5.4%
Total Consumption Expenditure	-0.6%	-0.6%	-0.7%	-0.4%
Terms of Trade	15.2%	13.4%	6.8%	34.5%

Table 3: The effects of a current account correction of 3% of GDP.

wealth and in consumption are quite significant—of the order of magnitude of 20 percent (for both the average and the median). Furthermore, as one can see from the table, this reduction takes place entirely through the reduction of consumption of the home good. There is some reduction of the quantity of imported goods, but the lion’s share of the adjustment occurs on the domestic good’s side. Interestingly, the change in domestic output is accompanied by a large swing in the terms of trade: the average across our simulations is slightly below 20 percent, and the median is about 16 percent.

Panel (b) reports the corresponding values for the case when the adjustment is through the demand side only. In our model, a change in the expenditure share has an impact on the terms of trade and the portfolio holdings. Hence, the adjustment of the current account may operate through expenditure switching rather than an income reduction as in the previous case. In particular, we find that the same current account correction can be achieved through changes in the expenditure shares leaving wealth almost unaffected. It even goes up slightly (the average is 0.3 percent). This implies that the required adjustment of the consumption expenditure is also tiny. It is on average -0.6 percent. Nevertheless, this does not mean that consumption is unaffected. Consumption of foreign goods drops significantly, by an average of 10 percent, with the largest number number exceeding 20 percent. To reduce the current account deficit, the domestic agents move their consumption toward the home good, increasing it by about 3 percent. Although the consumption and wealth patterns differ significantly between this panel and the previous one, the movement in the terms of

trade is similar in both. In this case, the change in relative prices is on average 15 percent with a median of 13 percent—a very significant drop indeed!

## 5. Valuation Effects: Expected and Unexpected Capital Gains

Capital gains (valuation effects) have been at the source of the debate on the current state of external imbalances in the US and worldwide. Capital gains can be split between expected and unexpected capital gains, which contribute in rather different ways to the international adjustment process. The empirical literature faces a significant challenge of being able to disentangle the expected part of the capital gains from the unexpected part. In this section, we build on our theoretical insights and study the properties of capital gains within our simulation.

Recall our decomposition of the current account:

$$CA_H(t) = \left[ TB_H(t) + \underbrace{s_H^{S^*}(t)p^*(t)Y^*(t) - s_F^S(t)p(t)Y(t)}_{\text{Net Dividend Payments}} + \underbrace{s_H^B(t)B(t)r(t)}_{\text{Net Interest Payments}} \right] dt$$

and

$$CGCA_H(t) = \left[ CA_H(t) + \underbrace{s_H^{S^*}(t)ECG_{S^*}(t) - s_F^S(t)ECG_S(t)}_{\text{Net Expected Capital Gains}} \right] dt + \underbrace{\left[ s_H^{S^*}(t)S^*(t)\sigma_{S^*}(t) - s_F^S(t)S(t)\sigma_S(t) \right] d\vec{w}(t)}_{\text{Net Unexpected Capital Gains}}$$

In what follows, we'll frequently drop the word “net” when we refer to capital gains, with the understanding that we are alluding to capital gains on the NFA positions.

To simplify the analysis, we simulate our model for nine different parameter specifications. The parameters that change across these simulations are again the relative size of the demand and supply shocks (i.e., we vary the volatility of the demand shock by keeping that of the supply shocks fixed) and the instantaneous correlation between the demand and supply shocks. We look at three different relative sizes of the demand shocks: small, medium, and large (0.45, 1.05, and 1.45, respectively), and three different values of the correlation between the demand and supply shocks: small, medium, and high (0.05, 0.25, and 0.45, respectively). Table 4 presents the mean and standard deviations of the expected and unexpected capital gains for each of the nine scenarios. (These are the mean and standard deviations computed across all the Monte Carlo simulations.)

The mean of expected capital gains is different from zero in all simulations. It is, however, very small: between 9 and 10 basis points. This is to be expected in a model with logarithmic preferences and stems from the fact that risk premia on both stocks are small. This happens for

Relative Size	small	med.	large	small	med.	large	small	med.	large
Correlation	5%	5%	5%	25%	25%	25%	45%	45%	45%
Mean of Expected Cap. Gains (bps)	0.089	0.090	0.090	0.099	0.097	0.096	0.113	0.109	0.108
Mean of Unexpected Cap. Gains (bps)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Std.Dev. of Expected Cap. Gains	0.009	0.011	0.012	0.008	0.010	0.012	0.008	0.010	0.012
Std.Dev. of Unexpected Cap. Gains	0.043	0.043	0.044	0.043	0.043	0.043	0.044	0.043	0.043

Table 4: Expected and unexpected capital gains: descriptive statistics. The average and standard deviations of expected capital gains are measured in basis points (bps) relative to GDP. The unexpected capital gains are measured in percentage terms.

similar reason as in the equity premium puzzle of Mehra and Prescott (1985). On the other hand, the average unexpected capital gain is exactly zero. This is not surprising because these gains are not anticipated by either country, and we would expect them to have a mean of zero.

An curious pattern that arises in the simulations is that expected capital gains on average are almost insensitive to increases in the variance of the demand shock, but they are clearly increasing with the correlation between demand and supply shocks. In other words, when we increase the likelihood that the preference parameter  $\alpha_H$  rises when Home has a positive output shock, expected capital gains increase as well. In Figure 6 we present expected capital gains for a range of parameters we used in the simulations. The increasing relationship between expected capital gains and the correlation is clearly visible in the figure. As pointed out in Pavlova and Rigobon (2008), the value of the portfolio that hedges demand risk becomes different from zero and possibly increases in absolute value when the correlation between the demand and supply shocks moves away from zero and continues to rise. In our simulations, this relationship is closely intertwined with the magnitude of expected capital gains.

In terms of the second moments, the unexpected capital gains on the NFA positions are orders of magnitude larger than the expected capital gains. In Table 4, one is measured in basis points and the other in percentages, and still the entry for the unexpected capital gains is four times larger than for the expected. This is a standard result in asset pricing, where it has been extensively documented that unexpected capital gains on equities dominate their short-run variation.

Let us now turn our attention to how capital gains are related to the macro variables in the model. Table 5 focuses on the expected capital gains, while Table 6 on the unexpected ones. In each table we present the correlations of the capital gain variable with real variables, external account variables, asset pricing variables, and portfolio measures (for the same set of nine simulations). The real variables consist of Home's real output, Foreign's real output, Home GDP, and Home's demand

Relative Variances Correlation	small 5%	med. 5%	large 5%	small 25%	med. 25%	large 25%	small 45%	med. 45%	large 45%
<i>Correlations with</i>									
Trade Balance	-89.1%	-92.1%	-93.3%	-87.9%	-90.9%	-92.3%	-86.5%	-89.1%	-90.7%
Net Interest Payments	-88.9%	-94.8%	-96.2%	-84.0%	-92.9%	-94.9%	-77.5%	-90.5%	-93.4%
Net Dividend Payments	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
Current Account	-88.9%	-94.8%	-96.2%	-84.0%	-92.9%	-94.9%	-77.5%	-90.5%	-93.4%
Current Account plus Ex- pected Cap. Gains	89.2%	92.2%	93.4%	88.0%	91.0%	92.4%	86.6%	89.2%	90.8%
Unexpected Capital Gains	11.6%	11.4%	11.4%	11.0%	10.7%	10.7%	10.2%	9.7%	9.8%
Capital-Gains Adjusted Current Account	11.7%	11.5%	11.5%	11.1%	10.8%	10.8%	10.3%	9.8%	9.9%
Home Real Output	32.9%	26.0%	23.0%	21.4%	12.5%	8.7%	6.6%	-3.9%	-8.0%
Foreign Real Output	-0.6%	-0.8%	-0.7%	-0.3%	-0.7%	-0.7%	0.1%	-0.5%	-0.6%
Home Weight on Home Goods (Alpha)	-86.0%	-91.1%	-92.8%	-83.5%	-89.9%	-92.0%	-82.2%	-89.5%	-91.9%
Home Weight on Foreign Goods (Beta)	9.8%	4.4%	3.5%	10.7%	4.6%	3.4%	12.7%	5.0%	3.5%
Home GDP	9.0%	-6.3%	-13.2%	0.9%	-15.7%	-22.8%	-9.3%	-26.6%	-33.6%
Relative weight $\lambda$	-3.9%	-3.4%	-3.1%	-4.0%	-3.5%	-3.2%	-4.0%	-3.5%	-3.2%
Terms of Trade	-72.6%	-82.0%	-84.9%	-64.3%	-76.4%	-80.5%	-50.9%	-67.9%	-73.9%
Interest Rate	66.6%	80.8%	86.0%	69.9%	78.2%	81.7%	63.0%	75.4%	80.0%
Exp. Return on Terms of Trade	2.9%	0.3%	-8.3%	-68.5%	-84.9%	-89.1%	-76.1%	-87.8%	-90.9%
Exp. Return on Home Stock	-91.4%	-97.5%	-98.0%	-86.2%	-96.9%	-97.6%	-73.0%	-95.8%	-97.2%
Exp. Return on Foreign Stock	0.7%	48.3%	62.0%	20.3%	60.3%	70.4%	41.4%	71.3%	78.3%
Exp. Return Differential	-75.5%	-83.7%	-86.8%	-77.6%	-84.2%	-87.2%	-81.6%	-86.1%	-88.6%
Fraction in Home Stock	2.4%	1.3%	1.0%	0.6%	0.0%	-0.2%	-0.3%	-0.5%	-0.6%
Fraction in Foreign Stock	47.1%	77.7%	84.6%	45.2%	74.7%	82.3%	38.5%	69.2%	78.3%
Fraction of Wealth in the Bond	-87.3%	-94.1%	-95.6%	-81.1%	-91.7%	-94.0%	-72.4%	-88.5%	-92.0%
Capital Flow to Home	13.7%	13.8%	13.9%	13.4%	13.7%	13.8%	13.1%	13.6%	13.8%
Capital Flow to Foreign	-2.2%	2.6%	4.4%	-2.1%	0.9%	2.3%	-3.5%	-1.8%	-0.8%
Capital Flow to the Bond	-12.5%	-13.4%	-13.6%	-11.7%	-13.1%	-13.4%	-10.6%	-12.8%	-13.3%

Table 5: Expected capital gains: correlations with macro variables.

shifters  $\alpha_H$  and  $\beta_H$ . The external accounts are represented by the trade balance, net interest payments, net dividend payments, conventional current account, current account plus expected capital gains, and capital-gains adjusted current account. For the relative prices and asset pricing measures, we consider the relative weight  $\lambda$ , terms of trade, interest rate, expected returns on Home and Foreign stocks, and expected return differential (Home minus Foreign). Finally, the portfolio measures include the portfolio weights assigned to the Home stock, the Foreign stock and the bond, as well as the capital flows, defined precisely as a percentage increase in the number of shares held by Home (we report separately the purchases of new shares of Home and Foreign stocks and the new issuance of the bond).

Relative Variances	small	med.	large	small	med.	large	small	med.	large
Correlation	5%	5%	5%	25%	25%	25%	45%	45%	45%
<i>Correlations with</i>									
Trade Balance	-12.9%	-12.8%	-12.8%	-12.8%	-12.5%	-12.5%	-12.6%	-12.3%	-12.2%
Interest Payment	-7.6%	-8.9%	-9.3%	-5.7%	-7.4%	-8.0%	-3.1%	-5.4%	-6.3%
Dividends	11.6%	11.4%	11.4%	11.0%	10.7%	10.7%	10.2%	9.7%	9.8%
Current Account	-7.6%	-8.9%	-9.3%	-5.7%	-7.4%	-8.0%	-3.1%	-5.4%	-6.2%
Expected Capital Gains	11.6%	11.4%	11.4%	11.0%	10.7%	10.7%	10.2%	9.7%	9.8%
Current Account plus Ex- pected Capital Gains	13.0%	12.8%	12.8%	12.8%	12.5%	12.5%	12.6%	12.3%	12.2%
Capital-Gains Adjusted Current Account	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
Home Real Output	6.7%	6.8%	6.7%	5.8%	5.8%	5.6%	4.8%	4.6%	4.3%
Foreign Real Output	0.8%	0.8%	0.7%	0.9%	0.8%	0.8%	1.0%	0.9%	0.9%
Home Weight on Home Goods (Alpha)	-8.2%	-8.6%	-9.0%	-6.8%	-7.4%	-7.9%	-5.2%	-6.1%	-6.6%
Home Weight on Foreign Goods (Beta)	6.2%	5.3%	5.0%	6.8%	5.8%	5.5%	7.6%	6.6%	6.2%
Home GDP	5.2%	4.1%	3.4%	4.8%	3.7%	2.9%	4.4%	3.2%	2.4%
Relative weight $\lambda$	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Terms of Trade (q)	-6.1%	-7.9%	-8.6%	-4.6%	-6.6%	-7.3%	-2.5%	-4.6%	-5.5%
Interest Rate	3.8%	6.0%	6.9%	4.4%	5.6%	6.3%	3.5%	4.7%	5.4%
Exp. Return on Terms of Trade	5.0%	4.3%	3.2%	-3.2%	-5.7%	-6.6%	-3.5%	-5.3%	-6.0%
Exp. Return on Home Stock	-8.3%	-9.3%	-9.6%	-6.7%	-8.2%	-8.5%	-4.4%	-6.6%	-7.1%
Exp. Return on Foreign Stock	0.5%	4.2%	5.5%	1.8%	4.6%	5.6%	2.8%	4.7%	5.5%
Exp. Return Differential	-7.2%	-7.7%	-8.2%	-6.3%	-6.8%	-7.3%	-5.2%	-5.8%	-6.3%
Fraction of Wealth in Home Stock	-0.1%	-0.2%	-0.3%	-0.4%	-0.5%	-0.5%	-0.7%	-0.7%	-0.7%
Fraction of Wealth in For- eign Stock	6.3%	9.8%	10.6%	5.9%	9.1%	9.9%	5.0%	8.1%	8.9%
Fraction of Wealth in the Bond	-7.2%	-8.7%	-9.2%	-5.1%	-7.1%	-7.8%	-2.2%	-4.9%	-5.8%
Capital Flow to Home	70.0%	67.9%	68.9%	61.6%	59.8%	61.4%	50.6%	49.3%	51.6%
Capital Flow to Foreign	-1.5%	37.6%	50.5%	5.0%	32.3%	42.3%	5.7%	23.8%	30.9%
Capital Flow to the Bond	-50.8%	-60.7%	-64.2%	-36.5%	-50.6%	-55.5%	-16.8%	-36.2%	-43.0%

Table 6: Unexpected capital gains: correlations with macro variables.

Recent empirical literature has produced an intriguing stylized fact: valuation effects—the sum of expected and unexpected capital gains—are negatively correlated with the trade balance (see Gourinchas and Rey (2007b) and Devereux and Sutherland (2008)), or, in other words, capital gains have a stabilizing effect on the trade balance. This evidence prompts us to analyze the implications of our model for the behavior of external accounts: the trade balance, net dividend payments, net interest payments, the conventional account (the sum of the last three items), the current account plus expected capital gains, and the current account plus expected and unexpected capital gains, which is our capital-gains adjusted current account. As one can see from Table 5, indeed in all our

simulations expected capital gains are highly negatively correlated with the trade balance (around -90 percent), providing a stabilizing effect. This result is consistent with Gourinchas and Rey. The correlation of the unexpected capital gains with the trade balance is consistently negative as well (Table 6), although the magnitudes of the correlations are much smaller (around -13 percent). Almost the same relationship exists for the correlations with the traditional current account (-90 percent for expected and -9 percent for unexpected capital gains).

One possible explanation for the negative correlations between the current account and expected capital gains is that expected returns and dividend payments are “mechanically” negatively correlated if the total asset returns are held constant and a fraction of that return is randomly attributed to a capital gain and a fraction to dividend. For example, assume that an asset has a total expected return on net foreign assets (expected capital gains plus dividends) of, say, 5 percent. Assume this is constant across all states of the world. If changes in the state variable imply high dividends, then, to keep the total expected return constant, an increase in the dividends has to imply a drop in the expected capital gain. If this is the case, therefore, because the current account has dividends in it but not capital gains, a negative correlation is just an outcome of accounting. We reject this possibility. First, expected capital gains are already negatively correlated with the trade balance. Second, when we compute the correlation between the expected capital gains and dividends, we find that they are perfectly positively correlated, and hence the negative relationship between the current account and expected capital gains is coming from the trade balance and interest payments terms.<sup>13</sup>

Note that the correlations of expected capital gains with the trade balance and with the current account are very high, while those of unexpected capital gains are much smaller. However, when we compare the correlations with the change in the net foreign asset positions—the capital-gains adjusted current account—the roles are reversed. Expected capital gains are slightly and positively correlated with the change in the NFA positions, but unexpected capital gains are perfectly positively correlated. The reason for the change is that unexpected capital gains completely dominate the share attributable to the current account and expected capital gains in the variation of net foreign assets. This conclusion is very much in line with the evidence reported in, among others, Devereux and Sutherland.

An alternative way to evaluate the correlation between the external accounts and the capital

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<sup>13</sup>We thank Pierre-Olivier Gourinchas for motivating us to explore this “accounting” explanation for the observed behavior.

gains is to perform a variance decomposition of the external accounts. For each of our nine parameter specifications, we first compare the variance of the trade balance with the variance of the conventional current account ( $CA_H$ ). We then contrast the traditional and the *expected* capital-gains adjusted current account and examine the variance reduction that the expected capital gains produce. Finally, we add the unexpected capital gains. Table 7 presents the results of the variance decomposition.

Relative Variances	small	med.	large	small	med.	large	small	med.	large
Correlation	5%	5%	5%	25%	25%	25%	45%	45%	45%
(a) Variance decomposition									
$TB_H$	0.49%	0.53%	0.56%	0.51%	0.54%	0.57%	0.53%	0.55%	0.58%
$CA_H$	0.49%	0.65%	0.73%	0.44%	0.60%	0.69%	0.42%	0.59%	0.68%
$CA_H + \text{Expected Capital Gains}$	0.49%	0.53%	0.56%	0.51%	0.54%	0.57%	0.53%	0.55%	0.58%
$CGCA_H$	4.27%	4.29%	4.37%	4.30%	4.25%	4.31%	4.38%	4.25%	4.28%
(b) Relative Ratio									
$TB_H$	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
$CA_H$	0.989	1.227	1.312	0.877	1.124	1.220	0.792	1.065	1.179
$CA_H + \text{Expected Capital Gains}$	1.001	1.005	1.007	1.001	1.004	1.007	1.000	1.004	1.006
$CGCA_H$	8.703	8.143	7.823	8.508	7.931	7.604	8.295	7.704	7.370

Table 7: A variance decomposition. The entries in panel (a) are standard deviations, not variances.

The first set of four rows show the actual standard deviations, while the last four rows are the standard deviations measured in terms of the standard deviation of the trade balance. When the demand shocks are small, the interest and dividend payments already provide some stabilization of trade balance fluctuations. Notice that in the 1, 4 and 7th columns the current account is less volatile than the trade balance. In those cases, adding the expected capital gains increases the variance of the (conventional) current account. On the other hand, when the demand shocks are relatively important, the current account is more volatile than the trade balance, and the expected capital gains offer significant stabilization. In some cases, the expected capital gains reduce the volatility of the current account by more than 20 percent. Interestingly, it turns out that the trade balance and the current account together with the expected capital gains are almost equally volatile. Finally, the inclusion of the unexpected capital gains increases the volatility by a factor of 10. This is because the unexpected capital gains themselves are extremely volatile.

Importantly, even though the expected capital-gains adjusted current account and the trade balance have the same volatility, it does not mean they are positively correlated. In fact, in all our simulations they are almost perfectly negatively correlated. That means that the expected capital gains, net dividends and interest payments completely offset the trade balance. For example, the

correlation between the conventional current account and the trade balance is positive for almost all parameter choices (Figure 7), while the correlation between the trade balance and the current account plus expected capital gains is almost perfectly negative (Figure 8). Hence, the stabilizing role of the expected capital gains with respect to the trade balance movements is quite significant.

Before we start analyzing the remaining correlations, it is important to remember the composition of Home's steady-state portfolio (Figure 3). In our steady state, when the demand shocks are small and uncorrelated with the supply shocks, the optimal portfolio implies Home holding 65% of the domestic stock and 40% of the foreign stock. Increases in the correlation and the importance of the demand shocks push the Home country to increase the number of both risky stocks in its hedging portfolio (the portfolio that hedges demand risk). It finances their purchases by issuing new shares of the bond.

Demand shocks play an important role in the properties of expected and unexpected capital gains. First, expected capital gains are highly negatively correlated with the shocks to  $\alpha_H$ . As we have discussed in the context of impact responses (Section 4.1), a demand shift towards the Home good implies an improvement in the terms of trade at Home and creates a gain for foreigners holding domestic assets and a loss for Home residents. Notice that the correlations are all between -80 and -95 percent. The opposite occurs for the demand shifts towards the Foreign good  $\beta_H$ , although the magnitudes are much smaller. Similarly, the unexpected capital gains respond negatively to demand shifts towards the Home good, and positively to the demand shifts towards Foreign goods. This second set of correlations is fully consistent with the discussion we have had in Section 4.1, where we have noted that the two stocks move in opposite directions in response to a demand shock and hence (given positive stock holdings by both countries) Home either suffers a capital loss (for an  $\alpha_H$  shock) or enjoys a capital gain (for a  $\beta_H$  shock) on its NFA positions. The main difficulty in analyzing these correlations—the one that we have not faced when we talked about impact responses—comes from the fact that simultaneously with a movement in  $\alpha_H$  or  $\beta_H$ , there is always a supply shock occurring in all of our simulations (i.e., the demand and supply shocks are correlated).

Figure 9 shows the relationship between the value of  $\alpha_H$  and the expected stock return differential (Home minus Foreign). One can see that the expected return differential is almost perfectly correlated with movements in  $\alpha_H$ . An increase in  $\alpha_H$  implies an increase in the expected return of Home versus Foreign. This benefits Foreign's NFA positions because, *ceteris paribus*, foreigners are

now enjoying a higher expected return on their holdings at Home and hence the expected capital gains on Home's NFA positions should turn negative (as they do).

We now turn our attention to supply shocks at Home (increases in Home's real output). Because supply and demand shocks are positively correlated in our calibration, separating the effects of a "pure" supply shock amounts to considering the case where the correlation between demand and supply shocks is small (first three columns of Tables 5 and 6). In contrast to the  $\alpha_H$  shocks, the Home supply shocks are positively correlated with the expected and unexpected capital gains. Notice that these are the realized output shocks and the expected and unexpected capital gains. The reasons why these correlations exist are the same as the ones justifying the demand shocks signs before: first, a positive supply shock at home implies a deterioration of the home terms of trade causing a loss to foreigners holding the domestic asset; and second, a change in the supply shifts expected returns accordingly.

Because demand and supply shocks, taken in isolation, have the opposite effects on the capital gains, we should expect that increasing the correlation of demand and supply shocks should counterbalance each other. Indeed, when increasing the correlation between demand and supply shocks, we can see that the entries in Tables 5 and 6 that we have been discussing become smaller in absolute value, and in some cases, they even shift from positive to negative (Home's real output and expected capital gains). Confirming the intuitions we have developed so far, we can look at the correlation between the capital gains components and the terms of trade. The terms of trade are negatively correlated with the unexpected capital gains, highlighting that one of the mechanisms of transmission between shocks and the returns on these assets is related to the movements in the terms of trade. The expected capital gains, however, are extremely correlated (negatively) with the terms of trade. As before, the mechanism is through the expected stock returns differential. An improvement in the terms of trade increases Home expected returns above Foreign expected returns. This implies that on average foreigners collect an additional source of income deteriorating the expected capital gains account.

Finally, before turning our attention to equilibrium portfolios, notice that the expected returns on the terms of trade, the Home stock, the Foreign stock, and the differential all have the expected signs (except when demand shocks are almost independent of the supply shocks). An increase in the expected return at Home (Foreign) is negatively (positively) correlated with the expected capital gains account. Hence, the differential is highly negatively correlated. The drift on the

terms of trade has the same properties. When the demand shocks are uncorrelated, however, there is an important exception to what we have been discussing. In this environment, the conventional current account is always zero. Expected returns compensate perfectly for the shocks to the terms of trade and therefore, they are uncorrelated with the expected returns (see example 3 in Pavlova and Rigobon (2008)).

The last objective of this section is to study the relationship between the capital gains and the portfolio decisions. We study the correlations between the share of wealth that home agents allocate to the Home stock, the Foreign stock, and the international bond. We also study the link between the capital gains and capital flows. For this purpose, we examine the contemporaneous correlation between the the capital gains and the changes in Home's portfolio holdings (changes in the number of shares of the Home and Foreign stock and the new bond issues). These correlations correspond to the last 6 rows of Tables 5 and 6. It is important to mention that even though we have closed-form solutions for the portfolio holdings, the intuitions are difficult to develop. Therefore, we mostly report the patterns we found interesting in the simulations and leave for future research the detailed account of the mechanisms behind the portfolio reallocations.

Unexpected capital gains are negatively correlated with the fraction of wealth invested in the home stock and the bond, and positively correlated with the fraction held in the foreign stock. In some dimensions, the intuition behind this result comes from the valuation effect on the international portfolios. *Ceteris paribus*, the bigger the holdings of the Foreign's stock, the bigger is the capital gain at Home. Similarly, the smaller the holdings of the Home's stock by foreigners, the bigger is the capital gain to Home. That is, in order to increase its (net) capital gain, Home needs to increase its holdings of both stocks. Accordingly, the last three rows in Table 6 indicate that positive unexpected capital gains are associated with purchases of home stocks, purchases of foreign stocks, and increases of foreign debt (which finances the purchases). Another interesting pattern in the simulation is that the higher the correlation of the demand shocks is, the smaller is portfolio reallocation. In other words, the number of shares purchased is smaller in absolute terms; even the increase in debt is smaller. Finally, the expected capital gains are positively and highly correlated with the share of wealth allocated to foreign stocks; they are also highly and negatively correlated with the share of wealth allocated to the bond.

## 6. Concluding Remarks

The swelling of international equity holdings in the last two decades has altered the way economists think of external sustainability: new measures of sustainability are being proposed, new channels of external adjustment are being uncovered, and new frameworks are being and will be developed. In this paper, we investigate properties of an economy which incorporates endogenous dynamics of international equity portfolios into a standard open economy macro model. Solving such a model relies on several important simplifications that future research needs to relax. First, in order to be able to obtain closed-form solutions and introduce asset pricing into our economy, we have chosen to close all the intrinsic dynamics and concentrate on the extrinsic dynamics of the model. In other words, all shocks are permanent and the economy is always in a (stochastic) steady state. Therefore, our definitions of sustainability and the relationship between the external accounts and the financial holdings are all steady-state characterizations. Extending the present framework to allow for intrinsic dynamics is clearly an important next step. Second, we have made a number of simplifying assumptions about the fundamentals of the model: preferences are log-linear, demand shocks come only in the form of expenditure shifts, output is produced by Lucas trees, and so on. While the model has been able to replicate some key stylized facts documented in the recent literature on net foreign asset dynamics, it is still a very crude depiction of reality. Clearly, our assumptions will have to be relaxed in the future to tackle important questions that afflict practitioners and policymakers.

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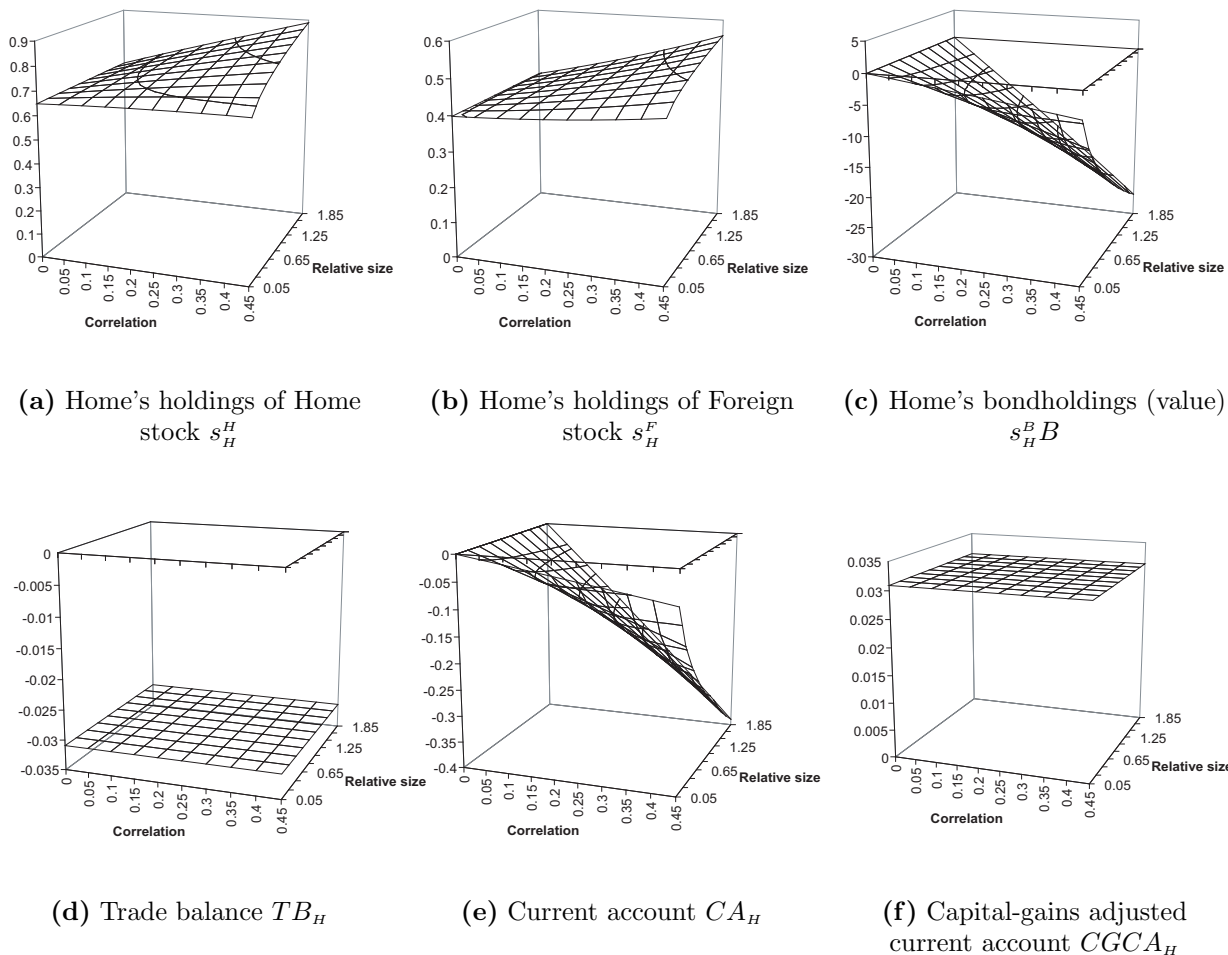
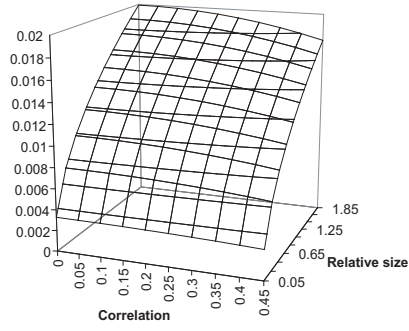
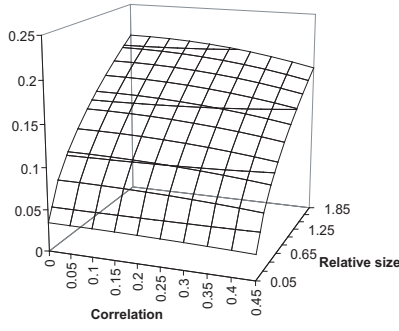


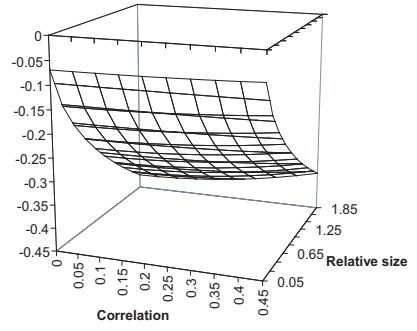
Figure 3: Steady state values. We first simulate our economy for a number of periods to reduce the dependence on the initial conditions. Then we set all underlying shocks,  $dw$ ,  $dw^*$ ,  $dw^\alpha$ ,  $dw^\beta$ , equal to zero for the remainder of the horizon. The horizontal axes measure (i) the instantaneous correlation between the demand and supply shocks  $\sigma_Y i_1 \sigma_{\alpha_H}^\top / (\sigma_Y \sqrt{\|\sigma_{\alpha_H}\|^2})$ , where  $i_1 = (1, 0, 0, 0)$ , and (ii) the ratio of the volatilities of the demand and supply shocks  $\sqrt{\|\sigma_{\alpha_H}\|^2} / \sigma_Y$ .



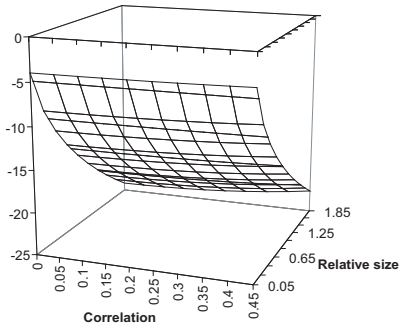
(a) Terms of trade  $q$



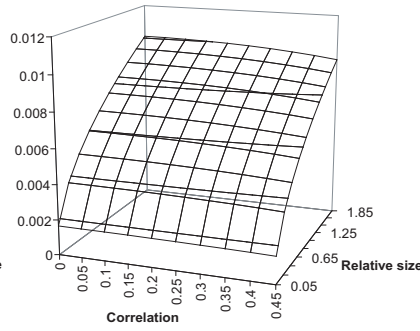
(b) Home stock  $S$



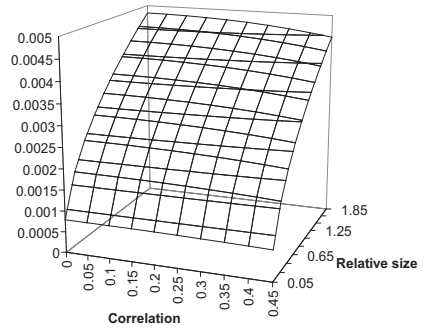
(c) Foreign stock  $S^*$



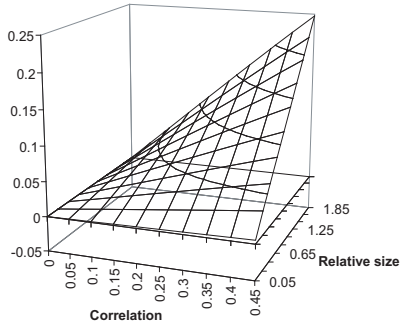
(d) Net unexpected capital gains of Home



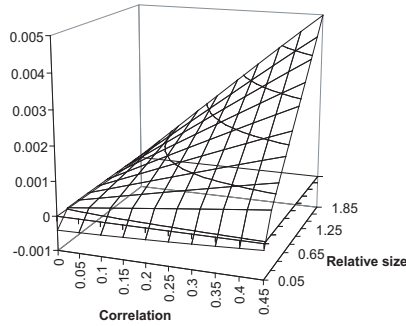
(e) Weight of Foreign  $\lambda$



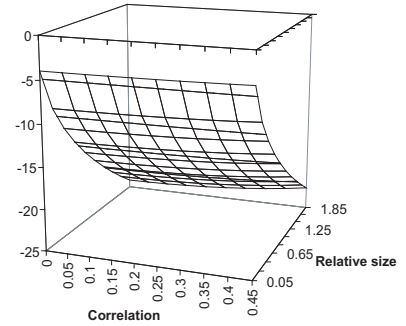
(f) Trade balance  $TB_H$



(g) Home's bondholdings (value)  
 $s_H^B B$

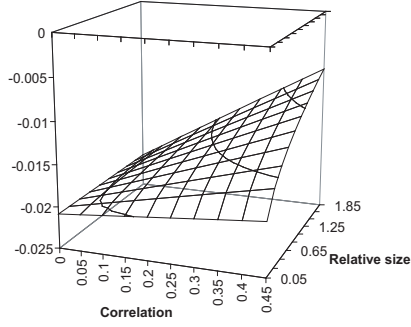


(h) Current account  $CA_H$

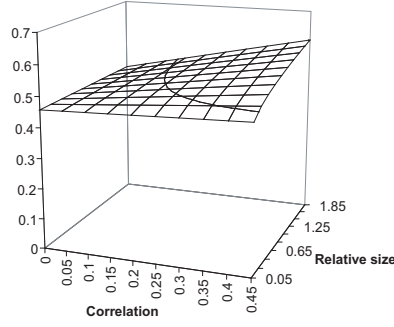


(i) Capital-gains adjusted current account  $CGCA_H$

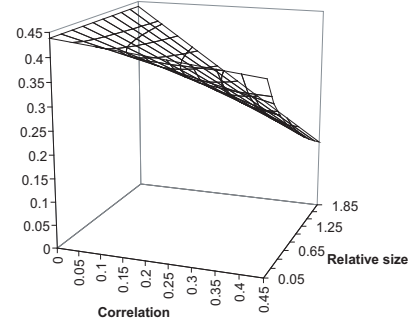
Figure 4: Impact responses to a shock  $dw^\alpha$  (a shock to the utility weight  $\alpha_H$ ). The horizontal axes measure (i) the instantaneous correlation between the demand and supply shocks  $\sigma_Y i_1 \sigma_{\alpha_H}^\top / (\sigma_Y \sqrt{\|\sigma_{\alpha_H}\|^2})$ , where  $i_1 = (1, 0, 0, 0)$ , and (ii) the ratio of the volatilities of the demand and supply shocks  $\sqrt{\|\sigma_{\alpha_H}\|^2} / \sigma_Y$ .



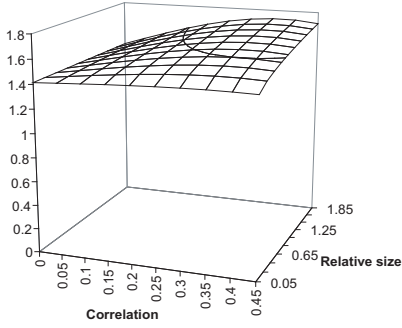
(a) Terms of trade  $q$



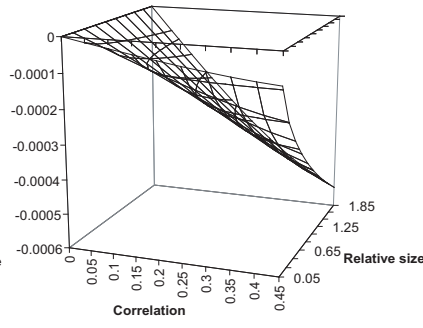
(b) Home stock  $S$



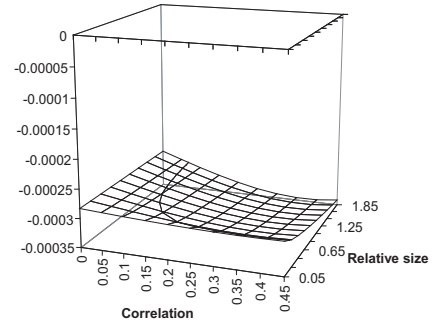
(c) Foreign stock  $S^*$



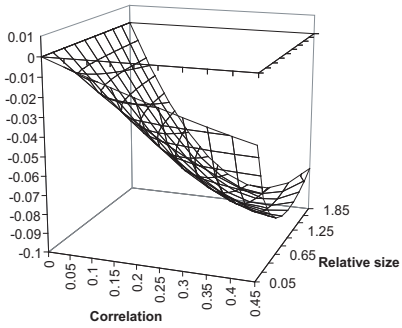
(d) Net unexpected capital gains of Home



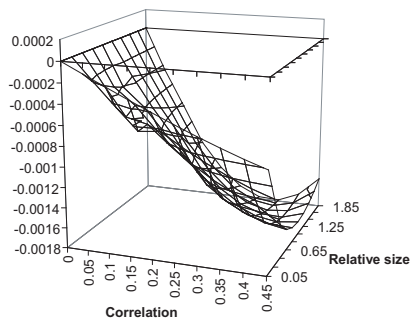
(e) Weight of Foreign  $\lambda$



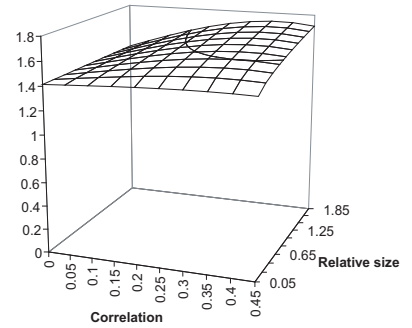
(f) Trade balance  $TB_H$



(g) Home's bondholdings (value)  
 $s_H^B B$



(h) Current account  $CA_H$



(i) Capital-gains adjusted current account  $CGCA_H$

Figure 5: Impact responses to an output shock at Home  $dw$ . The horizontal axes measure (i) the instantaneous correlation between the demand and supply shocks  $\sigma_Y i_1 \sigma_{\alpha_H}^T / (\sigma_Y \sqrt{\|\sigma_{\alpha_H}\|^2})$ , where  $i_1 = (1, 0, 0, 0)$ , and (ii) the ratio of the volatilities of the demand and supply shocks  $\sqrt{\|\sigma_{\alpha_H}\|^2} / \sigma_Y$ .

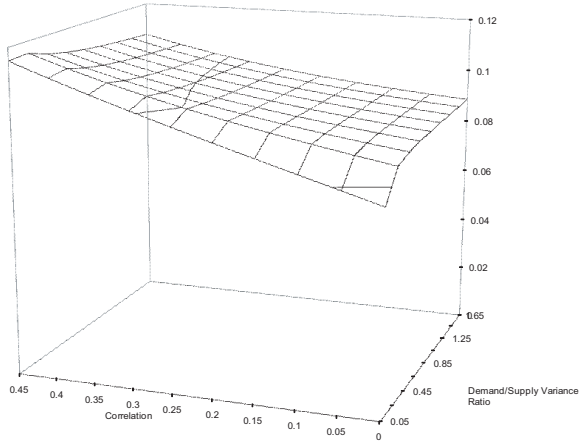


Figure 6: Expected capital gains.

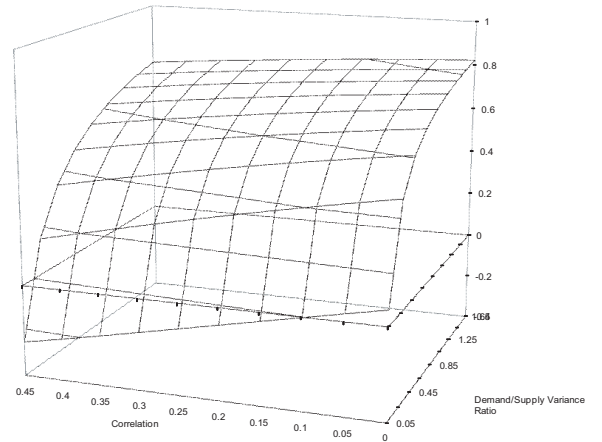


Figure 7: The correlation between the conventional current account and the trade balance.

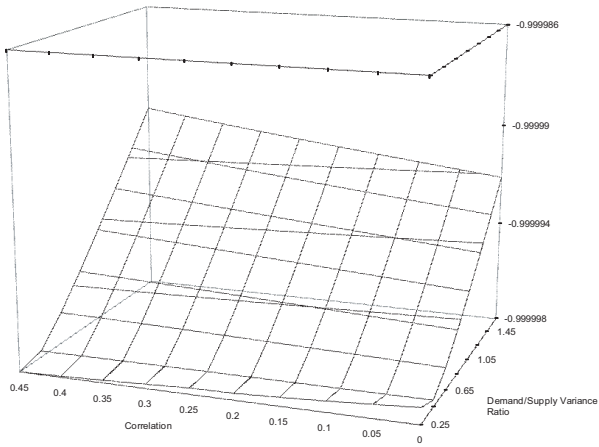


Figure 8: The correlation between the conventional current account plus the expected capital gains (expected  $CA_H$ ) and the trade balance.

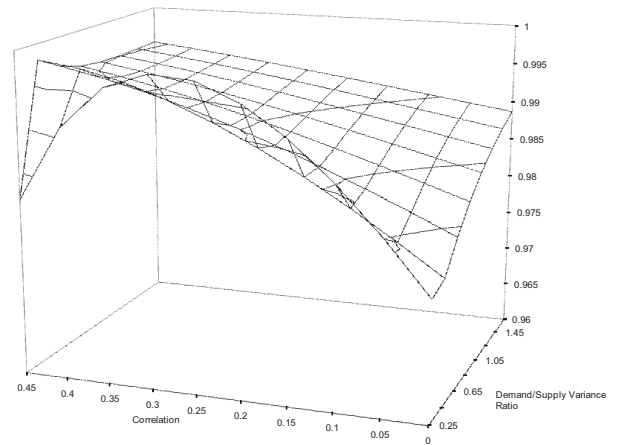


Figure 9: The correlation between the utility weight  $\alpha_H$  and the expected stock return differential (Home minus Foreign).