Welfare Implications of Exchange Rate Changes

Luis B Marques

Johns Hopkins University - SAIS

March 2007

Welfare Implications of Exchange Rate Changes*

Luis Marques

First draft: November 18, 2006.

This version: March 9, 2007.

Abstract

This paper measures the welfare implications of a depreciation of the US dollar against the euro using a dynamic equilibrium model. I calibrate a simple two-country stochastic endowment economy with trade in goods and financial assets and exogenous variations in the exchange rate. The model displays both a trade channel effect and an asset channel effect after a change in the value of the exchange rate. The welfare loss coming from the trade channel translates into the relatively higher price that consumers have to pay for imports. The asset channel effect arises from three sources. One is the traditional valuation effect associated with US debt being denominated mostly in dollars. The other two novel effects are: (1) the dollar value of investors net worth, mostly denominated in local currency, increases more in Europe than in the US; (2) asset prices change, causing a portfolio rebalancing effect which results in a fall in the share of world assets owned by the US. I show that a dollar depreciation has potentially large negative welfare effects as measured by the net present value of future consumption. After a temporary 10% depreciation of the dollar, with a half-life of one year, I calculate a 0.25% decrease in lifetime aggregate consumption for the US consumer.

* I thank Alan Stockman and Rui Albuquerque for useful discussions and advice. I also thank participants in seminars at the Board of Governors of the Federal Reserve System, European Central Bank, University of Bern, Bank of Spain, Federal Reserve Bank of Dallas, Federal Reserve Bank of Boston, Baruch College, The Johns Hopkins University - SAIS, West Virginia University, and Cornerstone Research for helpful comments. Financial support from Fundação para a Ciência e Tecnologia (Portugal) is gratefully acknowledged. The usual disclaimer applies. Department of Economics at the University of Rochester, Harkness Hall, University of Rochester, Rochester, NY 14627. Email: lmrq@troi.cc.rochester.edu.

1 Introduction

The continuing deterioration of the United States' current account and net foreign asset position has raised questions on how to reverse this trend and at what cost in terms of living standards. This shortfall in net savings will have to be compensated by a rise in exports and a decrease in imports and in overall consumption, in what is called the *trade channel effect*. Most economists believe a significant depreciation of the dollar will be needed for this to occur (Obstfeld and Rogoff (2005a) and (2005b)).[1]

Recently, it has been argued that, given the size of the US international investment position, exchange rate changes cause significant valuation effects in the form of capital gains or losses. According to this *asset channel effect*, all else equal, a country with large asset positions in foreign currency or large external liabilities in its own currency, like the United States, receives a positive wealth transfer from abroad, when its currency depreciates. The asset channel can potentially offset some or all of the negative effects of the trade channel (Tille (2005)).

The first main contribution of this paper is to quantify the costs of a dollar depreciation using realistic dynamics for the exchange rate. The model treats the exchange rate as an exogenous process with appropriate persistence and volatility properties.[2]

The second contribution is to allow for domestic and international portfolio choice when evaluating the welfare effects of exchange rate changes. Asset choice is relevant for the exercise as it allows for changes in exchange rates that lead to changes in asset returns and asset positions. As explained below, this is a new and quantitatively important component of the asset channel.[3]

In the model, a drop in the value of the dollar always reduces future US consumption and welfare if we consider the trade channel in isolation. This is because the price of goods that the US sells abroad falls relative to the price of goods it buys from the rest of the world.

A change in the dollar exchange rate also acts in the economy via an asset channel. There are three aspects to this channel. While the first effect contributes to an increase

[1] There is a growing body of literature that challenges this 'consensus view', as termed by Roubini and Setser (2005). See, for instance, Engle and Rogers (2006), Backus et al (2006), Cavallo and Tille (2006), and Mendoza et al. (2006).

[2] It is not without precedent, however, to take the exchange rate as given: see Dornbusch (1987), for instance.

[3] Hau and Rey (2006) find that returns in equity markets and net equity flows are correlated with changes in the exchange rate. I provide further evidence that this is the case.

in welfare, the latter two effects generate a decrease in welfare. First, a depreciation of the US dollar transfers wealth from foreign creditors to domestic debtors, as noted in Tille (2005), because the US foreign debt is mostly denominated in dollars. Second, due to home bias in equity, the dollar value of the US investors' portfolios is increased by less than the dollar value of the foreign investors' portfolios. Although 65% of the foreign asset position of the US is denominated in foreign currency (Tille (2005)), this is only 6% of the US' total financial assets and less than 14% of households' net worth (according to 2005 Flow of Funds data). The same holds true for other countries, where most assets are denominated in domestic currency.[4] Thus, in terms of total wealth measured in dollars, the valuation effect of a dollar depreciation against the Euro is much smaller for the US investor than for the European investor. Third, a fall in the value of the dollar makes domestic assets cheaper in foreign currency terms, causing a portfolio rebalancing in which foreign investors buy US equity, with the result that the share of total world wealth owned by US investors, and US claims to future dividends decrease.

This paper addresses the welfare effects of exchange rate movements in a setting of large international asset positions and price rigidity for tradable goods. On the one hand, some degree of stickiness is needed for exchange rate changes to translate into changes in the terms of trade. On the other hand, large foreign asset positions are needed for the valuation effects of exchange rate changes to be significant. These two assumptions are well documented in the literature. For instance, Lane and Milesi-Ferretti (2001) have documented an increasing trend in international financial integration which translates into sizable gross foreign assets and liabilities. Using disaggregated price data on imports and exports at-the-dock, Gopinath and Rigobon (2006) find significant price stickiness for traded goods.

A thorough attempt at quantifying the impact of an exchange rate depreciation on welfare has been done by Tille (2005). He concludes for large positive welfare effects arising from the asset channel. In his model, the negative impact of an exchange rate depreciation through the trade channel is reversed by a large wealth transfer from abroad when the country has a large gross asset position in foreign assets or a large negative foreign liability position in local currency. This valuation effect is only mildly counteracted by increased income payments to foreign investors because of higher domestic firm profits after a monetary expansion. Relative to Tille, I allow for lower elasticities of sub-

[4]For instance, in the United Kingdom, foreign currency denominated assets are 5.3% of total financial assets and 13% of households' net worth (2005 data from National Statistics).

stitution between goods, as well as domestic and international portfolio choice. Devereux and Saito (2006) study the behavior of the asset channel for external adjustment with a international portfolio choice model but do not look at the effects coming from the trade channel.

The model is solved using Evans and Hnatkovska's (2006) second order approximation method. The main advantage of this method is its ability to solve models of international portfolio choice in an incomplete markets setting with many assets, allowing for equilibria with time-varying risk premia. There has been a recent surge in the study of portfolio allocation problems in an international setting. Solving a portfolio choice model with two or more countries poses important numerical challenges, especially with incomplete markets. Nonlinear approaches other than perturbation methods are very difficult to implement unless the models are simple and with a small state space (see, for instance, Kubler and Schmedders (2003)). Linear approximations are a natural way of solving this class of problems, as long as one takes care of the fact that asset allocations at the non-stochastic steady-state are indeterminate. One solution to this is to use transaction costs, like in Ghironi *et al.* (2006), to create a wedge between returns of various assets in the steady state. Contrary to the method I use, however, this abstracts from second moments and does not encompass asset choice for risk diversification purposes.

In a complete markets setting, Engle and Matsumoto (2006) and Kollmann (2006) address home bias in equity using optimal international portfolio choice. The assumption of complete markets facilitates obtaining a solution, but is too restrictive for my analysis. This is because it ignores the wealth effects coming from the asset channel (see Stockman (1988)). As shown below, with incomplete markets, a dollar depreciation causes a persistent change in the distribution of financial wealth between countries that substantially increases the cost to US consumers of this currency movement.

In Section 2, I present a simplified model with two countries trading goods with each other and the rest of the world, but no trade in assets. The goal is to characterize analytically the conditions under which the United Sates might gain or lose from a dollar depreciation. With these results in mind, I develop a model with trade in goods and assets in Section 3. I then quantify the impact on consumption, asset holdings, returns, and welfare of a dollar depreciation. Section 4 concludes.

2 Simple model with no asset trade

Consider a simple economy where there are two countries, the United States (US) and Europe (EU), and the Rest of the World (RW). In this pure exchange economy, there are two traded goods. Good 1 is the US traded good, and good 2 the traded good from EU. Each country consumes one nontraded good, Y_{US} in the US and Y_{EU} in Europe.

There are also two numeraires, the dollar and the euro, such that the exchange rate is the relative price of the euro vis-à-vis the dollar. On the financial side, there is one nominal bond, [5] equity on each of the trees producing goods 1 and 2, and equity on each of the nontraded goods sectors. For now, I work in a deterministic setting where these asset holdings are assumed constant. In Section 3, I deal with the more general case of portfolio choice in a stochastic environment.

One of the principal features of the model is the assumption that the nominal exchange rate is exogenous, allowing one to take an agnostic stance on exchange rate determination and to account for the welfare cost of exchange rate movements, given appropriate volatility properties for the price of foreign currency.

A required feature of this model is the existence of terms of trade effects, ie, that a nominal exchange rate depreciation impacts the trade balance. For this, I assume price rigidity in the traded goods sectors, keeping the prices of nontraded goods flexible.[6] Hence, a change in the nominal exchange rate translates, at least initially, into a change in the terms of trade of equal proportion.

The Rest of the World is assumed to sell or buy any amount of either traded good at the given price. This means that markets do not have to clear at the given sticky prices. The model is closed by imposing a balanced current account with RW. This is achieved by assuming that there is a constant amount of debt outstanding with RW. If this position is negative (ie, RW is a creditor of the US and EU taken together), then the interest paid to it will be used to finance a trade deficit (of RW with US and EU).

Let θ and ψ be the fraction of equity on tradable goods 1 and 2 owned by the US investor, and γ and η be the fraction of equity on the US and EU nontradable goods, respectively, owned by the same individual. The total amount of bonds outstanding, B,

[5]it pays interest in dollars, not in units of any of the goods.

[6]There is evidence of significant price rigidity for import and export goods, as reported by Gopinath and Rigobon (2006). In fact, they find prices of traded goods at the border to have half-lives of roughly one year, which contrasts with Bils and Klenow's (2004) estimate of only one quarter for retail prices. This difference can be explained by the fact that a large component of the final price of goods consists of distribution costs and other services typically considered as nontraded (Burstein *et al.* (2005)).

is assumed to be negative and the US is a net debtor. Investors from Europe hold a fraction β of the US outstanding debt. The interest rate is r.

The US endowments of traded and nontraded goods are D_1 and Y_{US}, while the European endowments are D_2 and Y_{EU}, respectively. Consumption of each traded good and of the nontraded good are C_1^i, C_2^i, C_N^i in country $i \in \{US, EU\}$. The prices in local currency (ie, in dollars in US and in euros in EU) of good 1 and 2 are P_1 and P_2, whereas the prices of the US and EU nontraded goods are P_{US} and P_{EU}, respectively. For clarity, I use country superscripts for consumption and financial wealth (as well as for asset allocations in the next section), whereas for endowments and prices I use subscripts.

The consumers' problems can be stated as follows, for the US

$$\max_{C_{1t}^{US}, C_{2t}^{US}, C_{Nt}^{US}} \sum_{i=1}^{\infty} \delta^t \log\left(C_{1t}^{\alpha_1} C_{2t}^{\alpha_2} C_{Nt}^{1-\alpha_1-\alpha_2}\right), \tag{1}$$

$$\text{s.t.} \quad P_{1t} C_{1t}^{US} + S_t P_{2t} C_{2t}^{US} + P_{USt} C_{Nt}^{US} \leq W_t^{US}, \tag{2}$$

$$W_t^{US} = P_{1t} D_{1t} \theta + S_t P_{2t} D_{2t} \psi + P_{USt} Y_{USt} \gamma + S_t P_{EUt} Y_{EUt} \eta + rB$$

where α_1, and α_2 are the consumption shares of goods 1 and 2, in the US. For EU

$$\max_{C_{1t}^{EU}, C_{2t}^{EU}, C_{Nt}^{EU}} \sum_{i=1}^{\infty} \delta^t \log\left(C_{1t}^{\hat{\alpha}_1} C_{2t}^{\hat{\alpha}_2} C_{Nt}^{1-\hat{\alpha}_1-\hat{\alpha}_2}\right), \tag{3}$$

$$\text{s.t.} \quad P_{1t} C_{1t}^{EU} + S_t P_{2t} C_{2t}^{EU} + S_t P_{EUt} C_{Nt}^{EU} \leq W_t^{EU}, \tag{4}$$

$$W_t^{EU} = P_{1t} D_{1t}(1-\theta) + S_t P_{2t} D_{2t}(1-\psi) + P_{USt} Y_{USt}(1-\gamma) + S_t P_{EUt} Y_{EUt}(1-\eta) - \beta r B,$$

where $\hat{\alpha}_1$, and $\hat{\alpha}_2$ are the consumption shares of goods 1 and 2 in Europe.

I assume preferences to be Cobb-Douglas so that consumption of each good is a constant share of wealth.[7] In the macro literature the elasticities of substitution between traded goods and between these and the nontraded goods are usually considered to be at most unity (micro based estimates point to much higher values). In fact, Stockman and Tesar (1995) use unity for the former and 0.44 for the latter, and Mendoza (1995) uses 1 and 0.74, respectively. Lane and Milesi-Ferretti (2000) argue for values below unity for the elasticity between traded and nontraded goods, and Obstfeld and Rogoff (2000) use unity.

Given wealth and prices, the consumption allocations that solve the consumers prob-

[7] In earnest, I refer throughout this section to W^i $i = US, EU$ as wealth. In section, however, it simply measures income coming from financial wealth. I do this for comparability with the next section with optimal asset choice.

lems are

$$
\begin{aligned}
C_{1t}^{US} &= \alpha_1 \frac{W_t^{US}}{P_{1t}}, && (5) \\
C_{2t}^{US} &= \alpha_2 \frac{W_t^{US}}{S_t P_{2t}}, && (6) \\
C_{Nt}^{US} &= (1-\alpha_1-\alpha_2) \frac{W_t^{US}}{P_{USt}}, && (7)
\end{aligned}
$$

$$
\begin{aligned}
C_{1t}^{EU} &= \hat{\alpha}_1 \frac{W_t^{EU}}{P_{1t}}, && (8) \\
C_{2t}^{EU} &= \hat{\alpha}_2 \frac{W_t^{EU}}{S_t P_{2t}}, && (9) \\
C_{Nt}^{EU} &= (1-\hat{\alpha}_1-\hat{\alpha}_2) \frac{W_t^{EU}}{S_t P_{EUt}}. && (10)
\end{aligned}
$$

Market clearing in the market for each of the nontradables' markets requires

$$C_{Nt}^{US} = Y_{USt}, \tag{11}$$

and

$$C_{Nt}^{EU} = Y_{EUt}. \tag{12}$$

Definition 1 *An equilibrium in this economy is a collection of consumption allocations* $\{C_{1t}^{US}, C_{2t}^{US}, C_{1t}^{EU}, C_{2t}^{EU}, C_{Nt}^{US}, \text{and } C_{Nt}^{EU}\}$ *and prices* $\{P_{USt}, \text{and } P_{EUt}\}$ *such that consumers solve their utility maximization problem, and the markets for the nontraded goods clear, given* $S_t, P_{1t}, P_{2t}, D_{1t}, D_{2t}, Y_{USt}, \text{and } Y_{EUt}$.

To clarify the importance of the "Rest of the World" assumption, sum the two budget constraints and use the market clearing conditions for the non-tradable goods, and equity, to obtain the following residual condition for the traded goods and debt:

$$P_{1t}(C_{1t}^{US} + C_{1t}^{EU} - D_{1t}) + S_t P_{2t}(C_{2t}^{US} + C_{2t}^{EU} - D_{2t}) = (1-\beta)rB. \tag{13}$$

Condition (13) states there is a zero current account balance with RW. If RW is a net creditor, then it must be case that the interest payments it receives from the two other countries are being spent in imports of goods 1 and/or 2. This way, the total consumption of these goods by the US and the EU is smaller than the total endowment available. The sign of B and β determine whether the rest of the world is a net importer or exporter.

Replacing the equilibrium values in the utility function yields:

$$\begin{aligned} U_t^{US} &= \alpha_1 \log \frac{W_t^{US}}{P_{1t}} + \alpha_2 \log \frac{W_t^{US}}{S_t P_{2t}} + (1-\alpha_1-\alpha_2) \log Y_{USt} + \kappa \\ &= (\alpha_1+\alpha_2) \log W_t^{US} - \alpha_1 \log P_{1t} - \alpha_2 \log S_t P_{2t} - (1-\alpha_1-\alpha_2) \log Y_{USt} + \kappa, \end{aligned}$$

where κ is constant term. A similar expression holds for U_t^{EU}.

Differentiating with respect to S_t delivers for the US and EU yields:

$$\begin{aligned} \frac{\partial U_t^{US}}{\partial S_t} &= \frac{\alpha_1+\alpha_2}{W_t^{US}} \frac{\partial W_t^{US}}{\partial S_t} - \frac{\alpha_2}{S_t}, \\ \frac{\partial U_t^{EU}}{\partial S_t} &= \frac{\hat{\alpha}_1+\hat{\alpha}_2}{W_t^{EU}} \frac{\partial W_t^{EU}}{\partial S_t} - \frac{\hat{\alpha}_2}{S_t}. \end{aligned}$$

It is immediate from the above expressions that the response of welfare in each country to exchange rate changes depends on the fraction of wealth that is denominated in euros (ie, in the degree of home equity bias) and on the bias in preferences towards consumption of the home traded good. To be more specific, following a dollar depreciation, home bias in equity works to the detriment of the US, whereas home bias in consumption works in its favor. In what follows, I discuss the conditions needed to sign the above derivatives.

2.1 Only traded goods

Suppose there are only the two traded goods in the US and EU consumption bundles. The weight of good 1 in total consumption is now α and $\hat{\alpha}$ in the US and EU, respectively. In this case, since prices are fixed, the real exchange rate is equal to the terms of trade, defined as the relative price of the US traded good vis-à-vis the EU traded good. With price stickiness, the terms of trade are proportional to (the inverse) of the nominal exchange rate.

After a dollar depreciation, wealth measured in dollars increases in both countries because European assets are now more valuable. Specifically,

$$\begin{aligned} \frac{\partial W^{US}}{\partial S} &= P_2 D_2 \psi, \\ \frac{\partial W^{EU}}{\partial S} &= P_2 D_2 (1-\psi), \end{aligned}$$

which shows, given home bias in equity ($\psi < \frac{1}{2}$), that Europe's wealth benefits by more.

In this simple version of the model, the US trade balance is:

$$\begin{aligned} TB^{US} &\equiv P_1(D_1 - C_1^{US}) - SP_2C_2^{US} \\ &= P_1D_1(1-\theta) - SP_2D_2\psi - rB^{RW}, \end{aligned}$$

and for Europe

$$\begin{aligned} TB^{EU} &\equiv SP_2(D_2 - C_2^{EU}) - P_1C_1^{EU}, \\ &= SP_2D_2\psi + \beta rB^{RW}. \end{aligned}$$

The (consolidated) trade deficit with the rest of the world is constant and given by (13). An increase in the nominal exchange rate causes consumption of good 2 to decrease and that of good 1 to increase (as its relative price is now lower). Since the dollar value of the trade balance is constant, the US and Europe import more of good 1 from the rest of the world and less of good 2. A dollar depreciation causes a deterioration in the US trade balance and an improvement of the same magnitude in the European one. This is strictly a price effect: a dollar depreciation means imports from Europe are more expensive, whereas the unit value of US exports has not changed.[8] Noting that

$$\frac{\partial C_1^{US}}{\partial S} = \frac{\alpha}{P_1}\frac{\partial W^{US}}{\partial S} = \frac{\alpha}{P_1}P_2D_2\psi, \tag{14}$$

$$\frac{\partial C_1^{EU}}{\partial S} = \frac{\hat{\alpha}}{P_1}\frac{\partial W^{EU}}{\partial S} = \frac{\hat{\alpha}}{P_1}P_2D_2(1-\psi), \tag{15}$$

consumption of good 1 increases in both countries and this increase is proportional to the share of European equity held by the respective country, ψ in the US and $1-\psi$ in the EU. The higher this share is, the higher the increase in wealth measured in dollars. As ones expects the US to own a smaller fraction of equity on good 2 than Europe, the latter experiences a bigger increase in consumption of good 1.

As for good 2, the impact on consumption is

$$\frac{\partial C_2^{US}}{\partial S} = -(1-\alpha)\frac{(P_1D_1\theta + rB)}{P_2S^2}. \tag{16}$$

[8]This is an L-curve effect, or an extreme version of the J-curve effect for the trade balance documented in Backus et al. (1994).

The US reduces its consumption of the foreign good unless it owes more than $-P_1D_1\theta/r$. Furthermore, the higher the consumption home bias, the smaller is the sensitivity of good 2's consumption to an exchange rate change. As for Europe, consumption of its domestic good decreases if Europe's gross foreign income coming from the US is positive. The condition is given by:

$$\frac{\partial C_2^{EU}}{\partial S} = -\frac{1-\hat{\alpha}}{S^2 P_2}(P_1 D_1(1-\theta) - \beta r B) < 0,$$

which holds, given $B < 0$, if and only if

$$\beta > \frac{P_1 D_1}{rB}(1-\theta).$$

This means that for consumption of good 2 to decrease in Europe it must be that β is not too negative. Furthermore, it becomes clear that the changes in consumption depend on interest payments. Since these should be small and β is taken to be positive, we should expect a decrease in consumption of the European traded good, in both countries, following a dollar depreciation, as the likely outcome.

Putting all these effects in consumption together, the American consumer is worse off with a dollar depreciation if:

$$\begin{aligned}\frac{\partial U^{US}}{\partial S} &= \alpha\frac{\frac{\partial C_1^{US}}{\partial S}}{C_1^{US}} + (1-\alpha)\frac{\frac{\partial C_2^{US}}{\partial S}}{C_2^{US}} \\ &= \left(\alpha\frac{SP_2D_2\psi}{W^{US}} - (1-\alpha)\frac{P_1D_1\theta + rB}{W^{US}}\right)\frac{1}{S} \qquad (17)\end{aligned}$$

after replacing (14) and (16). From (17) we can see that home bias in consumption and in equity work in opposite directions in explaining welfare changes. From the first ratio on the right hand side of (17) we have that a dollar depreciation means the US foreign wealth is worth more in terms of good 1 and this translates into a US welfare improvement, which is large if the American consumer displays a high consumption bias towards this good and if the fraction of US wealth denominated in foreign currency is large. Conversely, the dollar depreciation means that the US wealth denominated in dollars is worth fewer units of good 2, which has a negative impact on US welfare proportional to the importance of this good to the American consumer (given by $(1-\alpha)$). Again, the higher the home bias in equity, the more negative it is the impact on US welfare of a dollar depreciation.

The role of debt is also made clear from this expression: with a large US net debt position in dollars, interest payments to Europe and the Rest of the World, measured in euros, decrease after the depreciation. This implies that consumption of good 2 falls by less.

A caveat is in order. Because, by assumption, all debt is rolled over and equity positions do not change, the size of this valuation channel depends on asset income, not on gross asset value. In the case of debt, interest payments are necessarily small when compared to total wealth. A more favorable case to the US consumer can be made if there are debt repayments following dollar depreciations.

In Figure 1, I reproduce quarterly net debt flow changes against changes in the euro-dollar rate.[9] There is no discernible relation and the correlation is negative but not significantly different from zero. Using the monthly data from the US Treasury on transactions between US residents and foreign residents from January, 1977 and until July, 2006, a positive but not significant contemporaneous correlation emerges between net purchases of US debt securities. The one month ahead correlation, however, is negative and significant. That is, following a dollar depreciation, US residents tend to sell US debt securities to foreign investors. The relation is nonetheless weak, as is further verified in Appendix A.

Rewrite (17) to separate the trade channel, ie, the effect on welfare of changes if the value of the dollar that occurs independently of international financial linkages, from the asset channel:

$$\frac{\partial U^{US}}{\partial S} = \left(\underbrace{-(1-\alpha)\frac{P_1 D_1}{W^{US}}}_{\text{trade channel}} + \underbrace{\frac{\alpha S P_2 D_2 \psi + (1-\alpha) P_1 D_1 (1-\theta) - (1-\alpha) r B}{W^{US}}}_{\text{asset channel}} \right) \frac{1}{S}.$$

The trade channel always works against the US consumer, but its importance is smaller the greater the home bias in consumption (high α). The asset channel works in favor of the US consumer (given that $B < 0$) but the home equity bias dampens its importance. The role of consumption bias in the magnification of the asset channel is ambiguous. On the one hand, it decreases the wealth transfer associated with the dollar denominated debt held by foreigners. On the other hand, it interacts positively with equity if the US has a positive foreign net position in equity. The US consumer is better off after a dollar

[9]This comes from quarterly data from the Flow of Funds on debt flows to and from the Rest of the World for the period 1975:1-2006:2.

depreciation if and only if

$$\frac{SP_2D_2\psi}{P_1D_1\theta + rB} > \frac{SP_2C_2^{US}}{P_1C_1^{US}}, \text{ or}$$
$$\frac{P_1D_1\theta + rB}{W^{US}} < \frac{P_1C_1^{US}}{P_1C_1^{US} + SP_2C_2^{US}}, \tag{18}$$

ie, if there is more home bias in consumption than there is in asset holdings.

In the past few decades, there has been increased international financial integration (Lane and Milesi-Ferreti (2006) and Albuquerque *et al.* (2005)) that translates into a smaller home equity bias and eased restrictions on external borrowing. However, Helbling *et al.* (2005) also report a downward trend in consumption bias, so it is hard to argue for a reduced impact of exchange rate changes in consumer welfare on the grounds that economies are increasingly integrated at the international level.

Redoing the same exercise for the European consumer yields the following expression:

$$\frac{\partial U^{EU}}{\partial S} = \left(\hat{\alpha}\frac{SP_2D_2(1-\psi)}{W^{US}} - (1-\hat{\alpha})\frac{P_1D_1(1-\theta) - \beta rB}{W^{US}}\right)\frac{1}{S}.$$

The first term just means Europe's share in its domestic equity is worth more in terms of units of good 1, and this impacts welfare proportionately to this good's importance in the European consumption bundle. The second term means Europe's dollar denominated wealth is now worth fewer units of good 2, with the impact on welfare depending on the importance of the domestic good on Europe's consumption. The trade channel operates in favor of the European consumer (but a higher home bias in consumption dampens it), whereas the asset channel is broadly against it.

Note that the distribution of wealth between the US and Europe does not affect these results. However, this analysis depends on asset holdings not changing. If consumers want asset allocations that assign roughly constant shares of wealth to each asset, as will be the case in the next section, then the distribution of wealth will matter. A decrease in the US share of total wealth (excluding RW) translates into an overall sale of equity by the US to Europe. The US share of total wealth is decreasing in the exchange rate as long as the share of European equity held by the US is smaller than the US share of total wealth (ie, as long as the US owns a larger share of domestic equity than of foreign equity and the US debt is not too large compared to the European one). That is, the distribution of wealth between the US and Europe moves unfavorably to the former if

$$\psi < \frac{W^{US}}{W^{US} + W^{EU}},$$

which is confirmed by data since the US' share of world wealth is much larger than the fraction of foreign equity that it owns.

2.2 Adding nontradable goods

The addition of nontradable goods and cross border positions in these equities increases the intensities of the movements in consumption and wealth. Let the share of nontradables in consumption be the same in the US and Europe: $1 - \alpha_1 - \alpha_2 = 1 - \hat{\alpha}_1 - \hat{\alpha}_2 = a$. Solving for US and EU wealth yields

$$\begin{aligned} W^{US} &= \frac{P_1 D_1 \theta + S P_2 D_2 \psi + rB}{1 - a(\gamma - \eta)} + \frac{P_1 D_1 + S P_2 D_2 + (1-\beta) rB}{(1-a)(1 - a(\gamma - \eta))} a\eta, \\ W^{EU} &= \frac{P_1 D_1 (1-\theta) + S P_2 D_2 (1-\psi) - \beta rB}{1 - a(\gamma - \eta)} + \frac{P_1 D_1 + S P_2 D_2 + (1-\beta) rB}{(1-a)(1 - a(\gamma - \eta))} a(1-\gamma). \end{aligned} \tag{19}$$

From (19) we see that only tradable wealth matters, ie, assets for which there are international holdings. Any shock to to nontradable output is fully offset by price changes in these goods.

The impact on wealth from exchange rate changes is

$$\begin{aligned} \frac{\partial W^{US}}{\partial S} &= \frac{(1-a)\psi + a\eta}{(1-a)(1 - a(\gamma - \eta))} P_2 D_2, \\ \frac{\partial W^{EU}}{\partial S} &= \frac{(1-a)(1-\psi) + a(1-\gamma)}{(1-a)(1 - a(\gamma - \eta))} P_2 D_2, \end{aligned}$$

and is positive for both countries, as in the previous setting. Note that if there are no cross border holdings in equity on the nontradable sectors, wealth responds to the exchange rate the same way as in the case with only tradable goods. That is, the nontradable goods sectors are only relevant if some of their equity is owned by foreigners. The requirement of cross-ownership of equity for valuation effects to matter is also present in Ghironi *et al.* (2006).

The responses of consumptions to exchange rate changes are:

$$\frac{\partial C_1^{US}}{\partial S} = \alpha_1 \frac{(1-a)\psi + a\eta}{(1-a)(1-a(\gamma-\eta))} \frac{P_2 D_2}{P_1},$$
$$\frac{\partial C_2^{US}}{\partial S} = -\alpha_2 \frac{P_1 D_1 \theta + rB}{1-a(\gamma-\eta)} \frac{1}{S^2 P_2},$$

given prices P_1 and P_2.[10] The existence of cross border holdings in equity on nontradable goods has an ambiguous impact on the effect of a dollar depreciation on consumption of good 1 in the US and Europe. However, it unambiguously decreases the negative impact on consumption of good 2 in both countries. Again, home equity bias works against the US consumer.

The condition for the US consumer to be better off ($\frac{\partial U^{US}}{\partial S} > 0$) is

$$\frac{P_1 D_1 \theta + rB}{S P_2 D_2 \psi} < \frac{P_1 C_1^{US}}{S P_2 C_2^{US}} (1 - a\frac{\psi - \eta}{\psi})$$

If the US holds no equity on the European nontradable goods sector, the above expression is almost the same as (18) but for the right hand side being scaled by the share of traded goods in consumption spending ($\alpha_1 + \alpha_2$). In this setting, the addition of nontradables makes it less likely that a dollar depreciation will be welfare improving. This remains true when the US owns some of Europe's nontradable sector, as long as it has a larger stake in the European tradable sector (ie, $\psi > \eta$). If there is no home bias in equity, then adding nontradables to the model is immaterial.

2.3 A *back-of-the-envelope* calibration with fixed prices

To uncover the impact of an exchange rate depreciation of the home currency on wealth, prices, consumption, and welfare, I evaluate the above expressions using reasonable values for the parameters, endowments, and asset holdings, as presented in Table 2. There is home bias in consumption and equity holdings. Consumption shares of tradable goods are the same as in Obstfeld and Rogoff (2005a) and Cavallo and Tille (2006). The share of nontradables is set to 50%, roughly the size of services in consumption in the US and

[10]The impact on EU consumption of goods 1 and 2 is $\frac{\partial C_1^{EU}}{\partial S} = \hat{\alpha}_1 \frac{(1-a)(1-\psi)+a(1-\gamma)}{(1-a)(1-a(\gamma-\eta))} \frac{P_2 D_2}{P_1}$, and $\frac{\partial C_2^{EU}}{\partial S} = -\hat{\alpha}_2 \frac{P_1 D_1 (1-\theta) - \beta r B}{1-a(\gamma-\eta)} \frac{1}{S^2 P_2}$, respectively.

the Eurozone.[11]

Debt is calibrated to the value of US net foreign debt assets as a share of Households and Nonprofit Organizations' net worth in 2004 (tables B.100 and L.107 of the Flow of Funds Accounts by the Board of Governors of the Federal Reserve System). The share of US foreign debt held by Europe is chosen to match the average of foreign holdings of US long- and short-term debt securities between 2000 and 2005, as reported by Treasury International Capital System (TIC) database of the US Department of the Treasury.

Equity holdings are set to match data from the US Department of the Treasury 2004 survey on Foreign Holdings of US Securities[12] This calculation assumes the market value of domestic equity to be evenly split between the tradable goods and nontradable goods sectors. This yields θ of about 0.807. The US share of Europe's equity markets is calculated using the US Department of the Treasury survey on U.S. Portfolio Holdings of Foreign Securities, under similar assumptions, yielding a ψ of 0.232. There is not much guidance on what the equity holdings on the nontradable sectors should be. I set them to be domestically owned up to 95% for the US and Europe. Following Stockman and Dellas (1989), I expect γ to be close to 1 and η close to 0.

For this baseline calibration, as well as for the case where there is no home bias in equity, the impact on consumption, welfare, and the distribution of wealth between the US and the EU of a 10% permanent dollar depreciation are stated in Table 3. Note that in the baseline calibration there is considerable home equity bias and this impacts negatively on the US consumer. In the most realistic case (middle column in Table 3), the favorable effect of the asset channel is not large enough to counteract the drop in consumption stemming from the terms of trade effect. In fact, consumption of the import goods rises sharply in the EU and significantly drops in the US, with real aggregate consumption behaving similarly.[13] In terms of welfare, there is a 0.172% increase in EU utility, whereas utility for the US falls by 0.114%.

With no home bias in equity (last column in Table 3), the US and the EU consumers share equally the increase in the dollar value of total wealth, but the US consumer

[11] This is likely an underestimate of the size of nontradable goods sector in the economy. For example, Burstein *et al.* (2005) argue that this share should be much higher as a large component of the consumption of tradables, such as transportation and retail services, is in fact nontradable.

[12] This roughly matches data on the foreign holdings of US equity as a share of total market value of domestic corporations from the Flow of Funds Accounts (Table L.213), for the same year, which is about 16%.

[13] This does not translate into an improvement in the US trade balance because the own currency prices of the traded goods are fixed.

also benefits from the positive wealth transfer associated with his debt being dollar denominated. In this case, the US consumer is better off after a depreciation of the dollar: US utility instantly increases by 0.52%. This is intuitive as the US shares with Europe in equal terms the increase in the dollar value of equity holdings in the latter. Since the US also has liabilities in dollars, its real wealth grows whereas the European one falls, resulting in a drop of 0.17% in EU utility.

In the next section, since assets are not perfect substitutes, the change in the distribution of wealth between the US and Europe matters. The results in (Table 3) indicate there is scope for adjustment in portfolio holdings in favor of European investors: the US share of world financial wealth drops by almost 2%. For this to happen, though, home bias in equity is required. This is because the distribution of financial wealth only changes if the countries' portfolios are not equally affected by the valuation effect of the currency depreciation.

The impact on utility is also disproportionately favorable to the US because of home bias in consumption. I repeat the exercise with home bias in equity and no cross border holdings in equity on nontradables ($\gamma = 1$ and $\eta = 0$), with and without home bias in consumption, for the cases where there are no nontradables and with nontradables. The results in Table 4 show that home bias in consumption works in favor of the US consumer. In fact, the impact on US welfare of the dollar depreciation is -0.7% without home bias, roughly triple of the impact when there is bias in consumption. The other implication is that including nontradable goods in the model is far from irrelevant as it considerably dampens the welfare losses for the US consumer (compare columns the second and third columns in Table 4 with the fourth and fifth columns of the same table).

3 Model with Optimal Portfolio Choice

In this section, I solve and simulate a model that incorporates optimal portfolio choice into the model presented in Section 2.

I solve for optimal portfolios when the nontradable sector is owned domestically in its entirety in each country, ie, $\gamma^{US} = 1$ and $\eta^{US} = 0$, following Stockman and Dellas (1989). Since these assets are not traded, but have dividend income that correlates with dividend income of other assets, markets are incomplete and there is imperfect international risk sharing (see Backus and Smith (1993) and Kollmann (1995) for evidence). In addition, as noted in Stockman and Svensson (1987) and Stockman (1988), because of incomplete international financial markets, exchange rate shocks produce wealth effects which change the distribution of wealth between countries. This is a crucial feature when analyzing the importance of the asset channel for consumer welfare.

The share of each asset in terms of wealth (net of total consumption spending) of the US and EU and the price of the given asset are given by a_t^{ic} and Q_{it}, for $i \in \{\theta, \psi, \gamma, \eta\}$, and $c \in \{US, EU\}$. The dollar gross return on each asset is $R_t^{i\$}$ and the gross interest rate is R_t.

The problems for the US and the EU consumer are similar to what was previously presented. For brevity, I present the problem for the US consumer only:

$$\begin{aligned} \max_{\left\{ \substack{C_{1t}^{US}, C_{2t}^{US}, C_{Nt}^{US}, \\ \theta_{t+1}^{US}, \psi_{t+1}^{US}, \gamma_{t+1}^{US}, b_{t+1}^{US}} \right\}_{t=0}^{\infty}} & E_0 \sum_{i=1}^{\infty} \delta^t U(C_{1t}^{US}, C_{2t}^{US}, C_{Nt}^{US}), \\ s.t. W_{t+1}^{US} &\leq R_{t+1}^{US}(W_t^{US} - P_t^{US} C_t^{US}), \\ P_t^{US} C_t^{US} &\equiv P_{1t} C_{1t}^{US} + S_t P_{2t} C_{2t}^{US} + P_{USt} C_{Nt}^{US}, \end{aligned} \tag{20}$$

where

$$W_t^{US} \equiv P_{1t}(Q_{\theta t} + D_{1t})\theta_t^{US} + S_t P_{2t}(Q_{\psi t} + D_{2t})\psi_t^{US} + B_t^{US} + P_{USt}(Q_{\gamma t} + Y_{USt}), \tag{21}$$

$$R_{t+1}^{US} \equiv R_t + a_t^{\theta US}(R_{t+1}^{\theta\$} - R_t) + a_t^{\psi US}(R_{t+1}^{\psi\$} - R_t) + a_{\gamma t}^{US}(R_t^{\gamma} - R_t), \tag{22}$$

$$a_t^{\theta US} \equiv \frac{P_{1t} Q_{\theta t}}{W_t^{US} - P_t^{US} C_t^{US}} \theta_{t+1}^{US},$$

$$R^{\theta\$} \equiv \frac{P_{1t+1}(Q_{\theta t+1} + D_{1t+1})}{P_{1t} Q_{\theta t}}.$$

The shares and returns of the other assets (ψ and γ) are similarly defined.

Each of the endowments, the exchange rate, and the prices for traded goods are assumed to follow a joint autoregressive (in logs) process given by

$$z_{t+1} = \boldsymbol{\rho} z_t + \varepsilon_{t+1}, \quad \mathrm{E}(\varepsilon_{t+1}\varepsilon_{t+1}') = V_{\varepsilon}.$$

The CPI in each country, in dollar terms, is[14]

$$\begin{aligned} P_t^{US} &= P_{1t}^{\alpha_1}(S_t P_{2t})^{\alpha_2} P_{USt}^{1-\alpha_1-\alpha_2}, \\ P_t^{EU} &= P_{1t}^{\hat{\alpha}_1}(S_t P_{2t})^{\hat{\alpha}_2}(S_t P_{EUt})^{1-\hat{\alpha}_1-\hat{\alpha}_2}. \end{aligned}$$

[14]This is a standard result from homothetic preferences. See Obstfeld and Rogoff (1997).

The share of wealth allocated to debt for each consumer is

$$a^{bi} \equiv \frac{\frac{1}{R_t} B_t^i}{W^i - P_t^i C_t^i},$$

and satisfies $a_t^{bh} = 1 - a_t^{\theta h} - a_t^{\psi h} - a_t^{\gamma h}$. As in the previous section, the discount bond is not in zero net supply between these two countries: there is a constant and nonzero amount of debt outstanding held by RW, such that

$$B_t^{US} + B_t^{EU} = B^{RW}. \tag{23}$$

This condition allows the prices of traded goods to be treated as exogenous, as made apparent by (13). However, in contrast with the previous section, debt positions are optmized.

The Euler equations and market clearing conditions for this economy are standard and, together with further details on the log-linear approximation, can be found in Appendix B.

Definition 2 *An equilibrium in this economy is a collection of consumption allocations* $\{C_{1t}^{US}, C_{2t}^{US}, C_{1t}^{EU}, C_{2t}^{EU}, C_{Nt}^{US}, \textit{and } C_{Nt}^{EU}\}$*, asset choices* $\{\theta_t^{US}, \theta_t^{EU}, \psi_t^{US}, \psi_t^{EU}, B_t^{US}, B_t^{EU}\}$*, and prices* $\{Q_{\theta t}, Q_{\psi t}, Q_{\gamma t}, Q_{\eta t}, R_t, P_{USt}, \textit{and } P_{EUt}\}$ *such that consumers solve their utility maximization problem, and the markets for assets and nontraded goods clear, given stochastic processes for* $\{P_{1t}, S_t, P_{2t}, D_{1t}, D_{2t}, Y_{USt}, \textit{and } Y_{EUt}\}$*.*

3.1 Calibration strategy and method

This problem cannot be solved analytically. Moreover, solving it numerically poses significant challenges. This is because first order approximations do not work here since asset allocations are indeterminate in the non-stochastic steady state. One possibility is to assume, as in Ghironi et al. (2006), transaction costs in asset trade such that returns are differentiated even in steady state. First order approximations, however, imply that returns and portfolio choices do not depend on second moments. Nonlinear methods can be used in this setting, but are computationally expensive for models with more than a few assets and shocks, and suffer from very ill-conditioned Jacobians. However, the problem can be significantly simplified using logarithmic utility and unit elasticities of substitution between goods, such that a second order approximation is viable[15]. I adopted the method developed by Evans and Hnatkovska (2006), which can handle many assets and incomplete markets. Furthermore, the method allows for heteroskedastic innovations, which naturally arise in a portfolio choice model with incomplete markets. For applications of this method, see Evans and Hnatkovska (2005) and Hnatkovska (2005).

In an portfolio choice model with incomplete markets, the state vector includes the forcing variables, z_t, and the distribution of wealth. The state vector includes not only levels of the state variables, but also their squared terms and cross products. Let the state vector be $X_t \equiv [1 \; x_t' \; \mathrm{vec}(x_t x_t')']$ and the vector of controls Y_t. The method consists in solving the set of equilibrium conditions compactly written as

$$\mathcal{F}(Y_{t+1}, Y_t, X_{t+1}, X_t, \mathcal{S}(X_t)) = 0, \tag{24}$$

under the following assumptions. First, control variables are linear functions of the state vector:

$$\mathbf{Y}_t = \Pi \mathbf{X}_t. \tag{25}$$

Second, the state vector follows a first order autoregressive process with heteroskedastic innovations:

$$\mathbf{X}_{t+1} = A\mathbf{X}_t + U_{t+1}, \quad \mathrm{E}_t(U_{t+1}U_{t+1}') = \mathcal{S}(X_t). \tag{26}$$

Finally, the state variables depend on their lagged values, and their lagged squared terms and cross products (with higher order terms discarded):

$$x_{t+1} = \Phi_0 + (I - \Phi_1)x_t + \Phi_2 \mathrm{vec}(x_t x_t') + \varepsilon_{t+1}. \tag{27}$$

The procedure consists in solving a set of equations that comes from approximating, to a first order, the variables on the real side of the model around the non-stochastic steady state and approximating to a second order the ones on the financial side of the model around an initial wealth distribution.

Special care is put in the choice of the parameter values that define the initial wealth distribution and the non-stochastic steady state. In the model presented in the previous section and augmented with portfolio choice in the current one, we have three trading

[15] To be rigorous, logarithmic utility and unit elasticity of substitution are not needed to solve the model but make approximations simple. The main shortcoming of logarithmic preferences is that they precludes asset demand for hedging concerns and consumers are fully myopic. Relaxing these assumptions is an immediate and important extension to this work.

blocks: US, Europe, and Rest of the World. I calibrate "Europe" to be the roughly equivalent to the aggregate of the countries in the European Union (EU15). The values for debt and equity holdings in this initial wealth distribution, as well as the values for preference parameters, are displayed in Table 2. Therefore, the net foreign debt to wealth ratio is set to 9% (from the Flow of Funds: foreign debt over household net worth). Of this debt, 33.5% is held by Europe, and the rest by the Rest of the World. Since there is not much guidance for choosing values for the preference parameters, namely those that describe home bias in consumption for tradables, I set these to the values used by Obstfeld and Rogoff (2005b): the domestic traded good amounts to 70% of the total consumption of tradables in each country. The share of nontradables is set to 50% in both countries. Elasticities of substitution are set unity, as discussed in Section 2. As the data is calibrated to a quarterly frequency, I set the discount factor, δ, to 0.99, which is standard in the literature.

Output for the traded and nontraded goods sectors in each country comes is derived from quarterly data for Gross Value Added by industry from the Bureau of Economic Analysis and the European Central Bank's Statistical Data Warehouse, for the period 1995:I - 2006:II. Specifically, I consider to be traded the output of the following sectors: Agriculture, forestry, fishing, and hunting; Mining; Utilities; and Manufacturing. Construction and all services are assigned to the sector of nontraded goods. All data is transformed to logarithms and filtered using the Hoddrick-Prescott filter. The autocorrelations and variances for the shocks to endowments are chosen by estimating a diagonal autoregressive system using the Seemingly Unrelated Regressions method. The covariance matrix of the resulting residuals is used as the covariance matrix for the shocks. Prices for the traded goods are set to unity.

3.2 Results

Using the solution for the policy functions, and laws of motion and covariances of the state vector, I simulate the behavior of the control variables, following a shock to the exchange rate, starting at a non-stochastic steady state and initial wealth distribution. Consider a 10% impulse on the exchange rate (roughly 2.46 standard deviation). This is done using a Cholesky decomposition of $\mathcal{S}(X_t)$.

The welfare cost of a temporary 10% dollar depreciation amounts to a 0.13% decrease in the US lifetime utility, whereas for Europe it represents a 0.176% increase (first column in Table 5). A substantial part of this welfare loss to the US comes from the fall in consumption of the imported good (Figure 5), that is not compensated (in terms of lifetime utility) by an increase in consumption of the US export good. The fact that the shock to the exchange rate has a very persistent effect on the distribution of financial wealth between the two countries plays a major role on this, as discussed below.

In terms of external adjustment, the dollar depreciation leads to a short run increase in the US' current account deficit (Figure 6), operated mainly through an increase in the deficit of the trade balance (not shown here). Gradually, this deficit is reversed as the US adjusts downwards its consumption because of the persistent fall in wealth, discussed below. Thus, the numerical solution to the model exhibits a J-curve pattern in the trade balance and current account (see Magee (1973), Doroodian *et al.* (1999), and Bahmani-Oskoee and Ratha (2004) for evidence).

Since the share of euro denominated assets in each portfolio is higher for the European investor than for the American investor, the dollar depreciation has a valuation effect over total net worth that is much larger for the former than for the latter. As expected and shown in Figure 2, at impact, wealth measured in dollars increases in both countries, but considerably more so in Europe than in the US. This tilts the distribution of wealth between these two blocks in favor of Europe. This is expected since the share of European equity that the US owns is considerable smaller than its share of total wealth (this condition was established before, at the end of Section 2.1).

As assets are imperfect substitutes, an increased wealth share for Europe causes it to buy equity from the US (see Figure 3), in a portfolio rebalancing effect as the one discussed in Bohn and Tesar (1996). To see how this is the case, consider the portfolio share of US traded equity in both countries: $a_t^{US} = \frac{P_1 Q_{\theta t} \theta_t}{W_t^{US}}$ and $a_t^{EU} = \frac{P_1 Q_{\theta t}(1-\theta_t)}{W_t^{EU}}$. Since financial wealth increases more in Europe than in the US, it must be the case that Europe is buying this equity from the US (ie, θ is decreasing, as shown in the top panel of Figure 3). This portfolio rebalancing due to exchange rate shocks is positively tested in Hau and Rey (2004) using TIC data on bilateral equity flows.

At the same time, as the US is now relatively poorer, but only temporarily so, it borrows from Europe to smooth consumption, lowering US wealth below the initial wealth level. For this reason, the US wealth will converge from below, given enough time, to the initial wealth distribution. The result that the US borrowing from foreigners increases after a dollar depreciation is consistent with the behavior of net purchases of debt securities from foreign residents. I find a positive, albeit weak, correlation between future (one month ahead) US external borrowing and a dollar depreciation (see Appendix A).

It is worth cautioning that we cannot directly compare this calibration exercise with the one presented in the previous section as here we discuss a temporary change in the value of the dollar, not a permanent one. For this reason, I redo the exercise without portfolio choice and with a temporary shock in the exchange rate of the same magnitude and with the same persistence. The costs to the US and EU consumers are stated in the last column of Table 5. The impacts on lifetime utility and real aggregate consumption are much smaller without optimal portfolio choice (in fact, ten times smaller). This is because there is no persistent effect on the distribution of wealth between the two blocks besides the one that is coming directly from the persistence of the exchange rate shock. Thus, asset trade and market incompleteness play a major role in increasing the cost of exchange rate depreciations by an order of magnitude.

Furthermore, in a setting with optimal portfolio choice, the impact on US wealth is less favorable because asset prices partially counteract the valuation effect stemming from the depreciation. In fact, at impact, the valuation effect is offset by as much as 70%, as is apparent by the top right panel in Figure 4. This result is in line with Hau and Rey's (2006) finding that higher returns in the home equity market are associated with a home currency depreciation (a Euro appreciation coexists with a fall in returns on European equity). In this figure we also see that dollar denominated asset prices exhibit considerable comovement. The increase in the dollar prices of all assets can be attributed to the fact that wealth increases in both countries and both investors try to keep constant asset shares.

These results also imply that models that do not solve for asset prices and allocations are bound to underestimate the costs for US consumers of a dollar depreciation. Finally, it supports Obstfeld and Rogoff's (2005b) scepticism on the magnitude of the contribution of valuation effects for the external adjustment of the US if asset returns respond to exchange rate changes.

4 Conclusions

The US has a sizeable external imbalance as measured by the current account deficit. To correct this imbalance a potentially large dollar depreciation is needed. However, this shortfall in US savings happens against a backdrop of large gross foreign asset positions.

This means any changes in the value of the dollar have large valuation effects, which can mitigate the adverse effects of deteriorating terms of trade. The cost of this adjustment in the value of foreign currency has recently been the subject of growing attention among researchers.

The exercise presented in this paper contributes to the quantification of the costs to US consumers of a dollar depreciation when there are large investments in foreign assets.

This cost is evaluated in a setting of price rigidity of traded goods and portfolio choice. The model shows that the relative magnitudes of these trade and asset channel effects on lifetime utility crucially depend on the extent of home biases in consumption and in asset holdings.

A dollar depreciation unmistakably makes the US consumer worse off as imports become relatively more expensive. This happens because the terms of trade worsen and there are only limited valuation gains from the net foreign asset position.

The size of the asset channel effects obtained from models without asset choice is dampened by the extent of home equity bias and by portfolio rebalancing. This means the positive wealth transfer that the US receives from abroad after the depreciation, because its foreign assets are worth more in dollar terms, is greatly reduced by a fall in foreign asset prices (measured in foreign currency). Furthermore, the temporary dollar depreciation implies that Europe owns a larger share of traded equity while the US increases its debt to smooth consumption. This effect on the distribution of wealth is very persistent because of incomplete international asset markets.

One aspect that deserves closer attention in future research is the substitutability between goods. If both traded and nontraded goods are worse substitutes than assumed here, the the welfare losses are likely to be higher. Another aspect that deserves further consideration is the price adjustment mechanism for traded goods. If the prices of traded goods are allowed to gradually adjust to changes in exchange rates, the negative effect of the trade channel may be dampened.

Appendix A: Cross border debt flows and the exchange rate

This section proceeds with a simple empirical analysis of changes in the amount of debt owed to Europe by the US following a dollar depreciation. Data on the dollar-euro rate is from International Financial Statistics and Global Financial Data. Data on net purchases of US and foreign debt securities by US residents from European residents comes from the Treasury International Capital System database of the United States Department of the Treasury. Data is available from 1977:1 until 2006:7. Net purchases of debt were regressed on log changes of the exchange rate and p-values for regression significance are obtained using Newey-West heteroskedasticity and autocorrelation robust standard errors. The results are in Table 1. The results on net purchases of US bonds show that at first there is repayment of debt as the contemporaneous correlation is positive (6.33%)), albeit not significant. The one period ahead correlation however is negative at -9.31% and significantly different from zero. This means that a dollar depreciation is significantly correlated with increased future borrowing by the US.

Appendix B: log-linearization

Here I describe the approximation to the equilibrium conditions and state variable dynamics used to solve the model with Evans and Hnatkovska's (2006) method. I draw extensively on this paper and Evans and Hnatkovska (2005).

The equilibrium in this model is defined by the Euler equations for assets and consumption, the two budget constraints, and the market clearing conditions for both assets and goods. In summary, we have the following conditions:

$$\begin{aligned}
P_{1t}C_{1t}^{US} &= \alpha_1(1-\delta)W_t^{US} \\
P_{1t}C_{1t}^{EU} &= \hat{\alpha}_1(1-\delta)W_t^{EU} \\
S_tP_{2t}C_{2t}^{US} &= \alpha_2(1-\delta)W_t^{US} \\
S_tP_{2t}C_{2t}^{EU} &= (1-\hat{\alpha}_1-\hat{\alpha}_2)(1-\delta)W_t^{EU} \\
P_{USt}C_{Nt}^{US} &= (1-\alpha_1-\alpha_2)(1-\delta)W_t^{US} \\
S_tP_{EUt}C_{Nt}^{EU} &= (1-\hat{\alpha}_1-\hat{\alpha}_2)(1-\delta)W_t^{EU}
\end{aligned}$$

$$
\begin{aligned}
1 &= E_t\left(R^{\theta}_{t+1}M^{US}_{t+1}\right)\\
1 &= E_t\left(R^{\psi}_{t+1}M^{US}_{t+1}\right)\\
1 &= E_t\left(R^{\gamma}_{t+1}M^{US}_{t+1}\right)\\
1 &= E_t\left(R^{\theta}_{t+1}M^{EU}_{t+1}\right)\\
1 &= E_t\left(R^{\psi}_{t+1}M^{EU}_{t+1}\right)\\
1 &= E_t\left(R^{\eta}_{t+1}M^{EU}_{t+1}\right)\\
1 &= E_t\left(R_t M^{US}_{t+1}\right)\\
1 &= E_t\left(R_t M^{EU}_{t+1}\right)\\
W^{US}_{t+1} &= R^{US}_{t+1}(W^{US}_t - P_{1t}C^{US}_{1t} - S_t P_{2t}C^{US}_{2t} - P_{USt}C^{US}_{Nt})\\
W^{EU}_{t+1} &= R^{EU}_{t+1}(W^{EU}_t - P_{1t}C^{EU}_{1t} - S_t P_{2t}C^{EU}_{2t} - S_t P_{EUt}C^{EU}_{Nt})\\
B^{RW} &= B^{US}_t + B^{EU}_t\\
1 &= \theta^{US}_t + \theta^{EU}_t\\
1 &= \psi^{US}_t + \psi^{EU}_t\\
1 &= \gamma^{US}_t + \gamma^{EU}_t\\
1 &= \eta^{US}_t + \eta^{EU}_t
\end{aligned}
$$

where wealth and its return are defined in (21) - (22) and their equivalent expressions for EU.

To economize space, I present the approximation only to the case where $\gamma^{US}_t = 1$ and $\eta^{US} = 0$. To generalize it to the case where there are cross border equity holdings in the nontradable goods sectors is relatively straightforward. The approximate solution comes from linearizing the equilibrium conditions around a non-stochastic steady-state and some initial wealth distribution. Evans and Hnatkovska's (2006) approach consists in log-linearizing up to the first order the equations and variables of the real side of the model, while the financial side is approximated up to the second order. From this point on, all small case letters mean log-deviations from either a non-stochastic steady state or the initial wealth distribution.

Log-returns are given by Campbell, Chan, and Viceira's (2003) approximation:

$$
r^{US}_t = r_t + a^{US}_{\theta t}(r_{\theta t} - r_t) + a^{US}_{\psi t}(r_{\psi t} - r_t) + a^{US}_{\gamma t}(r_{\gamma t} - r_t) + \frac{1}{2}(\mathrm{diag}(\Sigma^{US}_t) - \Sigma^{US}_t \mathbf{a}^{US}_t)
$$

$$
r^{EU}_t = r_t + a^{EU}_{\theta t}(r_{\theta t} - r_t) + a^{EU}_{\psi t}(r_{\psi t} - r_t) + a^{EU}_{\eta t}(r_{\eta t} - r_t) + \frac{1}{2}(\mathrm{diag}(\Sigma^{EU}_t) - \Sigma^{EU}_t \mathbf{a}^{EU}_t),
$$

where $\Sigma_t^c,\ c \in \{US, EU\}$ is the conditional covariance matrix for the relevant excess returns for each country. Each individual return is then approximated as a linear function of prices and shocks (in log-deviations), like in Campbell and Shiller (1989):

$$\begin{aligned}
r_{\theta t+1} &\simeq \delta q_{\theta t+1} + (1-\delta) d_{1t+1} + p_{1t+1} - q_{\theta t} - p_{1t} \\
r_{\psi t+1} &\simeq \delta q_{\psi t+1} + (1-\delta) d_{2t+1} + s_{t+1} + p_{2t+1} - q_{\psi t} - s_t - p_{2t} \\
r_{\gamma t+1} &\simeq \delta q_{\gamma t+1} + (1-\delta) y_{USt+1} + p_{USt+1} - q_{\gamma t} - p_{USt} \\
r_{\eta t+1} &\simeq \delta q_{\eta t+1} + (1-\delta) y_{EUt+1} + s_{t+1} + p_{EUt+1} - q_{\eta t} - s_t - p_{EUt}.
\end{aligned}$$

The Euler equations for consumption of nontradables are easily log-linearized and after imposing market clearing for these goods' markets can be written as follows:

$$\begin{aligned}
p_{USt} &= w_t^{US} - y_t^{US} \\
p_{EUt} &= w_t^{EU} - y_t^{EU} - s_t.
\end{aligned} \tag{B-1}$$

The six approximate Euler equations for returns can be written in vector form as:

$$E_t \mathbf{er}_{t+1}^c = \Sigma_t^c \mathbf{a}_t^c - \frac{1}{2}\text{diag}(\Sigma_t^c). \tag{B-2}$$

for $c \in \{US, EU\}$. These Euler equations are combined with the approximations to the returns and iterated forward, giving solutions to current equity prices as functions of future dividends (as in Lucas (1978)), goods prices, and excess equity returns.

Because of logarithmic utility, the consumption to wealth ratios are constant which makes it possible to solve for the stochastic discount factor as a function of wealth only. Using log-normality of returns, the budget constraints for each country $c \in \{US, EU\}$, combined with the Euler equations for the bond, are approximated by

$$E_t w_{t+1}^c = w_t^c + r_t + \frac{1}{2}\mathbf{a}_t^{c\prime} \Sigma_t^c \mathbf{a}_t^c. \tag{B-3}$$

It is worthwhile inspecting the Euler equations for European equities. For instance, the Euler equation of the US investor for equity on EU tradable sector is

$$\begin{aligned}
q_{\psi t} &= \left((\pi_s + \pi_{p2} + (1-\delta)\pi_{d2})A - \pi_r - \pi_s - \pi_{p2} - \pi_{er\psi}\right)(I - \delta A)^{-1} X_t \\
&= \left(-\pi_s - \pi_{p2} + ((1-\delta)(\pi_s + \pi_{p2} + \pi_{d2})A - \pi_r - \pi_{er\psi})(I-\delta A)^{-1}\right) X_t
\end{aligned}$$

where assumptions (25) and (26) are used, and $a_t = \pi_a X_t$ for any variable a. This shows that the price of traded equity responds to exchange rate changes. In fact, the impact of the currency depreciation in the dollar value of the European (tradable) equity market should be at least partially neutralized by a fall in the price of European equity in euro terms. This possibility was raised in Obstfeld and Rogoff (2005a) as a reason to look with caution at the valuation effects of currency depreciations as potential facilitators of external adjustment.

Using (B-2) and (B-3), the Euler equation for the nontraded equity of the European investor can be simplified to

$$q_{\eta t} = (\pi_{yf} + (\tfrac{1}{2}\Lambda_t^{EU} - \pi_{er\eta})(I - \delta A)^{-1})X_t$$

where $\Lambda_t^{EU} X_t = \mathbf{a}_t^{f\prime} \Sigma_t^{EU} \mathbf{a}_t^f$ and $E_t r_{\eta t+1} - r_t = \mathrm{cov}_t(w_{t+1}^{EU}, r_{\eta t+1}) - \frac{1}{2}\mathrm{var}_t(r_{\eta t+1}) = \pi_{er\eta} X_t$, as in Evans and Hnatkovska (2006). So, the price of nontraded equity only changes in response to the exchange rate through its effect in the equity risk premium. In fact, any shock to the economy that changes the equity risk premia has an impact on asset prices and equilibrium portfolio shares, as pointed out in Evans and Hnatkovska (2005). Specifically, shocks that change the covariances between consumption expenditures and dollar returns or the relative prices of consumption goods have this effect.

The market clearing in the bond market uses the definitions of asset shares, combined with the clearing conditions of the each equity. The approximate version is:

$$P_1 Q_\theta(p_{1t}+q_{\theta t})+SP_2 Q_\psi(s_t+p_{2t}+q_{\psi t})+P_h Q_\gamma(p_{USt}+q_{\gamma t})+SP_f Q_\eta(s_t+p_{EUt}+q_{\eta t})-B^{RW}/Rr_t$$
$$= \delta(W^{US} w_t^{US} + W^{EU} w_t^{EU}). \tag{B-4}$$

The market clearing conditions for equity are approximated, with minor modifications, as in the appendix of Evans and Hnatkovska (2005). Conditions (B-1)-(B-4) and the approximated market clearing conditions for equity are finally written in the same form as (24) as prescribed in Evans and Hnatkovska (2006). The resulting system of equations is solved for the policy functions ($\mathbf{\Pi}$), the law of motion of the state vector ($\mathbf{A}$), the variances of wealth, and covariances of wealths with one another and the forcing variables. When solving for the variance matrix Ω_0 we have to make sure that the result satisfies positive definiteness. This is done by solving for the coefficients of a Cholesky decomposition of that matrix and not for the matrix itself.

References

[1] Albuquerque, Rui, Norman Loayza, and Luis Servén (2005). World Market Integration Through the Lens of Foreign Direct Investors, *Journal of International Economics* 66, pp. 267-295.

[2] Backus, David, and Gregory Smith (1993). "Consumption and Real Exchange Rates in Dynamic Exchange Economies with Nontraded Goods," *Journal of International Economics* 35, pp. 297-316.

[3] Backus, David, Patrick J. Kehoe, and Finn Kydland (1994). "Dynamics of the Trade Balance and the Terms of Trade: The J-Curve?," *The American Economic Review* 84, pp. 84-103.

[4] Backus, David, Espen Henriksen, Frederic Lambert, and Chris Telmer (2006). "Current Account Fact or Fiction," mimeo, New York University.

[5] Bahmani-Oskoee, Mohsen, and Artatrana Ratha (2004). "The J-Curve: a literature review," *Applied Economics* 36, pp. 1377-1398.

[6] Bils, Mark, and Peter J. Klenow (2004). "Some Evidence on the Importance of Sticky Prices," *Journal of Political Economy*, 112 (5), pp. 947-985.

[7] Bohn, Henning, and Linda L. Tesar (1996). "U.S. Equity Investment in Foreign Markets: Portfolio Rebalancing or Return Chasing?", *American Economic Review* 86 (2), pp. 77-81.

[8] Burstein, Ariel, Martin Eichenbaum, and Sergio Rebelo (2005). "Large Devaluations and the Exchange Rate," *Journal of Political Economy* 113(4), pp. 742-784.

[9] Campbell, John Y., and Robert J. Shiller (1989). "The Dividend-Price Ratio and Expectations of Future Dividends and Discount Factors," *The Review of Financial Studies* 1 (3), pp. 195-228.

[10] Cavallo, Michele, and Cedric Tille (2006). "Could Capital Gains Smooth a Current Account Rebalancing?" FRBNY Staff Report no. 237.

[11] Devereux, Michael B., and Makoto Saito (2006). "A Portfolio Theory of International Capital Flows," (unpublished: University of British Columbia and Hitotsubashi University).

[12] Dornbusch, Rudiger (1987). "Exchange Rates and Prices," *American Economic Review* 77 (1), pp. 93-106.

[13] Doroodian, Khosrow, Chulho Jung, and Roy Boyd (1999). "The J-curve effect and US agricultural and industrial trade," *Applied Economics* 31, pp. 687-695.

[14] Engel, Charles, and John H. Rogers (2006). "The U.S. Current Account Deficit and the Expected Share of World Output," Journal of Monetary Economics 53, pp. 10631093.

[15] Engel, Charles, and Akito Matsumoto (2006). "Portfolio Choice in a Monetary Open-Economy DSGE Model," NBER Working Paper No. 12214.

[16] Evans, Martin, and Viktoria Hnatkovska (2005). "International Capital Flows, Returns and World Financial Integration," working paper, Georgetown University.

[17] Evans, Martin, and Viktoria Hnatkovska (2006). "Solving General Equilibrium Models with Incomplete Markets and Many Assets," working paper, Georgetown University.

[18] Ghironi, Fabio, Jaewoo Lee, and Alessandro Rebucci (2006). "The valuation channel of external adjustment," working paper, IMF.

[19] Gopinath, Gita, and Roberto Rigobon (2006). "Sticky Borders," NBER Working Paper No. 12095.

[20] Gourinchas, Pierre, and Helene Rey (2005). "From world banker to world venture capitalist: US external adjustment and the exorbitant privilege," *working paper, Princeton University.*

[21] Hau, Harald, and Hélène Rey (2004). "Can Portfolio Rebalancing Explain the Dynamics of Equity Returns, Equity Flows, and Exchange Rates?", *American Economic Review*, 94 (2), pp. 126-133.

[22] Hau, Harald, and Hélène Rey (2006). "Exchange Rates, Equity Prices, and Capital Flows," *Review of Financial Studies*, 19 (1), pp. 273-317.

[23] Helbling, T., N. Batini, and R. Cardarelli (2005). "Globalization and external imbalances," *IMF World Economic Outlook* (April 2005). International Monetary Fund, Washington DC, pp. 109-156.

[24] Hnatkovska, Viktoria (2005). “Home Bias and High Turnover: Dynamic Portfolio Choice with Incomplete Markets,” working paper, Georgetown University.

[25] Kollmann, Robert (1995). “Consumption, real exchange rates and the structure of international asset markets,” *Journal of International Money and Finance*, Vol. 14, No. 2, pp. 191 211.

[26] Kollmann, Robert (2006). “International Portfolio Equilibrium and the Current Account,” *CEPR Discussion Paper* 3819.

[27] Kubler, Felix and Karl Schmedders (2003) “Stationary Equilibria in Asset-Pricing Models with Incomplete Markets and Collateral,” *Econometrica* 71 (6), pp. 1767-1793.

[28] Lane, Philip R., and Gian Maria Milesi-Ferretti (2000). “The Transfer Paradox Revisited: Net Foreign Assets and Real Exchange Rates,” *IMF Working Paper* 00/123.

[29] Lane, Philip R., and Gian Maria Milesi-Ferretti (2001). “The External Wealth of Nations: measures of foreign assets and liabilities for industrial and developing countries,” *Journal of International Economics* 55, pp. 263-294.

[30] Lane, Philip R., and Gian Maria Milesi-Ferretti (2006). “The External Wealth of Nations Mark II: Revised and Extended Estimates of Foreign Assets and Liabilities, 1970-2004,” CEPR Discussion Paper No. 4745. *IMF Working Paper* 06/69.

[31] Lucas, Robert E. (1978). “Asset Prices in an Exchange Economy,” *Econometrica* 46 (6), pp. 1429-1445.

[32] Magee, Stephen P. (1973). “Currency Contracts, Pass-through, and Devaluation,” *Brookings Papers on Economic Activity* 1, pp. 303-325.

[33] . Mendoza, Enrique, Vincenzo Quadrini, and Victor Rios-Rull (2006) “Financial Integration, Financial Deepness and Global Imbalances,” the 7th Jacques Polak Annual Research Conference paper.

[34] Obstfeld, Maurice (2004). “External Adjustment”, Review of World Economics 2004, Vol. 140 (4).

[35] Obstfeld, Maurice, and Kenneth Rogoff (1997). *Foundations of International Macroeconomics*, The MIT Press, Cambridge, MA.

[36] Obstfeld, Maurice, and Kenneth Rogoff (2000). "Perspectives on OECD Economic Integration: Implications for U.S. Current Account Adjustment," ibn Federal Reserve Bank of Kansas City, *Global Economic Integration: Opportunities and Challenges,* pp. 169-208.

[37] Obstfeld, Maurice, and Kenneth Rogoff (2005a). "Global current account imbalances and exchange rate adjustments," *Brookings Papers on Economic Activity*, 1:2005, pp. 67-123.

[38] Obstfeld, Maurice, and Kenneth Rogoff (2005b). "The Unsustainable US Current Account Position Revisited," NBER working paper 10869.

[39] Roubini, Nouriel and Brad Setser (2005)."Will the Bretton Woods 2 Regime Unravel Soon? The Risk of a Hard Landing in 2005-2006", Unpublished manuscript, New York University and Oxford University.

[40] Stockman, Alan (1988). "Fiscal Polcies in International Financial Markets," in Jacob A. Frenkel (ed.) *International Aspects of Fiscal Policies.* Chicago: University of Chicago Press.

[41] Stockman, Alan, and Harris Dellas (1989). "International Portfolio Nondiversification and Exchange Rate Variablity," *Journal of International Economics*, 26, pp. 271-289.

[42] Stockman, Alan, and Lars E.O. Svensson (1987). "Capital Flows, Investment, and Exchange Rates," *Journal of Monetary Economics*, 19, pp. 171-201.

[43] Stockman, Alan and Linda Tesar (1995). "Tastes and Technology in a Two-Country Model of the Business Cycle: Explaining International Comovements," *American Economic Review*, 85 pp. 168-185.

[44] Tille, Cedric (2005). "Financial Integration and the Wealth Effect of Exchange Rate Fluctuations," *Staff Report no. 226, Federal Reserve Bank of New York.*

Table 1: Correlation of EUR-USD exchange rate and contemporaneous and one-month ahead net debt security and net stock purchases by US residents from Eurozone residents. rt stands for contemporaneous correlation and r_{t+1} for one month ahead correlation.

Net Purchase of	r_t	*p-value*	r_{t+1}	*p-value*
US debt securities	0.0633	0.1502	-0.0931	0.0299
Foreign debt securities	-0.0525	0.2500	0.0652	0.1799
US stocks	0.0701	0.1006	0.0531	0.2880
Foreign stocks	-0.1133	0.0117	0.0085	0.8760

Table 2: Calibration parameters for static model

Parameter	Value	Definition
α_1	0.35	Share of tradable good 1 in US consumption
α_2	0.15	Share of tradable good 2 in US consumption
$\hat{\alpha}_1$	0.15	Share of tradable good 1 in EU consumption.
$\hat{\alpha}_2$	0.35	Share of tradable good 2 in EU consumption.
β	0.335	Share of US debt owed to EU.
b	-0.09	Total US foreign debt as share of household net worth.
r	0.01	Interest rate.
D_1	10	Endowment of tradable good 1.
D_2	7	Endowment of tradable good 2.
Y_h	10	Endowment of US nontradable good.
Y_f	7	Endowment of EU nontradable good.
P_1	1	Price of tradable good 1 in dollars.
P_2	1	Price of tradable good 2 in euros.
θ	0.806	US's share of equity on tradable good 1.
ψ	0.232	US's share of equity on tradable good 2.
γ	0.95	US's share of equity on US's nontradable good.
η	0.05	US's share of equity on Europe's nontradable good.

Table 3: Percent changes in consumption, welfare, and distribution of wealth of a 10% dollar depreciation. **No asset choice.**

	Baseline values	
Impact on:	With Home Bias in Equity	No Home Bias in Equity
C_1^{US}	1.996%	3.929%
C_2^{US}	-6.167%	-2.497%
C_1^{EU}	6.464%	3.924%
C_2^{EU}	-1.967%	-2.505%
U^{US}	-0.114%	0.520%
U^{EU}	0.172%	-0.167%
Real agg. consumption in US	-0.343%	0.623%
Real agg. consumption in EU	0.107%	-1.163%
Real wealth in US	-0.327%	0.675%
Real wealth in EU	0.090%	-0.843%
$\frac{W^{US}}{W^{US}+W^{EU}}$	-1.932%	0.000%

Table 4: Percent changes in consumption, welfare, and distribution of wealth after a permanent 10% dollar depreciation. **No portfolio choice.**

	Model without nontradables		Model with nontradables	
Impact on:	No home bias in consumption of tradables	Home bias in consumption of tradables	No home bias in consumption of tradables	Home bias in consumption of tradables
C_1^{US}	1.645%	1.645%	1.647%	1.647%
C_2^{US}	-7.283%	-7.283%	-7.281%	-7.281%
C_1^{EU}	6.750%	6.750%	6.748%	6.748%
C_1^{EU}	-2.178%	-2.178%	-2.181%	-2.181%
U^{US}	-1.831%	-0.628%	-0.733%	-0.261%
U^{EU}	1.725%	0.361%	0.698%	0.149%
Real agg. cons. in US	-2.820%	-1.035%	-1.410%	-0.517%
Real agg. cons. in EU	2.287%	0.501%	1.142%	0.250%
Real wealth in US	-2.518%	-0.967%	-1.351%	-0.507%
Real wealth in EU	2.042%	-0.427%	0.948%	0.202%
$\frac{W^{US}}{W^{US}+W^{EU}}$	-2.281%	-2.281%	-2.281%	-2.281%

Table 5: Percent changes in discounted values of consumption, and welfare after a temporary 10% dollar depreciation (half-life of about one year). **Optimal asset choice.**

	Optimal Portfolio Choice	Static Model
C_1^{US}	-0.383%	0.001%
C_2^{US}	-0.737%	-0.003%
C_1^{EU}	0.854%	0.003%
C_1^{EU}	0.496%	-0.001%
U^{US}	-0.130%	-0.010%
U^{EU}	0.176%	0.007%
Real agg. consumption in US	-0.246%	-0.020%
Real agg. consumption in EU	0.300%	0.011%
Real wealth in US	-0.197%	-0.020%
Real wealth in EU	0.316%	0.011%

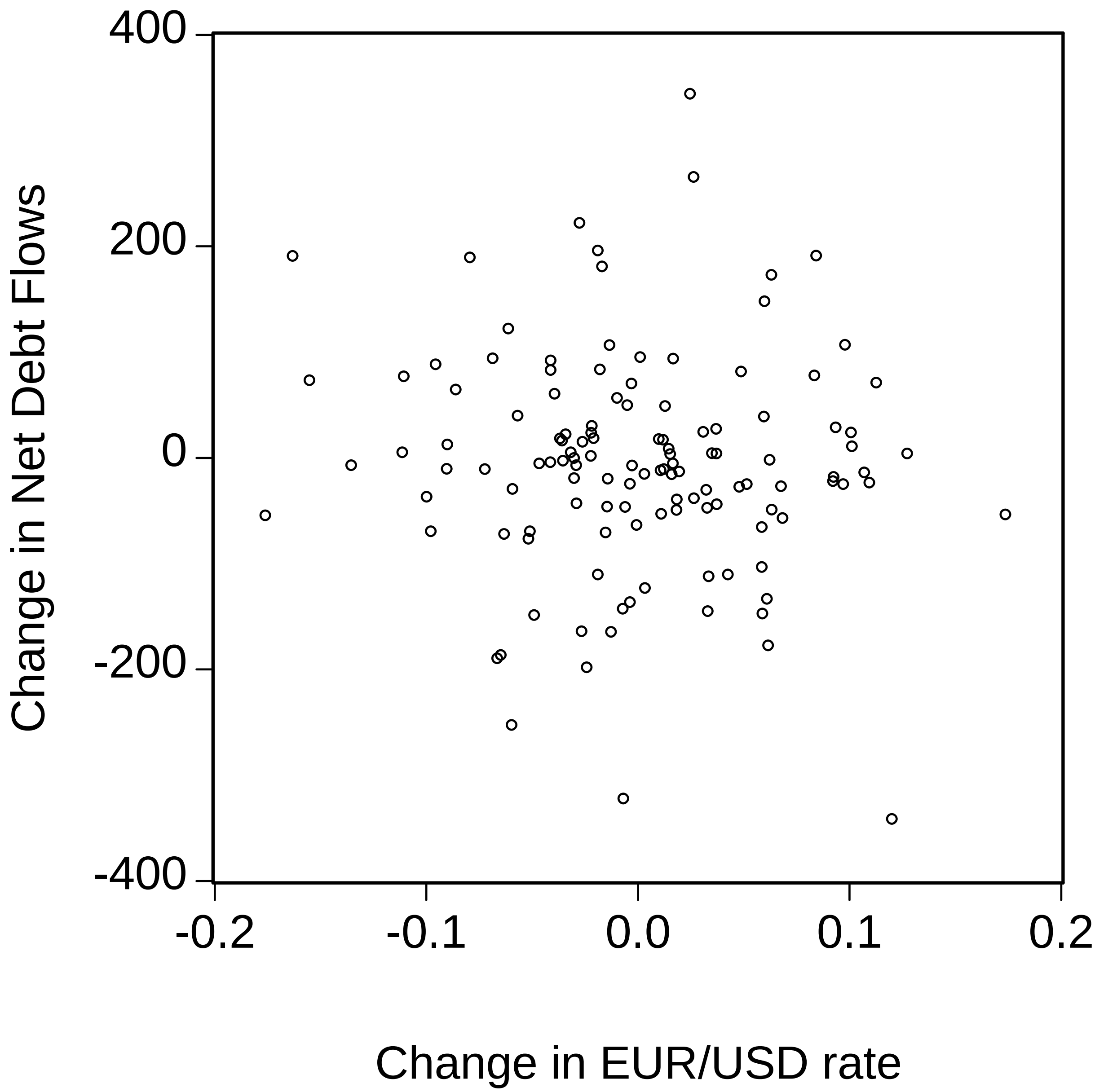

Figure 1: Exchange rate changes and Net Debt Flows (Billions of US dollars), 1975:I-2006:II.

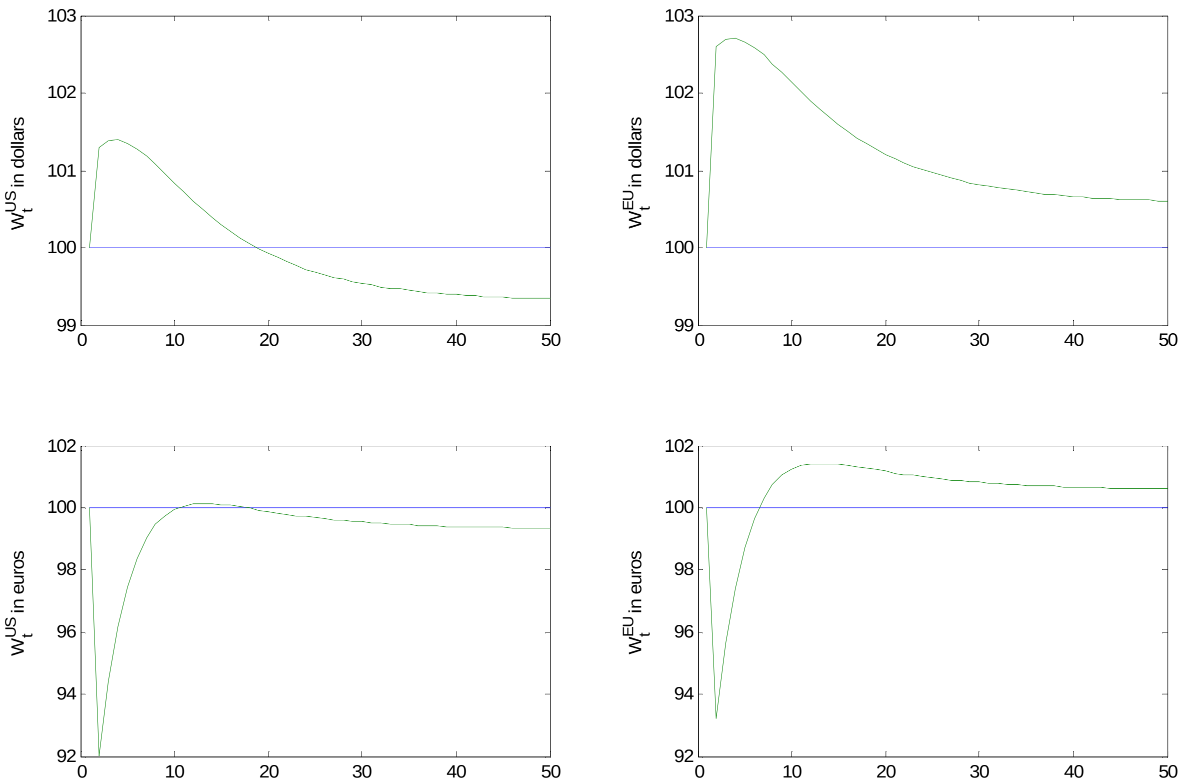

Figure 2: Impulse responses of wealth in US and EU after a 10% dollar depreciation.

Note: W_t^{US} is financial wealth in dollars in the US. W_t^{EU} is financial wealth in dollars in Europe. All values converted to percentage of initial wealth.

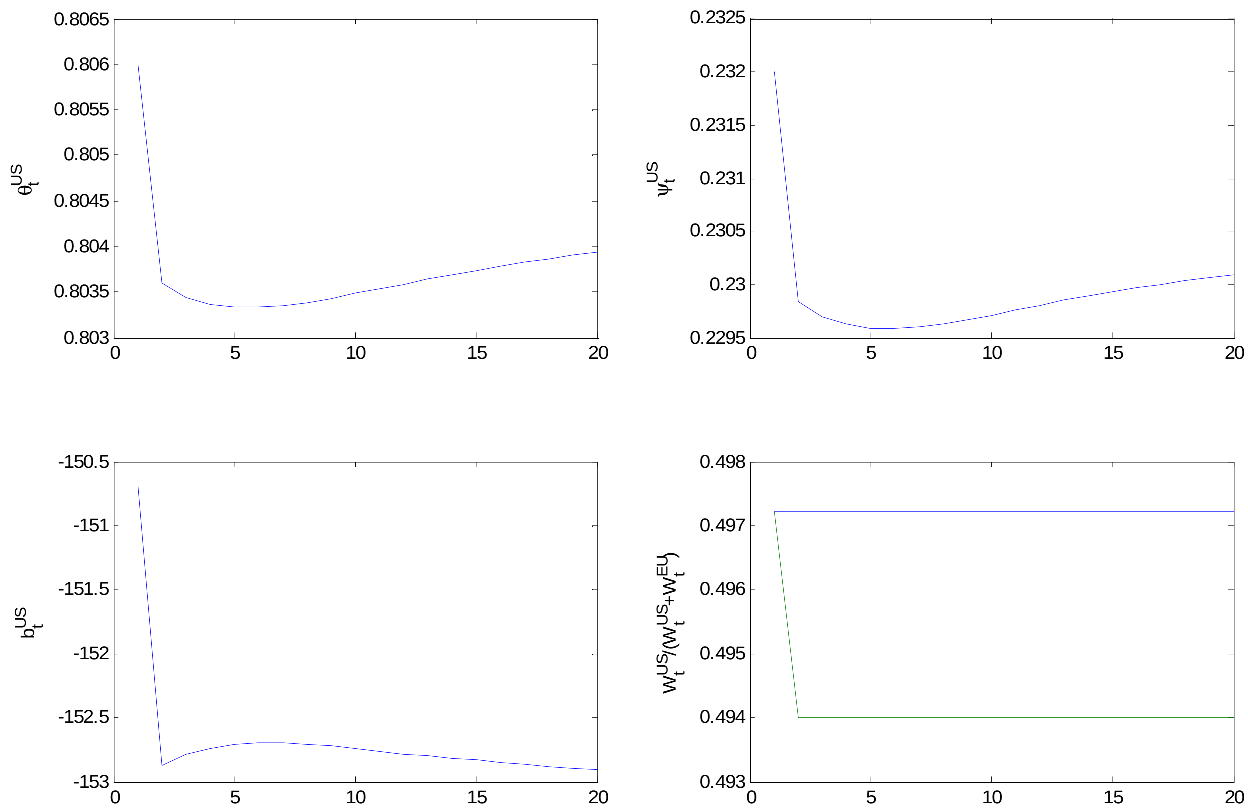

Figure 3: Impulse responses of shares of asset markets owned by US and EU investors after a a 10% dollar depreciation

Note: θ_t^{US} and ψ_t^{US} are the shares of US and EU equity markets owned by US investors, respectively. b_t^{US} is the US' external debt. $W_t^{US}/(W_t^{US}+W_t^{EU})$ is the share of total financial wealth owned by US investors.

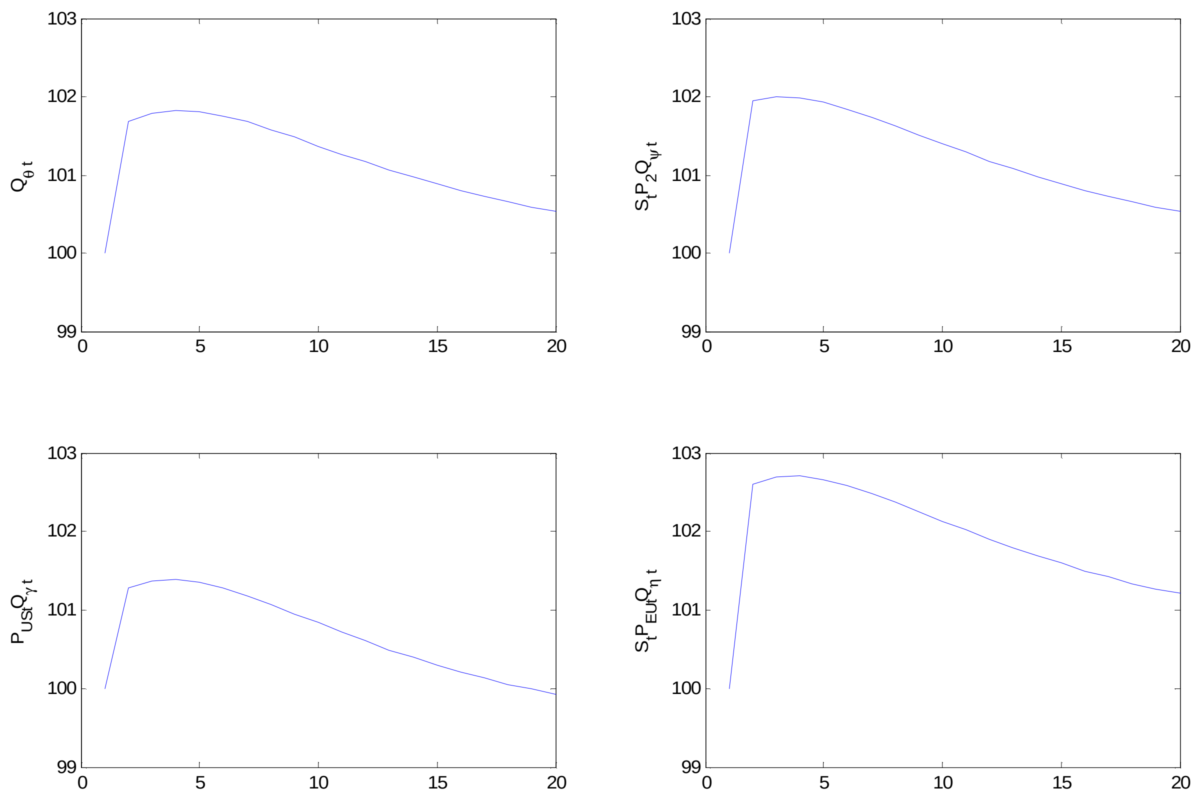

Figure 4: Impulse responses of equity prices in US and EU after a 10% dollar depreciation.

Note: $P_{1t}Q_{\theta t}$ and $P_t^{US}Q_{\gamma t}$ are the dollar prices for US traded and nontraded equities. $S_tP_{2t}Q_{\psi t}$ and $S_tP_t^{EU}Q_{\eta t}$ are the dollar prices for EU traded and nontraded equities.

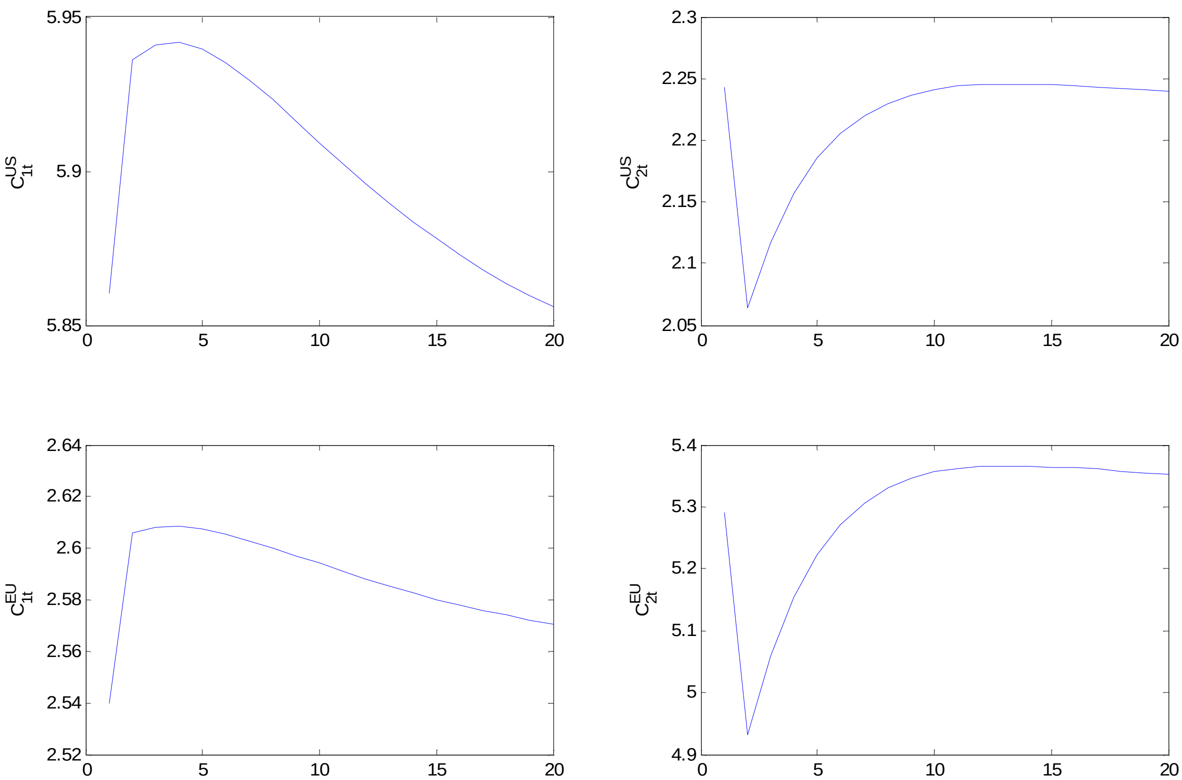

Figure 5: Impulse responses of consumption in US and EU after a 10% dollar depreciation.

Note: C_{1t}^{US} and C_{2t}^{US} is the consumption of US and EU traded goods in the US. C_{1t}^{EU} and C_{2t}^{EU} is consumption of US and EU traded goods in Europe.

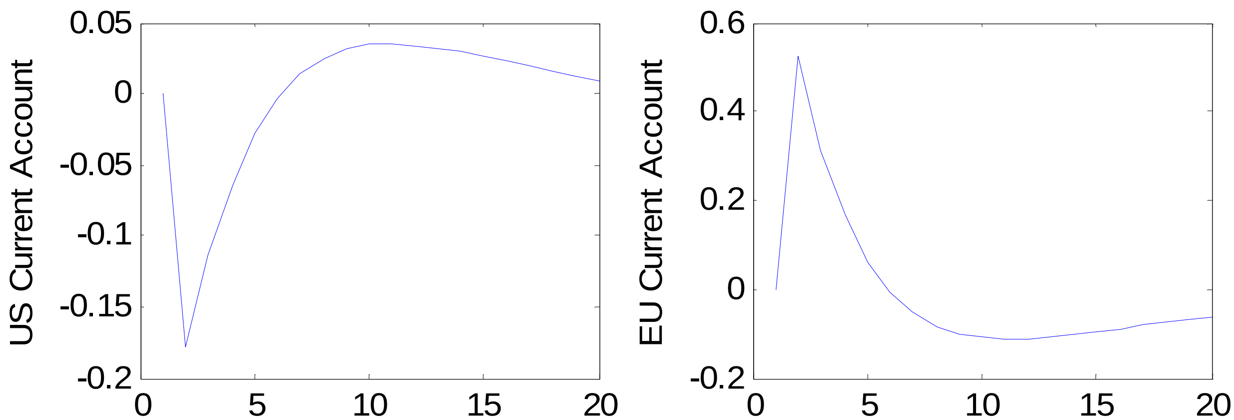

Figure 6: Impulse responses of current account in the US and Europe (in dollars) after a 10% dollar depreciation.