Tille, Cédric

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## Abstract

A growing body of research emphasizes the direct impact of exchange rate movements on the value of U.S. foreign assets. Because a substantial amount of U.S. assets are denominated in foreign currencies, a depreciation of the dollar leads to large capital gains. First, we present a detailed decomposition of the U.S. balance sheet, which exhibits substantial leverage in terms of currencies and across asset categories. The United States holds 50 percent of GDP in foreign-currency assets and is long in FDI (foreign direct investment) and equity positions and short in debt and banking positions. Then, we incorporate these features of international financial integration in a simple general equilibrium model and analyze how they affect the international transmission of monetary shocks. We find that financial integration is a central component of the model, with the valuation gains from an exchange rate depreciation leading to a welfare effect that is at least as large as that stemming from nominal rigidities alone but possibly much larger. We characterize how interdependence is affected by the composition of the portfolio across asset categories and how structural features of the model interact with financial integration.

Key words: foreign assets, valuation effect, exchange rate, interdependence

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Tille: Federal Reserve Bank of New York (e-mail: cedric.tille@ny.frb.org). The author thanks Roberto Chang, Pierre-Olivier Gourinchas, Philip Lane, Michael Moore, Paolo Pesenti, Richard Portes, Helene Rey, and Francis Warnock for helpful feedback. The author also thanks seminar audiences at the Federal Reserve Bank of New York, the Swiss National Bank, the European Economic Institute, the Graduate Institute of International Studies, Geneva (HEI), the University of Paris I, Queens University, the London School of Economics, the Bank of England, Yale University, the City University of New York, Cornell University, the Federal Reserve Bank of Dallas, the spring 2005 NBER International Finance and Macroeconomics Program meeting, the spring 2005 Federal Reserve System Committee on International Economic Analysis meeting, the 2005 Society for Economic Dynamics annual meeting, and the 2005 European Economic Association annual meeting for valuable comments. He also thanks Aaron Cooper and Svenja Gudell for providing research assistance. 

# 1 Introduction

A striking recent development in the U.S. economy is the apparent disconnect between its foreign debt and international borrowing. Over the last 20 years, the U.S. Net International Investment Position (hereinafter NIIP, the difference between foreign assets held by U.S. investors and U.S. liabilities to foreign investors) has regularly moved towards ever higher indebtedness, with the U.S. owing 22 percent of its GDP to the rest of the world at the end of 2004 (Nguyen 2005). While this is hardly surprising given the growing current account deficit of the U.S., the connection between the deficit and the NIIP is looser than one may expect. Figure 1 shows the NIIP (solid line, left scale) and the current account balance (dotted line, right scale). Over the last three years, the NIIP has remained steady despite the U.S. running a large current account deficit.

This apparent puzzle is explained by the direct impact of exchange rate movements on the NIIP. As detailed below, the U.S. owns a large amount of assets denominated in foreign currencies. The dollar value of these assets mechanically increases when the dollar depreciates. This so-called *valuation effect* of exchange rate movements is receiving a growing attention in the literature (Gourinchas and Rey 2005a,b, Lane and Milesi-Ferretti 2005a,b, 2003, Obstfeld 2004, Tille 2003).

The purpose of this paper is twofold. We first present a detailed description of the U.S. balance sheet, stressing the leverage across currencies and asset categories. We then consider a standard open-economy model and extend it to include international financial integration, with an emphasis on the valuation effect of exchange rate movements. We use the model to assess how financial integration affects the international transmission of monetary shocks.

A detailed breakdown of the composition of the U.S. assets and liabilities shows that the U.S. international portfolio is highly leveraged along several dimensions. In terms of currencies, the U.S. is a large net creditor in assets denominated in foreign currencies, which amount to 50 percent of GDP at the end of 2004. This is more than offset by net liabilities in dollar, that represent 72 percent of GDP, for a net overall debt of 22 percent of GDP. As a result of this leverage a depreciation of the dollar leads to a substantial transfer to the U.S., with a 10 percent movement transferring 5 percent of U.S. GDP. We also document a substantial leverage across various types of assets. The U.S. is a net creditor in FDI and equity, to the tune of 10 percent of GDP, while it owes the equivalent of 32 percent of GDP in debt and banking assets, a feature also documented in Gourinchas and Rey (2005b). Combining the two dimensions, we show that the currency leverage is concentrated in FDI and equity positions, with holdings of debt and banking positions being essentially in U.S. dollar.

We detail the composition of U.S. foreign currency assets across the world currencies, and show a prominent role of Europe. European currencies account for half the U.S. assets, a weight well above the role of Europe as a U.S. trading partner. A movement of the dollar exchange rate then operates through different channels depending which currencies it moves against. The valuation effect plays a more important role when the dollar moves against European currencies, whereas the usual trade channel matters more for a move against Asian currencies for instance.

The second contribution of the paper is to assess how financial integration impacts the international transmission mechanism. We consider a standard two-country model, namely the setup by Obstfeld and Rogoff (1995), and modify it to include international financial integration. Our simple extension allows us to consider cross-country holdings of various financial assets, while keeping the complexity of the model to a minimum. We focus on the impact of a permanent unexpected monetary shock that depreciates the currency of the home country, and illustrate how the transmission of shocks varies depending on the structure of financial integration. The structure of integration is taken as given for simplicity.

Financial integration is a central dimension of the model. When a country is a net creditor in foreign currency assets, even though its overall net international position is zero, a depreciation of its currency leads to a substantial transfer through a capital gain on its foreign assets, boosting the welfare of the home agent. The magnitude of this effect depends on the exact structure of international asset holdings. We assume that foreign currency assets amount to 50 percent of GDP, as in the U.S. When cross-border holdings take the form of debt instruments, the valuation effect magnifies the welfare gain from a monetary expansion by a factor of six, compared to the case where integration is absent.

Considering equity holdings dampens the effect. While a depreciation of the home currency still leads to a capital gain, it also boosts home profits. The value of equity holdings of foreign investors then increases, which represents a capital loss for the home agent. Under a parametrization based on the U.S. situation, we find that a monetary expansion in the home country leads to a welfare gain that is twice as large as the one when we abstract from financial integration. Cross-border asset holdings, and the associated transfers, therefore leads to welfare effects that are at least as large as the ones stemming from nominal rigidities.

We also show how the structure of financial integration interacts with other structural dimensions of the economy, such as the degree of exchange rate pass-through to import prices, the sensitivity of marginal costs to exchange rate movements, and the degree of substitutability between goods produced in different countries.

The paper is organized as follows. Section 2 reviews the literature associated to our analysis. We present a detailed analysis of the U.S. balance sheet in section 3. Section 4 derives a micro-founded general equilibrium model encompassing financial integration. We focus on the central features of the model, and the detailed derivations are presented in an Appendix. The transmission of monetary shocks is analyzed in section 5, contrasting various financial structures. Section 6 concludes.

## 2 An overview of related literature

The sizable role of valuation effects is receiving a growing attention in the literature. Cavallo (2004), Kouparitsas (2004) and Tille (2003) present non-technical overviews of the issue, stressing its relevance for the U.S. in recent years. Gourinchas and Rey (2005a,b) characterize the U.S. situation over a long horizon. They point that exchange rate movements adjust external imbalances in the U.S. economy both through the usual trade channel and through valuation gains on U.S. assets. They find that the latter channel accounts for one third of the total adjustment.

A broad multi-country perspective is offered in Lane and Milesi-Ferretti (2005a,b, 2003) and Lane (2004). Using an extensive multi-country dataset, they show that international gross asset holdings have substantially increased in the last decade, by more than net positions. The world has therefore moved towards higher financial integration, and exchange rate movements now have large valuation effects. They detail the sensitivity of financial positions to exchange rate fluctuations across asset categories for several countries.

Lane and Milesi-Ferretti (2005b) and IMF (2005) point that while the valuation effect of exchange rate movements is stabilizing in industrialized countries, with a depreciation associated with capital gains, the opposite is the case for emerging markets, with a depreciation generating capital losses through liabilities in foreign currencies. The presence of adverse valuation effects following a depreciation is a long-recognized dimension in the literature on emerging markets. Calvo and Reinhardt (2002) stress the role of these effects in motivating the 'fear of floating' in emerging markets. Several authors point to the interaction between the valuation effect of exchange rate movements and the financial fragility of an economy as a central element in determining optimal policy in emerging markets (Cespedes, Chang and Velasco 2004, Chang and Velasco 2004, Elekdag and Tchakarov 2004). Kray, Loayza, Serven and Ventura (2004) analyze the pattern of portfolio holdings between industrialized and emerging countries.

Obstfeld (2004) documents the increase in financial integration across several countries, and argues that open-economy models need to take this dimension into account. He stresses the need to improve our understanding of the motivations of international investors. An application of the valuation effect of exchange rate movements is the adjustment prospects for the current U.S. imbalances (Blanchard, Giavazzi and Sa 2005, Cavallo and Tille 2005, Obstfeld and Rogoff 2005). The effect can help the adjustment by smoothing it over time (Cavallo and Tille 2005), though it does not remove the prospect of a substantial depreciation of the dollar (Obstfeld and Rogoff 2005). Roubini and Setser (2004) point that while the valuation gains have benefited the U.S. so far, their sustainability is open to question given the large losses that this channel implies for foreign investors. Another application using data on investment positions is Corsetti and Konstantinou (2005) who find evidence supporting the intertemporal approach to the current account.

The valuation effect of exchange rate movements operates as a wealth transfer between countries, with the capital gains to U.S. investors following a dollar depreciation offset by capital losses for foreign investors. The welfare consequences of such a re-distribution of wealth can be substantial. In the last three years, the depreciation of the dollar has resulted in a \$ 0.9 trillion capital gain for the U.S.. Based on the estimates of Fair (2004), this transfer can result in a long run increase of consumption of \$ 27 billions, representing 0.25 percent of annual GDP. The large macroeconomic impact of redistribution is also discussed in Doepke and Schneider (2004).

The empirical relevance of international financial integration has led to this aspect being included in general equilibrium models of open economies. Benigno (2001), Cavallo and Ghironi (2002), Iscan, Ghironi and Rebucci

(2005) and Ghironi, Lee and Rebucci (2005) look at models where net asset positions are not zero. Benigno (2001) and Cavallo and Ghironi (2002) highlight the relevance of this dimension in the design of optimal monetary policy and exchange rate dynamics. These contributions however focus on a world where only one asset is traded internationally, and cannot capture the distinction between gross and net asset positions, which is a major dimension of international integration. Iscan, Ghironi and Rebucci (2005) and Ghironi, Lee and Rebucci (2005) look at a richer menu of assets in a setup with financial frictions. They focus on the dynamic response of the various variables to productivity shocks, and do not assess how the welfare impact depends on the structure of financial integration. Kollman (2005) presents a model with holdings in several assets, and replicates the observed dynamic properties of international asset positions.

The relevance of financial integration points to the need of a tractable model of international portfolio, as discussed by Obstfeld (2004). Understanding the extent of investment in foreign financial markets, the so-called 'home bias puzzle', is an active line of research, with Engel and Matsumoto (2005) and Heathcote and Perri (2004) providing two recent contributions, focusing on equity. Devereux and Saito (2005) derive a model of portfolio allocation in a world with different assets.

On the empirical side. the improvement of data on the U.S. portfolio in recent years has led to several contributions. Griever, Lee and Warnock (2001) present a detailed description of the available data, discussing the strengths and weaknesses of various sources. Ahearne, Griever and Warnock (2004) find a substantial role for information frictions in accounting for U.S. equity assets. Burger and Warnock (2004, 2003) look at the risk-sharing properties of U.S. investments in foreign-currency bonds., and point that the gains from diversification are limited when investors are exposed to exchange rate risk.

A central dimension in the analysis of international financial integration is the exact structure of linkages. For instance, an exchange rate depreciation can potentially lead to different gains depending on whether assets holdings are in debt instruments or equities, as equity and bond prices may react differently. Understanding the joint movement in exchange rates and asset prices is a fruitful avenue of research. Pavlova and Rigobon (2004) present a comprehensive model and stress that the co-movements in exchange rates and asset prices depend on the nature of the shocks hitting the economy. For instance, equity prices in different countries move in step following productivity shocks, but in different directions following demand shocks. Ehrmann, Fratzscher and Rigobon (2004) contrast the interdependence of various asset prices between Europe and the U.S., focusing on movements at daily frequencies. Some studies find a substantial interaction between equity prices and exchange rates (Bekaert and Hodrick 1992, Yang and Doong 2004), while other argue that the magnitude of linkages is small (Bodart and Reding 2001, Solnick and Freitas 1988)

# 3 The leveraged investment position of the U.S.

## 3.1 Exchange rate movements as a driver of the U.S. balance sheet

Over the last 20 years, the United States have moved from being a net creditor vis-a-vis the rest of the world to a net debtor. The evolution of the NIIP went through three distinct stages (Figure 1). Between 1982 and 1996 the U.S. position gradually changed, with the NIIP moving from + 7.3 to - 4.6 percent of GDP. The pace of debt accumulation then substantially picked up in the second half of the 1990s, with the NIIP reaching - 23.1 percent of GDP by the end of 2001. The foreign indebtedness of the U.S. has subsequently stabilized, with the NIIP actually narrowing to - 21.7 percent of GDP at the end of 2004.

The stability of the U.S. net position vis-a-vis the rest of the world in the last two years is quite striking, as the U.S. has been running an increasingly large current account deficit, borrowing 5.7 percent of its GDP in 2004 alone. A review the factors that drive the NIIP sheds light on this pattern,, as discussed in Tille (2003):

- Financial flows. The value of U.S. assets increases when U.S. investors purchase additional foreign assets, and similarly new purchases of U.S. assets by foreign investors boost U.S. liabilities. The difference between these flows corresponds to the current account balance, with the NIIP decreasing when the U.S. runs a current account deficit.

- Asset prices valuation. The value of the U.S. holdings of foreign assets increases with the prices of these assets, with gains in foreign stock markets boosting the value of U.S. equity assets for example. Similarly, the value of foreign holdings in the U.S. moves with the U.S. asset prices, with a rise in U.S. equity prices adding to the value of foreign investors' stake.

- Exchange rate valuation. The dollar value of assets denominated in foreign currencies increases when the dollar depreciates. For example, a depreciation of the dollar against the euro boosts the dollar value of a given portfolio in euro-denominated assets. As detailed below, the amount of U.S. assets denominated in foreign currencies far exceeds the amount of U.S. liabilities denominated in foreign currencies, so a depreciation of the dollar generates a capital gain for the U.S.

The influence of these three factors is detailed in the data from the Bureau of Economic Analysis. In addition of the asset and liability positions, the BEA publishes a detailed breakdown of the changes in the value of U.S. assets and liabilities between the three drivers described above, as well as changes stemming from revisions in the data coverage and methodology (referred to as 'other valuation' changes).[1] A shortcoming is that a detailed breakdown is published only for the most recent year, and a revised breakdown for earlier years is available only for the aggregate NIIP. We can nevertheless estimate a revised detailed breakdown for assets and liabilities, with the details described in the Appendix.

The decomposition of the changes in the value of U.S. gross assets is presented in figure 2, with all values expressed as percentage of GDP. Over the last 14 years, U.S. investors have substantially invested additional funds abroad, as shown by the positive capital outflows (grey bars). The valuation effect of asset price movements is depicted by the white bars. Rising asset prices in the late 1990s led to substantial capital gains for U.S. investors. These were offset by losses in 2000-2002 as foreign asset markets softened, and the last two years have witnessed renewed gains. Movements in exchange rates have a substantial effect on the value of U.S. assets (black bars). While the appreciation of the dollar in 2000-2001 reduced the value of U.S. assets, the mechanism has gone in reverse in the last three years.

The corresponding decomposition for U.S. liabilities is shown in figure 3. The increase in liabilities is dominated by the steady rise in fresh borrowing from the rest of the world. Movements in asset prices also have a substantial

[1] The data are published from 1990 on.

impact, with the pattern being quite similar to that observed for U.S. assets. By contrast, movements in exchange rates have only a negligible effect, as the bulk of U.S. liabilities is denominated in dollar, as detailed below.

Combining the changes for assets and liabilities leads to the decomposition of changes in the NIIP, presented in figure 4. Financial flows are steadily pushing the U.S. into debt, reflecting the large and increasing current account deficit. The valuation effect of asset prices is very small, especially since 2000. While movements in asset prices substantially affect the value of gross assets and liabilities, the two sides of the balance sheet essentially cancel out. No such offset is observed for the valuation effect of exchange rate movements, with gains and losses on U.S. assets translating nearly one-for-one in the net position. The magnitude of the exchange rate valuation effect is quite important. In the last three years, the depreciation of the dollar generated an average annual capital gain of 2.9 percent of GDP, offsetting 56 percent of the impact of financial flows.[2]

The magnitude of the exchange rate valuation effect has been increasing through time, as can be seen from figure 4. While this in part reflects the large fluctuations of exchange rates in recent years, it is also driven by the increasing degree of international financial integration, in the form of higher cross-holdings of financial assets across countries. Because the exchange rate valuation effect is concentrated on U.S. *gross* assets, a given movement in the external value of the dollar can have very different implications for a given NIIP depending on the degree of financial integration.[3] The larger the value of gross assets, i.e. the higher the degree of financial integration, the larger the valuation effect of a given exchange rate movement. The degree of financial integration between the U.S. and the rest of the world has indeed substantially increased, explaining the more prominent role of exchange rate valuation effects. Figure 5 presents the gross U.S. assets and liabilities, scaled by GDP. Over the last ten years the value of U.S. assets nearly doubled as a percentage of GDP, with an even larger increase for the value of U.S. liabilities. This rise in integration is not specific to the U.S. and reflects a worldwide pattern, as discussed in Lane and Milesi-Ferretti (2005a,b).

[2] Figure 4 also shows a substantial contribution of the 'other valuation' category in 2002 and 2003. This reflects revisions in the benchmark surveys that underpin the BEA data. For instance, estimates of U.S. assets in debt securities were substantially revised upwards (Federal Reserve and al. 2005a).

[3] For a simple example illustrating this aspect, see Tille (2003).

## 3.2 The detailed composition of U.S. assets and liabilities

### 3.2.1 Data sources and methodology

The concentration of the exchange rate valuation effect on U.S. clearly points to a substantial share of assets denominated in foreign currency. This section takes a closer look at the detailed composition of U.S. assets and liabilities, both in terms of the types of securities and the currencies involved. The composition of assets and liabilities across official positions, foreign direct investment (hereinafter FDI), equity, debt, bank and other is readily available from the BEA (Nguyen 2005). Assessing the currency composition of the positions requires additional steps. We start by reviewing the procedure used, which is described in more details in the Appendix.

On the asset side, the currency composition of official positions is inferred from the BEA data and the currency composition of foreign exchange reserves provided by the U.S. Treasury. The geographical composition of U.S. equity assets is decomposed by using the benchmark survey of U.S. Holdings of Foreign Securities as of December 31, 2003 (Federal Reserve Bank of New York et al. 2005a). This data source is the most recent issue of periodic benchmark surveys of U.S. custodians undertaken by the Federal Reserve System and the U.S. Treasury. The geographical composition at the end of 2003 is applied to the total U.S. equity assets at the end of 2004.

We assume that equity holdings in a given country are denominated in the currency of that country. For instance, a French stock held by a U.S. investor is denominated in euro, so a depreciation of the dollar increases its value, in dollar, holding all other prices constant. This assumption, which is consistent with the evidence of Solnick and Freitas (1988), implies that equity positions are not hedged for exchange rate risk. If U.S. investors were hedging this risk, we should consider the positions to be in dollar, as exchange rate movements would be offset by the derivative contracts. Hau and Rey (2005) and Levich et al. (1999) present evidence of a very limited extent of hedging. In addition, their estimates do not distinguish whether the hedging positions are held between two domestic investors, in which case they cancel out for the country as a whole, or whether they are held between domestic and foreign investors. This limited use can reflect the moderate effectiveness of hedging at long horizons, as discussed by Froot (1993). Our assumption that equity assets abroad are in foreign currency is then a good approximation.

A related question is the role of foreign firms listings in U.S. markets through American Depositary Receipts (ADR). We argue that the presence of ADR's does not invalidate our assumption that holdings of foreign equities are denominated in foreign currencies. First, ADR's represent only 16 % of U.S. equity assets (Federal Reserve Bank of New York et al. 2005a, Table 7). Second, while ADR's are listed in dollar in the U.S., there is an active arbitraging activity keeping their dollar price in the U.S. in line with the foreign currency price in the foreign market, so the dollar price moves in step with the relevant exchange rate.[4]

The geographical composition of FDI assets relies on a complementary data from the BEA (2005), which cover the FDI positions in 2004 on a historical cost basis. We use this composition to allocate the FDI assets from the NIIP data, which are computed at market value, across countries. As for equity assets, we assume that holdings in a country are denominated in that country's currency. The currency composition of U.S. debt assets is taken from the benchmark survey discussed earlier (Federal Reserve Bank of New York et al. 2005a), and applied to the total value of debt assets at the end of 2004. The composition of U.S. assets in bank and other securities is taken from Nguyen (2005), with these categories consisting primarily of positions denominated in dollar.

The analysis of the liability side is more straightforward. All liabilities in the official, FDI and equity categories are in dollar. While some debt liabilities are in foreign currencies, they represent only a small fraction of the total position and the currency allocation is based on the benchmark survey of Foreign Holdings of U.S. Securities as of June 30, 2004 (Federal Reserve Bank of New York et al. 2005b). The composition of U.S. liabilities in bank and other securities, which are primarily in dollar, is taken from Nguyen (2005).

#### 3.2.2 The multiple leverages of the U.S. balance sheet

The U.S. balance sheet is substantially leveraged along several dimensions. First, the substantial net debt of the U.S. reflects even larger gross asset and liabilities, as shown in figure 5. A measure of leverage is given by the Grubel-Lloyd index discussed by Obstfeld (2004). This index is the ratio

[4] I am grateful to John Duca and Francis Warnock for comments on ADR's.

of the (absolute) net position to the sum of the gross positions:

$$LEV_{\text{Aggregate}} = 1 - \frac{Abs\,[\text{NIIP}]}{\text{Gross assets} + \text{Gross Liabilities}}$$

This measure is equal to zero if there is no leverage, that is when the NIIP reflects a one-sided gross position. It increases the larger the gross positions are for a given net position. At the end of 2004, this measure of the degree of leverage between gross assets and liabilities amounted to 0.85.

We now turn to assessing the relevance of positions in all foreign currencies for various asset categories.[5] The top panel of table 1 shows the value of U.S. assets, with a decomposition of the total between positions in FDI, equity, and all other categories of assets. For each category, the overall position is decomposed between positions denominated in U.S. dollar and positions denominated in foreign currencies.

U.S. assets are fairly balanced across the various categories, with FDI and equity accounting for 58 percent of all assets. In terms of the currency composition, foreign currencies represent a substantial fraction of U.S. assets, accounting for 65 percent of the total. The prominence of foreign currencies is quite uneven across the various asset classes. While they account for nearly all FDI and equity assets, they represent only 17 percent of the remaining assets. This reflects the fact that the bulk of U.S. assets in debt securities and banking consist of dollar denominated positions.

The composition of U.S. liabilities is presented in the second panel of Table 1. Liabilities are tilted towards debt and banking positions, with FDI and equity representing only 37 percent of the total. Foreign currencies play a marginal role, with the dollar accounting for 95 percent of U.S. liabilities.

The third panel of Table 1 shows the values of the various positions in net terms. The U.S. is substantially leveraged in terms of currencies. The net debt of $ 2.5 trillions represents the difference between $ 8.4 trillions worth of dollar denominated liabilities and $ 5.9 trillions worth of assets denominated in foreign currencies. The extend of currency leverage is substantial, of the same order of magnitude as the leverage between gross assets and liabilities, with a leverage index of 0.82.[6]

The third and final dimension of leverage is observed across the various categories of assets. While the U.S. is a net creditor in terms of FDI and

[5] A more detailed breakdown is presented in the Appendix, with Tables A.1 and A.2 showing the positions at the end of 2004, and the end of 2003, respectively.

[6] 0.82=1-[2,542]/[8,393+5,851]

equity, to the tune of \$ 1.2 trillions, this is more than offset by a \$ 3.7 trillions liabilities in other types of assets, mostly debt and banking positions. This leverage is substantial, with a value of 0.48 for our leverage index,[7] and prompted Gourinchas and Rey (2005b) to refer to the U.S. as the "world venture capitalist". Looking at the joint leverage across currencies and categories of assets, we see that the currency leverage is concentrated in FDI and equity, where the leverage ratio amounts to 0.89.[8] By contrast asset and liabilities in the other categories are essentially in dollar.

The bottom panel of Table 1 shows the net positions as percent of GDP. Overall, the U.S. holds 50 percent of GDP in assets denominated in foreign currencies, essentially consisting of FDI and equity positions. The U.S. net assets in FDI and equity represent 10 percent of GDP, while the net debt in the other categories amounting to 32 percent of GDP.

### 3.2.3 The prominent role of European currencies

Our analysis so far has contrasted the positions in U.S. dollar and foreign currencies, and we now complete it by taking a detailed look in the later category. Table 2 presents the decomposition of overall U.S. assets (column a) and liabilities (column b) across several currencies. The currency composition of net assets is given in the next two columns, both in absolute amounts (column c) and as percentages of GDP (column d). The final column indicates the shares of the various currencies to the total U.S. assets in foreign currencies, amounting to \$ 5,581 billions.

The main feature is the predominant role of European currencies, which account for slightly more than half of all assets denominated in foreign currencies. The euro area unsurprisingly makes the bulk of this position, with a substantial role for the United Kingdom and Switzerland, reflecting their role as financial centers. Asian currencies play a more modest role, accounting for only one-fifth of U.S. foreign currency assets. Currencies of the Western hemisphere make nearly a quarter of U.S. assets. A substantial fraction of this amount consists of U.S. assets invested in Caribbean currencies, which account for 8 percent of all U.S. assets. The extent to which these holdings can be viewed as assets in foreign currencies is open to question however. As Caribbean currencies show very little, if any, movements against the dollar, these positions are highly unlikely to generate any valuation effects from

[7] 0.48=1-[2,542]/[1,192+3,734]

[8] 0.89=1-[1,192]/[4,580+5,772]

exchange rate movements.[9]

We put the share of European currencies in context by contrasting the role of the various countries as financial counterparts with their role as trade partners. Specifically, we compare the shares of the various currencies in U.S. assets (column e of Table 2) with the weights of the corresponding countries in the broad trade-weighted exchange rate index published by the Board of Governors of the Federal Reserve.[10] Figure 6 contrasts the weights in foreign currency assets (horizontal axis) with the weights in the exchange rate index (vertical axis) for the major countries, with a more detailed comparison presented in Table 3. The role of the Euro area and the United Kingdom as financial counterparts substantially exceed their role as trading partners, the opposite being true for Non-Japan Asia, Canada and Latin America. The contrast is particularly striking for financial centers, such as the Caribbean countries and Switzerland.[11]

The contrasted roles of the various countries as financial and trading partners implies that a movement in the dollar exchange rate can operate through different channels, depending on which currencies the dollar moves against. The first mechanism is the trade channel, with a depreciation of the dollar making U.S. goods more competitive and thereby boosting U.S. exports. The second mechanism is the valuation channel, with a depreciation leading to a wealth transfer in favor of the U.S. by boosting the dollar value of U.S. assets denominated in foreign currencies. A depreciation of the U.S. dollar against Asian currencies or the Canadian dollar is likely to operate primarily through the trade channel, as these countries are substantial trading partners, but U.S. investors own relatively little assets in these currencies. By contrast, the financial channel will play a larger role in a depreciation of the dollar against the euro and the pound, as the weight of these countries in the U.S. portfolio exceeds their role as trading partners.

The difference between the trade and financial weights presented in Table 3 indicates that a trade-based exchange rate index, such as the trade-weighted index of the Board of Governors, is not the appropriate measure of the effec-

[9] Between January 1994 and January 2004, the East Caribbean dollar, Aruba guilder, Bahamian dollar, Bermudian dollar, Caymanian dollar, Netherlands Antillean guilder and Trinidad and Tobago dollar moved by 0.4 %, 0.3 %, 0 %, 0%, 0.2 %, 0.7 % and 11.6 %, respectively against the U.S. dollar.

[10] http://www.federalreserve.gov/releases/H10/Weights

[11] Our analysis uses the overal trade weights published by the Board of Governors. The results are similar if we use the export or import weights.

tive movement of the exchange rate viewed from the perspective of the U.S. portfolio. We construct an 'asset-weighted' exchange rate by combining the weights presented in Table 3[12] with the corresponding exchange rates, measured as the December values from 1999 on.[13] The annual depreciation of the dollar is presented in figure 7, in terms of the broad trade-weighted exchange rate (thin solid line), the asset-weighted exchange rate (thick solid line) and the asset-weighted exchange rate excluding the Caribbean countries, as their currencies are steady against the dollar (dotted line). The figure shows that the asset-weighted exchange rate has been more volatile, and that the depreciation of the dollar since the end of 2001 has been more pronounced in financial terms (23.3 percent) than in trade terms (14.5 percent). This reflects the fact that the dollar depreciation has been concentrated against European currencies. The depreciation has been more moderate movement against Asian currencies, and the dollar actually appreciated against the Latin American currencies.

Our analysis shows that international financial integration is a relevant feature of the U.S. economy, with substantial leverage in terms of gross positions, currency holdings, and across categories of assets. This dimension has so far received little attention in the standard open-economy models used to analyze international interdependence. Allowing for financial integration is a key step in assessing how the valuation effects described above affect the costs and benefits of exchange rate movements. For instance, one may conjecture that unrealized capital gains from valuation changes may mean little beyond affecting the net debt itself.

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[12] Specifically, we focus on the Euro area, the United Kingdom, Switzerland, Japan, China, Korea, Taiwan, Singapore, Hong Kong, Australia, Malaysia, the Philippines, Thailand, India, Canada, Mexico, Brazil, the Caribbeanss, Caribbean, and Israel.

[13] As we compute our estimates of the currency composition of assets in 2004 only, we do not look at exchange rate movements beyond 5 years, as possible shifts in the composition of assets may make our measure uncertain beyond that horizon.

# 4 A simple model of the impact of financial integration

## 4.1 General structure

We analyze the impact of exchange rate movements using a simple micro-founded general equilibrium model, following Obstfeld and Rogoff (1995). As their setup is by now standard, we focus on the novel dimensions of our analysis, with a more detailed exposition being presented in the Appendix.

The world is made of two countries, home and foreign, each of size 1/2. Each country is inhabited by a representative household who consumes a range of different goods and works in domestic firms. Agents can invest in bonds denominated in home and foreign currencies, as well as in equity in home and foreign firms. The model is solved in terms of linear expansions around a steady state where no country holds any *net* asset claims on the other, although holdings of *gross* claims denominated in different types of assets and currencies are allowed. This allows us to capture the financial leverage that we documented for the U.S. investment position. Our approach should be understood as showing the impact of shocks conditional on the structure or international assets holdings. We derive a general solution of the model, encompassing varying degrees of price and wage flexibility, openness and exchange rate pass-through. For simplicity the general solution is detailed in the Appendix, and we present the key features of the solution through a serie of particular cases.

## 4.2 Household's optimization

### 4.2.1 Consumption allocation

The goal of the home household at time $t$ is to maximize the following intertemporal utility:

$$U_t = \sum_{s=0}^{\infty} \beta^s \left[ \ln C_{t+s} + \chi \ln \left( \frac{M_{t+s}}{P_{t+s}} \right) - \kappa H_{t+s} \right] \tag{1}$$

where $C$ is consumption of a basket detailed below, $M$ are nominal balances, $P$ is the consumer price index, and $H$ is a measure of hours worked.

The composition of the aggregate consumption basket is illustrated in Figure 8. We allow for the presence of non-traded goods as in Hau (2000):

aggregate consumption is divided between baskets of home traded goods, foreign traded goods and domestically-produced non-traded goods. Specifically, aggregate consumption is written as a constant elasticity of substitution basket:

$$C=\left[\left(\frac{1-\gamma}{2-\gamma}\right)^{\frac{1}{\lambda}}\left(C_{HT}\right)^{\frac{\lambda-1}{\lambda}}+\left(\frac{1-\gamma}{2-\gamma}\right)^{\frac{1}{\lambda}}\left(C_{FT}\right)^{\frac{\lambda-1}{\lambda}}+\left(\frac{\gamma}{2-\gamma}\right)^{\frac{1}{\lambda}}\left(C_{N}\right)^{\frac{\lambda-1}{\lambda}}\right]^{\frac{\lambda}{\lambda-1}}$$

where $C_{HT}$ is a basket of traded goods produced in the home country, $C_{FT}$ is a basket of traded goods produced in the foreign country, $C_N$ is a basket of non-traded goods produced in the home country, and $\lambda$ is the elasticity of substitution between the three baskets. $\gamma \in [0,1]$ is the share of non-traded goods in the economy. There is a continuous unit range of brands available for consumption, with each country producing half the brands (Figure 8). Brands on the $[0,\gamma/2)$ interval are non-traded goods produced in the home country, brands on the $[\gamma/2,1/2)$ interval are traded goods produced in the home country, brands on the $[1/2,1-\gamma/2)$ interval are traded goods produced in the foreign country, brands on the $[1-\gamma/2,1]$ interval are non-traded goods produced in the foreign country. The consumption baskets for each type of good are written as constant elasticity of substitution aggregates over the corresponding brands:

$$\begin{aligned}
C_{HT} &= \left[\left(\frac{2}{1-\gamma}\right)^{\frac{1}{\theta}}\int_{\gamma/2}^{1/2}\left(C_{HT}(z)\right)^{\frac{\theta-1}{\theta}}dz\right]^{\frac{\theta}{\theta-1}}\\
C_{FT} &= \left[\left(\frac{2}{1-\gamma}\right)^{\frac{1}{\theta}}\int_{1/2}^{1-\gamma/2}\left(C_{FT}(z)\right)^{\frac{\theta-1}{\theta}}dz\right]^{\frac{\theta}{\theta-1}}\\
C_{N} &= \left[\left(\frac{2}{\gamma}\right)^{\frac{1}{\theta}}\int_{0}^{\gamma/2}\left(C_{N}(z)\right)^{\frac{\theta-1}{\theta}}dz\right]^{\frac{\theta}{\theta-1}}
\end{aligned}$$

where $z$ is an index of brands, and $\theta > 1$ is the elasticity of substitution between brands. We make the usual assumption that there is more substitutability between brands than between different types of goods: $\theta > \lambda$.

The demands for the various brands are computed along usual lines. They are driven by the aggregate consumption, as well as relative prices between types of goods and brands, with the impact of prices reflecting the relevant elasticities of substitution:

$$\begin{aligned}
C_{HT}(z) &= \frac{2}{2-\gamma}\left[\frac{P_{HT}(z)}{P_{HT}}\right]^{-\theta}\left[\frac{P_{HT}}{P}\right]^{-\lambda} C \\
C_{FT}(z) &= \frac{2}{2-\gamma}\left[\frac{P_{FT}(z)}{P_{FT}}\right]^{-\theta}\left[\frac{P_{FT}}{P}\right]^{-\lambda} C \\
C_{N}(z) &= \frac{2}{2-\gamma}\left[\frac{P_{N}(z)}{P_{N}}\right]^{-\theta}\left[\frac{P_{N}}{P}\right]^{-\lambda} C
\end{aligned}$$

where $P_{HT}(z)$ is the price, in home currency, of a unit of a traded brand $z$ produced in the home country. $P_{FT}(z)$ and $P_N(z)$ are the corresponding prices for a foreign traded brand and a home non-traded brand respectively. $P_{HT}$, $P_{FT}$, $P_N$ and $P$ are the usual cost-minimizing price indexes.[14] The consumption allocation of the foreign household is computed along similar lines. The consumer price indexes in both countries are:

$$P = \left[\frac{1-\gamma}{2-\gamma}[P_{HT}]^{1-\lambda} + \frac{1-\gamma}{2-\gamma}[P_{FT}]^{1-\lambda} + \frac{\gamma}{2-\gamma}[P_N]^{1-\lambda}\right]^{\frac{1}{1-\lambda}} \tag{2}$$

$$P^* = \left[\frac{1-\gamma}{2-\gamma}[P^*_{HT}]^{1-\lambda} + \frac{1-\gamma}{2-\gamma}[P^*_{FT}]^{1-\lambda} + \frac{\gamma}{2-\gamma}[P^*_N]^{1-\lambda}\right]^{\frac{1}{1-\lambda}} \tag{3}$$

#### 4.2.2 Budget constraint and intertemporal allocation

Each household has access to a diversified menu of assets. In addition of domestic currency, she can purchase nominal bonds denominated in home and foreign currencies. We consider both risk-free one-period bonds, as well as perpetuity bonds that pay a fixed nominal interest rate for all future

[14] Specifically:

$$\begin{aligned}
P_{HT} &= \left[\frac{2}{1-\gamma}\int_{\gamma/2}^{1/2}[P_{HT}(z)]^{1-\theta}\,dz\right]^{\frac{1}{1-\theta}} \\
P_{FT} &= \left[\frac{2}{1-\gamma}\int_{1/2}^{1-\gamma/2}[P_{FT}(z)]^{1-\theta}\,dz\right]^{\frac{1}{1-\theta}} \\
P_{N} &= \left[\frac{2}{\gamma}\int_{0}^{\gamma/2}[P_{N}(z)]^{1-\theta}\,dz\right]^{\frac{1}{1-\theta}}
\end{aligned}$$

periods. Each household can also purchase shares in home and foreign firms. For simplicity we consider that purchases of equity in firms of a given country take place through a mutual fund of all firms in that country. Investors therefore purchase claims on aggregate profits, and we abstract from any portfolio composition differential across investors.[15]

The budget constraint of the home household for period $t$ is expressed in nominal terms as:

$$\begin{aligned} & P_t C_t + M_t + [q_t K_{Ht+1} + S_t q_t^* K_{Ft+1}] \\ & + [BS_{Ht+1} + S_t BS_{Ft+1}] + [g_t BL_{Ht+1} + S_t g_t^* BL_{Ft+1}] \\ = \; & W_t H_t + M_{t-1} + T_t + [(q_t + D_t) K_{Ht} + S_t (q_t^* + D_t^*) K_{Ft}] \\ & + [(1 + i_{St}) BS_{Ht} + S_t (1 + i_{St}^*) BS_{Ft}] + [(g_t + i_L) BL_{Ht} + S_t (g_t^* + i_L^*) BL_{Ft}] \end{aligned} \tag{4}$$

The household allocates her resources between consumption, $P_t C_t$, nominal balances, $M_t$, and purchases of various assets. The first bracket on the left-hand side denotes equity purchases. The household purchases $K_{Ht+1}$ shares of home firms, paying a price $q_t$ for each share. She also buys $K_{Ft+1}$ shares of foreign firms, which sell for a price $q_t^*$ in foreign currency. That price is converted in home currency through the exchange rate $S_t$, defined in terms of units of home currency per units of foreign currency. The second bracket shows purchases of one-period bonds. The agent buys $BS_{Ht+1}$ units of the short bond denominated in home currency, and $BS_{Ft+1}$ units in the short bond denominated in foreign currency. The final bracket on the left hand side reflects the purchases of long term bonds. The household buys $BL_{Ht+1}$ units of the long term bond denominated in home currency, with each unit costing $g_t$ in terms of home currency. She also purchases $BL_{Ft+1}$ units of the long term bond denominated in foreign currency, with each unit costing $g_t^*$ in terms of foreign currency.

The right-hand side shows the resources of the home household, consisting of her wage income, $W_t H_t$, initial nominal balances, $M_{t-1}$, a lump-sum transfer from the government, $T_t$, and the value of her initial portfolio, including earnings for period $t$. The first bracket shows the returns on equity holdings. Each of the $K_{Ht}$ units of home shares pays a dividend $D_t$ and can be sold at the equity price $q_t$. Similarly, each share in foreign equity pays a dividend $D_t^*$, in foreign currency, and can be sold at the foreign-currency equity price

[15] For instance, it could be the case that domestic investors equally purchase shares of all home firms, while foreign investors concentrate their purchases to firms producing traded goods. We leave such refinments to future work.

$q_t^*$. The second bracket shows the returns on one-period bonds, with each unit of the home currency bond paying a return of $1 + i_{St}$, while each foreign currency bond pays off $1 + i_{St}^*$ units of foreign currency. The final bracket illustrates the returns on long-term bond. Each unit of the foreign currency bond pays and interest of $i_L$ and can be sold at the prevailing bond price $g_t$. Similarly, a foreign long-term bond pays an interest of $i_L^*$ in foreign currency and can be sold at a foreign-currency price $g_t^*$. Note that the interest rates on the face value of long-term bonds, $i_L$ and $i_L^*$, are invariant through time.

The maximization of (1) subject to (4) leads to the following first-order-conditions:

$$\frac{M_t}{P_t} = \chi \frac{C_t}{1 - \beta E_t \frac{P_t C_t}{P_{t+1} C_{t+1}}} \tag{5}$$

$$1 = \beta E_t \frac{q_{t+1} + D_{t+1}}{q_t} \frac{P_t C_t}{P_{t+1} C_{t+1}} = \beta E_t \frac{S_{t+1}}{S_t} \frac{q_{t+1}^* + D_{t+1}^*}{q_t^*} \frac{P_t C_t}{P_{t+1} C_{t+1}} \tag{6}$$

$$1 = \beta E_t \left(1 + i_{St+1}\right) \frac{P_t C_t}{P_{t+1} C_{t+1}} = \beta E_t \frac{S_{t+1}}{S_t} \left(1 + i_{St+1}^*\right) \frac{P_t C_t}{P_{t+1} C_{t+1}} \tag{7}$$

$$1 = \beta E_t \frac{g_{t+1} + i_L}{g_t} \frac{P_t C_t}{P_{t+1} C_{t+1}} = \beta E_t \frac{S_{t+1}}{S_t} \frac{g_{t+1}^* + i_L^*}{g_t^*} \frac{P_t C_t}{P_{t+1} C_{t+1}} \tag{8}$$

(5) is the usual money demand stemming from the maximization with respect to real balances $M_t/P_t$. (6) shows the optimality conditions with respect to the holdings of home equity and foreign equity. The cost of purchasing a unit of home equity $q_t$, adjusted by the current marginal utility of income, $(P_t C_t)^{-1}$, is equal to the expected discounted payoff from the equity, $q_{t+1} + D_{t+1}$, adjusted by the current marginal utility of income, $(P_{t+1} C_{t+1})^{-1}$. A similar relation holds for purchasing of foreign equities, with a role for the exchange rate. (7) is the optimality conditions with respect to the holdings of home- and foreign-currency one-period bonds. The interpretation is the same as for equity holdings. Finally, (8) is the optimality conditions with respect to the holdings of home- and foreign-currency long term bonds. The interpretation is again similar to the one for equity holdings.

Notice that the first order conditions (6)-(8) imply that in a certainty-equivalent world (i.e. where $E_t X_{t+1} Y_{t+1} = E_t X_{t+1} E_t Y_{t+1}$) the expected returns on all assets are identical when expressed in home currency. As our approach consists of solving the model in terms of first order linear approximations around a steady state, we can only solve for the total value of asset holdings, but not for their composition across the various available assets.[16]

The optimization of the foreign household is similar. Denoting foreign variables with an asterisk, the budget constraint of the foreign household for period $t$ is:

$$\begin{aligned} & P_t^* C_t^* + M_t^* + \left[ \frac{1}{S_t} q_t K_{Ht+1}^* + q_t^* K_{Ft+1}^* \right] \\ & + \left[ \frac{1}{S_t} BS_{Ht+1}^* + BS_{Ft+1}^* \right] + \left[ \frac{1}{S_t} g_t BL_{Ht+1}^* + g_t^* BL_{Ft+1}^* \right] \\ = \; & W_t^* H_t^* + M_{t-1}^* + T_t^* + \left[ \frac{1}{S_t} \left( q_t + D_t \right) K_{Ht}^* + \left( q_t^* + D_t^* \right) K_{Ft}^* \right] \\ & + \left[ \frac{1}{S_t} \left( 1 + i_{St} \right) BS_{Ht}^* + \left( 1 + i_{St}^* \right) BS_{Ft}^* \right] + \left[ \frac{1}{S_t} \left( g_t + i_L \right) BL_{Ht}^* + \left( g_t^* + i_L^* \right) BL_{Ft}^* \right] \end{aligned} \tag{9}$$

where the various variables are defined similarly to their home counterparts in (4). For instance, $B_{Ht}^*$ and $B_{Ft}^*$ are the quantity of home- and foreign-currency one-period bonds that the foreign household holds at the beginning of period $t$. The optimization by the foreign household leads to the following money demand and optimal portfolio conditions:

$$\frac{M_t^*}{P_t^*} = \chi \frac{C_t^*}{1 - \beta E_t \frac{P_t^* C_t^*}{P_{t+1}^* C_{t+1}^*}} \tag{10}$$

$$1 = \beta E_t \frac{S_t}{S_{t+1}} \frac{q_{t+1} + D_{t+1}}{q_t} \frac{P_t^* C_t^*}{P_{t+1}^* C_{t+1}^*} = \beta E_t \frac{q_{t+1}^* + D_{t+1}^*}{q_t^*} \frac{P_t^* C_t^*}{P_{t+1}^* C_{t+1}^*} \tag{11}$$

$$1 = \beta E_t \frac{S_t}{S_{t+1}} \left( 1 + i_{St+1} \right) \frac{P_t^* C_t^*}{P_{t+1}^* C_{t+1}^*} = \beta E_t \left( 1 + i_{St+1}^* \right) \frac{P_t^* C_t^*}{P_{t+1}^* C_{t+1}^*} \tag{12}$$

$$1 = \beta E_t \frac{S_t}{S_{t+1}} \frac{g_{t+1} + i_L}{g_t} \frac{P_t^* C_t^*}{P_{t+1}^* C_{t+1}^*} = \beta E_t \frac{g_{t+1}^* + i_L^*}{g_t^*} \frac{P_t^* C_t^*}{P_{t+1}^* C_{t+1}^*} \tag{13}$$

### 4.2.3 Labor supply

In order to allow for wage rigidities, we consider that households supply a continuum of differentiated labor services. The aggregate measure of hours

[16] Iscan, Ghironi and Rebucci (2005) and Ghironi, Lee and Rebucci (2005) get around this issue by introducing portfolio holding costs, thereby insuring that the first-order conditions pin down the composition of the portfolio.

in the home country is a constant elasticity of substitution index across hours in the various categories of labor:

$$H_t = \left[ \int_0^1 (H_t(j))^{\frac{\delta-1}{\delta}} dj \right]^{\frac{\delta}{\delta-1}}$$

where $\delta$ is the elasticity of substitution between the categories. The imperfect substitutability of labor implies that the household has a monopoly power in choosing her labor supply. Firms use a technology that is linear in aggregate labor, with each category of labor being equally productive. The demand by home firms for a particular type of labor $j$ is then given by:

$$H_t(j) = \left[ \frac{W_t(j)}{W_t} \right]^{-\delta} H_t \quad , \quad W_t = \left[ \int_0^1 [W_t(j)]^{1-\delta} dj \right]^{\frac{1}{1-\delta}}$$

where $W(j)$ is the wage charged for the type of labor and $W$ is an aggregate wage index. The total wage income in the budget constraint (4) is then:

$$W_t H_t = \int_0^1 W_t(j) \left[ \frac{W_t(j)}{W_t} \right]^{-\delta} H_t dj$$

When the household can adjust her wage, the first-order condition with respect to a category-specific wage leads to the labor supply:

$$W_t(j) = \frac{\delta}{\delta-1} \kappa P_t C_t \tag{14}$$

The optimization by the foreign household leads to a similar labor supply relation:

$$W_t^*(j) = \frac{\delta}{\delta-1} \kappa P_t^* C_t^* \tag{15}$$

## 4.3 Firms' optimization

The demand faced by the various firms are computed by aggregating the consumption allocation rules across the home and foreign households. The outputs of representative home firms in the traded and non traded sectors are:

$$\begin{aligned} Y_{Tt}(z) &= \frac{1}{2-\gamma}\left[\frac{P_{HTt}(z)}{P_{HTt}}\right]^{-\theta}\left[\frac{P_{HTt}}{P_t}\right]^{-\lambda}C_t \qquad (16) \\ &+\frac{1}{2-\gamma}\left[\frac{P^*_{HTt}(z)}{P^*_{HTt}}\right]^{-\theta}\left[\frac{P^*_{HTt}}{P^*_t}\right]^{-\lambda}C^*_t \\ Y_{Nt}(z) &= \frac{1}{2-\gamma}\left[\frac{P_{Nt}(z)}{P_{Nt}}\right]^{-\theta}\left[\frac{P_{Nt}}{P_t}\right]^{-\lambda}C_t \qquad (17) \end{aligned}$$

Similarly, the output of representative foreign firms are:

$$\begin{aligned} Y^*_{Tt}(z) &= \frac{1}{2-\gamma}\left[\frac{P_{FTt}(z)}{P_{FTt}}\right]^{-\theta}\left[\frac{P_{FTt}}{P_t}\right]^{-\lambda}C_t \qquad (18) \\ &+\frac{1}{2-\gamma}\left[\frac{P^*_{FTt}(z)}{P^*_{FTt}}\right]^{-\theta}\left[\frac{P^*_{FTt}}{P^*_t}\right]^{-\lambda}C^*_t \\ Y^*_{Nt}(z) &= \frac{1}{2-\gamma}\left[\frac{P^*_{Nt}(z)}{P^*_{Nt}}\right]^{-\theta}\left[\frac{P^*_{Nt}}{P^*_t}\right]^{-\lambda}C^*_t \qquad (19) \end{aligned}$$

All firms use a linear technology through which one unit of the aggregate hours index produces one unit of output. The home-currency profits of representative home firms are then given by:

$$\begin{aligned} \Pi_{Tt}(z) &= \frac{P_{HTt}(z)-W_t}{2-\gamma}\left[\frac{P_{HTt}(z)}{P_{HTt}}\right]^{-\theta}\left[\frac{P_{HTt}}{P_t}\right]^{-\lambda}C_t \qquad (20) \\ &+\frac{S_tP^*_{HTt}(z)-W_t}{2-\gamma}\left[\frac{P^*_{HTt}(z)}{P^*_{HTt}}\right]^{-\theta}\left[\frac{P^*_{HTt}}{P^*_t}\right]^{-\lambda}C^*_t \\ \Pi_{Nt}(z) &= \frac{P_{Nt}(z)-W_t}{2-\gamma}\left[\frac{P_{Nt}(z)}{P_{Nt}}\right]^{-\theta}\left[\frac{P_{Nt}}{P_t}\right]^{-\lambda}C_t \qquad (21) \end{aligned}$$

while the foreign-currency profits of foreign firms are:

$$\begin{aligned} \Pi^*_{Tt}(z) &= \frac{S_t^{-1}P_{FTt}(z)-W^*_t}{2-\gamma}\left[\frac{P_{FTt}(z)}{P_{FTt}}\right]^{-\theta}\left[\frac{P_{FTt}}{P_t}\right]^{-\lambda}C_t \qquad (22) \\ &+\frac{P^*_{FTt}(z)-W^*_t}{2-\gamma}\left[\frac{P^*_{FTt}(z)}{P^*_{FTt}}\right]^{-\theta}\left[\frac{P^*_{FTt}}{P^*_t}\right]^{-\lambda}C^*_t \\ \Pi^*_{Nt}(z) &= \frac{P^*_{Nt}(z)-W^*_t}{2-\gamma}\left[\frac{P^*_{Nt}(z)}{P^*_{Nt}}\right]^{-\theta}\left[\frac{P^*_{Nt}}{P^*_t}\right]^{-\lambda}C^*_t \qquad (23) \end{aligned}$$

We define the following measures of per-capita aggregate outputs and profits in both countries:

$$
\begin{aligned}
Y_t &= 2\int_{\gamma/2}^{1/2} Y_{Tt}(z)\,dz + 2\int_0^{\gamma/2} Y_{Nt}(z)\,dz && (24)\\
Y_t^* &= 2\int_{1/2}^{1-\gamma/2} Y_{Tt}^*(z)\,dz + 2\int_{1-\gamma/2}^{1} Y_{Nt}^*(z)\,dz && (25)\\
\Pi_t &= 2\int_{\gamma/2}^{1/2} \Pi_{Tt}(z)\,dz + 2\int_0^{\gamma/2} \Pi_{Nt}(z)\,dz && (26)\\
\Pi_t^* &= 2\int_{1/2}^{1-\gamma/2} \Pi_{Tt}^*(z)\,dz + 2\int_{1-\gamma/2}^{1} \Pi_{Nt}^*(z)\,dz && (27)
\end{aligned}
$$

Throughout the paper, we assume that the profits are entirely paid to shareholders as dividend: $\Pi_t = D_t$, $\Pi_t^* = D_t^*$, as in Ghironi, Lee and Rebucci (2005).

Each firm is the sole producer of a particular brand and benefits from monopoly power that it takes into account when setting prices. When firms can adjust their prices, the maximization of profits (20)-(23) with respect to the relevant brand prices lead firms to charge a markup over the wage cost for all sales, reflecting the substitutability between brands:

$$
\begin{aligned}
P_{HTt}(z) &= S_t P_{HTt}^*(z) = P_{Nt}(z) = \frac{\theta}{\theta-1} W_t && (28)\\
P_{FTt}^*(z) &= S_t^{-1} P_{FTt}(z) = P_{Nt}^*(z) = \frac{\theta}{\theta-1} W_t^* \qquad \forall z
\end{aligned}
$$

## 4.4 Current accounts and net foreign assets

We abstract from government spending and assume that in both countries seigniorage revenue is repaid to the household through a lump-sum transfer: $T_t = M_t - M_{t-1}$ and $T_t^* = M_t^* - M_{t-1}^*$. The market for each asset clears, with world demand equating world supply. We assume that each bond is in zero net supply worldwide, so positive holdings by the home agent are mirrored by negative holdings by the foreign agent. We also assume that there is a fixed amount of equity shares available for home firms, denoted by $K_H$, with $K_F$ denoting the fixed amount of equity shares in foreign firms. The clearing of asset markets at period $t$ then requires:

$$\begin{aligned} 0 &= BS_{Ht} + BS_{Ht}^{*} = BS_{Ft} + BS_{Ft}^{*} \\ &= BL_{Ht} + BL_{Ht}^{*} = BL_{Ft} + BL_{Ft}^{*} \\ &= \left(K_{Ht} + K_{Ht}^{*}\right) - K_{H} = \left(K_{Ft} + K_{Ft}^{*}\right) - K_{F} \end{aligned} \tag{29}$$

Using these assumptions, the current account for the home country is derived from the home agent's budget constraint (4) as follows:

$$\begin{aligned} & P_t C_t + \left[S_t q_t^{*}\left(K^{*} - K_{Ft+1}^{*}\right) - q_t\left(K - K_{Ht+1}\right)\right] \\ & + \left[BS_{Ht+1} + S_t BS_{Ft+1}\right] + \left[g_t BL_{Ht+1} + S_t g_t^{*} BL_{Ft+1}\right] \\ = \; & \Pi_t + W_t H_t + \left[S_t\left(q_t^{*} + \frac{\Pi_t^{*}}{K^{*}}\right)\left(K^{*} - K_{Ft}^{*}\right) - \left(q_t + \frac{\Pi_t}{K}\right)\left(K - K_{Ht}\right)\right] \\ & + \left[\left(1 + i_{St}\right) BS_{Ht} + S_t\left(1 + i_{St}^{*}\right) BS_{Ft}\right] + \left[\left(g_t + i_L\right) BL_{Ht} + S_t\left(g_t^{*} + i_L^{*}\right) BL_{Ft}\right] \end{aligned} \tag{30}$$

The interpretation of (30) parallels that of (4): consumption spending and final savings are financed by nominal GDP, consisting of total home profits and wage income, plus the gross return on initial asset holdings. We used the asset market clearing conditions (29) to rewrite the holdings of equities in net terms. For instance, the net holdings of equity at the end of the period is the value of the shares in foreign firms held by the home agent, $S_t q_t^{*}\left(K^{*} - K_{Ft+1}^{*}\right)$, minus the value of the shares in home firms held by the home agent, $q_t\left(K - K_{Ht+1}\right)$. The foreign current account can similarly be written as:

$$\begin{aligned} & P_t^{*} C_t^{*} + \left[\frac{1}{S_t} q_t\left(K - K_{Ht+1}\right) - q_t^{*}\left(K^{*} - K_{Ft+1}^{*}\right)\right] \\ & + \left[-\frac{1}{S_t} BS_{Ht+1} - BS_{Ft+1}\right] + \left[-\frac{1}{S_t} g_t BL_{Ht+1} - g_t^{*} BL_{Ft+1}\right] \\ = \; & \Pi_t^{*} + W_t^{*} H_t^{*} + \left[\frac{1}{S_t}\left(q_t + \frac{\Pi_t}{K}\right)\left(K - K_{Ht}\right) - \left(q_t^{*} + \frac{\Pi_t^{*}}{K^{*}}\right)\left(K^{*} - K_{Ft}^{*}\right)\right] \\ & + \left[-\frac{1}{S_t}\left(1 + i_{St}\right) BS_{Ht} - \left(1 + i_{St}^{*}\right) BS_{Ft}\right] + \left[-\frac{1}{S_t}\left(g_t + i_L\right) BL_{Ht} - \left(g_t^{*} + i_L^{*}\right) BL_{Ft}\right] \end{aligned} \tag{31}$$

We define the net foreign asset position of the home country, $NFA_{t+1}$, as the home currency value of its holdings at the end period $t$, evaluated at the asset prices of period $t$:

$$\begin{aligned} NFA_{t+1} &= \left[S_t q_t^* \left(K^* - K_{Ft+1}^*\right) - q_t \left(K - K_{Ht+1}\right)\right] \\ &\quad + \left[BS_{Ht+1} + S_t BS_{Ft+1}\right] + \left[g_t BL_{Ht+1} + S_t g_t^* BL_{Ft+1}\right] \end{aligned} \tag{32}$$

This measure corresponds to the BEA data that are measured at the end of a year. The foreign currency value of foreign holdings are simply equal to $-NFA_{t+1}/S_t$. Notice that the current account (30) is can be written as:

$$NFA_{t+1} - NFA_t = TB_t + NFI_t + \widetilde{NFA}_t - NFA_t$$

where $TB_t$ is the trade balance, $NFI_t$ the net factor income from asset holdings, $NFA_t$ and $\widetilde{NFA}_t$ the values of home asset holdings at the end period $t$, evaluated at the asset prices of period $t-1$ and period $t$ respectively.[17] The changes in the net asset positions between two periods is driven by financial flows, reflecting the trade balance and net factor income, and valuation changes, stemming from movements in asset prices and the exchange rate.

## 4.5 A steady state with cross-country asset holdings

While we cannot derive a closed form solution of the model in general, we can do so in the specific case where the two households do not hold any *net* claims on each other, i.e. $NFA_0 = 0$, with a zero subscript denoting the steady state.

In the baseline model of Obstfeld and Rogoff (1995) where only a one-period home currency bond is traded, this translates into zero gross asset holdings and there is no role for financial integration. Under our more general

[17] Specifcally:

$$\begin{aligned} TB_t &= \Pi_t + W_t H_t - P_t C_t \\ NFI_t &= \left[S_t \frac{\Pi_t^*}{K^*}\left(K^* - K_{Ft}^*\right) - \frac{\Pi_t}{K}\left(K - K_{Ht}\right)\right] \\ &\quad + \left[i_{St} BS_{Ht} + S_t i_{St}^* BS_{Ft}\right] + \left[i_L BL_{Ht} + S_t i_L^* BL_{Ft}\right] \\ NFA_t &= \left[S_{t-1} q_{t-1}^* \left(K^* - K_{Ft}^*\right) - q_{t-1}\left(K - K_{Ht}\right)\right] \\ &\quad + \left[BS_{Ht} + S_{t-1} BS_{Ft}\right] + \left[g_{t-1} BL_{Ht} + S_{t-1} g_{t-1}^* BL_{Ft}\right] \\ \widetilde{NFA}_t &= \left[S_t q_t^* \left(K^* - K_{Ft}^*\right) - q_t \left(K - K_{Ht}\right)\right] \\ &\quad + \left[BS_{Ht} + S_t BS_{Ft}\right] + \left[g_t BL_{Ht} + S_t g_t^* BL_{Ft}\right] \end{aligned}$$

asset menu by contrast, the absence of net claims is consistent with non-zero *gross* claims in the various assets:

$$\begin{aligned} 0 &= S_0 q_0^* \left(K^* - K_{F0}^*\right) - q_0 \left(K - K_{H0}\right) \\ &\quad + BS_{H0} + S_0 BS_{F0} + g_0 BL_{H0} + S_0 g_0^* BL_{F0} \end{aligned}$$

Our setup allows for several dimensions of leverage. For instance, holdings can be limited to one-period bonds with a long position in foreign currency bonds ($S_0 BS_{F0} = -BS_{H0} > 0$). Alternatively, the home agent can be a net creditor in equities, with this position financed by a net debt in long term bonds.

The composition of the portfolios in the symmetric steady state is entirely exogenous, as our model does not allow us to pin them down from an optimal portfolio choice. An alternative approach, as in Iscan, Ghironi and Rebucci (2005) and Ghironi, Lee and Rebucci (2005), is to introduce financial costs that depend on the various holdings. The first-order conditions (6)-(8) then pin down the composition of the portfolio even in the steady state. This alternative method is however quite close to the one we use, as the steady state portfolio is also exogenously determined through the financial costs.

For convenience, we define several measures related to financial positions in the steady state. $GF_0$ is the position in foreign-currency assets, with $GF_0 > 0$ indicating that the home country is a net creditor in foreign currency assets. $GK_0$ is the gross value of cross-border equity holdings, and $NFK_0$ is the net equity assets held by the home agent, with $NFK_0 > 0$ indicating that the home agent owns more foreign equity than the foreign agent owns home equity:

$$\begin{aligned} GF_0 &= S_0 q_0^* \left(K^* - K_{F0}^*\right) + S_0 BS_{F0} + S_0 g_0^* BL_{F0} \\ GK_0 &= S_0 q_0^* \left(K^* - K_{F0}^*\right) + q_0 \left(K - K_{H0}\right) \\ NFK_0 &= S_0 q_0^* \left(K^* - K_{F0}^*\right) - q_0 \left(K - K_{H0}\right) \end{aligned}$$

In the symmetric steady state the rate of return on all assets reflects the discount factor:

$$i_{S0} = i_{S0}^* = \frac{\Pi_0}{q_0 K} = \frac{\Pi_0^*}{q_0^* K^*} = \frac{i_L}{g_0} = \frac{i_L^*}{g_0^*} = \frac{1-\beta}{\beta}$$

All prices in a given currency are identical, purchasing power parity hold, and consumption is equalized in both countries reflecting the distortions in the good and labor markets:

$$C_0 = C_0^* = \frac{\theta - 1}{\kappa\theta}\frac{\delta - 1}{\delta}$$

The various outputs are:

$$Y_{T0}(z) = Y_{T0}^*(z) = \frac{2}{2-\gamma}C_0 \qquad Y_{N0}(z) = Y_{N0}^*(z) = \frac{1}{2-\gamma}C_0$$

The aggregate outputs, hours worked and profits are:

$$Y_0 = Y_0^* = H_0 = H_0^* = C_0 \qquad \frac{\Pi_0}{P_0C_0} = \frac{\Pi_0^*}{P_0^*C_0} = \frac{1}{\theta}$$

The ratio between equity market capitalization and GDP is the same in both countries:

$$\frac{q_0K}{P_0C_0} = \frac{q_0^*K^*}{P_0^*C_0} = \frac{\beta}{1-\beta}\frac{1}{\theta}$$

## 4.6 Linear approximations

### 4.6.1 General method

We solve our model by expressing the various relations in terms of linear approximations around the steady-state described above. We denote the logs deviations by San Serif letter: $\mathsf{x} = lnX - lnX_0 = (X - X_0)/X_0$. Most relations are standard, and the approximations are presented in the Appendix. The deviations of several financial variables from the steady states are expressed relative to the steady state GDP:

$$\begin{aligned}
\mathsf{nfa} &= \frac{NFA}{P_0C_0} \quad , \quad \mathsf{k}_H = \frac{K_H - K_{H0}}{P_0C_0} \quad , \quad \mathsf{k}_F^* = \frac{K_F^* - K_{F0}^*}{P_0C_0} \\
\mathsf{bs}_H &= \frac{BS_H - BS_{H0}}{P_0C_0} \quad , \quad \mathsf{bs}_F = \frac{BS_F - BS_{F0}}{P_0C_0} \\
\mathsf{bl}_H &= \frac{BL_H - BL_{H0}}{P_0C_0} \quad , \quad \mathsf{bl}_F = \frac{BL_F - BL_{F0}}{P_0C_0}
\end{aligned}$$

We consider the impact of monetary shocks allowing for nominal rigidities. The economy is initially in the symmetric steady-state, and agents learn the value of present and future monetary shocks at the beginning of period $t$. Prices and wages cannot necessarily fully react at period $t$, which we refer to as the short run. When prices and wages are preset, output and labor are demand determined with firms and workers meeting any unforeseen variation in output and effort. All prices and wages adjust from period $t+1$ onward, which we refer to as the long run. Long run variables are denoted with and upper bar.

### 4.6.2 Current accounts and asset positions

The role of financial integration is captured by the current account relations (30)-(31), which we express in terms of cross-country differences as:

$$\begin{aligned}
& (\mathsf{c}_t - \mathsf{c}_t^*) - (\mathsf{s}_t + \mathsf{p}_t^* - \mathsf{p}_t) + 2\mathsf{pos}_{t+1} \\
= \; & \frac{1}{\theta}\left[\Pi_t - \Pi_t^* - \mathsf{s}_t\right] + \frac{\theta - 1}{\theta}\left[(\mathsf{h}_t - \mathsf{h}_t^*) + (\mathsf{w}_t - \mathsf{w}_t^* - \mathsf{s}_t)\right] + \frac{1}{\beta}2\mathsf{pos}_t \\
& + 2\frac{1-\beta}{\beta}\frac{GF_0}{P_0C_0}\mathsf{s}_t + 2\left[di_{St}\frac{BS_{H0}}{P_0C_0} + di_{St}^*\frac{S_0BS_{F0}}{P_0C_0}\right] \\
& + \frac{1-\beta}{\beta}\left[\frac{NFK_0}{P_0C_0}(\Pi_t + \Pi_t^*) - \frac{GK_0}{P_0C_0}(\Pi_t - \Pi_t^*)\right]
\end{aligned} \tag{33}$$

where the term $\mathsf{pos}$ reflects the deviations in the quantities of assets, that is the deviation in net foreign assets valued at steady state prices:

$$\mathsf{pos}_{t+1} = \left[q_0\mathsf{k}_{Ht+1} - S_0q_0^*\mathsf{k}_{Ft+1}^*\right] + \left[\mathsf{bs}_{Ht+1} + S_0\mathsf{bs}_{Ft+1}\right] + \left[g_0\mathsf{bl}_{Ht+1} + S_0g_0^*\mathsf{bl}_{Ft+1}\right]$$

(33) is a central feature of our analysis, and shows how financial integration affects international interdependence, with the exact impact depending on the structure of asset holdings. Several mechanisms allow the home country to increase its consumption relative to the foreign country, adjusted for purchasing power differentials, or accumulate net financial claims. The home agent can consume more when GDP, i.e. the sum of profits and wage revenue, is higher in the home country. Another possibility is that the home country entered the period with claims on the foreign country ($\mathsf{pos}_t > 0$), and consume the interest income on these claims.

These two mechanisms, shown in the first row of the right-hand side of (33), are the ones at work in models that abstract from financial linkages. The role of financial integration is given in the last two rows of (33). The first element stemming from financial integration is the valuation effect of exchange rate movements. If the home country holds net assets denominated in foreign currency ($GF_0 > 0$), a depreciation of the home currency ($\mathsf{s}_t > 0$)

boosts the value of this position, in home currency, and leads to a transfer. The home country can then increase its consumption by the interest stream on this additional wealth. Another channel is given by changes in the interest rates received on one-period bonds. If the home country is a net creditor in bonds denominated in its own currency ($BS_{H0} > 0$), it benefits from an increase in the home interest rate ($di_{St} > 0$).

The final channel in (33) reflects the role of equity holdings. A first aspect is that the consumption differential is affected not only by profits differentials across the two countries, but also by the level of *worldwide* profits, provided that equity holdings are unevenly distributed ($NFK_0 \neq 0$). An increase in world profits ($\mathsf{\Pi}_t + \mathsf{\Pi}_t^* > 0$) allows the home country to increase its consumption if it is a net creditor in equity ($NFK_0 > 0$). As both countries are of the same size, an increase in world profits falls disproportionately in the pocket of the home household when she is a net creditor, thereby generating an income differential between the two countries. Another linkage reflects cross-country differential in profits, for which the value of *gross* international equity holdings, $GK_0$, is the relevant measure of integration. Consider a situation where home profits increase relative to foreign profits ($\mathsf{\Pi}_t - \mathsf{\Pi}_t^* > 0$). As foreign investors own a fraction of the home firms, they receive some of the home profits. Similarly low foreign profits reduce the income of the home agent from her foreign assets.

An interesting feature of (33) is the absence of equity and long-term bonds prices (the $\mathsf{q}$'s and $\mathsf{g}$'). This suggests that changes in the value of foreign assets stemming from asset prices fluctuations should be viewed in a different light as changes stemming from exchange rate fluctuations. Intuitively, the only relevant relevant fluctuations are the ones that affect the income stream of assets. Movements in equity and bond prices have no such effect *per se* to a first order. Consider for instance the role of the foreign equity price, $q_t^*$, in the home current account (31). It enters through the value of positions at the end of the period, $S_t q_t^* \left(K^* - K_{Ft+1}^*\right)$, and the beginning of the period, $S_t q_t^* \left(K^* - K_{Ft}^*\right)$. Taking first order expansions of these terms, evaluated at the steady state exchange rates and equity holdings, leads to the same expression for both terms, namely $S_0 q_0^* \left(K^* - K_{F0}^*\right) \mathsf{q}_t^*$, so they cancel out.[18] What matters for consumption is the flow of income from asset holdings, i.e. the profits $\Pi_t^*$. An increase in foreign profits boosts the revenue of the home

[18]Taking expansions beyond the first order terms would lead to different results, but our analysis ignores such higher order terms.

agent when she holds foreign stocks, thereby allowing her to consume more. By contrast, an increase in equity prices holding profits unchanged has no impact on her revenue.[19] A similar logic applies to the prices of long-term bonds. By contrast, movements in the exchange rate affect the income from asset holdings. For instance, a depreciation boosts the home currency value of a given stream of foreign profits, $S_t \Pi_t^*$.

The net foreign asset position (32) is written in terms of linear expansions as:

$$\begin{aligned}
\mathsf{nfa}_{t+1} &= \mathsf{pos}_{t+1} + \frac{GF_0}{P_0 C_0} \mathsf{s}_t \qquad (34) \\
&\quad + \frac{S_0 q_0^* \left(K^* - K_{F0}^*\right)}{P_0 C_0} \mathsf{q}_t^* - \frac{q_0 \left(K - K_{H0}\right)}{P_0 C_0} \mathsf{q}_t + \frac{g_0 B L_{H0}}{P_0 C_0} \mathsf{g}_t + \frac{S_0 g_0^* B L_{F0}}{P_0 C_0} \mathsf{g}_t^*
\end{aligned}$$

(34) shows that the deviation of the net foreign asset position from its steady state value reflects changes in the quantities of assets holdings, $\mathsf{pos}_{t+1}$, the valuation impact of exchange rate movements, as well as the valuation impact of movements in equity and bond prices.

#### 4.6.3 Short-run price and wage differentials

In the short-run, we consider that only an exogenous fraction $\tau$ of prices can be adjusted, with the cases of fully flexible prices and complete rigidity corresponding to $\tau = 1$ and $\tau = 0$ respectively. (28) shows that a firm which can adjust its prices brings them in line with its marginal cost and the law of one price holds. By contrast, the law of one price does not necessarily hold for a traded good firm that cannot adjust its price. While the price for the domestic market is obviously unchanged, the price for the export market can react to exchange rate movements. Following Corsetti and Pesenti (2005), we assume that an exogenous fraction $\eta$ of exchange rate movements is passed-through to prices in the foreign market, so that a 1 percent depreciation of the currency of the producer reduces the price paid by the foreign consumers in their own currency by $\eta$ percent. $\eta = 1$ corresponds to complete exchange rate pass-through, also referred to a 'producer currency pricing' (PCP), where the law of one price holds. The case of zero pass-through, also called 'local currency pricing' (LCP) is given by $\eta = 0$, in which case the law of price does not hold (Betts and Devereux 2000).

[19] While equity prices move with profits in equilibrium, the former have no direct impact on the current account.

The short run real-exchange rate is written by combining linear approximations of the consumer price indexes (2)-(3) and the optimal pricing rules (28) for the firms who can adjust their prices:

$$\mathsf{s} + \mathsf{p}^* - \mathsf{p} = \frac{\gamma + 2(1-\gamma)(1-\eta)}{2-\gamma}(1-\tau)\,\mathsf{s} + \frac{\gamma\tau}{2-\gamma}(\mathsf{s} + \mathsf{w}^* - \mathsf{w})$$

Deviations from purchasing power parity can stem from the presence of non traded goods ($\gamma > 0$), or the combination of price rigidities and incomplete exchange rate pass-through ($\tau < 1$, $\eta < 1$).

In addition of price rigidities, we also allow for partial adjustment of wages, assuming that in the short run only an exogenous fraction $\upsilon$ of wages is adjusted. Using linear approximations of the labor supplies (14) and (15), the short run wage differential is the written as:

$$\mathsf{s} + \mathsf{w}^* - \mathsf{w} = (1-\upsilon)\,\mathsf{s} + \upsilon\left[(\mathsf{s} + \mathsf{p}^* - \mathsf{p}) + (\mathsf{c}^* - \mathsf{c})\right]$$

Movements in relative wages reflect the fluctuations of the exchange rate and movements in relative consumption levels, adjusted for purchasing power.

### 4.6.4 Short-run profit differentials

Profits play a central role in the transmission of shocks in the presence of cross-country equity holdings, as shown by (33). The differential in short-run profits is driven by the exchange rate, as well as wage and output differentials:

$$\Pi - \Pi^* = \theta\frac{2-2\gamma}{2-\gamma}(1-\eta)(1-\tau)\,\mathsf{s} + [1-\theta(1-\tau)](\mathsf{w} - \mathsf{w}^*) + (\mathsf{y} - \mathsf{y}^*) \quad (35)$$

Several features can be seen from (35). When all prices and wages are flexible ($\tau = \upsilon = 1$), profits reflect the strength of demand and movements in wages, as the later are entirely passed into prices and firms operate at a positive markup:

$$\Pi - \Pi^* = (\mathsf{w} - \mathsf{w}^*) + (\mathsf{y} - \mathsf{y}^*)$$

When prices and wages are preset ($\tau = 0$, $\mathsf{w} - \mathsf{w}^* = 0$), profits are driven by the strength of demand and movements in the exchange rate, the later depending on the extent of exchange rate pass-through:

$$\Pi - \Pi^* = \theta\frac{2-2\gamma}{2-\gamma}(1-\eta)\,\mathsf{s} + (\mathsf{y} - \mathsf{y}^*)$$

Exchange rate movements have no impact under complete pass-through ($\eta = 1$) as firms receive a constant price in their own currency for any sale. By contrast, profits are directly affected by exchange rate movements when there is no pass-through ($\eta = 0$). A depreciation of the home currency then boosts the revenue of home exporters, in their own currency, which feeds straight into profits as wages are constant.

#### 4.6.5 Welfare

An advantage of our micro-founded setup is the availability of non-arbitrary welfare metric, namely the utility maximized by the representative agents (1). We follow the standard approach and focus on the impact of consumption and effort, abstracting from the direct impact of real balances. The welfare expressions for the home and the foreign agents are written as:

$$\mathsf{u} = \mathsf{c} - \frac{\theta - 1}{\theta}\frac{\delta - 1}{\delta}\mathsf{y} + \frac{\beta}{1-\beta}\left[\bar{\mathsf{c}} - \frac{\theta - 1}{\theta}\frac{\delta - 1}{\delta}\bar{\mathsf{y}}\right] \tag{36}$$

$$\mathsf{u}^* = \mathsf{c}^* - \frac{\theta - 1}{\theta}\frac{\delta - 1}{\delta}\mathsf{y}^* + \frac{\beta}{1-\beta}\left[\bar{\mathsf{c}}^* - \frac{\theta - 1}{\theta}\frac{\delta - 1}{\delta}\bar{\mathsf{y}}^*\right] \tag{37}$$

Our welfare measure reflects the impact of consumption and output, both in the short and the long run. A given increase in consumption generates a benefit larger than the cost of an identical increase in effort, as the economy operates at an inefficient level in the steady state because of monopolistic distortions in the good and labor markets. The values of the welfare measures can be interpreted as the percentage increase in short run consumption that would generate a similar gain.

# 5 The transmission of monetary shocks under financial integration

## 5.1 General approach

We consider the impact of an unforeseen permanent monetary shock: $\mathsf{m} = \bar{\mathsf{m}}$, $\mathsf{m}^* = \bar{\mathsf{m}}^*$.[20] We briefly discuss the solution in terms of worldwide aggregates which are independent of the structure of financial integration.

[20] The Appendix allows for different monetary shocks in the short and long-run.

We then present the results in terms of cross-country differences, building up the complexity of the model from a simple case. We focus on the main results, with the detailed derivations presented in the Appendix.

Our results are illustrated through a numerical example, with the structural parameters presented in Table 4. We set the elasticity of substitution across brands, $\theta$, to 8, which corresponds to a 14 percent markup of prices over wages in the steady state. For simplicity we set the elasticity across different types of goods, $\lambda$, to the same value for most computations, and consider the case of a unit elasticity as an extension, as this is a commonly used value (Corsetti and Pesenti 2005). The elasticity of substitution across the different types of labor, $\delta$, is set at 21, which implies a 5 percent markup of wages over the cost of effort in the steady state. Our parametrization leads to an overall distortion in goods and labor market that corresponds to a combined elasticity of 6.[21]

Through most of the paper, we consider that all goods are traded ($\gamma = 0$), and allow for non traded goods in an extension ($\gamma = 0.75$). We contrast the effects between a specification where all prices and wages are flexible ($\tau = \upsilon = 1$) and one where they are entirely sticky ($\tau = \upsilon = 0$). When considering price stickiness, we analyze the case of complete exchange rate pass-through ($\eta = 1$), as well as case of zero pass-through ($\eta = 0$). The discount rate is set at $\beta = 0.96$. Throughout we consider a unit monetary expansion in the home country ($\bar{\mathsf{m}} = 1$, $\bar{\mathsf{m}}^* = 0$).

The structure of financial integration is the central point of our analysis, and we contrast out results across four difference cases detailed in Table 5. The first case is the benchmark of no financial integration where all steady state positions are zero. The second case is a bond-only economy where all positions are in one-period bonds ( $GF_0 \neq 0$, $GK_0 = NFK_0 = 0$). We parametrize the holdings so that the foreign currency assets represent 50 percent of steady state GDP, in line with the U.S. values shown in the bottom panel of Table 1.[22] The third case is an equity-only economy, where

[21] Specifically:

$$\frac{8-1}{8}\frac{21-1}{21} = \frac{6-1}{6} = 0.833$$

[22] Our assumption that all bond positions consist of one-period bonds entails no loss of generality as we focus on permanent shocks with a log utility of consumption, ensuring that interest rates are constant. The allocation between one-period and long-term bonds would matter if we consider temporary shocks, or a more general functional form for the utility of consumption.

we again set foreign currency assets at 50 percent of GDP, but assume that all positions are in equities ($2GF_0 = GK_0$, $NFK_0 = 0$). The final case corresponds to the U.S. situation presented in Table 1. Gross equity assets and liabilities account for 50 percent and 40 percent of GDP respectively. Positions in bonds consist of home-currency one-period bond, with a small debt ensuring that net foreign assets are zero. Note that the U.S. situation is close, but not identical, to the equity-only economy.[23]

Despite the substantial cross-border holdings, the degree of financial integration appears moderate when benchmarked against the total capitalization of equities. Under our parametrization, the total value of equity in each country represents 3 times the value of GDP, so a cross-border position of 50 percent of GDP amounts to only one-sixth of the value of the domestic stock market.

In worldwide terms, monetary shocks have no real effects in the long run and feed entirely into wages and prices. The short run split between real and nominal effect reflects price and wage rigidities:

$$
\begin{aligned}
\mathsf{c} + \mathsf{c}^* &= \mathsf{y} + \mathsf{y}^* = (1 - \tau\upsilon)(\bar{\mathsf{m}} + \bar{\mathsf{m}}^*) \\
\mathsf{p} + \mathsf{p}^* &= \tau(\mathsf{w} + \mathsf{w}^*) = \tau\upsilon(\bar{\mathsf{m}} + \bar{\mathsf{m}}^*) \\
\Pi + \Pi^* &= [1 - \upsilon(1 - \tau)(\theta - 1)](\bar{\mathsf{m}} + \bar{\mathsf{m}}^*)
\end{aligned}
$$

The monetary expansion leads to a short-run increase in consumption, which translates into a decrease in the real interest. The monetary expansion also generate inflation between the short and the long run. Under our assumption of a log utility of consumption, the decrease in the real interest rate is exactly generated by inflation, and no movement is required from the short-run interest rate. With no such movement, the distinction between one-period and long-term bonds is irrelevant. In addition, the exchange rate and equity prices immediately reach their long run values:

$$
\mathsf{g} = \mathsf{g}^* = di_S = di_S^* = 0 \quad , \quad \mathsf{q} = \bar{\mathsf{q}} = \bar{\Pi} \qquad , \qquad \mathsf{q}^* = \bar{\mathsf{q}}^* = \bar{\Pi}^*
$$

[23] Our parametrization differs from the U.S. situation as we consider that the NIIP is zero. This is secondary,as the gross positions matter for the valuation effect.

## 5.2 International interdependence under alternative scenarios

### 5.2.1 Price and wage flexibility

We start with the case where all goods are traded ($\gamma = 0$) and prices and wages flexible ($\tau = \upsilon = 1$). The consumption differential is the same in the short and the long run, and is given by:

$$\mathsf{c} - \mathsf{c}^* = \Omega^{-1} \left[ 2 \frac{GF_0}{P_0 C_0} - \frac{GK_0}{P_0 C_0} \right] (\bar{\mathsf{m}} - \bar{\mathsf{m}}^*) + \Omega^{-1} \frac{NFK_0}{P_0 C_0} (\bar{\mathsf{m}} + \bar{\mathsf{m}}^*)$$

where:

$$\Omega = \lambda \frac{\beta}{1-\beta} + 2 \frac{GF_0}{P_0 C_0} - \lambda \frac{GK_0}{P_0 C_0}$$

The exchange rate and output differentials, in the short and the long run, are given by:

$$\begin{aligned}
\mathsf{s} &= \Omega^{-1} \left[ \lambda \frac{\beta}{1-\beta} - \frac{GK_0}{P_0 C_0} (\lambda - 1) \right] (\bar{\mathsf{m}} - \bar{\mathsf{m}}^*) - \Omega^{-1} \frac{NFK_0}{P_0 C_0} (\bar{\mathsf{m}} + \bar{\mathsf{m}}^*) \\
\mathsf{y} - \mathsf{y}^* &= -\lambda \Omega^{-1} \left[ \left[ 2 \frac{GF_0}{P_0 C_0} - \frac{GK_0}{P_0 C_0} \right] (\bar{\mathsf{m}} - \bar{\mathsf{m}}^*) + \frac{NFK_0}{P_0 C_0} (\bar{\mathsf{m}} + \bar{\mathsf{m}}^*) \right] \\
\bar{\mathsf{y}} - \bar{\mathsf{y}}^* &= -\lambda (\mathsf{c} - \mathsf{c}^*)
\end{aligned}$$

Combining these results with (36)-(37), we write the welfare differential as:

$$\mathsf{u} - \mathsf{u}^* = \frac{1 + \frac{\theta-1}{\theta} \frac{\delta-1}{\delta} \lambda}{\lambda \beta + (1-\beta) \left( 2 \frac{GF_0}{P_0 C_0} - \lambda \frac{GK_0}{P_0 C_0} \right)} \left[ \left[ 2 \frac{GF_0}{P_0 C_0} - \frac{GK_0}{P_0 C_0} \right] (\bar{\mathsf{m}} - \bar{\mathsf{m}}^*) + \frac{NFK_0}{P_0 C_0} (\bar{\mathsf{m}} + \bar{\mathsf{m}}^*) \right]$$

The case is illustrated through the numerical example presented in the top panel of Table 6. The columns correspond to the various setups of financial integration presented above. The table lists the values of the short run differentials for consumption, output and profits, followed by the corresponding differentials in the long run, and the discounted values over the entire horizon. The following rows present the movements in the exchange rate and equity prices. These are followed by the change in the net asset position, which is further disaggregated across its components. The bottom part of the table present the welfare differential, as well as the value for each country.

In the absence of financial integration, the monetary expansion in the home economy feeds entirely into a depreciation of the home currency and an increase in home nominal variables. In particular, home profits increase, leading to higher home equity prices. Things are more interesting once we allow for financial linkages. In the bond-only economy, the depreciation of the home currency generates a valuation gain that transfers resources to the home household, with an increase in the home net foreign asset position driven entirely by the valuation effect. The transfer allows the home agent to increase her consumption and reduce her effort, leading to a substantial welfare gain ($\mathsf{u} = 0.5$) at the expense of the foreign household.

A striking feature is that at first glance financial integration seems to add little to the model, as the movements in consumption and output are quite small. While they are moderate in a given period, they persist over the entire horizon, hence the impact in terms of welfare is more substantial. Taking a weighted sum of the current account relations (33) in the short- and the long-run, the direct impact of the exchange rate valuation effect on the resources available to the home household is given by:

$$2\frac{1-\beta}{\beta}\frac{GF_0}{P_0C_0}\mathsf{s} + 2\frac{\beta}{1-\beta}\frac{1-\beta}{\beta}\frac{GF_0}{P_0C_0}\bar{\mathsf{s}} = 2\frac{1}{\beta}\frac{GF_0}{P_0C_0}\mathsf{s}$$

where we use the fact that the exchange rate immediately adjusts to its long run value. Under our parametrization, a 1 percent depreciation leads to a transfer of resources equivalent to a 1 percent increase in relative consumption for one period, that is $\mathsf{u} - \mathsf{u}^* \simeq 1$. In other words, transferring the equivalent of 1 percent of GDP (in terms of cross-country differences) directly leads to a welfare differential of a similar magnitude.

The situation is noticeably different in the equity-only economy. The boost in home profits from the monetary expansion is now partially paid to the foreign agent as she owns home equity. The movements in profits are reflected in higher equity prices in the home country, generating a capital loss for the home agent. This loss exactly offsets the valuation gain from the depreciation, leaving the net foreign asset position unchanged. In terms of consumption and effort, the situation is identical to the case with no financial integration, as there is no transfer of resources across the two countries.

While the U.S. situation is close to the equity-only economy, it still involves a net position in equity. As a result, the home agent receives a transfer of resources as the valuation gain from the depreciation exceeds the capital loss on equity holdings. The home agent then increases consumption and reduces efforts, leading to a welfare differential in favor of the home country, though the magnitude is much smaller than in the bond-only economy ($\mathsf{u} = 0.1$).

### 5.2.2 Nominal rigidities and complete exchange rate pass-through

We now turn to the case where that all wages and prices are preset in the short-run ($\tau = \upsilon = 0$). There is full exchange-rate pass-through ($\eta = 1$), so that movements in the exchange rate lead to movements in relative consumer prices. This induces a consumption-switching effect towards home goods, boosting the income of the home agent. The consumption differential immediately reaches its long run value at:

$$\begin{aligned}\mathsf{c} - \mathsf{c}^* &= \Omega^{-1}\left[2\frac{GF_0}{P_0C_0} - \frac{GK_0}{P_0C_0}\right](\bar{\mathsf{m}} - \bar{\mathsf{m}}^*) + \Omega^{-1}\frac{NFK_0}{P_0C_0}(\bar{\mathsf{m}} + \bar{\mathsf{m}}^*) \\ &\quad + \Omega^{-1}(1-\beta)(\lambda - 1)\left(\frac{\beta}{1-\beta} - \frac{GK_0}{P_0C_0}\right)(\bar{\mathsf{m}} - \bar{\mathsf{m}}^*)\end{aligned}$$

The consumption differential is now affected by relative monetary shocks through an additional terms, compared with the flexible price case. The exchange rate and output differentials, in the short and the long run, are given by:

$$\begin{aligned}\mathsf{s} &= \Omega^{-1}\left[\lambda\frac{\beta}{1-\beta} - \beta\left(\frac{GK_0}{P_0C_0} + 1\right)(\lambda - 1)\right](\bar{\mathsf{m}} - \bar{\mathsf{m}}^*) - \Omega^{-1}\frac{NFK_0}{P_0C_0}(\bar{\mathsf{m}} + \bar{\mathsf{m}}^*) \\ \mathsf{y} - \mathsf{y}^* &= \lambda\Omega^{-1}\left\{\left[\lambda\frac{\beta}{1-\beta} - \beta\left(\frac{GK_0}{P_0C_0} + 1\right)(\lambda - 1)\right](\bar{\mathsf{m}} - \bar{\mathsf{m}}^*) - \frac{NFK_0}{P_0C_0}(\bar{\mathsf{m}} + \bar{\mathsf{m}}^*)\right\} \\ \bar{\mathsf{y}} - \bar{\mathsf{y}}^* &= -\lambda(\mathsf{c} - \mathsf{c}^*)\end{aligned}$$

The welfare differential is written as:

$$\begin{aligned}&(1-\beta)\Omega(\mathsf{u} - \mathsf{u}^*) \\ =\ &\beta\left[(\lambda - 1) - \frac{\theta - 1}{\theta}\frac{\delta - 1}{\delta}\lambda\right](\bar{\mathsf{m}} - \bar{\mathsf{m}}^*) \\ &+\left[1 + \frac{\theta - 1}{\theta}\frac{\delta - 1}{\delta}\lambda\right]\left[\left[2\frac{GF_0}{P_0C_0} - \frac{GK_0}{P_0C_0}\right](\bar{\mathsf{m}} - \bar{\mathsf{m}}^*) + \frac{NFK_0}{P_0C_0}(\bar{\mathsf{m}} + \bar{\mathsf{m}}^*)\right] \\ &-(1-\beta)\left[\left[1 + \frac{\theta - 1}{\theta}\frac{\delta - 1}{\delta}\lambda\right](\lambda - 1)\frac{GK_0}{P_0C_0} + \frac{\theta - 1}{\theta}\frac{\delta - 1}{\delta}\lambda\left[2\frac{GF_0}{P_0C_0} - \frac{GK_0}{P_0C_0}\lambda\right]\right](\bar{\mathsf{m}} - \bar{\mathsf{m}}^*)\end{aligned}$$

The numerical illustration for this case is presented in the bottom panel of Table 6. In the absence of financial integration, the monetary expansion in the home country leads to a depreciation of the home currency that translates into a substantial boost in output. This is because world demand is highly sensitive to relative prices because of the high elasticity $\lambda$. This shift boosts short run profits, and the revenue from the increased output allows the home agent to consume more at all horizons, and work less in the long run. Long run consumption is financed by a substantial accumulation of foreign assets. In welfare terms the expansion benefits primarily the home agent. This can appear at odds with the results of Obstfeld and Rogoff (1995) that all agents benefit equally. The however abstracted from labor market frictions (their model corresponds to $\delta \rightarrow \infty$), so that the elasticity of demand between home and foreign goods, $\lambda$, which drives the sensitivity of revenue to exchange rate movements, is equal to the elasticity driving the distortion in goods markets, $\theta$. In our case by contrast, the sensitivity of world demand to relative prices, $\lambda = 8$, is larger than the combined distortion in goods and labor market.[24] The additional income obtained from the higher sales of home output then more than offsets the cost of the required effort. This is the same mechanism as outlined by Tille (2001) who focuses on the opposite case.

Our parametrization shows that under sticky prices a monetary expansion generates a welfare differential ($\mathsf{u} - \mathsf{u}^* = 0.04$), with the home country gain amounting to $\mathsf{u} = 0.1$. These values reflect the impact of nominal rigidities themselves, as we so far abstract from financial integration. They provide a benchmark against which we can assess the results presented in the top panel of Table 6, where prices and wages are flexible. Financial integration generates welfare effects that are substantial, with the home welfare gain in the bond-only economy case under flexible prices ($\mathsf{u} = 0.5$) amounting to five times the effect under nominal rigidities and no integration ($\mathsf{u} = 0.1$). Considering the more realistic U.S. parametrization, financial integration per se leads to a welfare gain for the home country that is similar to the one stemming from nominal rigidities.

The last three columns of the bottom panel of table 6 show the impact

[24] Specifically, define $\zeta$ such that:

$$\frac{\zeta - 1}{\zeta} = \frac{\theta - 1}{\theta} \frac{\delta - 1}{\delta}$$

With $\theta = 8$ and $\delta = 21$ we get $\zeta = 6$.

of a monetary shock under nominal rigidities when financial integration is included. A noticeable feature is how most variables show little variation across the cases, with integration operating primarily through a reduction in overall effort. In particular, the monetary shock boosts home profits and home equity prices.

The exchange rate depreciation leads to substantial capital gains for the home country, that can be partially offset by the higher value of foreigners' claims on home equity. There is of course no such offset in the bond-only economy, where the valuation gain reinforces financial flows and accounts for 13% of the total change in net foreign assets. The offset from higher home-equity prices is partial even in the equity-only economy. An interesting feature is that while the change in net assets is broadly similar in the U.S. situation as in the case with no financial integration, the underlying sources are different. A small reduction of financial flows in the U.S. case is more than offset by the valuation gain from the depreciation, even taking the capital loss on equities into account. The exchange rate valuation accounts for 14% of the total increase in net foreign assets.

In welfare terms, the depreciation of the home currency leads to a substantial gain for the home country in the bond-only economy, with a welfare increase six times as large as in the absence of integration ($\mathsf{u} = 0.58$ vs. $\mathsf{u} = 0.1$). This highlights the usefulness of our welfare measure. Simply looking at consumption and output, one may infer that financial integration plays a marginal role. The situation is quite different in welfare terms: while consumption increases in the absence of integration, this increase is financed by a costly rise in effort, so the impact is limited in terms of welfare. While integration marginally affects the increase in consumption, it allows the home household to finance it through the wealth transfer from the exchange rate valuation effect. The welfare gain is then larger as a given increase in consumption can now be achieved with less effort.

Turning to the equity-only economy, the welfare effect is essentially unchanged from the case with no integration. This is because the increase in home profits is partially transferred to the foreign household when she holds home equities. Turning to the U.S. situation, financial integration boosts the home welfare. While the magnitude is smaller than in the bond-only case, the welfare gain is twice as large as in the absence of financial integration ($\mathsf{u} = 0.19$ vs. $\mathsf{u} = 0.1$). The presence of financial integration therefore generates an additional welfare effect that is of the same magnitude than the one stemming from price rigidities alone.

Our results show that the exact nature of portfolios plays a substantial role. An integration in the form of bond holdings is associated with much larger valuation effects than one in the form of equity holdings, as dividend flows counteract the valuation effect of exchange rate movements. In addition, the welfare results are quite sensitive to apparently moderate changes. While the U.S. situation looks close to the equity-only case, as shown in table 5, the welfare results are different.

### 5.2.3 The role of exchange rate pass-through

We now consider the case where import prices are insulated from exchange rate movements in the short run ($\eta = 0$). As relative prices do not move in the short-run, the exchange rate depreciation does not affect the output differential:

$$\mathsf{y} - \mathsf{y}^* = 0$$

The consumption differential in the short run is entirely unaffected by financial integration and only reflects the differential monetary shock:

$$\mathsf{c} - \mathsf{c}^* = \bar{\mathsf{m}} - \bar{\mathsf{m}}^*$$

The solution for the exchange rate is given by:

$$\Theta \mathsf{s} = \left[1 + \lambda \frac{\beta}{1-\beta} - (\lambda - 1) \frac{GK_0}{P_0 C_0}\right] (\bar{\mathsf{m}} - \bar{\mathsf{m}}^*) - \frac{1}{\beta} \frac{NFK_0}{P_0 C_0} (\bar{\mathsf{m}} + \bar{\mathsf{m}}^*)$$

where:

$$\Theta = 1 + \lambda \frac{\beta}{1-\beta} - (\lambda - 1) \frac{GK_0}{P_0 C_0} + \frac{1}{\beta} 2 \frac{GF_0}{P_0 C_0} - \frac{GK_0}{P_0 C_0} \left(1 + \frac{1-\beta}{\beta} \theta\right)$$

While financial integration has no impact on the short-run consumption and output differentials, it affects their long-run values::

$$\begin{aligned}
\Theta (\bar{\mathsf{c}} - \bar{\mathsf{c}}^*) &= \left[\frac{1}{\beta} 2 \frac{GF_0}{P_0 C_0} - \frac{GK_0}{P_0 C_0} \left(1 + \frac{1-\beta}{\beta} \theta\right)\right] (\bar{\mathsf{m}} - \bar{\mathsf{m}}^*) + \frac{1}{\beta} \frac{NFK_0}{P_0 C_0} (\bar{\mathsf{m}} + \bar{\mathsf{m}}^*) \\
\bar{\mathsf{y}} - \bar{\mathsf{y}}^* &= -\lambda (\bar{\mathsf{c}} - \bar{\mathsf{c}}^*)
\end{aligned}$$

Using these results, the welfare differential is:

$$\begin{aligned}
\Theta (\mathsf{u} - \mathsf{u}^*) &= \left[\Theta + \frac{1}{1-\beta} \left[1 + \frac{\theta - 1}{\theta} \frac{\delta - 1}{\delta} \lambda\right] \left[2 \frac{GF_0}{P_0 C_0} - \frac{GK_0}{P_0 C_0} (\beta + (1-\beta) \theta)\right]\right] (\bar{\mathsf{m}} - \bar{\mathsf{m}}^*) \\
&\quad + \frac{1}{1-\beta} \left[1 + \frac{\theta - 1}{\theta} \frac{\delta - 1}{\delta} \lambda\right] \frac{NFK_0}{P_0 C_0} (\bar{\mathsf{m}} + \bar{\mathsf{m}}^*)
\end{aligned}$$

Table 7 illustrates our results under zero pass-through. In the absence of financial integration, the depreciation of the home currency leads to a substantial welfare gain for the home country ($\mathsf{u} = 0.58$), at the expense of the foreign country. This 'beggar-thy-neighbor' pattern is a well-known feature of the model, documented by Betts and Devereux (2000). Intuitively, with import prices set in the customers' currency, the depreciation boosts the home currency revenue of home exporters. The nominal depreciation is also associated with a real depreciation, which allows for a boost in home consumption, as can be seen from (33). Under our parametrization, the impact is limited to the short run with the net asset position remaining unchanged.

Turning to the bond-only economy, the impact of financial integration is broadly unaffected by the degree of exchange rate pass-through, with the valuation effect adding an extra 0.5 to the increase in home welfare. The pattern is more subtle in the equity-only economy, with the home country actually faring worse under financial integration ($\mathsf{u} = 0.44$ vs. $\mathsf{u} = 0.58$). This feature reflects the combination of a large increase in home profits and the presence of foreign claims on these profits. The profit differential between the two countries is roughly 30 percent larger in the absence of pass-through, over the entire horizon (32 vs. 25 with complete pass-through). Intuitively, home exporters benefit from a higher revenue in home currency and face no changes in marginal costs in the short run. The higher home profits are shared with foreign investors when there are cross-country equity holdings. The increase in dividend payouts is then large enough to prevent the home household from financing her short-run consumption solely out of her short-run earnings, requiring her to borrow against her future output.

The higher home profits are also reflected in higher home equity prices, thereby increasing the value of foreign claims on home assets, a capital loss for the home agent. This negative valuation effect is large enough to fully erase the valuation gain from the depreciation of the home currency, while the offset was only partial under complete pass-through. The pattern is broadly similar in the U.S. situation, with the welfare gain in the home country being reduced from the case without financial integration.

## 5.3 Extensions of the setup

### 5.3.1 The impact of non-traded goods

We now allow for non-traded goods, setting $\gamma = 0.75$. The exact expressions for the results being fairly cumbersome, we focus our analysis on the numerical illustration presented in Table 8. The top panel shows the case of flexible prices and wages ($\tau = \upsilon = 1$), while the bottom panel corresponds to the situation where all wages and prices are preset in the short ($\tau = \upsilon = 0$), and there is full exchange-rate pass-through ($\eta = 1$).

When prices and wages can immediately adjust, a monetary shock has no real impact in the absence of integration, though it boosts home profits. Looking at the three situations that reflect financial integration, we see that the results are very close to the ones obtained in the model where all goods were traded (top panel of Table 6).

In the presence of nominal rigidities (bottom panel of Table 8), the introduction of non-traded goods generates a welfare differential in favor of the home country, increasing its gain by 50 percent when there is no financial integration ($\mathsf{u} = 0.15$ vs. $\mathsf{u} = 0.10$ when all goods are traded). This reflects the fact that the increased spending by home consumers now falls primarily on domestic goods, as shown by Hau (2000). While foreign agents benefit from cheaper imported goods, this has only a small impact as such goods have a moderate weight in their consumption basket.

Financial integration generates a substantial additional welfare gain for the home country in the bond-only case, thanks to the transfer of resources stemming from the exchange rate valuation effect. By contrast it slightly reduces the gain in the equity-only economy case, as the valuation gain is offset by losses on equity holdings. In the U.S. situation, this offset is partial and financial integration magnifies the home welfare gain, though by less than in the bond-only case ($\mathsf{u} = 0.23$ vs. $\mathsf{u} = 0.15$).

Overall, the inclusion of non-traded goods does not alter the main message of the paper, as the numbers in table 6 and 8 show similar effects of financial integration.

### 5.3.2 Nominal rigidities in the goods or labor markets

In our analysis of nominal rigidities, we assumed that both prices and wages are preset. We now assess how the results change if only prices or wages are preset. The case of flexible prices and sticky wages is straightforward

($\tau = 1$, $\upsilon = 0$). The optimal pricing rules (28) show that firms adjust their prices to keep them in line with wages. When wages are preset, there is then no need for firms to change their prices, and price flexibility is irrelevant.

The top panel of Table 9 shows the case where prices are set and wages can adjust ($\tau = 0$, $\upsilon = 1$), assuming full exchange-rate pass-through ($\eta = 1$). The key aspect is that while the monetary shock boosts home profits, the magnitude of this effect is smaller than in the case where wages are preset (bottom panel of Table 6): the profit differential between the two countries is roughly 30 percent smaller over the entire horizon (18 vs. 25). Intuitively, the expansion feeds into higher home wages, thereby reducing the margin of home firms as their prices are unchanged in the home currency. The smaller increase in home profits translates into a smaller dividend transfer to the foreign agent when she owns some home equity.

The welfare results are unchanged from the case of complete nominal rigidities when financial integration is either non-existent or limited to bond holdings. This is because profits are not re-distributed across borders in these two cases. In the equity-only and U.S. situation however, financial integration generates a much larger welfare tilt towards the home country when wages are flexible than when they are preset. For instance, financial integration triples the home welfare gain in the U.S. situation when wages are flexible ($\mathsf{u} = 0.30$ vs. $\mathsf{u} = 0.10$), compared with a mere doubling when wages are preset ($\mathsf{u} = 0.19$ vs. $\mathsf{u} = 0.10$). This reflects the movement in home profits and associated reduction of the transfer to foreign equity holders.

### 5.3.3 Limited substitutability between types of goods

We have so far considered a relatively high degree of substitutability between the various traded and non-traded goods ($\lambda = 8$). Several contributions argue for a smaller elasticity, with a unit value being a standard parametrization (see for instance Corsetti and Pesenti 2005). For brevity, we focus on the case of full nominal rigidities ($\tau = \upsilon = 0$) and complete exchange-rate pass-through ($\eta = 1$).

The results under this alternative specification are presented in Table 10. In the absence of financial integration, the impact is limited to the short run with no accumulation of net assets, this being a standard feature of a model with a unit elasticity of substitution. The depreciation of the home currency generates only a moderate boost in home output, as home and foreign goods are poor substitute. In terms of revenue, the worsening of the home household purchasing power exactly offsets the increase in home output, leaving the consumption differential unchanged. The home monetary expansion then has a substantial 'beggar-thyself' effect ($\mathsf{u} = -0.33$), as described in Tille (2001).

Introducing financial integration substantially alters the results. In the bond-only economy, the valuation effect of the depreciation substantially boosts the home welfare ($\mathsf{u} = 0.58$ vs. $\mathsf{u} = -0.33$), a shift that is nearly twice as large as in the case of high substitutability (0.91 vs. 0.48 when $\lambda = 8$). By contrast, financial integration has no effect when it takes the form of cross-corder equity holdings only. This result is however quite sensitive to the inclusion of even a small position in bonds. In the U.S. situation, financial integration substantially shifts the welfare towards the home country ($\mathsf{u} = -0.14$ vs. $\mathsf{u} = -0.33$, a shift of 0.19), the magnitude of the shift being again twice as large as when home and foreign goods are close substitutes (0.19 vs. 0.09 when $\lambda = 8$). The central role of the degree of substitutability is also a feature of the analysis by Ghironi, Lee and Rebucci (2005).

# 6 Conclusion

The impact of exchange rate movements on the value of U.S. foreign assets is receiving a growing amount of attention, driven by its sizable role in recent years. This paper first shows that the U.S. international investment position exhibits a substantial amount of leverage along several dimensions. While the U.S. owes 22 % of GDP to foreign investors at the end of 2004, it owns a large amount of foreign-currency assets (50 % of GDP), offset by larger dollar liabilities. It is also a net creditor in FDI and equity (10 % of GDP), and a net debtor in debt and banking instruments. The foreign currency assets of the U.S. are concentrated on European currencies, to an extent that exceeds the role of Europe as a trading partner. A depreciation of the dollar then operates through different channels depending on which currencies the dollar moves against.

Having presented the nature of international financial integration from the point of view of the U.S., we incorporate this aspect in a standard open-economy model, and consider the impact of a monetary expansion in the home economy. Financial integration can substantially tilts the situation in favor of the home country. When bonds are the vehicle of integration, the valuation gain from the depreciation of the home currency magnifies the benefit for the home economy by a factor of six.

The exact nature of financial integration plays an important role. When equity holdings are the vehicle of integration, two countervailing mechanisms operate. First, the depreciation of the home currency leads to a valuation gain for the home agent on her assets denominated in foreign currency. Second, the home monetary expansion boosts home profits, leading to increased dividend payments to foreign investors. These two mechanisms essentially cancel out when integration takes place entirely through equity holding. Looking at the situation of the U.S., where integration mostly, but not exclusively, takes place through equity holdings, we find that it doubles the benefit of a monetary expansion in the home country. The role of financial integration in terms of welfare is therefore of a similar magnitude as the role of nominal rigidities.

We extent our analysis along several dimensions. The benefit of financial integration is substantially reduced when import prices are insulated from exchange rate movements, as profits movements are then larger. Our results are not affected by the inclusion of non-traded goods, but are sensitive to the volatility of marginal costs. Allowing a monetary shock to affect wages but not prices dampens the movements in profits. This reduces the dividend transfer to foreign investors, hence the offset of the direct valuation effect of the exchange rate. The welfare results are also more sensitive to financial integration when goods produced in different countries are poor substitutes.

Our analysis highlight the relevance of both the magnitude and composition of cross-border asset holdings for international interdependence. It remains a first step, and several extensions are likely to be fruitful avenues for future research. The main limitation is that the setup focuses on the transmission of shocks under alternative financial structures, but takes these structures as given. Our analysis lacks an optimal portfolio dimension, as all assets provide identical returns to a first order. Allowing for an endogenous portfolio allocation, with the possibility of it being influenced by policy rules, is an important future extension.

Another avenue of research is a finer modelling of the allocation of profits. We simply assume that the large movements in profits are immediately transmitted to shareholders, and abstract from retained earnings. We also show that the results are sensitive to the responsiveness of marginal cost to monetary shocks. A possible extension is to include imported inputs, with exchange rate movements then directly affecting marginal costs. Considering alternative shocks is another promising extension, as co-movement in profit-linked equity prices and exchange rates depends on the nature of shocks (Pavlova and Rigobon 2004). Given the central role played by profits in our analysis, a better understanding on their international distribution is a relevant direction for research.

The large valuation effects of exchange rate movements also provide a new angle in the analysis of the relative costs and benefits of flexible and fixed exchange rate regimes, as well as the optimal scope for risk sharing, as taking large positions in assets denominated in foreign currencies can itself be a source of substantial wealth volatility.

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# 7 Appendix A: A decomposition of the changes in U.S. assets and liabilities

## 7.1 Methodology

The data on U.S. foreign assets and liabilities are taken from the Bureau of Economic Analysis (Nguyen 2005). The data cover the positions for various categories of assets at the end of year from 1982 on. The data also decompose the changes in position between two consecutive years between financial flows, the valuation effect of exchange rate movements, the valuation effects of asset prices changes, and other valuation effects, such as changes in coverage. Time series for the positions are available on a revised basis, including the latest adjustments from benchmark survey. Combining these values with revised data for the financial flows from the BEA balance of payments statistics,[25] we compute the revised total valuation effect for the various categories of assets and liabilities. The BEA does not however provide detailed revised values for the decomposition of the valuation effect between its three components (exchange rate, asset prices, and other), and publishes a revised decomposition only for the aggregate net international investment position.[26]

We compute revised estimates for the various components of the valuation effect ('exchange rate', 'asset prices' and 'other') for each category of assets by combining information from the preliminary detailed decomposition and the revised aggregate decomposition. The method allocates the revision in a specific valuation component of the NIIP across the various categories (assets and liabilities) based on the absolute size of the preliminary component in the categories.

The first step is to take the absolute values of the exchange rate and asset prices components for each category in the preliminary data. We also compute the following sums of absolute values:

$$\begin{aligned} ABS^{\text{Total}}_{\text{Exchange rate}} &= \sum_k Abs\left[\begin{array}{c}\text{Exchange rate component,}\\ \text{category } k\text{, preliminary data}\end{array}\right] \\ ABS^{\text{Total}}_{\text{Asset prices}} &= \sum_k Abs\left[\begin{array}{c}\text{Asset prices component,}\\ \text{category } k\text{, preliminary data}\end{array}\right] \end{aligned}$$

[25] http://www.bea.gov/bea/di/home/bop.htm

[26] The revised numbers are avaiable at: http://www.bea.gov/bea/di/intinv04_t3.pdf

where $Abs\,[\mathrm{x}]$ is the absolute value of x. We denote the revisions of the exchange rate and asset prices components in the aggregate NIIP as follows:

$$\begin{aligned}
REV^{\mathrm{NIIP}}_{\mathrm{Exchange\ rate}} &= [\text{Exchange rate component, NIIP, revised data}] \\
&\quad -[\text{Exchange rate component, NIIP, preliminary data}] \\
REV^{\mathrm{NIIP}}_{\mathrm{Asset\ prices}} &= [\text{Asset prices component, NIIP, revised data}] \\
&\quad -[\text{Asset prices component, NIIP, preliminary data}]
\end{aligned}$$

The estimated revised exchange rate components for specific asset and liabilities categories are then computed as follows. For a category $j$ on the asset side of the balance sheet:

$$\begin{aligned}
& [\text{Exchange rate component, category } j\text{, revised estimate}] \\
= \; & [\text{Exchange rate component, category } j\text{, preliminary data}] \\
& + REV^{\mathrm{NIIP}}_{\mathrm{Exchange\ rate}} \frac{Abs\,[\text{Exchange rate component, category } j\text{, preliminary data}]}{ABS^{\mathrm{Total}}_{\mathrm{Exchange\ rate}}}
\end{aligned}$$

For a category $j$ on the liability side of the balance sheet:

$$\begin{aligned}
& [\text{Exchange rate component, category } j\text{, revised estimate}] \\
= \; & [\text{Exchange rate component, category } j\text{, preliminary data}] \\
& - REV^{\mathrm{NIIP}}_{\mathrm{Exchange\ rate}} \frac{Abs\,[\text{Exchange rate component, category } j\text{, preliminary data}]}{ABS^{\mathrm{Total}}_{\mathrm{Exchange\ rate}}}
\end{aligned}$$

The estimated revised asset prices components for specific asset and liabilities categories are computed in a similar way. For a category $j$ on the asset side of the balance sheet:

$$\begin{aligned}
& [\text{Asset prices component, category } j\text{, revised estimate}] \\
= \; & [\text{Asset prices component, category } j\text{, preliminary data}] \\
& + REV^{\mathrm{NIIP}}_{\mathrm{Asset\ prices}} \frac{Abs\,[\text{Asset prices component, category } j\text{, preliminary data}]}{ABS^{\mathrm{Total}}_{\mathrm{Asset\ prices}}}
\end{aligned}$$

While for a category $j$ on the liability side of the balance sheet:

$$\begin{aligned}
& [\text{Asset prices component, category } j\text{, revised estimate}] \\
= \; & [\text{Asset prices component, category } j\text{, preliminary data}] \\
& - REV^{\mathrm{NIIP}}_{\mathrm{Asset\ prices}} \frac{Abs\,[\text{Asset prices component, category } j\text{, preliminary data}]}{ABS^{\mathrm{Total}}_{\mathrm{Asset\ prices}}}
\end{aligned}$$

The revised 'other' components are simply taken as the residuals:

$$\begin{aligned} & [\text{Other component, category } j\text{, revised estimate}] \\ = \; & [\text{Total valuation, category } j\text{, revised data}] \\ & -[\text{Exchange rate component, category } j\text{, revised estimate}] \\ & -[\text{Asset prices component, category } j\text{, revised estimate}] \end{aligned}$$

The method is applied to the various categories of assets (Official, FDI, equity, bonds, banks, other) and liabilities (Official, FDI, equity, bonds, Treasury debt, banks, other). We compare the sums across these categories for assets and liabilities with the estimates obtained by applying the method directly on the total assets and liabilities. Differences are negligible.

## 7.2 The currency composition of U.S. assets and liabilities

### 7.2.1 U.S. assets

U.S. official assets at then end of 2004 are allocated based on the BEA figures in Nguyen (2005). U.S. official reserves assets ($ 189,591 mls) consist of $ 113,947 mls in gold, $ 33,172 mls in SDR and the position at the IMF, and $ 42,472 mls in foreign exchange reserves. The U.S. International Reserve Position as of December 31 2004, taken from the Treasury, amounts to $42,889 mls.[27] Of this amount, $ 24,491 mls are in euro with the $ 18,398 mls balance in yen. We use this to allocate the BEA foreign exchange reserves ($ 42,472 mls) across euro and yen. U.S. official assets other than reserves ($ 83,556 mls) include $ 3,026 mls in foreign currencies, with no further breakdown available.

The currency composition of U.S. equity is estimated based on the Survey of U.S. holdings of foreign securities as of December 31, 2003 (Federal Reserve Bank of New York et al. 2005a, table 16). The survey breaks down the total equity holdings by U.S. investors ($ 2,079,420 mls) across a large number of countries. We assume that equity holdings in a country are denominated in the currency of that country, with the currencies taken from the CIA world factbook.[28] We group several different countries into some currency blocks

[27] http://www.treasury.gov/press/releases/200511016152516639.htm
[28] http://www.cia.gov/cia/publications/factbook/fields/2065.html

for the euro, the U.K. pound, the U.S. dollar and the Swiss franc.[29] We use the shares of the various currencies in 2003 to allocate the U.S. equity assets at the end of 2004 ($ 2,520,063 mls) across the various countries.

We also use the Survey of U.S. holdings of foreign securities (Federal Reserve Bank of New York et al. 2005a, table 18) to allocate the U.S. holdings of long term debt across currencies, totalling $ 874,326 mls. at the end of 2003. The survey gives the value of debt denominated in U.S. dollar, U.K. pound, euro, yen and other currency for each country. We take the 'other currency' category to be in the country's own currency. While this is not entirely accurate, the ensuing discrepancy is negligible.[30] We use the estimated shares of the various currencies to allocate the debt assets at the end of 2004, amounting to $ 916,655 mls.

Our allocation of FDI assets across currency relies on the geographical data published by the BEA (2005). While the data are on a historical cost basis (totalling $ 2,063,998 mls), unlike the figures for the U.S. assets and liabilities where FDI is evaluated at market value (totalling $ 3,287,373 mls), we use them to compute the share of the various currencies and apply them to the data at market value. We assume that FDI holdings in a country are denominated in the currency of that country. We aggregate countries for the euro and the U.S. dollar.[31] The country breakdown is less detailed than the one for equity holdings (Federal Reserve Bank of New York et al. 2005, table 16). An issue arises for Australia, Indonesia, Taiwan, and other Asia-Pacific: the data are not given for confidentiality reasons. We compute estimates for Australia and Taiwan as follows (Indonesia is put in other Asia). We use the published 2003 numbers for Australia and Taiwan. Combining them with an assumption that both together account for the same share of the total for Asia-Pacific in 2004 as it did in 2003, we get an amount for both countries

[29] The specific aggregation is: euro (Austria, Belgium, Germany, Finland, France, Greece, Ireland, Italy, Luxembourg, Monaco, Netherlands, Portugal, Spain), pound (Guernsey, Isle of Man, Jersey, United Kingdom), U.S. dollar (British Virgin Island, Ecuador, Salvador, Marshall Islands, Panama, Turk and Cacaio), Swiss Franc: (Liechtenstein, Switzerland).

[30] Specifically: euro (Austria, Belgium, Germany, Finland, France, Greece, Ireland, Italy, Luxembourg, Monaco, Netherlands, Portugal, Spain), pound (Guernsey, Isle of Man, Jersey, United Kingdom), U.S. dollar (British Virgin Island, Ecuador, Salvador, Marshall Islands, Panama, Turk and Cacaio), Swiss Franc (Liechtenstein, Switzerland).

[31] Specifically: euro (Austria, Belgium, Germany, Finland, France, Greece, Ireland, Italy, Luxembourg, Netherlands, Portugal, Spain), pound (United Kingdom), U.S. dollar (Ecuador, Panama), Swiss Franc (Switzerland).

together for 2004. We allocate this number using the 2003 shares.

We estimate the FDI assets in Liechstenstein ($ 16 mls) by relying on the equity assets in the Liechstenstein and Switzerland, as well as the value of FDI assets in Switzerland. The amount is allocated to the Swiss franc, and out of the 'other Europe' category. We compute an estimate of FDI holdings in Salvador ($ 0 mls) by using the total FDI and equity assets in Latin America, minus Mexico, Panama, Brazil and Ecuador, and the equity assets in Salvador. The amount is allocated to the U.S. dollar and taken out of the 'other central America' category. The category 'U.K. Islands, Caribbean' is allocated across the U.S. dollar, the U.K. pound and local currencies by relying on equity assets in the corresponding countries.[32]

The BEA reports that $ 155,200 mls worth of banking assets were denominated in foreign currencies at the end of 2004, out of a total of $ 2,174,009 mls (Nguyen 2005, table D and table 1). While no figures are available for the currency composition of 'other' assets, the valuation effect of exchange rate movements reported by the BEA is similar to that of banking assets, suggesting a similar amount of foreign currency denominated debt for the 'other' category, that we estimate at $ 179,763 mls out of a total of $ 801,536 mls.

### 7.2.2 U.S. liabilities

The BEA data indicate that the only categories of U.S. liabilities including some securities denominated in foreign currencies are debt securities, banks and other, as the valuation impact of exchange rate movements is zero for all other categories (Nguyen 2005, table 1).

The currency composition of debt liabilities, excluding Treasury securities, is estimated based on the Survey of foreign holdings of U.S. securities (Federal Reserve Bank of New York et al. 2005b, tables 17 and 22). As of June 30, 2004, foreign investors held $ 3,514,530 millions of U.S. long term debt securities, of which $ 1,462,356 mls consisted of Treasury debt (table 14) denominated in dollar. The currency composition of the remaining debt is given in table 22. We use the share of the various currencies in the non-Treasury debt liabilities to allocate the amount at the end of 2004 ($ 2,059,250 mls).

[32]Specifically, the allocation is: U.S. dollar (British Virgin Islands, Turk and Cacaio), pound (Guernsey, Isle of Man, Jersey), own currency (Antigua, Aruba, Cayman, Grenada, Jamaica, St. Kitts and Nevis, Trinidad and Tobago).

The BEA reports that at the end of 2004 \$ 91,800 mls worth of banking liabilities were denominated in foreign currencies, out of a total of \$ 2,304,640 mls (Nguyen 2005, table I and table 1). While no figures are available for the currency composition of 'other' liabilities, the valuation effect of exchange rate movements reported by the BEA is similar to that of banking liabilities, suggesting a similar amount of foreign currency denominated debt for the 'other' category, that we estimate at \$ 90,348 mls out of a total of \$ 913,993 mls.

# 8 Appendix B: A model of international transmission under financial integration

## 8.1 Linear approximations

### 8.1.1 Consumer prices

The consumer price indexes (2)-(3) are expressed in terms of linear approximations as follows:

$$
\begin{aligned}
\mathsf{p}_t &= \frac{2}{2-\gamma}\left[\int_{\gamma/2}^{1/2} \mathsf{p}_{HTt}(z)\,dz + \int_{1/2}^{1-\gamma/2} \mathsf{p}_{FTt}(z)\,dz + \int_{0}^{\gamma/2} \mathsf{p}_{Nt}(z)\,dz\right] \\
&= \frac{1-\gamma}{2-\gamma}\mathsf{p}_{HTt} + \frac{1-\gamma}{2-\gamma}\mathsf{p}_{FTt} + \frac{\gamma}{2-\gamma}\mathsf{p}_{Nt} \\
\mathsf{p}_t^* &= \frac{2}{2-\gamma}\left[\int_{\gamma/2}^{1/2} \mathsf{p}_{HTt}^*(z)\,dz + \int_{1/2}^{1-\gamma/2} \mathsf{p}_{FTt}^*(z)\,dz + \int_{1-\gamma/2}^{1} \mathsf{p}_{Nt}^*(z)\,dz\right] \\
&= \frac{1-\gamma}{2-\gamma}\mathsf{p}_{HTt}^* + \frac{1-\gamma}{2-\gamma}\mathsf{p}_{FTt}^* + \frac{\gamma}{2-\gamma}\mathsf{p}_{Nt}^*
\end{aligned}
$$

In terms of worldwide averages and cross country differences, we write:

$$
\begin{aligned}
\mathsf{p}_t + \mathsf{p}_t^* &= \frac{1-\gamma}{2-\gamma}\left(\mathsf{p}_{HTt} + \mathsf{p}_{HTt}^* + \mathsf{p}_{FTt} + \mathsf{p}_{FTt}^*\right) \qquad (38) \\
&\quad + \frac{\gamma}{2-\gamma}\left(\mathsf{p}_{Nt} + \mathsf{p}_{Nt}^*\right) \\
\mathsf{p}_t - \mathsf{p}_t^* &= \frac{1-\gamma}{2-\gamma}\left[\left(\mathsf{p}_{HTt} - \mathsf{p}_{HTt}^*\right) + \left(\mathsf{p}_{FTt} - \mathsf{p}_{FTt}^*\right)\right] \qquad (39) \\
&\quad + \frac{\gamma}{2-\gamma}\left(\mathsf{p}_{Nt} - \mathsf{p}_{Nt}^*\right)
\end{aligned}
$$

### 8.1.2 Outputs, profits and price-setting

The aggregate measures of output and profits (24)-(27) are approximated as:

$$
\begin{aligned}
\mathsf{y}_t &= \frac{2-2\gamma}{2-\gamma}\left[-\lambda\left[\frac{1}{2}\left(\mathsf{p}_{HTt}-\mathsf{p}_t\right)+\frac{1}{2}\left(\mathsf{p}^*_{HTt}-\mathsf{p}^*_t\right)\right]+\frac{1}{2}\left(\mathsf{c}_t+\mathsf{c}^*_t\right)\right] \\
&\quad +\frac{\gamma}{2-\gamma}\left[-\lambda\left(\mathsf{p}_{Nt}-\mathsf{p}_t\right)+\mathsf{c}_t\right] \\
\mathsf{y}^*_t &= \frac{2-2\gamma}{2-\gamma}\left[-\lambda\left[\frac{1}{2}\left(\mathsf{p}_{FTt}-\mathsf{p}_t\right)+\frac{1}{2}\left(\mathsf{p}^*_{FTt}-\mathsf{p}^*_t\right)\right]+\frac{1}{2}\left(\mathsf{c}_t+\mathsf{c}^*_t\right)\right] \\
&\quad +\frac{\gamma}{2-\gamma}\left[-\lambda\left(\mathsf{p}^*_{Nt}-\mathsf{p}^*_t\right)+\mathsf{c}^*_t\right] \\
\Pi_t &= \theta\left[\frac{2-2\gamma}{2-\gamma}\left[\frac{1}{2}\mathsf{p}_{HTt}+\frac{1}{2}\left(\mathsf{s}_t+\mathsf{p}^*_{HTt}\right)\right]+\frac{\gamma}{2-\gamma}\mathsf{p}_{Nt}\right]-\left(\theta-1\right)\mathsf{w}_t+\mathsf{y}_t \\
\Pi^*_t &= \theta\left[\frac{2-2\gamma}{2-\gamma}\left[\frac{1}{2}\left(\mathsf{p}_{FTt}-\mathsf{s}_t\right)+\frac{1}{2}\mathsf{p}^*_{FTt}\right]+\frac{\gamma}{2-\gamma}\mathsf{p}^*_{Nt}\right]-\left(\theta-1\right)\mathsf{w}^*_t+\mathsf{y}^*_t
\end{aligned}
$$

Taking worldwide sums of the outputs and profits leads to:

$$
\begin{aligned}
\mathsf{y}_t+\mathsf{y}^*_t &= \mathsf{c}_t+\mathsf{c}^*_t \qquad (40) \\
\Pi_t+\Pi^*_t &= \theta\left(\mathsf{p}_t+\mathsf{p}^*_t\right)-\left(\theta-1\right)\left(\mathsf{w}_t+\mathsf{w}^*_t\right)+\mathsf{c}_t+\mathsf{c}^*_t
\end{aligned}
$$

$$
\begin{aligned}
\mathsf{y}_t-\mathsf{y}^*_t &= -\lambda\frac{1-\gamma}{2-\gamma}\left[\left(\mathsf{p}_{HTt}-\mathsf{p}_{FTt}\right)+\left(\mathsf{p}^*_{HTt}-\mathsf{p}^*_{FTt}\right)\right] \qquad (41) \\
&\quad -\lambda\frac{\gamma}{2-\gamma}\left[\left(\mathsf{p}_{Nt}-\mathsf{p}^*_{Nt}\right)-\left(\mathsf{p}_t-\mathsf{p}^*_t\right)\right]+\frac{\gamma}{2-\gamma}\left(\mathsf{c}_t-\mathsf{c}^*_t\right) \\
\Pi_t-\Pi^*_t-\mathsf{s}_t &= \theta\frac{1-\gamma}{2-\gamma}\left[\left(\mathsf{p}_{HTt}-\mathsf{p}_{FTt}\right)+\left(\mathsf{p}^*_{HTt}-\mathsf{p}^*_{FTt}\right)\right] \qquad (42) \\
&\quad +\theta\frac{\gamma}{2-\gamma}\left(\mathsf{p}_{Nt}-\mathsf{p}^*_{Nt}-\mathsf{s}_t\right) \\
&\quad -\left(\theta-1\right)\left(\mathsf{w}_t-\mathsf{w}^*_t-\mathsf{s}_t\right)+\left(\mathsf{y}_t-\mathsf{y}^*_t\right)
\end{aligned}
$$

When firms can set their prices, they bring them in line with marginal costs. Linearizing the optimal price-setting relation (28) leads to:

$$
\begin{aligned}
\mathsf{p}_{Ht}\left(z\right) &= \mathsf{s}_t+\mathsf{p}^*_{Ht}\left(z\right)=\mathsf{p}_{Nt}\left(z\right)=\mathsf{w}_t \qquad (43) \\
\mathsf{p}^*_{Ft}\left(z\right) &= \mathsf{p}_{Ft}\left(z\right)-\mathsf{s}_t=\mathsf{p}^*_{Nt}\left(z\right)=\mathsf{w}^*_t
\end{aligned}
$$

### 8.1.3 Consumer optimization

The money demands (5) and (10) are linearized as follows:

$$\mathsf{m}_t - \mathsf{p}_t = \mathsf{c}_t - \frac{\beta}{1-\beta} E_t \beta di_{St+1} \qquad , \qquad \mathsf{m}_t^* - \mathsf{p}_t^* = \mathsf{c}_t^* - \frac{\beta}{1-\beta} E_t \beta di_{St+1}^* \quad (44)$$

The optimal portfolio allocations (6)-(8) and (11)-(13) lead to the following relations:

$$\begin{aligned} E_t \beta di_{St+1} &= E_t\left(\mathsf{c}_{t+1} - \mathsf{c}_t\right) + E_t\left(\mathsf{p}_{t+1} - \mathsf{p}_t\right) & (45) \\ &= E_t\left[(1-\beta)\,\mathsf{D}_{t+1} + \beta \mathsf{q}_{t+1} - \mathsf{q}_t\right] \\ &= E_t\left(\beta \mathsf{g}_{t+1} - \mathsf{g}_t\right) \\ E_t \beta di_{St+1}^* &= E_t\left(\mathsf{c}_{t+1}^* - \mathsf{c}_t^*\right) + E_t\left(\mathsf{p}_{t+1}^* - \mathsf{p}_t^*\right) & (46) \\ &= E_t\left[(1-\beta)\,\mathsf{D}_{t+1}^* + \beta \mathsf{q}_{t+1}^* - \mathsf{q}_t^*\right] \\ &= E_t\left(\beta \mathsf{g}_{t+1}^* - \mathsf{g}_t^*\right) \end{aligned}$$

These relations imply that the interest parity condition holds:

$$E_t \beta di_{St+1} = E_t \beta di_{St+1}^* + E_t\left(\mathsf{s}_{t+1} - \mathsf{s}_t\right)$$

When workers can adjust their wages, the labor supplies (14) and (15) imply:

$$\mathsf{w}_t\,(j) = \mathsf{p}_t + \mathsf{c}_t \qquad \mathsf{w}_t^*\,(j) = \mathsf{p}_t^* + \mathsf{c}_t^* \quad (47)$$

### 8.1.4 Net asset positions and budget constraints

The linear expansion of the net foreign asset position (32) is given by:

$$\begin{aligned} \mathsf{nfa}_{t+1} &= \mathsf{pos}_{t+1} + \frac{S_0 q_0^* \left(K^* - K_{F0}^*\right)}{P_0 C_0} \mathsf{q}_t^* - \frac{q_0 \left(K - K_{H0}\right)}{P_0 C_0} \mathsf{q}_t \\ &\quad + \frac{g_0 B L_{H0}}{P_0 C_0} \mathsf{g}_t + \frac{S_0 g_0^* B L_{F0}}{P_0 C_0} \mathsf{g}_t^* + \frac{G F_0}{P_0 C_0} \mathsf{s}_t \end{aligned}$$

where $\mathsf{pos}_{t+1}$ reflects the various asset positions evaluated at the steady state asset prices:

$$\mathsf{pos}_{t+1} = \left[q_0 \mathsf{k}_{Ht+1} - S_0 q_0^* \mathsf{k}_{Ft+1}^*\right] + \left[\mathsf{bs}_{Ht+1} + S_0 \mathsf{bs}_{Ft+1}\right] + \left[g_0 \mathsf{bl}_{Ht+1} + S_0 g_0^* \mathsf{bl}_{Ft+1}\right]$$

We expand the home country current account (4) as:

$$
\begin{aligned}
& (\mathsf{p}_t + \mathsf{c}_t) + \mathsf{pos}_{t+1} \\
= \; & \frac{1}{\theta}\Pi_t + \frac{\theta - 1}{\theta}(\mathsf{w}_t + \mathsf{h}_t) + \frac{1}{\beta}\mathsf{pos}_t \\
& + \frac{1-\beta}{\beta}\left[ \begin{array}{c} \frac{GF_0}{P_0C_0}\mathsf{s}_t + \frac{S_0q_0^*\left(K^* - K_{F0}^*\right)}{P_0C_0}\Pi_t^* - \frac{q_0(K - K_{H0})}{P_0C_0}\Pi_t \\ + \frac{1}{1-\beta}\left[\beta di_{St}\frac{BS_{H0}}{P_0C_0} + \beta di_{St}^*\frac{S_0BS_{F0}}{P_0C_0}\right] \end{array} \right]
\end{aligned}
$$

Similarly, the foreign current account (9) is:

$$
\begin{aligned}
& (\mathsf{p}_t^* + \mathsf{c}_t^* + \mathsf{s}_t) - \mathsf{pos}_{t+1} \\
= \; & \frac{1}{\theta}(\Pi_t^* + \mathsf{s}_t) + \frac{\theta - 1}{\theta}(\mathsf{w}_t^* + \mathsf{h}_t^* + \mathsf{s}_t) - \frac{1}{\beta}\mathsf{pos}_t \\
& - \frac{1-\beta}{\beta}\left[ \begin{array}{c} \frac{GF_0}{P_0C_0}\mathsf{s}_t + \frac{S_0q_0^*\left(K^* - K_{F0}^*\right)}{P_0C_0}\Pi_t^* - \frac{q_0(K - K_{H0})}{P_0C_0}\Pi_t \\ + \frac{1}{1-\beta}\left[\beta di_{St}\frac{BS_{H0}}{P_0C_0} + \beta di_{St}^*\frac{S_0BS_{F0}}{P_0C_0}\right] \end{array} \right]
\end{aligned}
$$

Summing these two current account relations, world consumption is equal to world nominal GDP (i.e. wage income and profits):

$$
(\mathsf{p}_t + \mathsf{c}_t) + (\mathsf{p}_t^* + \mathsf{c}_t^*) = \frac{\theta - 1}{\theta}\left[(\mathsf{w}_t + \mathsf{h}_t) + (\mathsf{w}_t^* + \mathsf{h}_t^*)\right] + \frac{1}{\theta}\left[\Pi_t + \Pi_t^*\right] \tag{48}
$$

In terms of cross-country differences, we get:

$$
\begin{aligned}
& (\mathsf{c}_t - \mathsf{c}_t^*) - (\mathsf{s}_t + \mathsf{p}_t^* - \mathsf{p}_t) + 2\mathsf{pos}_{t+1} \\
= \; & \frac{1}{\theta}\left[\Pi_t - \Pi_t^* - \mathsf{s}_t\right] + \frac{\theta - 1}{\theta}\left[(\mathsf{h}_t - \mathsf{h}_t^*) + (\mathsf{w}_t - \mathsf{w}_t^* - \mathsf{s}_t)\right] + \frac{1}{\beta}2\mathsf{pos}_t \quad (49) \\
& + 2\frac{1-\beta}{\beta}\left[\frac{GF_0}{P_0C_0}\mathsf{s}_t - \frac{q_0\left(K - K_{H0}\right)}{P_0C_0}\Pi_t + \frac{S_0q_0^*\left(K^* - K_{F0}^*\right)}{P_0C_0}\Pi_t^*\right] \\
& + 2\left[di_{St}\frac{BS_{H0}}{P_0C_0} + di_{St}^*\frac{S_0BS_{F0}}{P_0C_0}\right]
\end{aligned}
$$

We get (33) by using the fact that:

$$
\Pi_t = \frac{1}{2}(\Pi_t + \Pi_t^*) + \frac{1}{2}(\Pi_t - \Pi_t^*) \qquad \Pi_t^* = \frac{1}{2}(\Pi_t + \Pi_t^*) - \frac{1}{2}(\Pi_t - \Pi_t^*)
$$

## 8.2 Impact of a monetary shock: the long run

We consider monetary shocks in the home and foreign countries. We allow the long-run ($\bar{\mathsf{m}}$, $\bar{\mathsf{m}}^*$) and short-run ($\mathsf{m}$, $\mathsf{m}^*$) shocks to differ (the main text focuses on the case of permanent shocks: $\mathsf{m} = \bar{\mathsf{m}}$, $\mathsf{m}^* = \bar{\mathsf{m}}^*$).

In the long run all variables are constant, and the returns on all assets are equal to the discount factor. All prices and wage are flexible. The price indexes (38)-(39) and optimal price setting rule (43) imply:

$$\bar{\mathsf{p}} + \bar{\mathsf{p}}^* = \bar{\mathsf{w}} + \bar{\mathsf{w}}^* \qquad \bar{\mathsf{p}} - \bar{\mathsf{p}}^* = \bar{\mathsf{s}} + \frac{\gamma}{2-\gamma}\left(\bar{\mathsf{w}} - \bar{\mathsf{w}}^* - \bar{\mathsf{s}}\right)$$

The outputs and profits relations (40)-(42) are:

$$\begin{aligned}
\bar{\mathsf{y}} + \bar{\mathsf{y}}^* &= \bar{\mathsf{c}} + \bar{\mathsf{c}}^* \qquad , \qquad \bar{\Pi} + \bar{\Pi}^* = \bar{\mathsf{w}} + \bar{\mathsf{w}}^* + \bar{\mathsf{c}} + \bar{\mathsf{c}}^* \\
\bar{\mathsf{y}} - \bar{\mathsf{y}}^* &= -\lambda \frac{2-2\gamma}{2-\gamma} \frac{2}{2-\gamma} \left(\bar{\mathsf{w}} - \bar{\mathsf{w}}^* - \bar{\mathsf{s}}\right) + \frac{\gamma}{2-\gamma}\left(\bar{\mathsf{c}} - \bar{\mathsf{c}}^*\right) \\
\bar{\Pi} - \bar{\Pi}^* &= \bar{\mathsf{s}} + \left(1 - \lambda \frac{2-2\gamma}{2-\gamma} \frac{2}{2-\gamma}\right)\left(\bar{\mathsf{w}} - \bar{\mathsf{w}}^* - \bar{\mathsf{s}}\right) + \frac{\gamma}{2-\gamma}\left(\bar{\mathsf{c}} - \bar{\mathsf{c}}^*\right)
\end{aligned}$$

Combining this result with the labor supplies (47) shows that there is no worldwide real effect:

$$\bar{\mathsf{w}} + \bar{\mathsf{w}}^* = \bar{\mathsf{p}} + \bar{\mathsf{p}}^* + \bar{\mathsf{c}} + \bar{\mathsf{c}}^* \Rightarrow \bar{\mathsf{c}} + \bar{\mathsf{c}}^* = 0$$

$$\frac{2-2\gamma}{2-\gamma}\left(\bar{\mathsf{w}} - \bar{\mathsf{w}}^* - \bar{\mathsf{s}}\right) = \bar{\mathsf{c}} - \bar{\mathsf{c}}^*$$

The money demands (44) imply:

$$\begin{aligned}
\bar{\mathsf{p}} + \bar{\mathsf{p}}^* &= \bar{\mathsf{w}} + \bar{\mathsf{w}}^* = \bar{\mathsf{m}} + \bar{\mathsf{m}}^* \\
\bar{\mathsf{p}} - \bar{\mathsf{p}}^* &= \left(\bar{\mathsf{m}} - \bar{\mathsf{m}}^*\right) - \left(\bar{\mathsf{c}} - \bar{\mathsf{c}}^*\right)
\end{aligned}$$

The households' intertemporal optimization (45)-(46) implies that all assets pay the steady state interest rate:

$$di_S = di_S^* = \bar{\mathsf{g}} = \bar{\mathsf{g}}^* = 0 \qquad , \qquad \bar{\mathsf{q}} = \bar{\Pi} \qquad , \qquad \bar{\mathsf{q}}^* = \bar{\Pi}^*$$

Using our results, and the fact that hours worked are equal to output, the current account relation (49) is written as:

$$
\begin{aligned}
&\left(\bar{\mathsf{c}}-\bar{\mathsf{c}}^*\right)+\frac{\gamma}{2-\gamma}\left(\bar{\mathsf{w}}-\bar{\mathsf{w}}^*-\bar{\mathsf{s}}\right) \\
= \; & \frac{1}{\theta}\left[\bar{\Pi}-\bar{\Pi}^*-\bar{\mathsf{s}}\right]+\frac{\theta-1}{\theta}\left[\left(\bar{\mathsf{y}}-\bar{\mathsf{y}}^*\right)+\left(\bar{\mathsf{w}}-\bar{\mathsf{w}}^*-\bar{\mathsf{s}}\right)\right]+\frac{1-\beta}{\beta}2\overline{\mathsf{pos}} \\
&+2\frac{1-\beta}{\beta}\left[\frac{GF_0}{P_0C_0}\bar{\mathsf{s}}-\frac{q_0\left(K-K_{H0}\right)}{P_0C_0}\bar{\Pi}+\frac{S_0q_0^*\left(K^*-K_{F0}^*\right)}{P_0C_0}\bar{\Pi}^*\right]
\end{aligned}
$$

Combining the various relations in cross-country terms, the consumption and output differentials are:

$$
\Psi\left(\bar{\mathsf{c}}-\bar{\mathsf{c}}^*\right) = 2\overline{\mathsf{pos}}+\left[2\frac{GF_0}{P_0C_0}-\frac{GK_0}{P_0C_0}\right]\left(\bar{\mathsf{m}}-\bar{\mathsf{m}}^*\right)+\frac{NFK_0}{P_0C_0}\left(\bar{\mathsf{m}}+\bar{\mathsf{m}}^*\right) \tag{50}
$$

$$
\bar{\mathsf{y}}-\bar{\mathsf{y}}^* = -\frac{2\lambda-\gamma}{2-\gamma}\left(\bar{\mathsf{c}}-\bar{\mathsf{c}}^*\right) \tag{51}
$$

where:

$$
\Psi=\frac{2\lambda-\gamma}{2-\gamma}\frac{\beta}{1-\beta}+\frac{2-\gamma}{2-2\gamma}2\frac{GF_0}{P_0C_0}-\frac{2\lambda-\gamma}{2-\gamma}\frac{GK_0}{P_0C_0}
$$

## 8.3 Impact of a monetary shock: the short run

### 8.3.1 Main relations

In the short run a fraction $\tau$ of firms can adjust their prices. Among the firms with preset prices, a fraction $\eta$ keep the prices constant in their own currency. Similarly, a fraction $\upsilon$ of wages are adjusted. The price indexes (38)-(39) and optimal price setting rule (43) imply:

$$
\mathsf{p}+\mathsf{p}^*=\tau\left(\mathsf{w}+\mathsf{w}^*\right) \qquad , \qquad \mathsf{p}-\mathsf{p}^*=\frac{\gamma\tau}{2-\gamma}\left(\mathsf{w}-\mathsf{w}^*\right)+\frac{2-2\gamma}{2-\gamma}\left[\tau+\left(1-\tau\right)\eta\right]\mathsf{s}
$$

The outputs and profits relations (40)-(42) are:

$$
\begin{aligned}
\mathsf{y}+\mathsf{y}^* &= \mathsf{c}+\mathsf{c}^* \qquad , \qquad \Pi+\Pi^*=\left[1-\theta\left(1-\tau\right)\right]\left(\mathsf{w}+\mathsf{w}^*\right)+\mathsf{c}+\mathsf{c}^* \\
\mathsf{y}-\mathsf{y}^* &= -\lambda\frac{2-2\gamma}{2-\gamma}\frac{2}{2-\gamma}\left[\tau\left(\mathsf{w}-\mathsf{w}^*-\mathsf{s}\right)-\left(1-\tau\right)\eta\mathsf{s}\right]+\frac{\gamma}{2-\gamma}\left(\mathsf{c}-\mathsf{c}^*\right) \\
\Pi-\Pi^* &= \theta\frac{2-2\gamma}{2-\gamma}\left(1-\eta\right)\left(1-\tau\right)\mathsf{s} \\
&\quad+\left[1-\theta\left(1-\tau\right)\right]\left(\mathsf{w}-\mathsf{w}^*\right)+\left(\mathsf{y}-\mathsf{y}^*\right)
\end{aligned} \tag{52}
$$

The labor supplies (47) imply:

$$\begin{aligned}\mathsf{w}+\mathsf{w}^{*} &= \frac{\upsilon}{1-\tau\upsilon}\left(\mathsf{c}+\mathsf{c}^{*}\right)\\ \mathsf{w}-\mathsf{w}^{*} &= \frac{\upsilon}{1-\tau\upsilon\frac{\gamma}{2-\gamma}}\left[\frac{2-2\gamma}{2-\gamma}\left[\tau+(1-\tau)\,\eta\right]\mathsf{s}+\left(\mathsf{c}-\mathsf{c}^{*}\right)\right]\end{aligned}$$

In terms of cross-country differences, the money demands (44) in the short and long run, and intertemporal optimization (45)-(46) imply that the exchange rate dynamics reflect the path of monetary shocks:

$$\begin{aligned}\left(\bar{\mathsf{p}}-\bar{\mathsf{p}}^{*}\right)+\left(\bar{\mathsf{c}}-\bar{\mathsf{c}}^{*}\right) &= \left(\bar{\mathsf{m}}-\bar{\mathsf{m}}^{*}\right)\\ \left(\mathsf{p}-\mathsf{p}^{*}\right)+\left(\mathsf{c}-\mathsf{c}^{*}\right) &= \left(\mathsf{m}-\mathsf{m}^{*}\right)+\frac{\beta}{1-\beta}\left(\bar{\mathsf{s}}-\mathsf{s}\right)\\ \left(\bar{\mathsf{p}}-\bar{\mathsf{p}}^{*}\right)+\left(\bar{\mathsf{c}}-\bar{\mathsf{c}}^{*}\right) &= \left(\mathsf{p}-\mathsf{p}^{*}\right)+\left(\mathsf{c}-\mathsf{c}^{*}\right)+\left(\bar{\mathsf{s}}-\mathsf{s}\right) \qquad (53)\\ &\Rightarrow \bar{\mathsf{s}}-\mathsf{s}=(1-\beta)\left[\left(\bar{\mathsf{m}}-\bar{\mathsf{m}}^{*}\right)-\left(\mathsf{m}-\mathsf{m}^{*}\right)\right]\end{aligned}$$

In worldwide terms, the same relations imply that the short run interest rates reflect the dynamics of country-specific monetary shocks:

$$\begin{aligned}\bar{\mathsf{p}}+\bar{\mathsf{p}}^{*} &= \bar{\mathsf{m}}+\bar{\mathsf{m}}^{*}\\ \left(\mathsf{p}+\mathsf{p}^{*}\right)+\left(\mathsf{c}+\mathsf{c}^{*}\right) &= \mathsf{m}+\mathsf{m}^{*}+\frac{\beta}{1-\beta}\left[2\beta di_{S}-\left(\bar{\mathsf{s}}-\mathsf{s}\right)\right]\\ \bar{\mathsf{p}}+\bar{\mathsf{p}}^{*} &= \left(\mathsf{p}+\mathsf{p}^{*}\right)+\left(\mathsf{c}+\mathsf{c}^{*}\right)+\left[2\beta di_{S}-\left(\bar{\mathsf{s}}-\mathsf{s}\right)\right]\\ \Rightarrow \beta di_{S}=(1-\beta)\left(\bar{\mathsf{m}}-\mathsf{m}\right) &\qquad , \qquad \beta di_{S}^{*}=(1-\beta)\left(\bar{\mathsf{m}}^{*}-\mathsf{m}^{*}\right)\end{aligned}$$

The prices of long-term bonds reflects the short run interest rates, and the equity prices reflect the interest rates and long-run profits:

$$\begin{aligned}\mathsf{g} &= -\beta di_{S} \qquad , \qquad \mathsf{g}^{*}=-\beta di_{S}^{*}\\ \mathsf{q} &= \bar{\Pi}-\beta di_{S} \qquad , \qquad \mathsf{q}^{*}=\bar{\Pi}^{*}-\beta di_{S}^{*}\end{aligned}$$

### 8.3.2 Worldwide solution

Combining the various expressions in worldwide terms, we get the following solution:

$$\begin{aligned}\mathsf{c}+\mathsf{c}^{*} &= \mathsf{y}+\mathsf{y}^{*}=(1-\tau\upsilon)\left[\beta\left(\bar{\mathsf{m}}+\bar{\mathsf{m}}^{*}\right)+(1-\beta)\left(\mathsf{m}+\mathsf{m}^{*}\right)\right]\\ \mathsf{w}+\mathsf{w}^{*} &= \upsilon\left[\beta\left(\bar{\mathsf{m}}+\bar{\mathsf{m}}^{*}\right)+(1-\beta)\left(\mathsf{m}+\mathsf{m}^{*}\right)\right]\\ \mathsf{p}+\mathsf{p}^{*} &= \tau\upsilon\left[\beta\left(\bar{\mathsf{m}}+\bar{\mathsf{m}}^{*}\right)+(1-\beta)\left(\mathsf{m}+\mathsf{m}^{*}\right)\right]\\ \Pi+\Pi^{*} &= \left[1-\upsilon(1-\tau)(\theta-1)\right]\left[\beta\left(\bar{\mathsf{m}}+\bar{\mathsf{m}}^{*}\right)+(1-\beta)\left(\mathsf{m}+\mathsf{m}^{*}\right)\right]\end{aligned}$$

### 8.3.3 Cross-country solution

Combining the cross-country differences of consumer prices, the labor supplies and the money demands, we get a relation between the monetary shocks, the exchange rate and relative consumption:

$$\begin{aligned}&\left(1-\tau\upsilon\frac{\gamma}{2-\gamma}\right)\left[\left(1-\beta\right)\left(\mathsf{m}-\mathsf{m}^*\right)+\beta\left(\bar{\mathsf{m}}-\bar{\mathsf{m}}^*\right)\right] \\ =\ &\frac{2-2\gamma}{2-\gamma}\left[\tau+\left(1-\tau\right)\eta\right]\mathsf{s}+\left(\mathsf{c}-\mathsf{c}^*\right)\end{aligned} \tag{54}$$

The cross-country differences of consumer prices and the labor supplies also allow us to write the real exchange rate:

$$\left(\mathsf{s}+\mathsf{p}^*-\mathsf{p}\right)=\left[1-\frac{1}{1-\tau\upsilon\frac{\gamma}{2-\gamma}}\frac{2-2\gamma}{2-\gamma}\left[\tau+\left(1-\tau\right)\eta\right]\right]\mathsf{s}-\frac{\tau\upsilon\frac{\gamma}{2-\gamma}}{1-\tau\upsilon\frac{\gamma}{2-\gamma}}\left(\mathsf{c}-\mathsf{c}^*\right) \tag{55}$$

Using the fact that hours worked are equal to output, the current account relation (49) is written as:

$$\begin{aligned}&\left(\mathsf{c}-\mathsf{c}^*\right)-\left(\mathsf{s}+\mathsf{p}^*-\mathsf{p}\right)+2\overline{\mathsf{pos}} \\ =\ &\frac{1}{\theta}\left[\Pi-\Pi^*-\mathsf{s}\right]+\frac{\theta-1}{\theta}\left[\left(\mathsf{y}-\mathsf{y}^*\right)+\left(\mathsf{w}-\mathsf{w}^*-\mathsf{s}\right)\right] \\ &+2\frac{1-\beta}{\beta}\left[\frac{GF_0}{P_0C_0}\mathsf{s}+\frac{S_0q_0^*\left(K^*-K_{F0}^*\right)}{P_0C_0}\Pi^*-\frac{q_0\left(K-K_{H0}\right)}{P_0C_0}\Pi\right] \\ &+2\left[di_S\frac{BS_{H0}}{P_0C_0}+di_S^*\frac{S_0BS_{F0}}{P_0C_0}\right]\end{aligned} \tag{56}$$

Using the profit differential (52), we write the differential between national incomes as:

$$\begin{aligned}&\frac{1}{\theta}\left[\Pi-\Pi^*-\mathsf{s}\right]+\frac{\theta-1}{\theta}\left[\left(\mathsf{y}-\mathsf{y}^*\right)+\left(\mathsf{w}-\mathsf{w}^*-\mathsf{s}\right)\right] \\ =\ &\left[\frac{2-2\gamma}{2-\gamma}\left(1-\eta\right)-1\right]\left(1-\tau\right)\mathsf{s}+\tau\left(\mathsf{w}-\mathsf{w}^*-\mathsf{s}\right)+\left(\mathsf{y}-\mathsf{y}^*\right)\end{aligned}$$

The terms involving profits in the right-hand side bracket of (56) are transformed as follows:

$$
\begin{aligned}
& \frac{S_0 q_0^* \left(K^* - K_{F0}^*\right)}{P_0 C_0} \mathsf{\Pi}^* - \frac{q_0 \left(K - K_{H0}\right)}{P_0 C_0} \mathsf{\Pi} \\
= \; & \frac{NFK_0}{P_0 C_0} \frac{1}{2} \left(\mathsf{\Pi} + \mathsf{\Pi}^*\right) - \frac{GK_0}{P_0 C_0} \frac{1}{2} \left(\mathsf{\Pi} - \mathsf{\Pi}^*\right) \\
= \; & \frac{NFK_0}{P_0 C_0} \frac{1}{2} \left[1 - \upsilon \left(1 - \tau\right) \left(\theta - 1\right)\right] \left[\beta \left(\bar{\mathsf{m}} + \bar{\mathsf{m}}^*\right) + \left(1 - \beta\right) \left(\mathsf{m} + \mathsf{m}^*\right)\right] \\
& - \frac{GK_0}{P_0 C_0} \frac{1}{2} \left(\mathsf{\Pi} - \mathsf{\Pi}^*\right)
\end{aligned}
$$

Using the cross-country differentials in outputs and labor supplies, the profit differential (52) becomes:

$$
\begin{aligned}
\mathsf{\Pi} - \mathsf{\Pi}^* \; = \; & \frac{2 - 2\gamma}{2 - \gamma} \left[ \begin{array}{c} \theta \left(1 - \eta\right) \left(1 - \tau\right) + \lambda \frac{2}{2 - \gamma} \frac{1 - \tau\upsilon}{1 - \tau\upsilon \frac{\gamma}{2 - \gamma}} \left[\tau + \left(1 - \tau\right) \eta\right] \\ + \left[1 - \theta \left(1 - \tau\right)\right] \frac{\upsilon}{1 - \tau\upsilon \frac{\gamma}{2 - \gamma}} \left[\tau + \left(1 - \tau\right) \eta\right] \end{array} \right] \mathsf{s} \\
& + \left[ \left[1 - \theta \left(1 - \tau\right) - \lambda \frac{2 - 2\gamma}{2 - \gamma} \frac{2}{2 - \gamma} \tau\right] \frac{\upsilon}{1 - \tau\upsilon \frac{\gamma}{2 - \gamma}} + \frac{\gamma}{2 - \gamma} \right] \left(\mathsf{c} - \mathsf{c}^*\right)
\end{aligned}
$$

Combining the various terms, along with real exchange rate (55), the relation between the exchange rate and the consumption differential in the short run (54), and re-arranging, (56) leads to a relation between the short-run consumption differential, $\mathsf{c} - \mathsf{c}^*$, changes in asset holdings, $\overline{\mathsf{pos}}$, and the monetary shocks:

$$
\begin{aligned}
& \left(\mathsf{c} - \mathsf{c}^*\right) \left[ \begin{array}{c} \frac{2\lambda - \gamma}{2 - \gamma} + \frac{(1-\eta)(1-\tau)}{\tau + (1-\tau)\eta} - \frac{1-\beta}{\beta} \frac{GK_0}{P_0 C_0} \left[\frac{2\lambda - \gamma}{2 - \gamma} + \theta \frac{(1-\eta)(1-\tau)}{\tau + (1-\tau)\eta}\right] \\ + 2 \frac{1-\beta}{\beta} \frac{GF_0}{P_0 C_0} \frac{2-\gamma}{2-2\gamma} \frac{1}{\tau + (1-\tau)\eta} \end{array} \right] + 2\overline{\mathsf{pos}} \qquad (57) \\
= & \left\{ \begin{array}{c} \left[\left(\lambda - 1\right) \frac{2}{2-\gamma} + \frac{\gamma}{2-\gamma}\right] \left(1 - \tau\upsilon\right) + \frac{(1-\eta)(1-\tau)}{\tau + (1-\tau)\eta} \left(1 - \tau\upsilon \frac{\gamma}{2-\gamma}\right) \\ - \frac{1-\beta}{\beta} \frac{GK_0}{P_0 C_0} \left[ \begin{array}{c} \left(\lambda - 1\right) \frac{2}{2-\gamma} \left(1 - \tau\upsilon\right) - \left(\theta - 1\right) \upsilon \left(1 - \tau\right) \\ + \theta \frac{(1-\eta)(1-\tau)}{\tau + (1-\tau)\eta} \left(1 - \tau\upsilon \frac{\gamma}{2-\gamma}\right) + \frac{\gamma}{2-\gamma} \\ + \left(1 - \frac{2-\gamma}{2-2\gamma} \frac{1}{\tau + (1-\tau)\eta}\right) \left(1 - \tau\upsilon \frac{\gamma}{2-\gamma}\right) \end{array} \right] \\ + \frac{1-\beta}{\beta} \left(2 \frac{GF_0}{P_0 C_0} - \frac{GK_0}{P_0 C_0}\right) \frac{2-\gamma}{2-2\gamma} \frac{1}{\tau + (1-\tau)\eta} \left(1 - \tau\upsilon \frac{\gamma}{2-\gamma}\right) \end{array} \right\} \left[ \begin{array}{c} \left(1 - \beta\right) \left(\mathsf{m} - \mathsf{m}^*\right) \\ + \beta \left(\bar{\mathsf{m}} - \bar{\mathsf{m}}^*\right) \end{array} \right] \\
& + 2 \frac{1 - \beta}{\beta} \left[ \begin{array}{c} \frac{NFK_0}{P_0 C_0} \frac{1}{2} \left[1 - \upsilon \left(1 - \tau\right) \left(\theta - 1\right)\right] \left[\beta \left(\bar{\mathsf{m}} + \bar{\mathsf{m}}^*\right) + \left(1 - \beta\right) \left(\mathsf{m} + \mathsf{m}^*\right)\right] \\ + \frac{1}{1-\beta} \left[\beta di_{St} \frac{BS_{H0}}{P_0 C_0} + \beta di_{St}^* \frac{S_0 BS_{F0}}{P_0 C_0}\right] \end{array} \right]
\end{aligned}
$$

The next step is to substitute for $\overline{\mathsf{pos}}$ using the long run solution. Start with the dynamics of relative consumption (53). Using the long run results and the short run real exchange rate (55) we get:

$$\begin{aligned}
(\bar{\mathsf{c}}-\bar{\mathsf{c}}^{*}) &= (\mathsf{c}-\mathsf{c}^{*})-(\mathsf{s}+\mathsf{p}^{*}-\mathsf{p})-(\bar{\mathsf{p}}-\bar{\mathsf{p}}^{*}-\bar{\mathsf{s}}) \\
&= \frac{1}{1-\tau\upsilon\frac{\gamma}{2-\gamma}}(\mathsf{c}-\mathsf{c}^{*})-\frac{\gamma}{2-2\gamma}(\bar{\mathsf{c}}-\bar{\mathsf{c}}^{*}) \\
&\quad -\left[1-\frac{1}{1-\tau\upsilon\frac{\gamma}{2-\gamma}}\frac{2-2\gamma}{2-\gamma}\left[\tau+(1-\tau)\eta\right]\right]\mathsf{s}
\end{aligned}$$

Using (54) we re-write the above relation as:

$$\begin{aligned}
(\bar{\mathsf{c}}-\bar{\mathsf{c}}^{*}) &= \frac{1}{\tau+(1-\tau)\eta}(\mathsf{c}-\mathsf{c}^{*}) \\
&\quad +\left[\frac{2-2\gamma}{2-\gamma}-\frac{1-\tau\upsilon\frac{\gamma}{2-\gamma}}{\tau+(1-\tau)\eta}\right]\left[(1-\beta)(\mathsf{m}-\mathsf{m}^{*})+\beta(\bar{\mathsf{m}}-\bar{\mathsf{m}}^{*})\right]
\end{aligned} \tag{58}$$

We combine (58) with the solution for the long-run consumption differential (50) to express the changes in asset holdings, $\overline{\mathsf{pos}}$, as a function of the short-run consumption differential, $\mathsf{c}-\mathsf{c}^{*}$:

$$\begin{aligned}
2\overline{\mathsf{pos}} &= \Psi\frac{1}{\tau+(1-\tau)\eta}(\mathsf{c}-\mathsf{c}^{*}) \\
&\quad +\Psi\left[\frac{2-2\gamma}{2-\gamma}-\frac{1-\tau\upsilon\frac{\gamma}{2-\gamma}}{\tau+(1-\tau)\eta}\right]\left[(1-\beta)(\mathsf{m}-\mathsf{m}^{*})+\beta(\bar{\mathsf{m}}-\bar{\mathsf{m}}^{*})\right] \\
&\quad -\left[2\frac{GF_0}{P_0C_0}-\frac{GK_0}{P_0C_0}\right](\bar{\mathsf{m}}-\bar{\mathsf{m}}^{*})-\frac{NFK_0}{P_0C_0}(\bar{\mathsf{m}}+\bar{\mathsf{m}}^{*})
\end{aligned}$$

Using this to substitute for $\overline{\mathsf{pos}}$ in (57), we solve for the short run consumption differential as a function of the monetary shocks:

$$
\begin{aligned}
&(\mathsf{c}-\mathsf{c}^*)\,\Theta \\
=\;& \left[2\frac{GF_0}{P_0C_0}-\frac{GK_0}{P_0C_0}\right](\bar{\mathsf{m}}-\bar{\mathsf{m}}^*)+\frac{NFK_0}{P_0C_0}(\bar{\mathsf{m}}+\bar{\mathsf{m}}^*) \\
&+\left\{\begin{array}{c}
\left[(\lambda-1)\frac{2}{2-\gamma}+\frac{\gamma}{2-\gamma}\right](1-\tau\upsilon)+\frac{(1-\eta)(1-\tau)}{\tau+(1-\tau)\eta}\left(1-\tau\upsilon\frac{\gamma}{2-\gamma}\right)\\
-\frac{1-\beta}{\beta}\frac{GK_0}{P_0C_0}\left[\begin{array}{c}(\lambda-1)\frac{2}{2-\gamma}(1-\tau\upsilon)-(\theta-1)\upsilon(1-\tau)\\ +\theta\frac{(1-\eta)(1-\tau)}{\tau+(1-\tau)\eta}\left(1-\tau\upsilon\frac{\gamma}{2-\gamma}\right)+\frac{\gamma}{2-\gamma}\\ +\left(1-\frac{2-\gamma}{2-2\gamma}\frac{1}{\tau+(1-\tau)\eta}\right)\left(1-\tau\upsilon\frac{\gamma}{2-\gamma}\right)\end{array}\right]\\
+\frac{1-\beta}{\beta}\left(2\frac{GF_0}{P_0C_0}-\frac{GK_0}{P_0C_0}\right)\frac{2-\gamma}{2-2\gamma}\frac{1}{\tau+(1-\tau)\eta}\left(1-\tau\upsilon\frac{\gamma}{2-\gamma}\right)\\
-\left(\frac{2\lambda-\gamma}{2-\gamma}\frac{\beta}{1-\beta}+\frac{2-\gamma}{2-2\gamma}2\frac{GF_0}{P_0C_0}-\frac{2\lambda-\gamma}{2-\gamma}\frac{GK_0}{P_0C_0}\right)\left[\frac{2-2\gamma}{2-\gamma}-\frac{1-\tau\upsilon\frac{\gamma}{2-\gamma}}{\tau+(1-\tau)\eta}\right]
\end{array}\right\}\left[\begin{array}{c}(1-\beta)(\mathsf{m}-\mathsf{m}^*)\\+\beta(\bar{\mathsf{m}}-\bar{\mathsf{m}}^*)\end{array}\right]\\
&+2\frac{1-\beta}{\beta}\left[\begin{array}{c}\frac{NFK_0}{P_0C_0}\frac{1}{2}[1-\upsilon(1-\tau)(\theta-1)][\beta(\bar{\mathsf{m}}+\bar{\mathsf{m}}^*)+(1-\beta)(\mathsf{m}+\mathsf{m}^*)]\\ +(\bar{\mathsf{m}}-\mathsf{m})\frac{BS_{H0}}{P_0C_0}+(\bar{\mathsf{m}}^*-\mathsf{m}^*)\frac{S_0BS_{F0}}{P_0C_0}\end{array}\right]
\end{aligned}
\tag{59}
$$

where:

$$
\Theta=\left[\begin{array}{c}\frac{2\lambda-\gamma}{2-\gamma}\left(1+\frac{\beta}{1-\beta}\frac{1}{\tau+(1-\tau)\eta}\right)+\frac{(1-\eta)(1-\tau)}{\tau+(1-\tau)\eta}+\frac{1}{\beta}\frac{1}{\tau+(1-\tau)\eta}\frac{2-\gamma}{2-2\gamma}2\frac{GF_0}{P_0C_0}\\ -\frac{1-\beta}{\beta}\frac{GK_0}{P_0C_0}\left[\frac{2\lambda-\gamma}{2-\gamma}\left(1+\frac{\beta}{1-\beta}\frac{1}{\tau+(1-\tau)\eta}\right)+\theta\frac{(1-\eta)(1-\tau)}{\tau+(1-\tau)\eta}\right]\end{array}\right]
$$

Combining (54) and (59) we write the solution for the short-run exchange rate as:

$$
\begin{aligned}
& \frac{2-2\gamma}{2-\gamma}\left[\tau+(1-\tau)\eta\right]\Theta\mathsf{s} \\
= & -\left[2\frac{GF_0}{P_0C_0}-\frac{GK_0}{P_0C_0}\right]\left(\bar{\mathsf{m}}-\bar{\mathsf{m}}^*\right)-\frac{NFK_0}{P_0C_0}\left(\bar{\mathsf{m}}+\bar{\mathsf{m}}^*\right) \qquad (60) \\
& -\left\{\begin{array}{c}
\left[(\lambda-1)\frac{2}{2-\gamma}+\frac{\gamma}{2-\gamma}\right](1-\tau\upsilon)+ \\
-\frac{1-\beta}{\beta}\frac{GK_0}{P_0C_0}\left[\begin{array}{c}
(\lambda-1)\frac{2}{2-\gamma}(1-\tau\upsilon)-(\theta-1)\upsilon(1-\tau)+\frac{\gamma}{2-\gamma} \\
+\left(1-\frac{2-\gamma}{2-2\gamma}\frac{1}{\tau+(1-\tau)\eta}\right)\left(1-\tau\upsilon\frac{\gamma}{2-\gamma}\right) \\
-\frac{2\lambda-\gamma}{2-\gamma}\left(1+\frac{\beta}{1-\beta}\frac{1}{\tau+(1-\tau)\eta}\right)\left(1-\tau\upsilon\frac{\gamma}{2-\gamma}\right)
\end{array}\right] \\
-\left(2\frac{GF_0}{P_0C_0}-\frac{GK_0}{P_0C_0}\right)\frac{2-\gamma}{2-2\gamma}\frac{1}{\tau+(1-\tau)\eta}\left(1-\tau\upsilon\frac{\gamma}{2-\gamma}\right) \\
-\left(\frac{2\lambda-\gamma}{2-\gamma}\frac{\beta}{1-\beta}+\frac{2-\gamma}{2-2\gamma}2\frac{GF_0}{P_0C_0}-\frac{2\lambda-\gamma}{2-\gamma}\frac{GK_0}{P_0C_0}\right)\left[\frac{2-2\gamma}{2-\gamma}-\frac{1-\tau\upsilon\frac{\gamma}{2-\gamma}}{\tau+(1-\tau)\eta}\right] \\
-\left[\frac{2\lambda-\gamma}{2-\gamma}\left(1+\frac{\beta}{1-\beta}\frac{1}{\tau+(1-\tau)\eta}\right)+\frac{1}{\beta}\frac{1}{\tau+(1-\tau)\eta}\frac{2-\gamma}{2-2\gamma}\frac{GK_0}{P_0C_0}\right]\left(1-\tau\upsilon\frac{\gamma}{2-\gamma}\right)
\end{array}\right\} \\
& \times\left[\begin{array}{c}
(1-\beta)\left(\mathsf{m}-\mathsf{m}^*\right) \\
+\beta\left(\bar{\mathsf{m}}-\bar{\mathsf{m}}^*\right)
\end{array}\right] \\
& -2\frac{1-\beta}{\beta}\left[\begin{array}{c}
\frac{NFK_0}{P_0C_0}\frac{1}{2}\left[1-\upsilon(1-\tau)(\theta-1)\right]\left[\beta\left(\bar{\mathsf{m}}+\bar{\mathsf{m}}^*\right)+(1-\beta)\left(\mathsf{m}+\mathsf{m}^*\right)\right] \\
+\left(\bar{\mathsf{m}}-\mathsf{m}\right)\frac{BS_{H0}}{P_0C_0}+\left(\bar{\mathsf{m}}^*-\mathsf{m}^*\right)\frac{S_0BS_{F0}}{P_0C_0}
\end{array}\right]
\end{aligned}
$$

Using the labor supplies, and (54) the short-run output differential is:

$$
\begin{aligned}
\mathsf{y}-\mathsf{y}^* = & -\frac{2\lambda-\gamma}{2-\gamma}\left(\mathsf{c}-\mathsf{c}^*\right) \\
& +\frac{2\lambda}{2-\gamma}(1-\tau\upsilon)\left[(1-\beta)\left(\mathsf{m}-\mathsf{m}^*\right)+\beta\left(\bar{\mathsf{m}}-\bar{\mathsf{m}}^*\right)\right] \qquad (61)
\end{aligned}
$$

### 8.3.4 Welfare

In worldwide terms the welfare reflects worldwide shocks and nominal rigidities:

$$
\begin{aligned}
\mathsf{u}^W = & \left(\mathsf{c}+\mathsf{c}^*\right)-\frac{\theta-1}{\theta}\frac{\delta-1}{\delta}\left(\mathsf{y}+\mathsf{y}^*\right)+\frac{\beta}{1-\beta}\left[\left(\bar{\mathsf{c}}+\bar{\mathsf{c}}^*\right)-\frac{\theta-1}{\theta}\frac{\delta-1}{\delta}\left(\bar{\mathsf{y}}+\bar{\mathsf{y}}^*\right)\right] \\
= & \left(1-\frac{\theta-1}{\theta}\frac{\delta-1}{\delta}\right)(1-\tau\upsilon)\left[\beta\left(\bar{\mathsf{m}}+\bar{\mathsf{m}}^*\right)+(1-\beta)\left(\mathsf{m}+\mathsf{m}^*\right)\right]
\end{aligned}
$$

In cross-country terms we write:

$$\mathsf{u}-\mathsf{u}^* = (\mathsf{c}-\mathsf{c}^*) - \frac{\theta-1}{\theta}\frac{\delta-1}{\delta}(\mathsf{y}-\mathsf{y}^*) + \frac{\beta}{1-\beta}\left[(\bar{\mathsf{c}}-\bar{\mathsf{c}}^*) - \frac{\theta-1}{\theta}\frac{\delta-1}{\delta}(\bar{\mathsf{y}}-\bar{\mathsf{y}}^*)\right]$$

## 8.4 A special case: permanent shocks in a setup with only traded goods

### 8.4.1 Flexible prices and wages

Consider the case where all goods are traded ($\gamma = 0$) and the shocks are permanent: $\mathsf{m} = \bar{\mathsf{m}}$, $\mathsf{m}^* = \bar{\mathsf{m}}^*$. If all prices and wages are flexible ($\tau = \upsilon = 1$), the consumption differential in the short and the long run is:

$$\begin{aligned}(\mathsf{c}-\mathsf{c}^*)\,\beta\Theta &= \left[2\frac{GF_0}{P_0C_0} - \frac{GK_0}{P_0C_0}\right](\bar{\mathsf{m}}-\bar{\mathsf{m}}^*) + \frac{NFK_0}{P_0C_0}(\bar{\mathsf{m}}+\bar{\mathsf{m}}^*) \\ \bar{\mathsf{c}}-\bar{\mathsf{c}}^* &= \mathsf{c}-\mathsf{c}^*\end{aligned}$$

where:

$$\beta\Theta = \lambda\frac{\beta}{1-\beta} + 2\frac{GF_0}{P_0C_0} - \frac{GK_0}{P_0C_0}\lambda$$

The exchange rate at all horizons is:

$$\beta\Theta\mathsf{s} = \left\{\lambda\frac{\beta}{1-\beta} - \frac{GK_0}{P_0C_0}(\lambda-1)\right\}(\bar{\mathsf{m}}-\bar{\mathsf{m}}^*) - \frac{NFK_0}{P_0C_0}(\bar{\mathsf{m}}+\bar{\mathsf{m}}^*)$$

The output differentials are:

$$\mathsf{y}-\mathsf{y}^* = \bar{\mathsf{y}}-\bar{\mathsf{y}}^* = -\lambda(\mathsf{c}-\mathsf{c}^*)$$

The welfare differential is:

$$\begin{aligned}\mathsf{u}-\mathsf{u}^* &= \frac{1}{1-\beta}\left[1+\frac{\theta-1}{\theta}\frac{\delta-1}{\delta}\lambda\right](\mathsf{c}-\mathsf{c}^*) \\ &= \frac{1+\frac{\theta-1}{\theta}\frac{\delta-1}{\delta}\lambda}{\lambda\beta+(1-\beta)\left(2\frac{GF_0}{P_0C_0}-\lambda\frac{GK_0}{P_0C_0}\right)}\left[\begin{array}{c}\left[2\frac{GF_0}{P_0C_0}-\frac{GK_0}{P_0C_0}\right](\bar{\mathsf{m}}-\bar{\mathsf{m}}^*) \\ +\frac{NFK_0}{P_0C_0}(\bar{\mathsf{m}}+\bar{\mathsf{m}}^*)\end{array}\right]\end{aligned}$$

### 8.4.2 Sticky prices and wages, full pass-through

Consider that all wages and prices are preset ($\tau = \upsilon = 0$) and there is full exchange-rate pass-through ($\eta = 1$). The consumption differential in the short and long run is:

$$\begin{aligned}
(\mathsf{c}-\mathsf{c}^*)\,\beta\Theta &= \left[2\frac{GF_0}{P_0C_0}-\frac{GK_0}{P_0C_0}\right](\bar{\mathsf{m}}-\bar{\mathsf{m}}^*)+\frac{NFK_0}{P_0C_0}(\bar{\mathsf{m}}+\bar{\mathsf{m}}^*)\\
&\quad+(1-\beta)(\lambda-1)\left(\frac{\beta}{1-\beta}-\frac{GK_0}{P_0C_0}\right)(\bar{\mathsf{m}}-\bar{\mathsf{m}}^*)\\
\bar{\mathsf{c}}-\bar{\mathsf{c}}^* &= \mathsf{c}-\mathsf{c}^*
\end{aligned}$$

where:

$$\beta\Theta=\lambda\left(\frac{\beta}{1-\beta}-\frac{GK_0}{P_0C_0}\right)+2\frac{GF_0}{P_0C_0}$$

The exchange rate at all horizons is:

$$\beta\Theta\mathsf{s}=\left[\lambda\frac{\beta}{1-\beta}-\beta\left(\frac{GK_0}{P_0C_0}+1\right)(\lambda-1)\right](\bar{\mathsf{m}}-\bar{\mathsf{m}}^*)-\frac{NFK_0}{P_0C_0}(\bar{\mathsf{m}}+\bar{\mathsf{m}}^*)$$

The output differentials in the short and long run are:

$$\begin{aligned}
\mathsf{y}-\mathsf{y}^* &= -\lambda\left[(\mathsf{c}-\mathsf{c}^*)-(\bar{\mathsf{m}}-\bar{\mathsf{m}}^*)\right]\\
&= \frac{\lambda}{\beta\Theta}\left(\left[\lambda\frac{\beta}{1-\beta}-\beta\left(\frac{GK_0}{P_0C_0}+1\right)(\lambda-1)\right](\bar{\mathsf{m}}-\bar{\mathsf{m}}^*)-\frac{NFK_0}{P_0C_0}(\bar{\mathsf{m}}+\bar{\mathsf{m}}^*)\right)\\
\bar{\mathsf{y}}-\bar{\mathsf{y}}^* &= -\lambda(\mathsf{c}-\mathsf{c}^*)
\end{aligned}$$

The welfare differential is:

$$\begin{aligned}
&\beta(1-\beta)\,\Theta\,(\mathsf{u}-\mathsf{u}^*)\\
=\;&\beta\left[(\lambda-1)-\frac{\theta-1}{\theta}\frac{\delta-1}{\delta}\lambda\right](\bar{\mathsf{m}}-\bar{\mathsf{m}}^*)\\
&+\left[1+\frac{\theta-1}{\theta}\frac{\delta-1}{\delta}\lambda\right]\left[\left[2\frac{GF_0}{P_0C_0}-\frac{GK_0}{P_0C_0}\right](\bar{\mathsf{m}}-\bar{\mathsf{m}}^*)+\frac{NFK_0}{P_0C_0}(\bar{\mathsf{m}}+\bar{\mathsf{m}}^*)\right]\\
&-(1-\beta)\left[\begin{array}{c}\left[1+\frac{\theta-1}{\theta}\frac{\delta-1}{\delta}\lambda\right](\lambda-1)\frac{GK_0}{P_0C_0}\\+\frac{\theta-1}{\theta}\frac{\delta-1}{\delta}\lambda\left[2\frac{GF_0}{P_0C_0}-\frac{GK_0}{P_0C_0}\lambda\right]\end{array}\right](\bar{\mathsf{m}}-\bar{\mathsf{m}}^*)
\end{aligned}$$

### 8.4.3 Sticky prices and wages, no pass-through

Consider that all wages and prices are preset ($\tau = \upsilon = 0$) and there is no exchange-rate pass-through ($\eta = 0$). The consumption differential in the short run is simply the relative monetary shock:

$$(\mathsf{c} - \mathsf{c}^*) = (\bar{\mathsf{m}} - \bar{\mathsf{m}}^*)$$

The exchange rate at all horizons is:

$$\tilde{\Theta}\mathsf{s} = \left[1 + \lambda\frac{\beta}{1-\beta} - (\lambda - 1)\frac{GK_0}{P_0C_0}\right](\bar{\mathsf{m}} - \bar{\mathsf{m}}^*) - \frac{1}{\beta}\frac{NFK_0}{P_0C_0}(\bar{\mathsf{m}} + \bar{\mathsf{m}}^*)$$

where:

$$\tilde{\Theta} = 1 + \lambda\frac{\beta}{1-\beta} - (\lambda - 1)\frac{GK_0}{P_0C_0} + \frac{1}{\beta}2\frac{GF_0}{P_0C_0} - \frac{GK_0}{P_0C_0}\left(1 + \frac{1-\beta}{\beta}\theta\right)$$

The long run consumption differential is:

$$\tilde{\Theta}(\bar{\mathsf{c}} - \bar{\mathsf{c}}^*) = \left[\frac{1}{\beta}2\frac{GF_0}{P_0C_0} - \frac{GK_0}{P_0C_0}\left(1 + \frac{1-\beta}{\beta}\theta\right)\right](\bar{\mathsf{m}} - \bar{\mathsf{m}}^*) + \frac{1}{\beta}\frac{NFK_0}{P_0C_0}(\bar{\mathsf{m}} + \bar{\mathsf{m}}^*)$$

The short and long run output differentials are then:

$$\mathsf{y} - \mathsf{y}^* = 0 \qquad\qquad \bar{\mathsf{y}} - \bar{\mathsf{y}}^* = -\lambda(\bar{\mathsf{c}} - \bar{\mathsf{c}}^*)$$

The welfare differential is then:

$$\begin{aligned}\tilde{\Theta}(\mathsf{u} - \mathsf{u}^*) \quad = \quad & \left[\tilde{\Theta} + \frac{1}{1-\beta}\left[1 + \frac{\theta-1}{\theta}\frac{\delta-1}{\delta}\lambda\right]\left[2\frac{GF_0}{P_0C_0} - \frac{GK_0}{P_0C_0}(\beta + (1-\beta)\theta)\right]\right](\bar{\mathsf{m}} - \bar{\mathsf{m}}^*) \\ & + \frac{1}{1-\beta}\left[1 + \frac{\theta-1}{\theta}\frac{\delta-1}{\delta}\lambda\right]\frac{NFK_0}{P_0C_0}(\bar{\mathsf{m}} + \bar{\mathsf{m}}^*)\end{aligned}$$

Table 1: Currency composition of selected asset categories

Assets, $ billions

| | Total | FDI | Equity | FDI+equity | Other |
|---|---|---|---|---|---|
| Total | 9,973 | 3,287 | 2,520 | 5,807 | 4,165 |
| U.S. dollar | 3,476 | 14 | 22 | 35 | 3,441 |
| Foreign currencies | 6,497 | 3,274 | 2,498 | 5,772 | 725 |

Liabilities, $ billions

| | Total | FDI | Equity | FDI+equity | Other |
|---|---|---|---|---|---|
| Total | 12,515 | 2,687 | 1,929 | 4,615 | 7,900 |
| U.S. dollar | 11,869 | 2,687 | 1,929 | 4,615 | 7,254 |
| Foreign currencies | 646 | 0 | 0 | 0 | 646 |

Net assets, $ billions

| | Total | FDI | Equity | FDI+equity | Other |
|---|---|---|---|---|---|
| Total | -2,542 | 600 | 592 | 1,192 | -3,734 |
| U.S. dollar | -8,393 | -2,673 | -1,907 | -4,580 | -3,813 |
| Foreign currencies | 5,851 | 3,274 | 2,498 | 5,772 | 79 |

Net assets, percent of GDP

| | Total | FDI | Equity | FDI+equity | Other |
|---|---|---|---|---|---|
| Total | -22% | 5% | 5% | 10% | -32% |
| U.S. dollar | -72% | -23% | -16% | -39% | -32% |
| Foreign currencies | 50% | 28% | 21% | 49% | 1% |

Table 2: Currency composition of assets and liabilities

| | Assets \$ billions (a) | Liabilities \$ billions (b) | Net assets \$ billions (c) | Net assets Percent of GDP (d) | Composition of foreign currency net assets (e) |
|---|---|---|---|---|---|
| Total | 9,973 | 12,515 | -2,542 | -22% | |
| U.S. dollar | 3,476 | 11,869 | -8,393 | -72% | |
| Foreign currencies | 6,497 | 646 | 5,851 | 50% | 100% |
| Europe | 3,351 | 385 | 2,966 | 25% | 51% |
| Euro area | 1,784 | 296 | 1,488 | 13% | 25% |
| United Kingdom | 1,039 | 71 | 968 | 8% | 17% |
| Switzerland | 304 | 18 | 286 | 2% | 5% |
| Other | 224 | 0 | 224 | 2% | 4% |
| Asia | 1,305 | 67 | 1,238 | 11% | 21% |
| Japan | 506 | 61 | 445 | 4% | 8% |
| Other | 799 | 6 | 792 | 7% | 14% |
| Western hemisphere | 1,351 | 1 | 1,350 | 12% | 23% |
| Canada | 557 | 1 | 556 | 5% | 9% |
| Latin America | 305 | 0 | 305 | 3% | 5% |
| Caribbeans | 489 | 0 | 489 | 4% | 8% |
| Rest of the world | 490 | 192 | 298 | 3% | 5% |
| Middle East and Africa | 118 | 0 | 118 | 1% | 2% |
| Other | 372 | 192 | 180 | 2% | 3% |

Table 3: Weights of regions as financial and trade partners

| | Share in foreign currency net assets | Weights in Board of Governors broad trade-weighted exchange rate |
|---|---|---|
| Europe | 50.7% | 27.3% |
| Euro area | 25.4% | 18.8% |
| United Kingdom | 16.5% | 5.2% |
| Switzerland | 4.9% | 1.4% |
| Other | 3.8% | 1.9% |
| Asia | 21.2% | 41.2% |
| Japan | 7.6% | 10.6% |
| China | 0.7% | 11.3% |
| Korea | 1.5% | 3.9% |
| Taiwan | 1.0% | 2.9% |
| Singapore | 2.0% | 2.1% |
| Hong Kong | 1.9% | 2.3% |
| Australia | 3.0% | 1.2% |
| Malaysia | 0.3% | 2.2% |
| Philippines | 0.2% | 1.1% |
| Thailand | 0.3% | 1.4% |
| India | 0.6% | 1.1% |
| Other | 2.0% | 1.0% |
| Western hemisphere | 23.1% | 29.9% |
| Canada | 9.5% | 16.4% |
| Mexico | 2.4% | 10.0% |
| Brazil | 1.6% | 1.8% |
| Caribbean | 8.4% | 0.0% |
| Other | 1.2% | 1.6% |
| Rest of the world | 5.1% | 1.6% |
| Israel | 0.5% | 1.0% |
| Other Middle-East | 0.5% | 0.6% |
| Africa | 1.0% | 0.0% |
| Other | 3.1% | 0.0% |

Table 4: Structural parameters

| | | |
|---|---|---|
| Elasticity of substitution | | |
| - between home and foreign goods | $\lambda$ | 8 or 1 |
| - between brands | $\theta$ | 8 |
| - between labor varieties | $\delta$ | 21 |
| Share of non-traded goods | $\gamma$ | 0 or 0.75 |
| Share of flexible prices | $\tau$ | 0 or 1 |
| Share of flexible wages | $\upsilon$ | 0 or 1 |
| Degree of exchange rate pass-through | $\eta$ | 0 or 1 |
| Discount rate | $\beta$ | 0.96 |

Table 5: Steady state positions
Share of GDP

| | | | No financial linkages | Bond only economy | Equity only economy | U.S. situation |
|---|---|---|---|---|---|---|
| Bonds | Home currency | $BS_{H0}$ | 0 | 0.5 | 0 | -0.1 |
| | Foreign currency | $S_0\ BS_{F0}$ | 0 | -0.5 | 0 | 0 |
| Equity | Home assets | $S_0\ q^*_0\ (K^*-K^*_{F0})$ | 0 | 0 | 0.5 | 0.5 |
| | Home liabilities | $q_0\ (K-K_{H0})$ | 0 | 0 | 0.5 | 0.4 |
| Assets in foreign currency | | $GF_0$ | 0 | 0.5 | 0.5 | 0.5 |
| Net equity assets | | $NFK_0$ | 0 | 0 | 0 | 0.1 |
| Gross equity positions | | $GK_0$ | 0 | 0 | 1 | 0.9 |

Table 6: Impact of financial integration
Permanent home monetary expansion ($m = 1$, $m^* = 0$)
All goods are traded ($\gamma = 0$)

Flexible prices and wages ($\tau = \upsilon = 1$)

| | | No financial linkages | Bond only economy | Equity only economy | U.S. situation |
|---|---|---|---|---|---|
| Short run differentials | Consumption | 0 | 0.01 | 0 | 0.00 |
| | Output | 0 | -0.04 | 0 | -0.01 |
| | Profits | 1 | 0.96 | 1 | 0.99 |
| Long run differentials | Consumption | 0 | 0.01 | 0 | 0.00 |
| | Output | 0 | -0.04 | 0 | -0.01 |
| | Profits | 1 | 0.96 | 1 | 0.99 |
| Total differential | Consumption | 0 | 0.13 | 0 | 0.03 |
| | Output | 0 | -1.04 | 0 | -0.22 |
| | Profits | 25 | 24 | 25 | 25 |
| Asset prices | Exchange rate | 1 | 0.99 | 1 | 1.00 |
| | Home equity | 1 | 0.98 | 1 | 1.00 |
| | Foreign equity | 0 | 0.02 | 0 | 0.00 |
| Net asset positions | Total | 0 | 0.50 | 0 | 0.10 |
| | - financial flows | 0 | 0 | 0 | 0 |
| | - exchange rate | 0 | 0.50 | 0.5 | 0.50 |
| | - asset prices | 0 | 0 | -0.5 | -0.40 |
| Welfare | Differential | 0 | 0.99 | 0 | 0.21 |
| | Home | 0 | 0.50 | 0 | 0.10 |
| | Foreign | 0 | -0.50 | 0 | -0.10 |

Sticky prices and wages ($\tau = \upsilon = 0$), full exchange rate pass-through ($\eta = 1$)

| | | No financial linkages | Bond only economy | Equity only economy | U.S. situation |
|---|---|---|---|---|---|
| Short run differentials | Consumption | 0.04 | 0.04 | 0.03 | 0.04 |
| | Output | 7.72 | 7.68 | 7.72 | 7.71 |
| | Profits | 7.72 | 7.68 | 7.72 | 7.71 |
| Long run differentials | Consumption | 0.04 | 0.04 | 0.03 | 0.04 |
| | Output | -0.28 | -0.32 | -0.28 | -0.29 |
| | Profits | 0.72 | 0.68 | 0.72 | 0.71 |
| Total differential | Consumption | 1 | 1.00 | 1 | 0.90 |
| | Output | 1 | 0.00 | 1 | 0.82 |
| | Profits | 25 | 24 | 25 | 25 |
| Asset prices | Exchange rate | 0.97 | 0.96 | 0.97 | 0.96 |
| | Home equity | 0.86 | 0.84 | 0.86 | 0.86 |
| | Foreign equity | 0.14 | 0.16 | 0.14 | 0.14 |
| Net asset positions | Total | 3.36 | 3.84 | 3.34 | 3.45 |
| | - financial flows | 3.36 | 3.36 | 3.22 | 3.23 |
| | - exchange rate | 0 | 0.48 | 0.48 | 0.48 |
| | - asset prices | 0 | 0 | -0.36 | -0.27 |
| Welfare | Differential | 0.04 | 1 | 0.01 | 0.21 |
| | Home | 0.10 | 0.58 | 0.09 | 0.19 |
| | Foreign | 0.06 | -0.42 | 0.08 | -0.02 |

Table 7: Role of exchange rate pass-through
Permanent home monetary expansion (m = 1, m* = 0)
All goods are traded ($\gamma = 0$)

Sticky prices and wages ($\tau = \upsilon = 0$), no exchange rate pass-through ($\eta = 0$)

| | | No financial linkages | Bond only economy | Equity only economy | U.S. situation |
|---|---|---|---|---|---|
| Short run differentials | Consumption | 1.00 | 1.00 | 1.00 | 1.00 |
| | Output | 0.00 | 0.00 | 0.00 | 0.00 |
| | Profits | 8.00 | 7.96 | 8.01 | 8.00 |
| Long run differentials | Consumption | 0 | 0.01 | 0.00 | 0.00 |
| | Output | 0 | -0.04 | 0.01 | 0.00 |
| | Profits | 1 | 0.96 | 1.01 | 1.00 |
| Total differential | Consumption | 1 | 1.13 | 1 | 0.99 |
| | Output | 0 | -1.03 | 0 | 0.06 |
| | Profits | 32 | 31 | 32 | 32 |
| Asset prices | Exchange rate | 1 | 0.99 | 1.00 | 1.00 |
| | Home equity | 1 | 0.98 | 1.01 | 1.00 |
| | Foreign equity | 0 | 0.02 | -0.01 | 0.00 |
| Net asset positions | Total | 0.00 | 0.52 | -0.15 | -0.03 |
| | - financial flows | 0.00 | 0.02 | -0.15 | -0.13 |
| | - exchange rate | 0 | 0.50 | 0.50 | 0.50 |
| | - asset prices | 0 | 0 | -0.51 | -0.40 |
| Welfare | Differential | 1.00 | 1.99 | 0.71 | 0.95 |
| | Home | 0.58 | 1.08 | 0.44 | 0.56 |
| | Foreign | -0.42 | -0.91 | -0.27 | -0.39 |

Table 8: Role of non-traded goods
Permanent home monetary expansion ($m = 1$, $m^* = 0$)
Most goods are non-traded ($\gamma = 0.75$)

Flexible prices and wages ($\tau = \upsilon = 1$)

| | | No financial linkages | Bond only economy | Equity only economy | U.S. situation |
|---|---|---|---|---|---|
| Short run differentials | Consumption | 0 | 0.00 | 0 | 0.00 |
| | Output | 0 | -0.04 | 0 | -0.01 |
| | Profits | 1 | 0.96 | 1 | 0.99 |
| Long run differentials | Consumption | 0 | 0.00 | 0 | 0.00 |
| | Output | 0 | -0.04 | 0 | -0.01 |
| | Profits | 1 | 0.96 | 1 | 0.99 |
| Total differential | Consumption | 0 | 0.08 | 0 | 0.02 |
| | Output | 0 | -1.03 | 0 | -0.21 |
| | Profits | 25 | 24 | 25 | 25 |
| Asset prices | Exchange rate | 1 | 0.99 | 1 | 1.00 |
| | Home equity | 1 | 0.98 | 1 | 1.00 |
| | Foreign equity | 0 | 0.02 | 0 | 0.00 |
| Net asset positions | Total | 0 | 0.50 | 0 | 0.10 |
| | - financial flows | 0 | 0 | 0 | 0 |
| | - exchange rate | 0 | 0.50 | 0.5 | 0.50 |
| | - asset prices | 0 | 0 | -0.5 | -0.40 |
| Welfare | Differential | 0 | 0.95 | 0 | 0.20 |
| | Home | 0 | 0.47 | 0 | 0.10 |
| | Foreign | 0 | -0.47 | 0 | -0.10 |

Sticky prices and wages ($\tau = \upsilon = 0$), full exchange rate pass-through ($\eta = 1$)

| | | No financial linkages | Bond only economy | Equity only economy | U.S. situation |
|---|---|---|---|---|---|
| Short run differentials | Consumption | 0.61 | 0.62 | 0.61 | 0.62 |
| | Output | 5.30 | 5.26 | 5.30 | 5.29 |
| | Profits | 5.30 | 5.26 | 5.30 | 5.29 |
| Long run differentials | Consumption | 0.01 | 0.02 | 0.01 | 0.02 |
| | Output | -0.18 | -0.22 | -0.18 | -0.19 |
| | Profits | 0.82 | 0.78 | 0.82 | 0.81 |
| Total differential | Consumption | 1 | 1.05 | 1 | 0.98 |
| | Output | 1 | 0.01 | 1 | 0.82 |
| | Profits | 25 | 24 | 25 | 25 |
| Asset prices | Exchange rate | 0.96 | 0.96 | 0.96 | 0.96 |
| | Home equity | 0.91 | 0.89 | 0.91 | 0.91 |
| | Foreign equity | 0.09 | 0.11 | 0.09 | 0.09 |
| Net asset positions | Total | 2.15 | 2.63 | 2.13 | 2.23 |
| | - financial flows | 2.15 | 2.15 | 2.06 | 2.07 |
| | - exchange rate | 0 | 0.48 | 0.48 | 0.48 |
| | - asset prices | 0 | 0 | -0.41 | -0.32 |
| Welfare | Differential | 0.13 | 1.04 | 0.10 | 0.29 |
| | Home | 0.15 | 0.61 | 0.13 | 0.23 |
| | Foreign | 0.02 | -0.44 | 0.03 | -0.06 |

Table 9: Role of the exact nature of nominal rigidities
Permanent home monetary expansion ($m = 1$, $m^* = 0$)
All goods are traded ($\gamma = 0$)

Sticky prices and flexible wages ($\tau = 0$, $\upsilon = 1$), full exchange rate pass-through ($\eta = 1$)

| | | No financial linkages | Bond only economy | Equity only economy | U.S. situation |
|---|---|---|---|---|---|
| Short run differentials | Consumption | 0.03 | 0.04 | 0.04 | 0.04 |
| | Output | 7.72 | 7.68 | 7.71 | 7.70 |
| | Profits | 0.72 | 0.68 | 0.71 | 0.70 |
| Long run differentials | Consumption | 0.03 | 0.04 | 0.04 | 0.04 |
| | Output | -0.28 | -0.32 | -0.29 | -0.30 |
| | Profits | 0.72 | 0.68 | 0.71 | 0.70 |
| Total differential | Consumption | 0.87 | 1.00 | 0.91 | 0.93 |
| | Output | 1.00 | 0.00 | 0.74 | 0.58 |
| | Profits | 18 | 17 | 18 | 18 |
| Asset prices | Exchange rate | 0.97 | 0.96 | 0.96 | 0.96 |
| | Home equity | 0.86 | 0.84 | 0.85 | 0.85 |
| | Foreign equity | 0.14 | 0.16 | 0.15 | 0.15 |
| Net asset positions | Total | 3.36 | 3.84 | 3.49 | 3.56 |
| | - financial flows | 3.36 | 3.36 | 3.36 | 3.35 |
| | - exchange rate | 0 | 0.48 | 0.48 | 0.48 |
| | - asset prices | 0 | 0 | -0.35 | -0.27 |
| Welfare | Differential | 0.04 | 1.00 | 0.30 | 0.44 |
| | Home | 0.10 | 0.58 | 0.23 | 0.30 |
| | Foreign | 0.06 | -0.42 | -0.06 | -0.14 |

Table 10: Role of international substitutatbility
Permanent home monetary expansion ($m = 1$, $m^* = 0$)
All goods are traded ($\gamma = 0$), and are poor substitutes ($\lambda = 1$)

Sticky prices and wages ($\tau = \upsilon = 0$), full exchange rate pass-through ($\eta = 1$)

| | | No financial linkages | Bond only economy | Equity only economy | U.S. situation |
|---|---|---|---|---|---|
| Short run differentials | Consumption | 0.00 | 0.04 | 0.00 | 0.01 |
| | Output | 1.00 | 0.96 | 1.00 | 0.99 |
| | Profits | 1.00 | 0.96 | 1.00 | 0.99 |
| Long run differentials | Consumption | 0.00 | 0.04 | 0.00 | 0.01 |
| | Output | 0.00 | -0.04 | 0.00 | -0.01 |
| | Profits | 1.00 | 0.96 | 1.00 | 0.99 |
| Total differential | Consumption | 0 | 1.00 | 0 | 0.21 |
| | Output | 1 | 0.00 | 1 | 0.79 |
| | Profits | 25 | 24 | 25 | 25 |
| Asset prices | Exchange rate | 1.00 | 0.96 | 1.00 | 0.99 |
| | Home equity | 1.00 | 0.98 | 1.00 | 1.00 |
| | Foreign equity | 0.00 | 0.02 | 0.00 | 0.00 |
| Net asset positions | Total | 0.00 | 0.48 | 0.00 | 0.10 |
| | - financial flows | 0.00 | 0.00 | 0.00 | 0.00 |
| | - exchange rate | 0 | 0.48 | 0.50 | 0.50 |
| | - asset prices | 0 | 0 | -0.50 | -0.40 |
| Welfare | Differential | -0.83 | 1 | -0.83 | -0.45 |
| | Home | -0.33 | 0.58 | -0.33 | -0.14 |
| | Foreign | 0.50 | -0.42 | 0.50 | 0.31 |

**Figure 1: U.S. Net International Investment Position and Current Account** (percent of GDP)

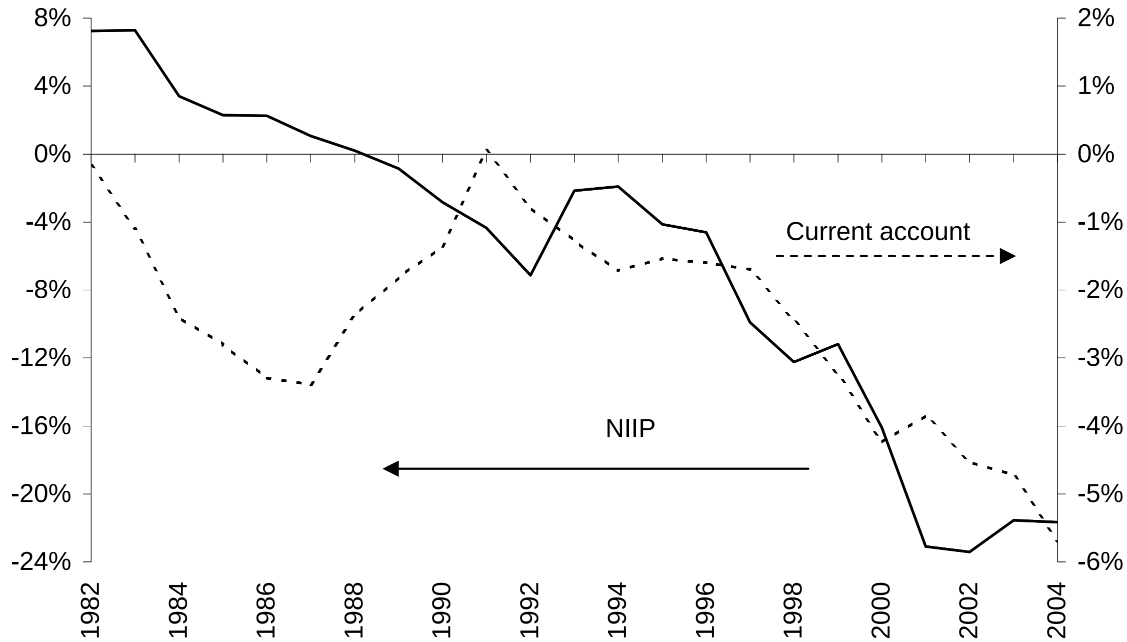


**Figure 2: Changes in gross asset position**

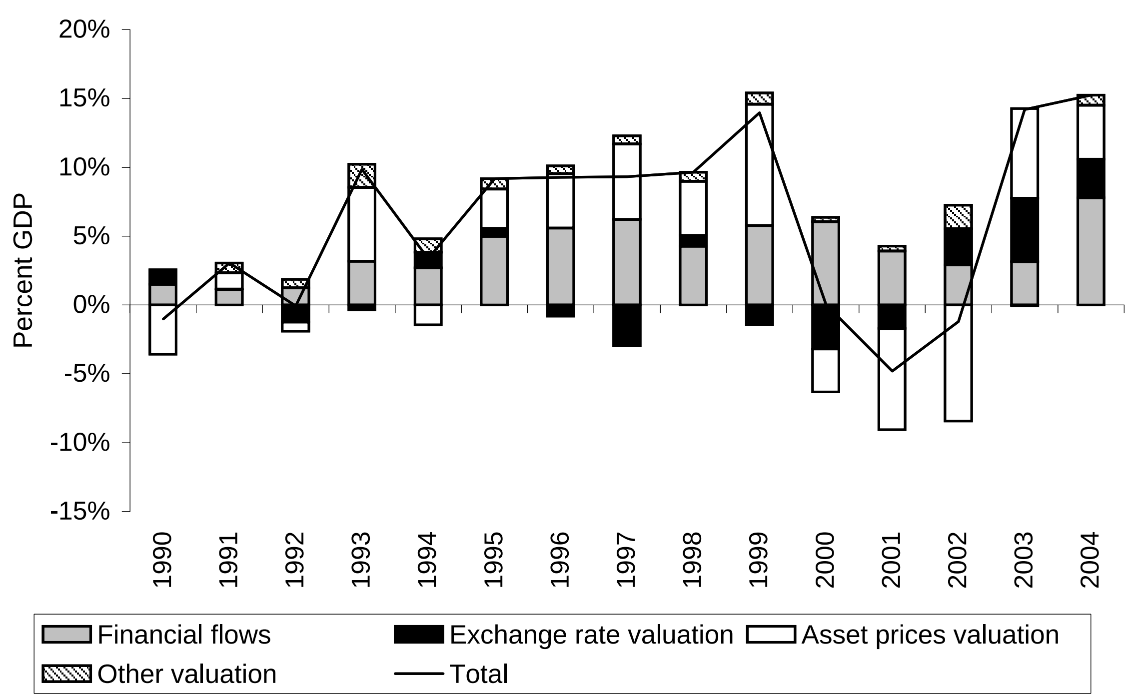

**Figure 3: Changes in gross liability position**

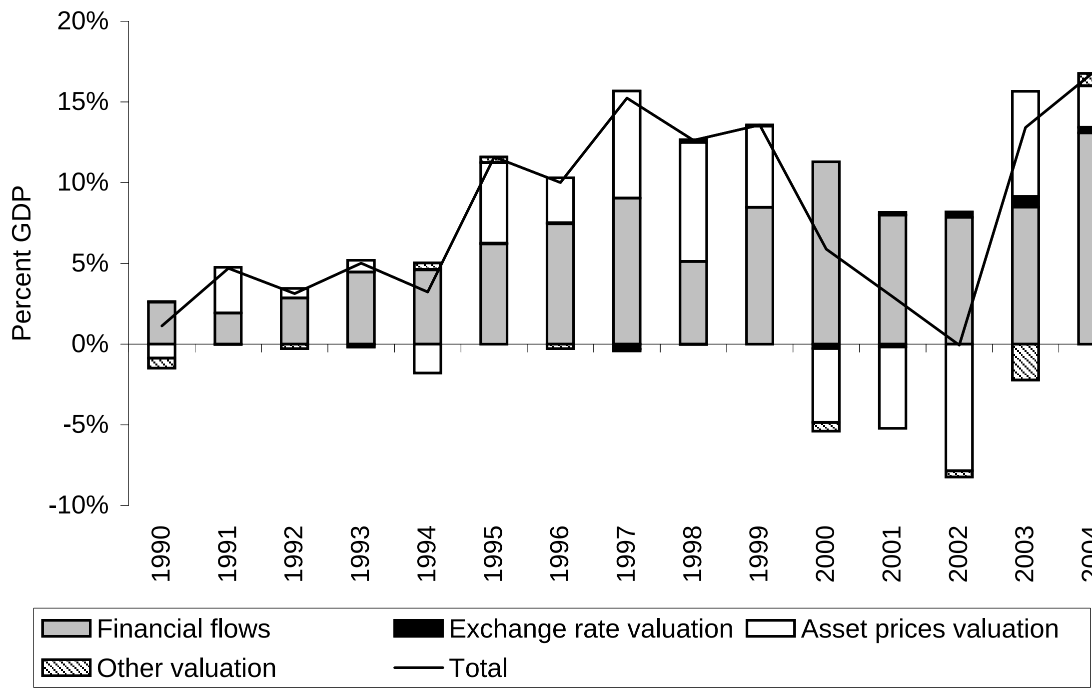


**Figure 4: Changes in net investment position**

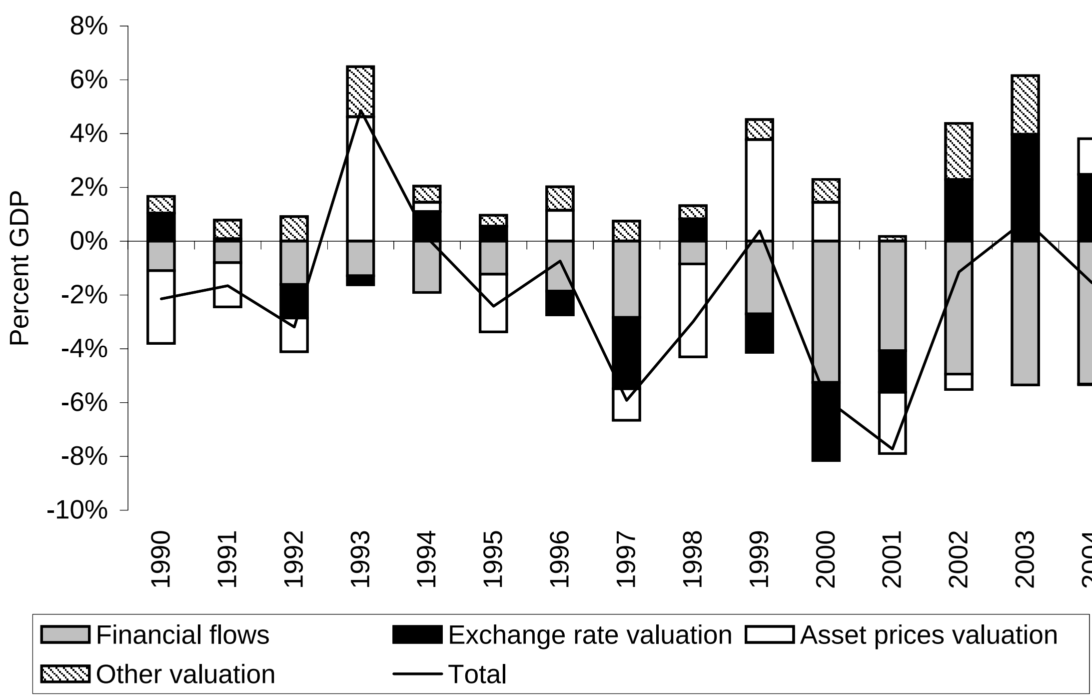

**Figure 5: U.S. gross asset and liability positions**

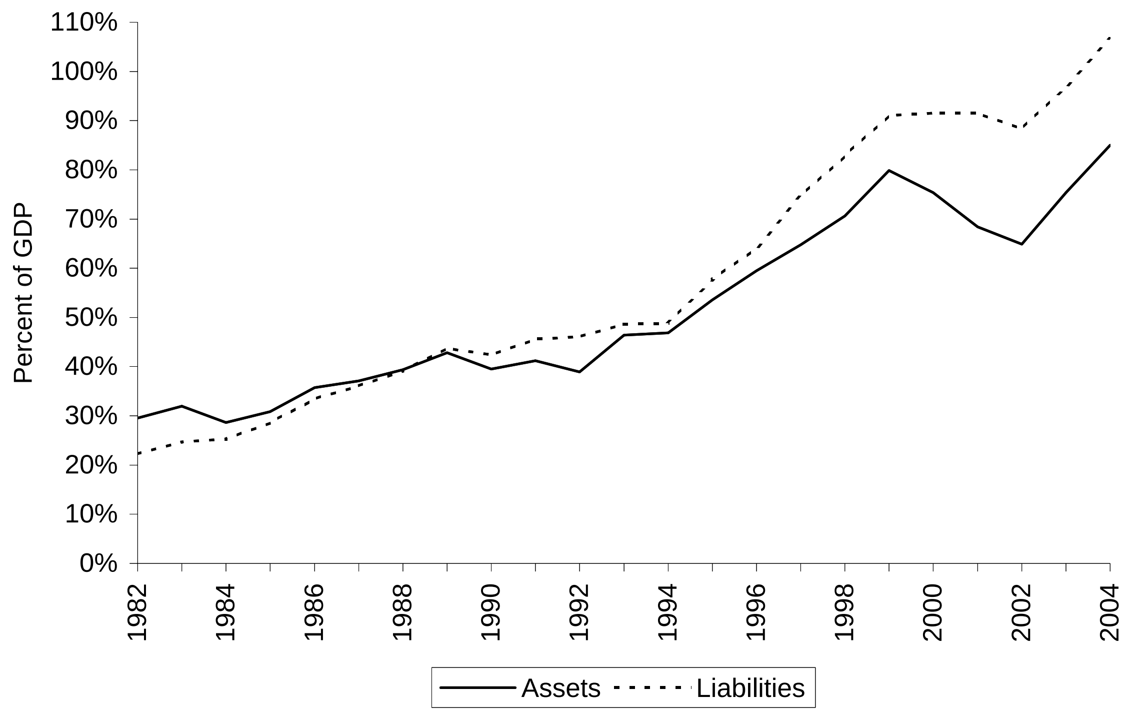


**Figure 6: Weights in foreign currency net assets, and in broad trade index**

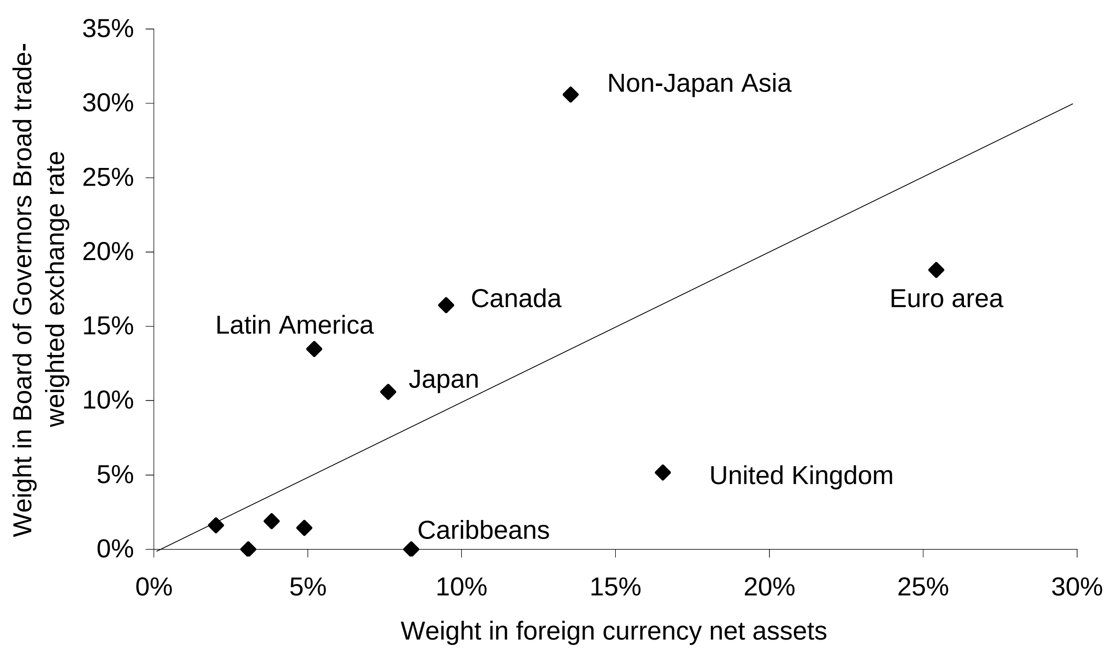

**Figure 7: Change in the U.S. dollar exchange rate**
(a positive value indicates a dollar appreciation)

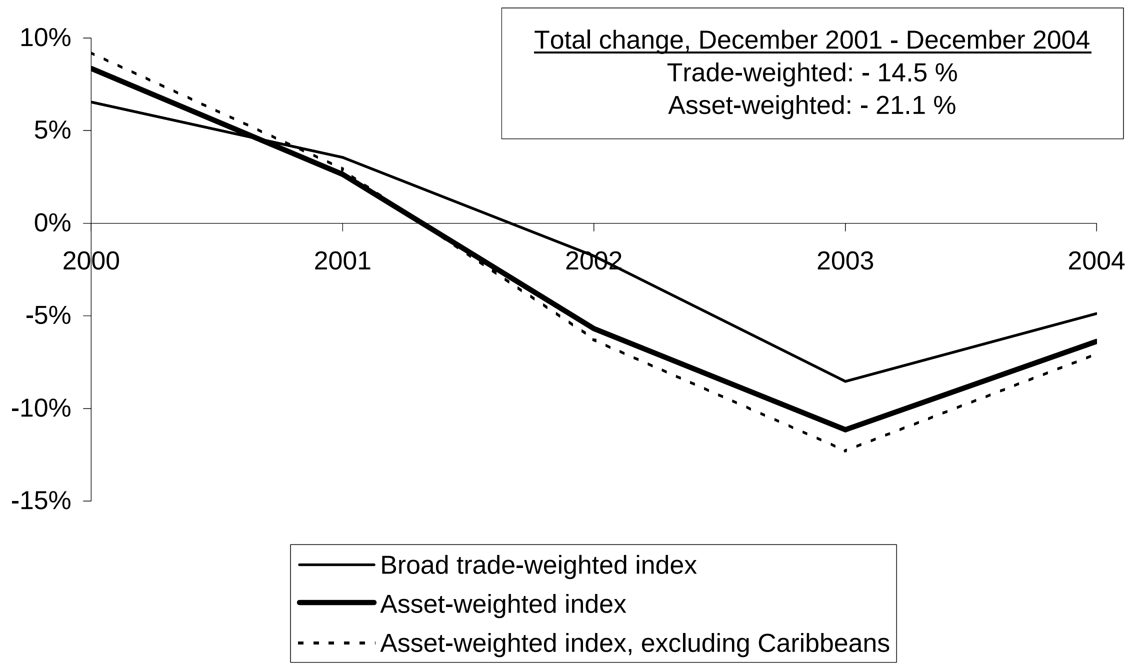

**Figure 8: Allocation of consumtpion**

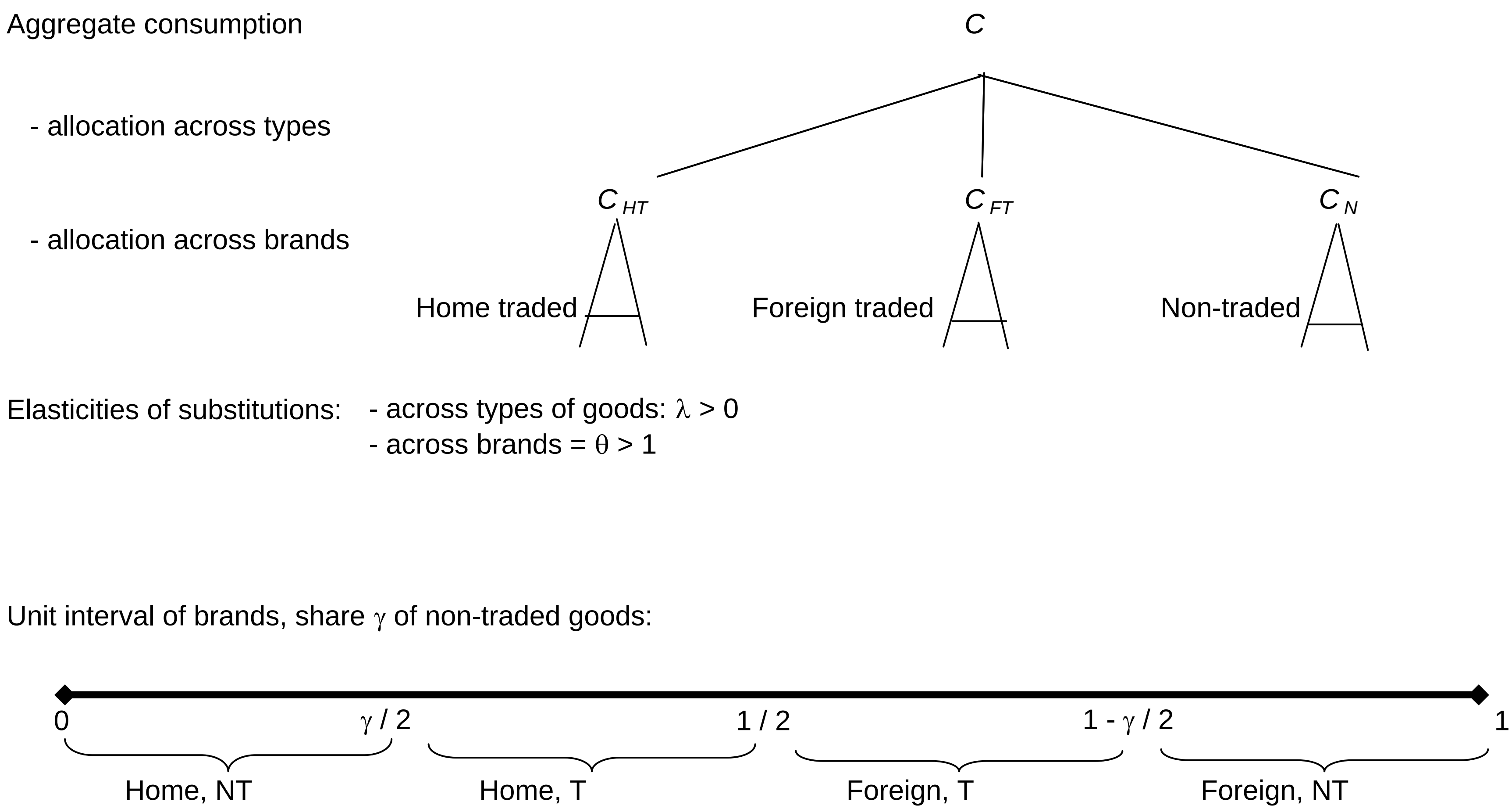

Table A.1: U.S. assets at the end of 2004 ($ billions)

| | Official | FDI | Equity | Debt | Banks | Other | Total |
|---|---|---|---|---|---|---|---|
| U.S. dollar | 194.477 | 13.698 | 21.642 | 605.532 | 2,018.809 | 621.773 | 3,475.930 |
| Foreign currencies | 78.670 | 3,273.675 | 2,498.421 | 311.123 | 155.200 | 179.763 | 6,496.853 |
| Canada | | 344.937 | 180.897 | 30.800 | | | 556.635 |
| Euro area | 24.253 | 966.183 | 628.249 | 165.370 | | | 1,784.055 |
| Mexico | | 106.002 | 34.574 | 0.678 | | | 141.255 |
| Japan | 18.219 | 127.809 | 309.634 | 50.747 | | | 506.410 |
| U.K. | | 489.063 | 516.487 | 33.771 | | | 1,039.321 |
| China | | 24.576 | 15.832 | 0.000 | | | 40.408 |
| Korea | | 27.605 | 59.530 | 0.290 | | | 87.425 |
| Taiwan | | 26.730 | 32.685 | 0.113 | | | 59.529 |
| Singapore | | 90.626 | 26.579 | 0.197 | | | 117.402 |
| Hong Kong | | 69.670 | 43.883 | 0.113 | | | 113.667 |
| Australia | | 107.506 | 68.417 | 5.765 | | | 181.688 |
| Brazil | | 52.985 | 38.516 | 0.116 | | | 91.617 |
| Malaysia | | 13.841 | 4.939 | 0.014 | | | 18.793 |
| Switzerland | | 160.456 | 142.919 | 0.519 | | | 303.894 |
| Philippines | | 10.095 | 1.980 | 0.079 | | | 12.154 |
| Israel | | 10.815 | 19.828 | 0.483 | | | 31.126 |
| Thailand | | 12.339 | 7.850 | 0.191 | | | 20.379 |
| India | | 9.880 | 22.420 | 0.002 | | | 32.302 |
| Other | 36.198 | 622.559 | 343.201 | 21.874 | 155.200 | 179.763 | 1,358.795 |
| Latin America | | 66.120 | 5.584 | 0.243 | | | 71.948 |
| Caribbean | | 273.021 | 215.732 | 0.541 | | | 489.294 |
| Middle-East | | 23.365 | 4.660 | 0.035 | | | 28.060 |
| Africa | | 35.452 | 22.667 | 0.689 | | | 58.809 |
| Western Europe | | 102.031 | 60.536 | 15.248 | | | 177.814 |
| Eastern Europe and Russia | | 21.921 | 23.117 | 1.229 | | | 46.266 |
| Eastern Asia and Pacific | | 100.645 | 10.304 | 3.718 | | | 114.666 |
| South and Central Asia | | 0.000 | 0.143 | 0.000 | | | 0.143 |
| Unidentified | 36.198 | 0.003 | 0.457 | 0.173 | 155.200 | 179.763 | 371.794 |
| Total | 273.147 | 3,287.373 | 2,520.063 | 916.655 | 2,174.009 | 801.536 | 9,972.783 |

Table A.1 (contd.): U.S. liabilities at the end of 2004 ($ billions)

| | Official | FDI | Equity | Debt | Treasuries | Banks | Other | Total |
|---|---|---|---|---|---|---|---|---|
| U.S. dollar | 1,981.992 | 2,686.890 | 1,928.547 | 1,595.376 | 639.716 | 2,212.840 | 823.645 | 11,869.006 |
| Foreign currencies | | | | 463.874 | | 91.800 | 90.348 | 646.022 |
| Canada | | | | 1.051 | | | | 1.051 |
| Euro area | | | | 296.421 | | | | 296.421 |
| Mexico | | | | 0.000 | | | | 0.000 |
| Japan | | | | 60.932 | | | | 60.932 |
| U.K. | | | | 71.397 | | | | 71.397 |
| China | | | | | | | | |
| Korea | | | | | | | | |
| Taiwan | | | | | | | | |
| Singapore | | | | | | | | |
| Hong Kong | | | | | | | | |
| Australia | | | | 6.416 | | | | 6.416 |
| Brazil | | | | | | | | |
| Malaysia | | | | | | | | |
| Switzerland | | | | 17.566 | | | | 17.566 |
| Philippines | | | | | | | | |
| Israel | | | | | | | | |
| Thailand | | | | | | | | |
| India | | | | | | | | |
| Other | | | | 10.091 | | 91.800 | 90.348 | 192.238 |
| Latin America | | | | | | | | |
| Caribbean | | | | | | | | |
| Middle-East | | | | | | | | |
| Africa | | | | | | | | |
| Western Europe | | | | | | | | |
| Eastern Europe and Russia | | | | | | | | |
| Eastern Asia and Pacific | | | | | | | | |
| South and Central Asia | | | | | | | | |
| Unidentified | | | | 10.091 | | 91.800 | 90.348 | 192.238 |
| Total | 1,981.992 | 2,686.890 | 1,928.547 | 2,059.250 | 639.716 | 2,304.640 | 913.993 | 12,515.028 |

Othe liabilities include U.S. currency

Table A.1 (contd.): U.S. net assets at the end of 2004 ($ billions)

| | Official | FDI | Equity | Debt | Banks | Other | Total |
|---|---|---|---|---|---|---|---|
| U.S. dollar | -1,787.515 | -2,673.192 | -1,906.905 | -1,629.560 | -194.031 | -201.873 | -8,393.076 |
| Foreign currencies | 78.670 | 3,273.675 | 2,498.421 | -152.751 | 63.400 | 89.416 | 5,850.831 |
| Canada | | 344.937 | 180.897 | 29.750 | | | 555.584 |
| Euro area | 24.253 | 966.183 | 628.249 | -131.051 | | | 1,487.634 |
| Mexico | 0.000 | 106.002 | 34.574 | 0.678 | | | 141.255 |
| Japan | 18.219 | 127.809 | 309.634 | -10.186 | | | 445.477 |
| U.K. | | 489.063 | 516.487 | -37.626 | | | 967.924 |
| China | | 24.576 | 15.832 | 0.000 | | | 40.408 |
| Korea | | 27.605 | 59.530 | 0.290 | | | 87.425 |
| Taiwan | | 26.730 | 32.685 | 0.113 | | | 59.529 |
| Singapore | | 90.626 | 26.579 | 0.197 | | | 117.402 |
| Hong Kong | | 69.670 | 43.883 | 0.113 | | | 113.667 |
| Australia | | 107.506 | 68.417 | -0.651 | | | 175.272 |
| Brazil | | 52.985 | 38.516 | 0.116 | | | 91.617 |
| Malaysia | | 13.841 | 4.939 | 0.014 | | | 18.793 |
| Switzerland | | 160.456 | 142.919 | -17.047 | | | 286.327 |
| Philippines | | 10.095 | 1.980 | 0.079 | | | 12.154 |
| Israel | | 10.815 | 19.828 | 0.483 | | | 31.126 |
| Thailand | | 12.339 | 7.850 | 0.191 | | | 20.379 |
| India | | 9.880 | 22.420 | 0.002 | | | 32.302 |
| Other | 36.198 | 622.559 | 343.201 | 11.784 | 63.400 | 89.416 | 1,166.556 |
| | | | | | | | |
| Latin America | | 66.120 | 5.584 | 0.243 | | | 71.948 |
| Caribbean | | 273.021 | 215.732 | 0.541 | | | 489.294 |
| Middle-East | | 23.365 | 4.660 | 0.035 | | | 28.060 |
| Africa | | 35.452 | 22.667 | 0.689 | | | 58.809 |
| Western Europe | | 102.031 | 60.536 | 15.248 | | | 177.814 |
| Eastern Europe and Russia | | 21.921 | 23.117 | 1.229 | | | 46.266 |
| Eastern Asia and Pacific | | 100.645 | 10.304 | 3.718 | | | 114.666 |
| South and Central Asia | | | 0.143 | | | | 0.143 |
| Unidentified | 36.198 | 0.003 | 0.457 | -9.918 | 63.400 | 89.416 | 179.556 |
| | | | | | | | |
| Total | -1,708.845 | 600.483 | 591.516 | -1,782.311 | -130.631 | -112.457 | -2,542.245 |

Table A.2: U.S. assets at the end of 2003 ($ billions)

| | Official | FDI | Equity | Debt | Banks | Other | Total |
|---|---|---|---|---|---|---|---|
| U.S. dollar | 190.572 | 12.657 | 17.858 | 577.589 | 1,656.347 | 477.659 | 2,932.682 |
| Foreign currencies | 77.777 | 2,705.546 | 2,061.564 | 296.767 | 103.000 | 119.302 | 5,363.956 |
| Canada | | 287.847 | 149.267 | 29.379 | | | 466.492 |
| Euro area | 21.916 | 822.867 | 518.398 | 157.739 | | | 1,520.920 |
| Mexico | | 89.606 | 28.529 | 0.647 | | | 118.782 |
| Japan | 17.622 | 103.299 | 255.494 | 48.405 | | | 424.820 |
| U.K. | | 429.027 | 426.178 | 32.213 | | | 887.418 |
| China | | 17.507 | 13.064 | 0.000 | | | 30.571 |
| Korea | | 19.766 | 49.121 | 0.277 | | | 69.164 |
| Taiwan | | 18.428 | 26.970 | 0.108 | | | 45.506 |
| Singapore | | 76.368 | 21.932 | 0.188 | | | 98.488 |
| Hong Kong | | 56.987 | 36.210 | 0.108 | | | 93.305 |
| Australia | | 74.115 | 56.454 | 5.499 | | | 136.068 |
| Brazil | | 48.149 | 31.781 | 0.111 | | | 80.041 |
| Malaysia | | 11.028 | 4.075 | 0.013 | | | 15.116 |
| Switzerland | | 134.939 | 117.929 | 0.495 | | | 253.363 |
| Philippines | | 8.783 | 1.634 | 0.075 | | | 10.492 |
| Israel | | 10.673 | 16.361 | 0.461 | | | 27.495 |
| Thailand | | 10.767 | 6.477 | 0.182 | | | 17.426 |
| India | | 7.328 | 18.500 | 0.002 | | | 25.830 |
| Other | 38.239 | 478.061 | 283.191 | 20.865 | 103.000 | 119.302 | 1,042.658 |
| Latin America | | 60.315 | 4.608 | 0.232 | | | 65.155 |
| Caribbean | | 239.214 | 178.011 | 0.516 | | | 417.741 |
| Middle-East | | 18.677 | 3.845 | 0.033 | | | 22.555 |
| Africa | | 28.789 | 18.704 | 0.657 | | | 48.150 |
| Western Europe | | 90.643 | 49.951 | 14.544 | | | 155.138 |
| Eastern Europe and Russia | | 16.460 | 19.075 | 1.172 | | | 36.707 |
| Eastern Asia and Pacific | | 23.963 | 8.502 | 3.546 | | | 36.011 |
| South and Central Asia | | 0.000 | 0.118 | 0.000 | | | 0.118 |
| Unidentified | 38.239 | 0.000 | 0.377 | 0.165 | 103.000 | 119.302 | 261.083 |
| Total | 268.349 | 2,718.203 | 2,079.422 | 874.356 | 1,759.347 | 596.961 | 8,296.638 |

Table A.2 (contd.): U.S. liabilities at the end of 2003 ($ billions)

| | Official | FDI | Equity | Debt | Treasuries | Banks | Other | Total |
|---|---|---|---|---|---|---|---|---|
| U.S. dollar | 1,567.124 | 2,457.217 | 1,700.907 | 1,322.635 | 543.209 | 1,854.220 | 706.383 | 10,151.695 |
| Foreign currencies | | | | 384.571 | | 66.900 | 65.842 | 517.313 |
| Canada | | | | 0.871 | | | | 0.871 |
| Euro area | | | | 245.745 | | | | 245.745 |
| Mexico | | | | 0.000 | | | | 0.000 |
| Japan | | | | 50.516 | | | | 50.516 |
| U.K. | | | | 59.191 | | | | 59.191 |
| China | | | | | | | | |
| Korea | | | | | | | | |
| Taiwan | | | | | | | | |
| Singapore | | | | | | | | |
| Hong Kong | | | | | | | | |
| Australia | | | | 5.319 | | | | 5.319 |
| Brazil | | | | | | | | |
| Malaysia | | | | | | | | |
| Switzerland | | | | 14.563 | | | | 14.563 |
| Philippines | | | | | | | | |
| Israel | | | | | | | | |
| Thailand | | | | | | | | |
| India | | | | | | | | |
| Other | | | | 8.366 | | 66.900 | 65.842 | 141.107 |
| Latin America | | | | | | | | |
| Caribbean | | | | | | | | |
| Middle-East | | | | | | | | |
| Africa | | | | | | | | |
| Western Europe | | | | | | | | |
| Eastern Europe and Russia | | | | | | | | |
| Eastern Asia and Pacific | | | | | | | | |
| South and Central Asia | | | | | | | | |
| Unidentified | | | | 8.366 | | 66.900 | 65.842 | 141.107 |
| Total | 1,567.124 | 2,457.217 | 1,700.907 | 1,707.206 | 543.209 | 1,921.120 | 772.225 | 10,669.008 |

Othe liabilities include U.S. currency

Table A.2 (contd.): U.S. net assets at the end of 2003  ($ billions)

| | Official | FDI | Equity | Debt | Banks | Other | Total |
|---|---|---|---|---|---|---|---|
| U.S. dollar | -1,376.552 | -2,444.560 | -1,683.049 | -1,288.254 | -197.873 | -228.724 | -7,219.013 |
| Foreign currencies | 77.777 | 2,705.546 | 2,061.564 | -87.805 | 36.100 | 53.460 | 4,846.643 |
| Canada | | 287.847 | 149.267 | 28.508 | | | 465.621 |
| Euro area | 21.916 | 822.867 | 518.398 | -88.006 | | | 1,275.175 |
| Mexico | 0.000 | 89.606 | 28.529 | 0.647 | | | 118.782 |
| Japan | 17.622 | 103.299 | 255.494 | -2.111 | | | 374.305 |
| U.K. | | 429.027 | 426.178 | -26.978 | | | 828.226 |
| China | | 17.507 | 13.064 | 0.000 | | | 30.571 |
| Korea | | 19.766 | 49.121 | 0.277 | | | 69.164 |
| Taiwan | | 18.428 | 26.970 | 0.108 | | | 45.506 |
| Singapore | | 76.368 | 21.932 | 0.188 | | | 98.488 |
| Hong Kong | | 56.987 | 36.210 | 0.108 | | | 93.305 |
| Australia | | 74.115 | 56.454 | 0.180 | | | 130.749 |
| Brazil | | 48.149 | 31.781 | 0.111 | | | 80.041 |
| Malaysia | | 11.028 | 4.075 | 0.013 | | | 15.116 |
| Switzerland | | 134.939 | 117.929 | -14.068 | | | 238.800 |
| Philippines | | 8.783 | 1.634 | 0.075 | | | 10.492 |
| Israel | | 10.673 | 16.361 | 0.461 | | | 27.495 |
| Thailand | | 10.767 | 6.477 | 0.182 | | | 17.426 |
| India | | 7.328 | 18.500 | 0.002 | | | 25.830 |
| Other | 38.239 | 478.061 | 283.191 | 12.499 | 36.100 | 53.460 | 901.551 |
| Latin America | | 60.315 | 4.608 | 0.232 | | | 65.155 |
| Caribbean | | 239.214 | 178.011 | 0.516 | | | 417.741 |
| Middle-East | | 18.677 | 3.845 | 0.033 | | | 22.555 |
| Africa | | 28.789 | 18.704 | 0.657 | | | 48.150 |
| Western Europe | | 90.643 | 49.951 | 14.544 | | | 155.138 |
| Eastern Europe and Russia | | 16.460 | 19.075 | 1.172 | | | 36.707 |
| Eastern Asia and Pacific | | 23.963 | 8.502 | 3.546 | | | 36.011 |
| South and Central Asia | | | 0.118 | | | | 0.118 |
| Unidentified | 38.239 | 0.000 | 0.377 | -8.201 | 36.100 | 53.460 | 119.975 |
| Total | -1,298.775 | 260.986 | 378.515 | -1,376.059 | -161.773 | -175.264 | -2,372.370 |