

ESSAYS IN INTERNATIONAL MACROECONOMICS

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By

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ABSTRACT

What are the factors behind differences in cyclical behavior of portfolio flows across countries? How important are growth rate productivity shocks, as opposed to level productivity shocks, in understanding those differences? Do the productivity changes in the nontradable goods sector matter for external positions of countries? Newly advanced solution techniques facilitate the simultaneous examination of general equilibrium dynamics and international portfolio flows. This dissertation presents a review of these techniques and uses them to answer above questions.

Chapter 1 presents a literature review of the recent research in international macroeconomics and finance. The review focuses on the work that uses new solution techniques to incorporate portfolio choice problems into international macroeconomics models. Major subjects reviewed are divided into three main categories: (a) international risk sharing and portfolio diversification, (b) international portfolio flows, and (c) valuation effects.

Chapter 2 studies the cyclicity of portfolio flows under the presence of productivity growth rate shocks. Productivity growth rate shocks successfully replicate countercyclical net equity outflows and procyclical bond inflows for advanced countries, which could not be captured in a model with only level productivity shocks. Similarly, for an emerging market economy, the model with growth shocks generates countercyclical net equity inflows and procyclical bond inflows in accordance with data. Following a growth rate shock, home agents experience a decrease both in equity inflows and outflows on impact. Inflows decrease due to sales of home equity to realize capital gains and outflows decrease due to initial dissaving to finance increases in consumption and investment. Equity inflows increase later, as home dividends rise. Equity outflows pick up also as wealthier home agents increase purchases of foreign assets to hedge against home productivity shocks.

Chapter 3 examines the valuation effects of various macroeconomic shocks on external wealth in a two-country four-good model of the world economy. Of the shocks considered, transitory shocks to the nontradable goods sector produce the strongly countercyclical current account deficit and offsetting valuation effects observed in U.S. most closely. Transitory shocks to nontradable goods sector generate valuation effects that move inversely with the current account. An increase in supply of nontradable goods increases home demand for both nontradable and tradable goods. Home country tries to smooth consumption by increasing borrowing and running a current account deficit. In the meanwhile, country experiences positive valuation effects stemming from a decline in relative price of home equity, which reduces the value of home's foreign liabilities.

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INTRODUCTION

This dissertation consists of three essays in international macroeconomics. While the first chapter presents a literature review of the recent research in international macroeconomics and finance, the last two chapters study the effects of productivity shocks on portfolio flows and external accounts of countries.

While the stylized theoretical models offer essential insights regarding international financial markets and the external investment positions of countries, new empirical evidence inspired and challenged researchers to develop a more sophisticated set of tools to examine the interaction between international financial markets with the real economy. Work on both empirical and theoretical grounds has achieved remarkable progress. Increased availability of data led to detailed analysis of the evolution of external positions, and the movement and composition of portfolio flows. Theoretical models of international portfolio choice analyses have evolved from limited asset structure and financial market settings they featured.

Previous studies of international macroeconomics were bounded by complete markets assumption, which suppressed the role of international financial markets and net foreign asset dynamics. The analyses were focused on equilibrium portfolio holdings, as they were not capable of producing current account and portfolio flow dynamics. Studies with incomplete financial markets were also restricted in the menu of financial assets they employed. Additionally, those models had to feature a certain set of assumptions about preference and technology parameters to guarantee a closed form

solution.

Today, there is a class of richer models that are not constrained by these features and can offer more realistic representation of current international financial trends. For example, Devereux and Sutherland (2008), Devereux and Sutherland (2010a), Evans and Hnatkovska (2007), Tille and Van Wincoop (2010) and Pavlova and Rigobon (2010b) are some of the proposed methods to incorporate full-fledged portfolio choice problems into conventional dynamic stochastic general equilibrium models of international finance and macroeconomics. The advancement of these computational solution techniques allowed researchers to gain additional insight into many existing questions and puzzles in the field and also to launch new venues of study. This chapter presents a review of the recent theoretical literature that uses the newly developed tools in investigating main topics related to external financial positions and portfolio flows of countries within a two-country dynamic stochastic general equilibrium framework. Central topics to this literature include portfolio flows, international risk sharing and portfolio diversification and external valuation effects.

Chapter 2 contributes to understanding the distinct characteristics of advanced and emerging market economy portfolio flows. Direction and cyclicity of portfolio flows exhibit significant deviations across different groups of countries. There are differences at times, even between G-7 countries and other advanced countries. What could be the factors behind such deviations across countries? In particular, what are the determinants of portfolio flows between emerging market and advanced

economies? Aguiar and Gopinath (2007) suggested that varying composition and predominance of productivity level and growth rate shocks help understand the differences between emerging market and advanced economies business cycles. They were successful in replicating the observed strong countercyclicality of net exports for emerging market economies and acyclicity of net exports for advanced economies simply by modifying the persistence and volatilities of these two types of productivity shocks across the countries according to the data. Broner and Rigobon (2006) also attributed the volatile behavior of emerging market economy capital flows to relatively more persistent shocks experienced in these countries.

This chapter aims at exploring the significance of the differentiation between level productivity and productivity growth rate shocks in replicating the observed distinct cyclical behavior of equity and debt flows across advanced and emerging market economies. I solve a two-country, single good model of the world economy with capital accumulation and endogenous labor choice. The model features an explicit portfolio choice problem in both countries, which makes it possible to study not only the net capital flows, but also debt and equity outflows and inflows separately.

I find that growth rate shocks significantly alter the predictions of the standard model for moments of capital flows. My results suggest that inclusion of growth rate shocks contribute in generating the observed countercyclical net equity outflows in advanced countries and countercyclical net equity inflows in emerging market economies. The model also captures procyclical bond inflows in both groups of countries, as in

data. The main mechanism driving these results is the difference in the optimal actions of agents and firms between each shock. A temporary expansion in output leaves relative consumption profile roughly unchanged and results in a one-time investment boom. The increase in domestic absorption is limited as the output increase is only temporary. Transitory shock causes a decline in equity inflows and bond inflows as well as an increase in equity outflows. This result suggests that the country experiences initial repatriation of foreign holdings of its equity to realize the capital gains and the windfall is saved by purchasing foreign equity.

When the shock is to the productivity growth rate, on the other hand, households shift their consumption profile up and investment exhibits a prolonged boom. In this case, the country experiences a decline in all equity inflows, equity outflows and bond inflows. The change in the direction of equity outflows is due to the dissaving of home households to finance the increase in consumption and investment. Following the initial impact, both equity inflows and outflows experience a surge. Equity inflows increase due to the higher future stream of home dividends with higher expected future productivity. Equity outflows increase as home households enjoy the attractive hedge provided by the foreign equity.

Chapter 3 analyzes the link between macroeconomic shocks and the current account in an open economy macro model in an attempt to identify the shocks that yield the strongly countercyclical current account and offsetting valuation effects, as observed in the U.S. since the 1990's. Of the shocks considered, transitory shocks to

the nontradable goods sector fit the U.S. pattern most closely. The importance of changes in labor productivity in the nontradable sector to the total productivity of the country is documented. For example, Guerrieri, Henderson, and Kim (2005) present a thorough assessment of sectoral breakdown of 1990's U.S. labor productivity from alternative data sources and claim that all measurements confirm the significance of the advancement of labor productivity in the nontradable sector during the expansion in that decade. Productivity changes in nontradable goods sector are also known to impact external accounts of countries. Cova, Pisani, Batini, and Rebucci (2008) show that productivity developments in advanced countries and specifically the productivity increase in the nontradable sector in U.S. are the main factors behind the worsening U.S. trade balance since 1998.

The analysis features a two-country, four-good open economy macroeconomic model. Each country is endowed with a time-varying supply of tradable and nontradable goods. Households like to consume “baskets” of domestic and foreign tradable goods, as well as domestic nontradable goods. Following Hnatkovska (2010), households view nontradable goods and tradable baskets as complements, but they view home and foreign tradable goods as substitutes within the tradable baskets. Loosely speaking, U.S. households like to consume houses and furniture together, but they choose between U.S.-manufactured and foreign-manufactured furniture based on price. When the prices of home and foreign tradable goods are the same, households tilt their consumption towards domestic tradable goods (consumption home bias).

Crucially, financial markets are incomplete. Households in both countries trade equity claims to the two tradable endowments, but they cannot trade claims to the nontradable endowments. This arrangement leads to nonzero capital flows and time variation in the relative welfare of each country.

Three types of country-specific shocks are considered: transitory shocks to the tradable endowment, transitory shocks to the nontradable endowment, and trend shocks that affect both endowments. The transitory shocks are persistent but temporary (AR(1)), while the trend shocks are permanent. In the model, a positive trend shock generates a current account deficit. Together with the specification for preferences, trend shocks yield another desirable feature: equity home bias. In particular, in the long run, households hold more than half of their financial wealth in the domestic equity. In response to a positive, transitory shock to its tradable good endowment, the home country runs a current account surplus and experiences large negative valuation effects. In response to a positive, transitory shock to its nontradable good endowment, the home country runs a current account deficit. At the same time, the home country experiences a positive valuation effect that partially (but not completely) offsets the deficit. Therefore, transitory shock to the nontradable goods endowment closely matches the U.S. data. The intuition for these results is as follows. Home tradable and nontradable goods are complements, so an increase in the supply of nontradable goods (“nontradables”) increases home’s demand for home tradable goods (“tradables”). Because this demand is relatively inelastic, the price of home

tradables must rise a lot, increasing home's desired consumption expenditures. As a result, home households smooth consumption by borrowing. In the model, the only vehicle for saving and borrowing is via foreigners, so the home country runs a current account deficit. The offsetting positive valuation effect stems from a small decline in the relative price of the home equity, which reduces the value of home's foreign liabilities.

Chapter 1

A Literature Review of Recent Research in International Macroeconomics and Finance

1.1 Introduction

While the stylized theoretical models offer essential insights regarding international financial markets and the external investment positions of countries, new empirical evidence inspired and challenged researchers to develop a more sophisticated set of tools to examine the interaction between international financial markets with the real economy. Work on both empirical and theoretical grounds has achieved remarkable progress. Increased availability of data led to detailed analysis of the evolution of

external positions, and the movement and composition of portfolio flows. Theoretical models of international portfolio choice analyses have evolved from limited asset structure and financial market settings they featured.

Previous studies of international macroeconomics were bounded by complete markets assumption, which suppressed the role of international financial markets and net foreign asset dynamics. The analyses were focused on equilibrium portfolio holdings, as they were not capable of producing current account and portfolio flow dynamics. Studies with incomplete financial markets were also restricted in the menu of financial assets they employed. Additionally, those models had to feature a certain set of assumptions about preference and technology parameters to guarantee a closed form solution.

Today, there is a class of richer models that are not constrained by these features and can offer more realistic representation of current international financial trends. For example, Devereux and Sutherland (2008), Devereux and Sutherland (2010a), Evans and Hnatkovska (2007), Tille and Van Wincoop (2010) and Pavlova and Rigobon (2010b) are some of the proposed methods to incorporate full-fledged portfolio choice problems into conventional dynamic stochastic general equilibrium models of international finance and macroeconomics.

The advancement of these computational solution techniques allowed researchers to gain additional insight into many existing questions and puzzles in the field and also to launch new venues of study. This chapter presents a review of the recent theoretical

literature that uses the newly developed tools in investigating main topics related to external financial positions and portfolio flows of countries within a two-country dynamic stochastic general equilibrium framework. Central topics to this literature include portfolio flows, international risk sharing and portfolio diversification and external valuation effects.

French and Poterba (1991) put forth empirical evidence that suggests that the portfolio composition of many industrialized countries is biased towards domestic equity. This evidence contradicts with predictions of the standard portfolio models. There had been intensive research efforts to explain and examine this phenomenon of equity home bias puzzle. The main strand of this literature argues that the consumption home bias is the primary reason for the observed equity home bias; however, they vary in the ways they impose consumption home bias in their models. Cole and Obstfeld (1991), and Kollmann (2006) assume consumption home bias in preferences and study its implications on equity portfolio in two-country endowment economy models. Heathcote and Perri (2008) and Coeurdacier, Kollmann, and Martin (2010) analyze the local input bias in investment spending in models with capital accumulation. The financial asset structure in Coeurdacier, Kollmann, and Martin (2010) features a wider range of assets. Transportation costs in goods trade are also proposed as a reason for consumption home bias, and its implications on equity home bias are examined by Uppal (1993) and Obstfeld and Rogoff (2000). Their findings are at odds with each other. Coeurdacier (2009) supports Uppal (1993) and argues

that the results of models with trade costs are sensitive to preference parameters. A significant and growing research in this subject investigates the presence of a non-tradable goods sector, which is considered an extreme form of home consumption bias. Stockman and Dellas (1989), Collard, Dellas, Diba, and Stockman (2007) and Hnatkowska (2010) argue that existence of non-traded goods help reproduce portfolio home bias. Baxter, Jermann, and King (1998), and Coeurdacier (2009) claim that this result stems from sensitive nature of these models to preference and technology parameters.

Studying the effects of non-tradable labor income risk on international risk-sharing and portfolio composition has been another research venue. Primary work within this strand of literature includes Baxter and Jermann (1997) and Heathcote and Perri (2008). The attractiveness of the domestic equity depends on the correlation between labor income and dividend income, and thus the extent of insurance the domestic equity provides against labor income risk. When dividend and labor incomes are negatively correlated, labor income risk plays an important role in explaining home bias in equity portfolio. Within this literature, there is a dichotomy in terms of interpreting the results of these models. Baxter and Jermann (1997) argue that labor income risk causes deeper home bias, whereas Heathcote and Perri (2008) argue that it is the reason of home bias.

Another strand of literature uses exogenous shocks in producing the wealth effects that are exhibited due to missing insurance markets. In most of the (international)

macroeconomics literature, productivity shocks are considered to be the main drivers of business cycles. However, recent research started using other sources of uncertainty within the class of business cycle models to induce market incompleteness. Pavlova and Rigobon (2010a) study the influence of demand shocks on asset prices and portfolio holdings. In addition to demand shocks, redistributive shocks to shares of capital and labor income and investment efficiency shocks are also found to have interesting implications for external positions and international relative price dynamics that could not be produced by supply shocks. Coeurdacier, Kollmann, and Martin (2007), and Coeurdacier, Kollmann, and Martin (2010) are examples of such work.

The full-fledged analyses of international portfolio flows have blossomed after the advancement of new solution techniques of international macro and finance models with endogenous portfolio choice problem in a rich class of assets. Tille and Van Wincoop (2010) study the dynamics of equity flows. Coeurdacier and Gourinchas (2008) and Coeurdacier, Kollmann, and Martin (2010) emphasize the importance of nominal bonds and how bonds alter predictions of the models for equity flows. Evans and Hnatkovska (2005) provide an excellent benchmark in understanding the dynamics of portfolio flows in the presence of nontradable goods sector. The authors focus on the properties of capital flows in an incomplete markets setting and investigate dynamics and determinants of capital flows under various asset structures.

External valuation effects literature is one of the new venues being researched. Due to the increase in the volume of gross external assets and liabilities of countries,

current account alone doesn't accurately reflect the net foreign asset position of countries. This strand of literature highlights the importance of capital gains and losses accrue on gross holdings of external assets and liabilities and endeavors to quantify the effects of valuation channel on the evolution of net foreign assets. Empirical work in this area initially surpassed theoretical work. Theoretical work caught up only after the advancement of frameworks that allow a rich class of financial assets and time-varying portfolio flows. Devereux and Sutherland (2010b), Ghironi, Lee, and Rebucci (2009) and Pavlova and Rigobon (2010a) are some of the leading research in this area. Nguyen (2010) examines valuation effects under shocks to productivity level and growth rate.

The remainder of this chapter discusses these areas in more detail and is organized as follows. Section 1.2 documents the departure of the literature from narrow models with complete markets and limited asset menus to models with incomplete markets and many assets. Section 1.3 reviews the recent solution methods proposed to integrate portfolio choice analysis to dynamic stochastic general equilibrium framework of international macro models. Section 1.4 reviews studies about international risk sharing and composition of equilibrium portfolio holdings of countries. Section 1.5 reports main findings of recent work with rich classes of financial assets on determinants and dynamics of portfolio flows. Section 1.6 covers studies about valuation effects. Section 1.7 concludes.

1.2 Asset Market Structure in International Macro Models

Early theoretical models of international portfolio choice analyses are limited in the asset structure and financial market settings they feature. Most models assume complete financial markets and models with incomplete financial markets are restricted by a set of assumptions about preference and technology parameters to guarantee a closed form solution. Although these models offer essential insights, they produce international business cycle statistics that are at odds with empirical evidence and they don't provide the grounds for the analysis of international financial flows.

When agents have access to markets for a complete set of contingent claims, they are able to insure themselves at every possible state of the economy. Equilibrium conditions under this assumption imply that marginal utility of consumption across different states is proportional to ratio of prices of the state contingent Arrow-Debreu securities. In a two-country model, this condition implies that the intertemporal marginal rate of substitution across countries are equal. However, this prediction is at odds with the empirical evidence of less-than-perfect cross-country consumption correlations. This anomaly is called 'consumption correlation puzzle' or 'quantity puzzle'.

The conflicting predictions of the real business cycle models due to complete markets assumption have triggered examination of the role of market incompleteness in

explaining those anomalies. Kollmann (1996) argues that market incompleteness is essential in getting more realistic predictions. A two-country one-good real business cycle model with international trade in only risk-free bonds predicts less closely correlated consumption across countries by eliminating perfect risk pooling. Once the international risk sharing is limited, the effects of idiosyncratic income shocks could only partially be mitigated by the trading in bonds. Baxter and Crucini (1995) compare the predictions of a similar model to the predictions of a complete asset markets model and a model of financial autarky. They report that the predictions from the restricted asset market setting are very similar to the predictions of the standard complete market setting only when the productivity process is trend-stationary. The main reason for this difference between the two asset structures is the diverse wealth effects generated when the shocks are permanent. In response to a positive productivity shock, output, consumption and investment all increase, regardless of the asset structure. However, when the shock is permanent, the response of labor supply is sensitive to the menu of available assets. Wealth effects cause labor supply to decline in the bond-only economy since the value of all domestically owned assets increase, whereas the opposite happens in complete markets economy.

Backus, Kehoe, and Kydland (1994) investigate a two-good framework with imperfect substitution, and state that the risk sharing condition attained due to complete markets assumption implies perfect correlation between marginal utilities of consumption and real exchange rate between the two countries. Data, on the other

hand, implies no or negative correlation between consumption and real exchange rate. This anomaly is called ‘consumption real exchange rate anomaly’. Cole and Obstfeld (1991) examine and reject the role of market incompleteness in reaching this result. They argue that, in two-good models, terms-of-trade act as a substitute for risk sharing and it dampens the wealth effects associated with productivity shocks. Therefore, it is possible that consumption under financial autarky is identical to the one under complete markets. Corsetti, Dedola, and Leduc (2008), on the other hand, claim that with incomplete markets, productivity shocks produce large uninsurable wealth effects, depending on the value of trade elasticity and persistence of the shock. With low trade elasticity or highly persistence shocks, the increase in demand due to wealth effects surpasses the increase in supply, crowding out the external demand and causing a terms-of-trade and real exchange rate appreciation, as seen in the data.

Early models of international macroeconomics with complete asset markets have also been criticized for ignoring the role of net foreign asset dynamics in transmission of shocks across countries. Ghironi (2006) investigates the significance of asset market structure and reviews its implications on the net foreign asset dynamics in transmission of shocks. He documents that models that assume unit elasticity of substitution between home and foreign goods and zero initial net foreign assets miss significant dynamics, even if the shock is not permanent. When the elasticity of substitution is not different than one, both market settings produce similar results, which is similar to findings of Baxter and Crucini (1995) in their single-good model. However, when

this assumption is relaxed, terms-of-trade movements and current account dynamics generate substantive differences between the two settings.

1.3 Solution Methods

The incomplete markets setting is usually de-emphasized due to computational difficulties when using local solution methods that are accurate only around a stationary path. With incomplete asset market models, the steady state depends on the country's initial net foreign asset position. In deterministic models, the standard assumption that the subjective discount rate equals the (average) real interest rate implies a constant consumption profile. However, in stochastic models, future income is uncertain and financial assets don't insure against all states of the world. Therefore, the standard assumption fails and the marginal utility of consumption follows a martingale process, which converges only if net foreign assets converge to infinity. Equilibrium dynamics possess a random walk component and transitory shocks have long-run effects on the state of the economy. The random walk property of the dynamics implies that the unconditional second moments of variables such as asset holdings and consumption are infinite.

A framework that integrates dynamics of economy general equilibrium with portfolio dynamics is vital in the analysis of transmission of financial shocks, portfolio flows, portfolio composition and international risk sharing. There are, however, two technical issues associated with incorporating portfolio choice to dynamic stochastic

general equilibrium models. Since the non-stochastic asset equilibrium conditions imply equal rate of returns for different assets, equilibrium portfolio allocations cannot be pinned down. This is called the portfolio indeterminacy problem. Therefore, this natural approximation point is no longer available for local perturbation techniques. Similarly, the expected returns of different assets from first-order approximation of the equilibrium conditions are also identical and this impedes computation of the time-varying portfolio allocations. Financial assets differ from each other in their risk characteristics, but these second-order characteristics are not reflected in non-stochastic steady state (zero-order) conditions and first-order approximations (due to certainty equivalence).

Devereux and Sutherland (2008) and Tille and Van Wincoop (2010) propose similar solution methods that involve local approximation methods to study portfolio flows in a general equilibrium setting with incomplete asset markets. Devereux and Sutherland (2008) dissect the solution process into two steps. In their approach, the first step involves computing steady state portfolio allocation by approximating the portfolio equilibrium conditions to the second-order and the non-portfolio (macro economy) equilibrium conditions to the first-order. First-order non-portfolio conditions of the model depend only on the steady state portfolio. Steady state portfolio shows up in the budget constraint of the household together with first-order excess returns. This expression is an i.i.d. process with zero conditional mean, which disappears in the non-stochastic equilibrium computations. In the second step, which

is elaborated in the companion paper Devereux and Sutherland (2010a), they approximate portfolio equilibrium conditions to the third-order and the non-portfolio equilibrium conditions to the second-order to solve for the time varying portfolio asset values.

Evans and Hnatkovska (2007) present a numerical approach that relies on a combination of perturbation and continuous time approximation techniques. They resolve the portfolio indeterminacy problem by using the continuous time approximations similar to that of Campbell, Chan, and Viceira (2003), which do not require the existence of a unique portfolio allocation in the non-stochastic steady state. They solve the model around an initial wealth distribution to prevent nonstationary wealth effects. Pavlova and Rigobon (2010b) use an exact solution approach within continuous time framework. They solve a two-country two-good endowment economy model with log-linear preferences and with demand shocks. They use a partial equilibrium portfolio choice solution method by Cuoco and He (1994) and embed it in a general equilibrium international macro model.

1.4 International Risk Sharing and Portfolio Diversification

Lucas (1982) is one of the early works that study the equilibrium portfolio results of a frictionless two-country one-good endowment model. The model features inter-

national trade in claims on endowments. Although Arrow-Debreu securities are not assumed, logarithmic utility function and the absence of labor income risk renders the asset markets effectively complete. The model predicts that portfolio holdings are perfectly diversified, such that each agent holds one half of the claims to home and foreign endowment. Full diversification is an immediate prediction of a frictionless standard international macro model. This prediction of Lucas (1982), however, is at odds with empirical evidence of equity home bias presented by French and Poterba (1991). Despite the increased global capital mobility and financial integration, countries continue to hold a greater fraction of their wealth in domestic assets.

There has been vast amount of efforts to replicate this pervasive observation. A significant part of the literature attributes the low level of observed diversification to consumption home bias. Consumption home bias is the empirical observation that domestic households consume more of the domestic goods relative to foreign goods. One way of imposing consumption home bias to the models is through asymmetric preferences. Assigning an elasticity of substitution between home and foreign goods that is less than unitary induces consumption demand bias towards the domestic good. Cole and Obstfeld (1991), for instance, extend Lucas (1982) to a two-good framework with imperfect substitutability between tradable goods. They show that changes in the relative endowments cause corresponding changes in the relative prices of the goods, which facilitates perfect risk sharing through goods trade and justifies low portfolio diversification. However, their results are sensitive to elasticity of sub-

stitution between home and foreign goods. Within the more recent models of equity home bias with endogenous portfolio choice problem, Kollmann (2006) suggests that a two-country two-good endowment economy model with consumption home bias in preferences could replicate home bias in portfolio equity. The resulting portfolio allocation depends on constant relative risk aversion (CRRA) preferences and an elasticity of substitution between domestic and foreign tradable goods that is within a narrow range strictly below unity.

Heathcote and Perri (2008) also argue that the low levels of diversification observed in the data are consistent with perfect risk sharing and that a frictionless two-country two-good model with international equity trade could reproduce the observed portfolio composition (home bias in equity). They use a two-country two-good model of production economy with international trade in home and foreign equities. The model features log utility and unit elasticity of substitution between goods to get a closed form expression to equilibrium portfolio. There is local input bias in investment, which, along with capital accumulation, drives the equity home bias implication of their model. When risk aversion and elasticity of substitution are unity, relative consumption between the countries is constant, while the relative labor income is perfectly negatively correlated with relative dividends. Therefore local domestic equity is a good hedge for the labor income risk.

Coeurdacier, Kollmann, and Martin (2010) argue that the result in Heathcote and Perri (2008) is driven by the negative covariance between the wages and the div-

identends conditional on the terms-of-trade, which is empirically wrong. They study a two-country two-good production economy model with international trade in goods, equities and own currency denominated bonds. Investment spending uses both home and foreign inputs, as in Heathcote and Perri (2008), with bias in domestic inputs. The resulting equity home bias in the in the steady state equilibrium portfolio is independent of the preference parameters and persistence of shocks and their correlation. The local bias in inputs is the main mechanism that drives this result. However, the steady state equilibrium bond portfolio depends on the preference parameters and risk aversion. When the substitution elasticity between the goods is low, the country has negative holdings of own bond and positive holdings of the foreign bond. When the elasticity is high, the country has positive holdings of the domestic bond and negative holdings of the foreign bond. Any increase in terms-of-trade creates positive wealth effects and risk sharing motive dictates sales of home bonds and purchases of foreign bonds in response to the positive wealth effects. The elasticity of substitution determines the effect of the change in output on the terms-of-trade by varying the degree of change in domestic demand for the home good.

The equity home bias literature also questions the importance of frictions in international trade of goods as an explanation of low international diversification. Obstfeld and Rogoff (2000) argue that costs to trade in international goods markets could explain most of the established puzzles in international finance. Uppal (1993), on the other hand, argues this outcome hinges on preference parameters and could only be

produced if the representative household's relative risk aversion is less than unity. He assumes perfect substitutability between home and foreign goods and concludes that although trade costs yield consumption bias towards domestic goods, they don't imply bias towards domestic assets. Coeurdacier (2009) studies the impact of trade costs within a dynamic stochastic general equilibrium endowment economy model with portfolio choice, using Devereux and Sutherland (2008) technique. His findings support Uppal (1993). When the home output is high, due to the trade cost, home consumption rises along with it. This results in home households purchasing foreign assets to hedge against the home supply shocks. Therefore, although trade costs produce home bias in consumption, they fail to produce home bias in the equity portfolio. He emphasizes that this outcome depends on the risk aversion coefficient and the implied covariance between home equity returns and the home real exchange rate. More risk averse investors demand a high paying asset when the real exchange rate appreciates, which implies home bias in equities. Although this covariance is influenced by the size of the trade cost, for reasonable values, the model produces negative covariance between home equity return and real exchange rate, and thus foreign equity bias.

A significant and growing research in this subject investigates the presence of the nontradable goods sector, which is considered an extreme form of home consumption bias. Stockman and Dellas (1989) analyze the implications of consumption home bias on equity home bias using a two-country four-good endowment economy model absent

bias in preferences. They find that with separable utility between tradable and non-tradable goods consumption, optimal portfolio imposes full ownership of nontradable goods stream and a fully diversified ownership of claims on tradable goods endowments. The presence of nontradable goods yields home bias, which increases in the consumption of the nontradable good. Collard, Dellas, Diba, and Stockman (2007) support this finding by extending Stockman and Dellas (1989) to a more general model with non-separable utility and imperfect substitution between tradable and nontradable goods consumption and more than unitary elasticity between the two country tradable goods. They find consistent theoretical evidence that tradable good consumption bias in preferences together with nontradable goods sector yields equity home bias.

Baxter, Jermann, and King (1998), on the other hand, model a general equilibrium, two-period exchange economy in which tradable goods are perfect substitutes. They argue that although equity holdings in the nontradable goods are home biased, it is not sufficient to make the total portfolio exhibit home bias. This result is similar to Coeurdacier (2009), who assumes that claims on tradable and nontradable goods endowments shouldn't be separated, since all tradable goods production has a certain level of nontradable element. Therefore, home equity represents claims on the aggregate output. He argues that, most of the opposite results depend on the complementarity between tradable and the nontradable goods, which yields the contradictory positive correlation between home equity return and real exchange rate.

One of the recent works that studies the implications of presence of nontradable goods on international diversification is Hnatkovska (2010). The model is richer than existing models as it features capital accumulation and incomplete asset markets. The author employs a two-country four-good model of the world economy. The incomplete asset market setting is induced by restricting international trade in nontradable good producing firms' equities. Household preferences are such that tradable and nontradable goods are complements and home and foreign tradable goods are imperfect substitutes. A positive supply shock in nontradable goods sector increases both nontradable and tradable goods consumption. Since the home tradable goods supply is unchanged and home and foreign tradable goods are not perfect substitutes, the increase in consumption of tradable goods gives rise to an increase in the relative price of home tradable goods, which in turn increases the value of home equity payouts. Thus, in the presence of nontradable goods, households are more inclined to accumulate domestic assets.

Nontradable labor income risk has been one of the main features of the models that study equity home bias. However, whether it produces home equity bias or foreign equity bias is still a debate. One of the influential works in this area is that of Baxter and Jermann (1997). They study a two-country one-good framework with capital formation. They point out that a production function with constant factor shares implies perfectly correlated returns to physical and human capital within a country. Therefore, hedging labor income risk requires negative holdings of the do-

mestic equity. In addition, since factor returns are only weakly correlated across countries, diversification incentive dictates an even shorter position in the domestic asset. Thus, they claim that introducing labor choice to the standard model makes observed home bias even more puzzling. Heathcote and Perri (2008) argue when risk aversion and elasticity of substitution are unity, relative consumption between the countries is constant, while the relative labor income is perfectly negatively correlated with relative dividends. Therefore the local equity is a good hedge for the labor income risk. Jermann (2002) solves a multi-country model using the method from Baxter, Jermann, and King (1998). He similarly emphasizes that nontradable human labor income makes the foreign asset a more attractive hedge and that non-separable preferences over consumption and leisure help alleviate this incentive to an extent. The substitutability between consumption and leisure ensures that when labor supply is high, due to the decrease in production of "home-made" goods such as child-care and cleaning, the household ends up increasing market consumption. Therefore, consumption-leisure substitutability helps create some home bias in optimal portfolio. The hedging motive due to labor income risk is sensitive to alternative sources of uncertainty. Coeurdacier, Kollmann, and Martin (2007) argue that the non-diversifiable labor income risk doesn't affect the portfolio position as in the existing literature, when redistributive shocks are present. Those shocks weaken the correlation between equity returns and wage income and they are hedged by holding local equity. They also emphasize that the class of financial assets considered also

affects the results. In a model with local good denominated bonds, equity home bias is not determined by the correlation of equity return and wage income.

A new emerging strand of literature deviates from the standard practice of studying productivity or supply side shocks as the main sources of uncertainty and resorts to a variety of other shocks in explaining the equity home bias. These additional shocks induce market incompleteness. This approach is favored over eliminating assets to mimic missing insurance markets by studies that intend to explore rich classes of assets. Demand shocks in particular, among others, are included as their effect on terms-of-trade yields a desired (negative) covariance between equity returns and real exchange rate.

Coeurdacier, Kollmann, and Martin (2007) point that supply shocks generate capital gains on external assets simultaneously with real exchange rate appreciation. However, in practice, industrialized countries experience capital loss when the real exchange rate appreciates. As a result, they argue that, one has to start considering other shocks as determinants of country business cycles in order to obtain realistic predictions. They use a two-country two-good endowment model with international trade in claims on home and foreign goods along with home and foreign good denominated bonds. They assume consumption home bias in preferences. There are three sources of uncertainty in the model. Supply shocks, redistributive shocks and demand shocks. The ability of a supply shock to create equity home bias depends on the change it would produce in equity return, which depends on the elasticity of sub-

stitution between home and foreign goods. A negative supply shock to the home good endowment causes a real exchange rate appreciation and terms-of-trade improvement. If the substitution elasticity is less than unity, then the return on home equity would rise and home equity would be an attractive hedge for home supply shocks. On the other hand, if the elasticity is greater than one, then the return on home equity is lower than the return on foreign equity, which makes the foreign equity an appropriate hedge. However, this yields an unrealistic positive correlation between relative equity returns and terms-of-trade. They argue that the additional two shocks break this link. A redistributive shock increases dividends of domestic firms while decreasing the domestic labor income, which could be hedged by holding home equity. Demand shocks have a direct effect on the real exchange rate through changes in preferences or in quality and number of varieties of goods. Demand shocks are hedged by using bonds.

Coeurdacier, Kollmann, and Martin (2010) analyzes the effects of investment efficiency shocks in addition to productivity shocks, with local input bias in investment spending. A positive investment shock raises output and, on impact, improves terms-of-trade due to increased demand for the home good. A positive productivity shock also raises the output, but it deteriorates the terms-of-trade. When both productivity and investment efficiency shocks are introduced, the model predicts countercyclical change in net foreign assets, equity purchases and bond purchases. Change in net foreign equity purchases are procyclical because local equity is a good hedge for local

labor income risk.

1.5 International Portfolio Flows

Portfolio choice was mostly absent from general equilibrium models of international macroeconomics. Either a risk-free bond is traded or complete financial markets are assumed. Therefore, these models didn't allow analysis of gross international portfolio flows. The full-fledged analyses of international portfolio flows have blossomed after the advancement of new solution techniques that enable the study of rich classes of assets simultaneously.

Tille and Van Wincoop (2010) document capital flow dynamics in a simple two-country two-good model of the world economy with international trade in equities only. They assume home bias in preferences and introduce an iceberg cost to asset trade to induce market incompleteness. An increase in saving due to a temporary productivity boost is initially allocated across the two assets according to the steady state portfolio shares. The simultaneous rise in home equity price increases the value of existing asset holdings, causing a repatriation of the foreign equity holdings to purchase home equities in accordance with home equity bias. Therefore, on impact, the country experiences a decrease both in gross capital inflows and outflows. After the initial shock, home equity price gradually declines to its steady state level. Asset market clearing condition also requires that the excess demand in home equity is offset by a decrease in its expected excess return. Therefore, following the initial shock,

both country households reallocate their portfolio towards foreign equity, resulting in positive capital outflows and negative capital inflows.

Tille and Van Wincoop (2010) state that, even though lack of bonds doesn't alter their results (due to symmetry of the countries), bonds make up a significant part of international financial flows. Previous models of international macroeconomics that assume complete markets or study special cases of efficient risk sharing with equity trade yield results in which bonds are redundant. Coeurdacier and Gourinchas (2008) argue that, in models with market incompleteness, due to additional sources of uncertainty, bonds become an important part of equilibrium portfolio allocation. Relative bond returns are positively correlated with real exchange rate. Therefore, it is optimal for households to hold nonzero amounts of bonds to hedge real exchange rate risk. For example, Coeurdacier, Kollmann, and Martin (2010) study a two-country two-good model with productivity and investment efficiency shocks and report results for portfolio flow dynamics. Their model predicts that net bond purchases are perfectly negatively correlated with net equity purchases, which is close to the empirical evidence for G7 countries. The change in net foreign assets is more volatile than GDP and is countercyclical. Net foreign equity purchases are procyclical while net foreign bond purchases are countercyclical. When there is an investment boom due to increased investment efficiency, dividends fall while wage income rises, causing a negative covariance between them. Increase in investment efficiency also causes the real exchange rate to appreciate. When there is an increase in output due to a

productivity shock, real exchange rate depreciates.

As is the case in equilibrium portfolio literature, the presence of nontradable goods and the implications of productivity shocks in the nontradable goods sector has proven to be important for portfolio dynamics, as well. Evans and Hnatkovska (2005) investigate whether and how the size and volatility of international capital flows are affected by the degree of financial integration in financial assets markets in an incomplete markets model with nontradable goods. They study a two-country model with portfolio choice and evaluate the effects of productivity shocks to tradable and nontradable goods sectors on international capital flows and financial returns. Degrees of financial integration are characterized by varying array of financial assets available under each scenario. Firms issue equities and an international risk-free bond is available. Under financial autarky, none of the assets are traded internationally, while under full integration all are traded internationally. Under partial integration, the only internationally traded asset is the risk-free bond.

In response to a positive shock to the level of productivity, marginal product of capital increases, which in turn boosts investment. The investment boom implies an increase in the future stream of dividends, thereby increasing the current price of the equity of the firm. For holders of equity, capital gains entail an increase in wealth and a consequent increase in demand for tradable and nontradable goods. However, the results due to increased demand will be different depending on the financial integration scenario. Under financial autarky, the increased demand for

tradable goods is accommodated by the increase in their supply. The increase in demand for nontradable goods, due to unchanged supply, raises the relative price of nontradable goods. Since international trade is not an option, the current account will be zero and the change in the relative price will be more drastic.

When the only available asset is an international risk-free bond (partial integration), part of the demand for tradable goods is acquired from the foreign country by selling bonds. As the investment boom dies out, the trade deficit starts shrinking. After all the foreign debt is paid back, home country lends to foreign households and the trade balance turns to surplus. This final effect on the trade balance is interpreted as the result of consumption smoothing by the households and it is due to the permanent effects of the temporary shock on the wealth distribution in this class of models. The effect on the relative price of nontradable goods in this scenario will be less than the autarky case.

When all the assets are accessible for international trade, the capital gains due to the increased productivity accrues to both country households and demand for tradable and nontradable goods in both countries increase. In this scenario, if the agents take a fully diversified position, the current account stays in balance. Relative price of nontradable goods increases, but by less compared to the partial integration case.

If the positive productivity shock hits the nontradable goods sector, the current account turns negative under partial and full integration, due to the absence of the

increase in investment; however the magnitude of the deficit is smaller. An increase in the supply of nontradable goods decreases their relative price and also increases the demand for tradable goods. In the pure debt financing case, foreign borrowing is used to finance consumption smoothing. When both equities and bond are traded, foreign borrowing is used to purchase foreign equities to diversify the financial portfolio. They claim that, otherwise, bonds are redundant in the full integration case.

They also look at the individual financial asset flows under partial and full integration cases. In the former, a positive shock to productivity level in tradable goods sector results in an initial outflow of bonds followed by an inflow of bonds (and bond holdings settle at a level higher than the initial). When the shock hits the nontradable goods sector, bond holding turns negative, initially small, and remains so for a longer duration.

Under the full integration scenario, assuming households start with a fully diversified portfolio (half of wealth in home equities and other half in foreign equities), the shock doesn't change the existing portfolio composition and doesn't induce any foreign borrowing and lending. The fact that households have a diversified portfolio doesn't induce any additional lending or borrowing to smooth consumption. They follow a so-called buy-and-hold strategy and passively consume their dividends every period. So the markets are effectively complete under this scenario. On the other hand, shock to the nontradable goods sector makes the domestic firm equities a better hedge and thus causes the individual to sell bonds to finance the increase in holdings

of domestic equity. Thus an outflow of bonds is observed together with accumulation of own equity. As the shock dies out, an outflow of domestic equity is observed to finance the still high tradable consumption and to pay back the bond borrowing.

1.6 Valuation Effects

It is documented that, although the net international portfolio flows have been mostly stable, gross external assets and liabilities have increased dramatically over the last twenty years. This change implies that there are considerable capital gains and losses over the gross financial holdings that depend on asset prices, returns and real exchange rates. Thus, conventional measures of external sustainability could be misleading because they leave out valuation effects from net foreign asset position analysis. An unexpected productivity increase in a tradable good sector increases the price of its equity due to the increase in its dividends. The issuer country, then, incurs a capital loss on the foreign holdings of the domestic equity. In the meanwhile, depending on the simultaneous development in the foreign stock market, the country might incur a loss or gain on its own existing foreign assets. Despite the abundant empirical evidence, theoretical work on determinants and components of valuation effects had only begun after the introduction of new techniques to incorporate sophisticated portfolio choice problems into the dynamic stochastic international macro economy models.

One of the prominent works in this area is the Devereux and Sutherland (2010b).

They have a two-country one-good endowment economy model with portfolio choice in which they analyze the importance and components of valuation effects. Capital income and labor income are country-specific, stochastic, exogenous processes. Capital income risk is diversified by trading equities in the international markets and labor income risk is not directly diversifiable. Equities are the only internationally traded assets.

The valuation effect is defined as the difference between the change in the net foreign assets and the current account. Valuation effects are composed of "anticipated" and "unanticipated" changes. "Unanticipated" capital gains and losses arise due to the impact effect of shocks to the excess returns and the portfolio holdings. These effects are found to be the largest component of the valuation effects and can be represented by a zero mean i.i.d. process. The magnitude and size of the "unanticipated" effects depend on the steady state portfolio and the first-order behavior of the excess returns, which is a linear function of the realized values of innovations. The current account improves immediately in response to a positive shock and the "unanticipated" valuation effect is positive if foreign country has a positive position in home equity and it is negative if foreign country has a negative position in home equity. The volatility of the "unanticipated" valuation effects is an increasing function of the size of the gross asset position, and persistence and volatility of endowment shocks.

The degree of home bias in this model depends on the correlation between capital

and labor income. When there is negative correlation between labor and capital income, local equity becomes a reasonable hedge for domestic endowment shocks. For not too persistent shocks, a country with home bias in its equity, experiences small valuation effects compared to a country with no labor income or with no home bias. When foreign agents hold a positive position of home equity, home agents experience a negative valuation effect due to the positive excess return on home equity.

"Anticipated" valuation effects stem from the second-order and third-order changes in the excess return and the adjustment on the existing portfolio. Second-order expected excess return is a function of capital income volatility and correlation of capital and labor income. The expected excess return on home equity is negative if foreign capital is more volatile and/or if covariance of capital and labor income is relatively higher for the foreign country. The magnitude of second-order portfolio adjustments depends on the degree of home bias and on how close the optimal portfolio is to the full risk sharing portfolio. The greater the degree of home bias and the closer the model equilibrium is to full risk sharing, the less the portfolio adjustments' contribution to valuation effects. The third-order valuation effect reduces to time-varying expected excess returns for the steady state portfolio. When the home country is hit by a negative capital income shock, expected excess return on home equity is negative and the home equity holding of the foreign country is positive. Thus, the total third-order valuation effect is positive, though a very small fraction of GDP.

They conclude that most of the valuation effects result from changes in the ex-

pected excess returns and the portfolio rebalancing component has a very little contribution. They also analyze a model with imperfect substitutability between home and foreign goods and with internationally traded bonds. In both cases, the valuation effects are negatively correlated with the current account, suggesting that, regardless of the asset structure, valuation effects increase risk sharing across the countries. In the pure equity trading scenario, most of the variation in valuation effects comes from changes in the asset prices. In the second scenario with bonds, while the asset prices are still important, terms-of-trade movements are as important as asset prices. The effect of dividends remains little under both scenarios.

Ghironi, Lee, and Rebucci (2009) focus on analyzing the valuation effects that stem from capital gains and losses on the gross foreign assets and liabilities due to changes in asset prices, which they call the "valuation channel". They study the valuation channel in a two-country two-good dynamic stochastic general equilibrium framework with monopolistically competitive firms. The equities of these firms are traded internationally. Production uses labor as the only input. There are two sources of risk in the model: productivity shocks and government spending shocks. When the labor supply is inelastic or when the government spending shocks are absent, the agents achieve full risk sharing portfolio in the steady state. When both shocks are present, the asset markets are incomplete.

They decompose the first-order log-approximation of the change in net foreign assets to its determinants. The portfolio adjustment component is defined as the

change in net foreign equity holdings, or equivalently as current account, and the valuation channel is defined as the change in relative equity prices. The parameters are set such that home agents always hold a positive share of foreign equity in the steady state. When that is the case, an increase in relative productivity of home country increases home households' holdings of foreign equity. An increase in home government spending, on the other hand, decreases holdings of foreign equity, since it crowds out home consumption and causes the terms-of-trade to deteriorate, increasing the foreign demand for home good. The increase in demand for home goods causes the home labor supply and hence output in the home country to increase, which renders the home equity a desirable hedge for the foreign households.

The valuation effect is negative in response to an increase in home relative productivity, due to the resulting increase in the home firm's equity price. Meanwhile, the increase in purchases of foreign assets generates current account surplus. Overall, the negative valuation effect dampens the positive effect of a current account surplus on the change in net foreign assets. In response to an increase in government spending, the decrease in relative home consumption creates a current account deficit. The negative valuation effect appears upon the impact of the shock, while the valuation effect is zero in the years after the shock.

The relative price of home equity is an increasing function of home net foreign assets, and relative productivity, government spending and excess return shocks. The change in relative equity valuation follows an ARMA(1,1) process in response to

relative productivity shocks. This is in conflict with Devereux and Sutherland (2010b) finding that first-order valuation effects (based on excess returns) resemble an i.i.d. process. The relative price of home equity follows an i.i.d. process in response to fiscal shocks. This difference between productivity and fiscal shocks stems from relative consumption and relative dividends' one-time jump on impact, following the positive fiscal shock. Relative productivity shocks, on the other hand, have persistent effects on labor supply choice and output.

They also provide analysis of effects of valuation on macroeconomic dynamics during external adjustment. In response to a positive shock to home productivity, the terms-of-trade worsens. Lower purchasing power and increased demand for domestically produced goods by foreign households induce domestic households to increase labor supply, which increases domestic income further. The increased wealth results in increased purchases of foreign equity. The home country experiences a trade surplus and a decrease in net foreign income from abroad. Overall, the change in net foreign assets is negative, which implies that the negative valuation effect due to the increased relative home equity price was the dominant factor, dampening the current account surplus.

A fiscal shock immediately causes trade deficit and sales of foreign assets. In return, the home country experiences a one-time and permanent decrease in relative consumption and increase in relative labor supply. The rise in income causes the relative price of home equity to increase to a higher long-run level. The resulting negative

valuation effect together with the trade deficit worsens the net foreign asset position. In subsequent periods, the valuation effect is zero and all the dynamics resulting from the change in net foreign assets come from domestic households switching out of foreign equity and foreign households purchasing home equity.

Their results significantly differ from those of Devereux and Sutherland (2010b) in that Ghironi, Lee, and Rebucci (2009) find nonnegligible dynamics caused by the anticipated portfolio adjustment component. Additionally, the valuation channel in Devereux and Sutherland (2010b) depends on the dynamics of excess return in first and higher-orders, whereas in Ghironi, Lee, and Rebucci (2009), the valuation channel is measured by the change in relative equity prices. Ghironi, Lee, and Rebucci (2009) argue that, mainly due to this differentiation, they could attribute a considerable role to portfolio adjustment component of the valuation effects. They conclude that, productivity shocks have a constant and non-zero valuation effects on the change in net foreign assets in the periods following the realization of the shock, while government spending shocks have a one-time valuation effect on the impact period and the change in net foreign assets is solely due to portfolio adjustments for the following periods.

Pavlova and Rigobon (2010a) study an endowment economy model with international trade in stocks and bonds. They focus on updating the conventional current account measure with expected and unexpected capital gains to get a more accurate capital-gains adjusted current account (CGCA, hereafter). Similar to the rest of the literature, they differentiate and try to identify the expected and unexpected capital

gains. They use a continuous time endowment economy model with international trade in equities and a "world" bond. Their analysis is based on exact, closed-form solution they develop in Pavlova and Rigobon (2010b).

There are two sources of uncertainty in their model: productivity shocks and demand shocks. A positive productivity shock increases home country dividends and equity price. Due to the increased supply of the home good, the home terms-of-trade worsens, which in turn implies an improvement in the foreign country terms-of-trade. This effect increases the value of foreign output, thereby rising their equity price. An increase in the demand for the home good rises the terms-of-trade causing the value of home output to increase. The reverse is observed for the foreign country. They also study the effects of a change in the wealth distribution across the countries. If, for example, the home country were "bigger" relative to foreign country, one would expect to see increased demand for both goods by home consumers but relatively higher for the home good due to home bias in consumption. The increase in demand improves home terms-of-trade, which in turn raises the home equity price above the foreign equity price.

The CGCA differs from the conventional measure of current account in two ways. The first one is an unexpected capital gains component which is a function of volatilities of the expected returns on equities. It increases the current account whenever the return on foreign asset holdings is greater than the return on home equity holdings of foreign households. The second difference is in the expected capital gains component.

Traditional measure includes net dividend payments on equities and net interest payments on the riskless bond, in addition to trade balance. The adjusted measure also incorporates expected capital gains to equity holdings.

While the conventional current account and the trade balance feature persistence, the CGCA is a much more volatile and serially uncorrelated process. Much of this variation is driven by the unexpected capital gains. In line with the empirical literature, they find that both the expected and unexpected capital gains are negatively correlated with trade balance and the conventional current account, suggesting a stabilizing role for valuation effects. However, the correlations with the CGCA are positive indicating the dominant role of unexpected capital gains in driving the changes in the net foreign asset dynamics.

They also analyze the external adjustment of the general economy. The asset-pricing view they defend is highlighted through their study of equilibrium dynamics of the macro economy. The trade balance adjustment is triggered by capital gains and losses. They assume that initially portfolios are determined. Once the shock takes place, first line of action is to determine its impact on output and asset prices. As a second step, they trace the effects on external accounts.

The dynamics in response to a positive productivity shock is complicated due to the resulting simultaneous shift in preferences towards the home good. A positive productivity shock boosts both stock markets, but the preference shift dictates an increase in home stock market and a decrease in foreign stock market. In this case,

both the unexpected capital gains, and the net foreign assets are positive. The reason for this is a simultaneous change in the relative sizes of the countries. Capital gains on the home country portfolio imply a wealth transfer from the foreign country to home, which allows the home country to increase its trade deficit. The CGCA, however, is positive in accordance with the unexpected capital gains.

A pure demand shock improves the home stock market and deteriorates the foreign stock market, causing net unexpected capital loss to home country. Net foreign asset position is negative despite a trade surplus.

Nguyen (2010) studies the consequences of growth shocks for valuation effects and the current account using Devereux and Sutherland (2008) techniques within a two-country production economy with portfolio. He argues that the correlation of valuation effects with the current account depends on the nature of the productivity shock being studied. He uses a two-country one-good model with production and portfolio choice. There is international trade in equities. He imposes home bias by introducing transaction costs to purchases of "other country" equity.

The economic mechanism relies on the differing consequences of growth rate and level productivity shocks on current account. In response to a temporary and persistent productivity level shock, domestic abruption doesn't increase as much as the increase in output and most of the windfall is saved. This gives rise to current account surplus. However, when there is a positive, temporary and persistent shock to the growth rate of productivity, expected future income and productivity are also higher.

Consumption smoothing households adjust their consumption profile and investment also dramatically increases, both causing a current account deficit.

Regardless of the nature of the productivity shock, valuation effects are negative under both cases. Therefore, under level productivity shocks, valuation effects are stabilizing, as they are negatively correlated with current account; however, under growth rate shocks, valuation effects are positively correlated with the current account. Thus, in contrast to the recent empirical and theoretical findings, valuation effects could be amplifying.

1.7 Conclusion

This chapter presents a literature review of the recent theoretical advancements in international financial macroeconomics and the latest research for three main topics in this field: portfolio diversification and international risk sharing, international portfolio flows, and external valuation effects. Early models of international macro assumed complete asset markets, ignoring the impact of financial markets on the economy. Baxter and Crucini (1995) and Ghironi (2006) are two noticeable examples of the work that discusses the importance of asset market settings. The substantive difference between the implications of complete and incomplete market settings invigorated research efforts to integrate macro dynamics with international portfolio analysis. Devereux and Sutherland (2008), Devereux and Sutherland (2010a), Evans and Hnatkovska (2007), Tille and Van Wincoop (2010), Pavlova and Rigobon

(2010b) are seminal works that developed different solution techniques to produce a more sophisticated analysis of international portfolio choice.

These techniques have been used in the investigations of many topics in international macroeconomics. The international risk sharing and portfolio diversification literature have expanded with analyses of incomplete markets settings featuring rich classes of financial assets and alternative sources of uncertainty. The portfolio flows literature has gained speed as we are equipped with tools to compute both steady state and time varying portfolio allocations within DSGE models of macro economy without resorting to restricting asset structures and parameterizations. Research in analyses of external adjustment through capital gains and losses on external wealth of countries has blossomed due to the enabled breakdown of portfolio flows to its determinants.

Although, so far, there is no complete agreement on how to model portfolio choice , the recent efforts to explore the implications of missing insurance markets and the interaction of the real economy with the international financial markets are necessary first steps in understanding portfolio flows; the progress so far is promising and opportunities for new research in the field abound.

Chapter 2

Growth Shocks and Portfolio Flows

2.1 Introduction

Advanced and emerging market economy portfolio flows feature distinct characteristics. Table 2.1 displays cyclical properties of disaggregated portfolio flows of 22 advanced countries and emerging market economies over the period 1992-2005 from Contessi, De Pace, and Francis (2009). Direction and cyclicity of portfolio flows exhibit significant deviations across different groups of countries. There are differences at times, even between G7 countries and other advanced countries. What could be the factors behind such deviations across countries? In particular, what are the determinants of portfolio flows between emerging market and advanced economies? Aguiar and Gopinath (2007) suggested that varying composition and predominance of productivity level and growth rate shocks help understand the differences between

	Tot. in	Tot. out	Net tot. out	FDI in	FDI out	Net FDI out
G7	?/+	?/+	-	+	?/+	-
Advanced	+	-	-	+	-	-
Emerging	+	-	-	-	?	+
	FPI in	FPI out	Bond in	Bond out		
G7	+	?/+	?/-	-		
Advanced	+	?/-	+	-		
Emerging	+	-	+	+		

Table 2.1: Source: Contessi, De Pace and Francis (2009), Table 11. Correlations of total inflows (abbreviated as "Tot. in"), total outflows (abbreviated as "Tot. out"), net total outflows, foreign direct investment (FDI) inflows, FDI outflows, net FDI outflows, foreign portfolio investment (FPI) inflows and outflows and bond inflows and outflows with log GDP over the period of 1992-2005.

emerging market and advanced economies business cycles. They were successful in replicating the observed strong countercyclicality of net exports for emerging market economies and acyclicity of net exports for advanced economies simply by modifying the persistence and volatilities of these two types of productivity shocks across the countries according to the data. Broner and Rigobon (2006) also attributed the volatile behavior of emerging market economy capital flows to relatively more persistent shocks experienced in these countries.

This paper aims at exploring the significance of the differentiation between level productivity and productivity growth rate shocks in replicating the observed distinct cyclical behavior of equity and debt flows across advanced and emerging market economies. I solve a two-country, single good model of the world economy with capital accumulation and endogenous labor choice. The model features an explicit portfolio choice problem in both countries, which makes it possible to study not only the net

capital flows, but also debt and equity outflows and inflows separately.

I find that growth rate shocks significantly alter the predictions of the standard model for moments of capital flows. My results suggest that inclusion of growth rate shocks contribute in generating the observed countercyclical net equity outflows in advanced countries and countercyclical net equity inflows in emerging market economies. The model also captures procyclical bond inflows in both groups of countries, as in data. The main mechanism driving these results is the difference in the optimal actions of agents and firms between each shock. A temporary expansion in output leaves relative consumption profile roughly unchanged and results in a one-time investment boom. The increase in domestic absorption is limited as the output increase is only temporary. Transitory shock causes a decline in equity inflows and bond inflows as well as an increase in equity outflows. This result suggests that the country experiences initial repatriation of foreign holdings of its equity to realize the capital gains and the windfall is saved by purchasing foreign equity.

When the shock is to the productivity growth rate, on the other hand, households shift their consumption profile up and investment exhibits a prolonged boom. In this case, the country experiences a decline in all equity inflows, equity outflows and bond inflows. The change in the direction of equity outflows is due to the dissaving of home households to finance the increase in consumption and investment. Following the initial impact, both equity inflows and outflows experience a surge. Equity inflows increase due to the higher future stream of home dividends with higher expected future

productivity. Equity outflows increase as home households enjoy the attractive hedge provided by the foreign equity. In portfolio models with endogenous labor choice, it is established that the covariance between wage income and dividend income determines the home equity bias and foreign equity bias.¹ When this covariance is positive, equilibrium portfolio allocation exhibits foreign equity bias, as is the case in the analysis here.

This study is related to two big strands of the economics literature. First strand studies the effects of different macroeconomic shocks within otherwise standard models and assesses their implications. Edge, Laubach, and Williams (2007) study implications of transitory and permanent shocks in a closed economy framework. Cova, Pisani, Batini, and Rebucci (2008) argue that productivity shocks are main determinants of global imbalances experienced across countries. Aguiar and Gopinath (2007) express the importance of growth rate shocks in understanding and explaining emerging market economies' business cycles, within a small open economy framework. Nguyen (2010) studies growth rate shocks within a similar two-country model, however he doesn't have time-varying portfolio analysis and his focus is different.

The other related strand of literature studies endogenous portfolio choice within a general equilibrium framework of the world economy. Evans and Hnatkovska (2005) set a benchmark in studying and understanding capital flows in a two-country two-sector world economy, but they don't explore growth shocks. Tille and Van Win-

¹See Baxter and Jermann (1997), Heathcote and Perri (2008) and Coeurdacier, Kollmann and Martin (2010) for details.

coop (2010) study equity flows in an incomplete markets setting with transitory productivity shocks. Although their focus is home equity bias, Coeurdacier, Kollmann, and Martin (2010) also present some of their findings regarding capital flows for G7 countries using a combination of level productivity and investment efficiency shocks. Within the strand of literature studying international portfolio flows, a separate branch focuses on investigating and understanding emerging market economy capital flows. The closest work to the one presented here is Devereux and Sutherland (2009) in terms of both their focus on financial flows between an emerging market and an advanced economy, and their solution technique. However, they use level productivity shocks only and attain their results by restricting the available menu of financial assets and the financial market structure. In their empirical analysis of volatility of the emerging market capital flows, Broner and Rigobon (2006) conclude that emerging markets have more volatile capital flows. They argue that the higher volatility is mostly the result of relatively more persistent shocks in EMs. Kaminsky, Reinhart, and Vegh (2004) find that net capital inflows are more strongly procyclical in emerging markets and this could also be attributed to trend shocks.²

This work contributes to the literature on several grounds. First, this is the first paper that analyzes the implications of capital accumulation and endogenous labor choice on portfolio choice in the presence of productivity growth rate shocks. Second, it is the first paper to analyze time-varying portfolio flows both between two

²See Gopinath (2004) comment on Kaminsky, Reinhart, and Vegh (2004).

advanced economies and an emerging market economy and an advanced economy under a combination of level and growth rate productivity shocks.

The remainder of the chapter is organized as follows. Section 2.2 describes the model, including the portfolio choice problem faced by each country. Section 2.3 summarizes quantitative analysis. Section 2.4 concludes.

2.2 Model

The model features two countries, Home (H) and Foreign (F), and a single good. A continuum of identical, perfectly competitive firms in each country produce the single good using physical capital and labor as inputs. Each country has a stochastic process governing productivity. The productivity process in each country includes both a labor-augmenting trend component and a transitory component, as in Aguiar and Gopinath (2007). The population consists of identical households who decide, in an optimizing framework, how much to consume and work as well as what assets to hold. There is no restriction on the trade of goods.

2.2.1 Firms

In both countries, $i = \{H, F\}$, firms produce output using a Cobb-Douglas production function:

$$Y_t^i = e^{z_t^i} (K_t^i)^\theta (\Gamma_t^i L_t^i)^{1-\theta}, \quad 0 < \theta < 1 \quad (2.1)$$

where K_t^i and L_t^i denote capital and labor inputs employed in the production of output Y_t^i and $\theta \in (0, 1)$ is the share of capital in output. z_t^i is the transitory component of productivity in country i . It represents shocks to the level of productivity and it follows a stationary autoregressive process:

$$z_t^i = \rho_z z_{t-1}^i + \varepsilon_t^{iz}, \quad |\rho_z| < 1 \text{ and } \varepsilon^{iz} \sim iidN(0, \sigma_{iz}) \quad (2.2)$$

Γ_t^i stands for the cumulative product of labor-augmenting growth shocks. It represents transitory changes in the growth rate of productivity, which implies permanent changes in the level of productivity. It is defined recursively as follows:

$$\Gamma_t^i = e^{g_t^i} \Gamma_{t-1}^i \left(\frac{\Gamma_{t-1}^j}{\Gamma_{t-1}^i} \right)^\lambda, \quad 0 < \lambda < 1, \text{ for } i \neq j$$

where g_t^i denotes the shocks to the growth rate of productivity and it evolves according to:

$$g_t^i = (1 - \rho_g) \bar{g} + \rho_g g_{t-1}^i + \varepsilon_t^{ig}, \quad |\rho_g| < 1 \text{ and } \varepsilon^{ig} \sim iidN(0, \sigma_{ig}) \quad (2.3)$$

\bar{g} is the long-run average growth rate, which is assumed to be the same in both countries. In a two-country model framework with trend growth, a restriction pertaining to the countries' relative total factor productivity is required to guarantee stationarity. This restriction assures that, even though productivities can diverge for some time, overall process is consistent with absolute long run convergence. In other words, the cumulative growth shocks across the two countries are assumed to be cointegrated.

$\left(\frac{\Gamma_{t-1}^j}{\Gamma_{t-1}^i}\right)^\lambda$ is the convergence factor, as in Nguyen (2010), which keeps the detrended model stationary.³ This convergence factor is denoted as $\pi_t \equiv \frac{\Gamma_{t-1}^F}{\Gamma_{t-1}^H}$ and it evolves according to

$$\pi_{t+1} \equiv \frac{\Gamma_{t-1}^F}{\Gamma_{t-1}^H} = \frac{e^{g_t^F}}{e^{g_t^H}} (\pi_t)^{1-2\lambda}$$

The speed of convergence depends on the choice of parameter λ .⁴

This representation of the growth shocks could be interpreted as a vector error correction model:

$$\ln \Gamma_t^i = \ln \Gamma_{t-1}^i + g_t^i + \lambda (\ln \Gamma_{t-1}^j - \ln \Gamma_{t-1}^i)$$

Suppose that $\Gamma_{t-1}^F > \Gamma_{t-1}^H$. The last expression on the right hand side increases Γ_t^H by adding the difference between cumulative growth shocks. Similarly, this difference is subtracted from Γ_t^F , decreasing it. Eventually, this system guarantees the convergence of productivity processes.

Firms choose labor demand, dividends, and investment to maximize the expected present discounted value of dividend payments to shareholders. The representative firm's objective function is:

$$\max E_t \left[\sum_{s=0}^{\infty} M_{t+s,t}^i D_{t+s}^i \right] \quad (2.4)$$

³See Rabanal, Rubio-Ramirez and Tuesta (2009) for further information on cointegration of productivity processes in two-country models.

⁴When $\lambda > 0$, the convergence process π_t makes the productivity processes cointegrated across the countries. A small λ means long convergence.

where $M_{t+s,t}^i$ is the stochastic intertemporal marginal rate of substitution (SMRS) of the country i household.

Dividends are defined as:

$$D_t^i = Y_t^i - W_t^i L_t^i - I_t^i \quad (2.5)$$

where D_t^i, W_t^i, I_t^i denote dividend payments, real wages, and investment, respectively.

Investment, in turn, is defined as follows:

$$I_t^i = K_{t+1}^i - (1 - \delta)K_t^i + \frac{\varphi}{2} \left(\frac{K_{t+1}^i}{K_t^i} - e^{\bar{g}} \right)^2 K_t^i \quad (2.6)$$

I assume that capital depreciates at the rate δ , and firms face quadratic capital adjustment costs, as in Aguiar and Gopinath (2007) and Nguyen (2010), where φ is the adjustment cost parameter.

2.2.2 Assets

There are three types of financial assets in this world: equity in home country firms (A_t^H), equity in foreign country firms (A_t^F), a one-period, and a risk-free real international bond (B_t). The prices of these securities are P_t^H , P_t^F , and P_t^B , respectively. The holder of an equity claim from period $t-1$ receives a dividend payment in period t and can also collect capital gains by selling the equity for its current price. Thus, the overall return on a country equity is:

$$R_t^i = \frac{D_t^i + P_t^i}{P_{t-1}^i} \quad (2.7)$$

An international bond purchased in period $t - 1$ delivers one unit of the global consumption good in period t , so the return on the bond is:

$$R_t^B = \frac{1}{P_{t-1}^B} \quad (2.8)$$

2.2.3 Households

Infinitely lived households in each country choose consumption (C^i), labor supply (L^i), and asset holdings (A^{iH}, A^{iF}, B^i) to maximize their expected present discounted utility:

$$U_t^i = E_t \left[\sum_{s=0}^{\infty} \Psi_{t+s}^i \frac{((C_{t+s}^i)^\gamma (1 - L_{t+s}^i)^{1-\gamma})^{1-\sigma}}{1 - \sigma} \right] \quad (2.9)$$

where γ is the weight on consumption, $\sigma > 0$ is the coefficient of relative risk aversion, and Ψ_t^i is endogenous discount factor that depends on the detrended, lagged consumption of country i household ($c_{t-1}^i = C_{t-1}^i / \Gamma_{t-2}$) and is defined as:

$$\Psi_t^i = \Psi_{t-1}^i \beta(c_{t-1}^i), \Psi_0 = 1$$

$$\beta(c_{t-1}^i) = \omega^i (c_{t-1}^i)^{-\eta}$$

This form of the (internalized) endogenous discount factor ensures stationarity of the cross-country wealth distribution and uniqueness of the steady state, as in Schmitt-Grohé and Uribe (2003) and Devereux and Sutherland (2008). As the rate of impatience rises with the level of consumption, a stationary consumption profile is possible.⁵

The model features international trade in both equities and the real international bond. A representative household in country i maximizes (2.9) by choosing how much to consume and how much to borrow or lend subject to the following budget constraint:

$$C_t^i + P_t^i A_t^{ii} + P_t^j A_t^{ji} + P_t^B B_t^i = W_t^i L_t^i + (D_t^i + P_t^i) A_{t-1}^{ii} + (D_t^j + P_t^j) A_{t-1}^{ji} + B_{t-1}^i \quad (2.10)$$

every period, where $i, j = \{H, F\}$ and $i \neq j$. The variable A_t^{ji} denotes household i 's holdings of country j 's equity at the end of period t and the variable P_t^j denotes the price of equity j . P_t^B is the price of the real bond and B_t^i denotes household i 's holdings of the international bond.

It will be convenient while solving the portfolio choice problem to rewrite the budget constraint in terms of net foreign assets. Define the net foreign assets of a representative household in each country as:

$$NFA_t^i = P_t^j A_t^{ji} + P_t^i (A_t^{ii} - 1) + P_t^B B_t^i$$

⁵See Schmitte-Grohe and Uribe (2003) for further details.

Then, I can rewrite the budget constraint of the country i household as:

$$C_t^i + NFA_t^i = W_t^i L_t^i + R_t^B NFA_{t-1}^i - P_t^i + R_t^B P_{t-1}^i + R'_{x,t} \alpha_{t-1}^i \quad (2.11)$$

$$\alpha_t^i = [P_t^i A_t^{ii} \quad P_t^j A_t^{ji}]$$

$$R'_{x,t} = [R_t^H - R_t^B, \quad R_t^F - R_t^B]$$

2.2.4 Equilibrium Conditions

Households maximize (2.9) subject to the budget constraint relevant with the asset configuration, taking wages, dividends, and prices as given. The first-order conditions for households in each country can be written as follows:

$$L_t^i : \frac{C_t^i}{\gamma} = \frac{W_t^i(1 - L_t^i)}{1 - \gamma} \quad (2.12)$$

$$A_t^{ii} : 1 = E_t M_{t+1,t}^i R_t^i \quad (2.13)$$

$$A_t^{ji} : 1 = E_t M_{t+1,t}^i R_t^j \quad (2.14)$$

$$B_t^i : 1 = E_t M_{t+1,t}^i R_t^B \quad (2.15)$$

$$M_{t,t-1}^i \equiv \beta (c_{t-1}^i) \frac{\mu_t^i}{\mu_{t-1}^i}, \text{ where} \quad (2.16)$$

$$: \mu_t^i = [(C_t^i)^{\gamma(1-\sigma)-1} (1 - L_t^i)^{(1-\gamma)(1-\sigma)}] + \varsigma_t^i \eta \omega c_{t-1}^{i(-1-\eta)} \quad (2.17)$$

$$: \varsigma_t^i = E_t \left[\varsigma_{t+1}^i \omega c_{t+1}^{i(-\eta)} + \frac{[(C_{t+1}^i)^\gamma (1 - L_{t+1}^i)^{(1-\gamma)}]^{(1-\sigma)}}{(1 - \sigma)} \right] \quad (2.18)$$

$M_{t,t-1}^i$ is the intertemporal marginal rate of substitution. μ_t is the lagrange multiplier of the budget constraint and ς_t is the lagrange multiplier associated with the internal-

ized endogenous discount factor. An increase in current consumption decreases the discount factor and reduces the period t utility. It could be interpreted as the present discounted value of the utility from period $t + 1$ onwards.

Similarly, firms maximize (2.4) subject to (2.5) and the capital-accumulation equation (2.6). The first-order conditions for firms in each country can be written:

$$L_t^i \quad : \quad W_t^i = (1 - \theta) \frac{Y_t^i}{L_t^i} \quad (2.19)$$

$$\begin{aligned} K_{t+1}^i \quad : \quad & \left(1 + \varphi \left(\frac{K_{t+1}^i}{K_t^i} - e^{\bar{g}} \right) \right) \\ & = E_t \left[\Phi_{t+1,t}^i \left(\begin{array}{c} e^{z_{t+1}^i} \theta (K_{t+1}^i)^{\theta-1} (\Gamma_{t+1}^i L_{t+1}^i)^{1-\theta} \\ + (1 - \delta) + \frac{\varphi}{2} \left(\left(\frac{K_{t+2}^i}{K_{t+1}^i} \right)^2 - (e^{\bar{g}})^2 \right) \end{array} \right) \right] \end{aligned} \quad (2.20)$$

Firms demand labor until cost of one additional unit of labor and marginal product raised due to the additional hire are equalized. They invest in capital until marginal product of capital is equal to marginal cost of investing in an additional unit of capital.

The market-clearing conditions for goods and financial assets are as follows:

$$Y_t^H + Y_t^F = C_t^H + C_t^F + I_t^H + I_t^F \quad (2.21)$$

$$1 = A_t^{HH} + A_t^{HF} \quad (2.22)$$

$$1 = A_t^{FF} + A_t^{FH} \quad (2.23)$$

$$0 = B_t^H + B_t^F \quad (2.24)$$

The supply of equity shares in each country is normalized to unity. International bonds are in zero net supply.

2.3 Analysis

2.3.1 Calibration

The model incorporates a portfolio choice problem to the conventional growth model using recent computational methods. The menu of internationally traded assets consists of home equity, foreign equity and an international risk-free bond. Pairs of countries are identified by symmetry of the the standard deviations of the shocks. In the symmetric model, I assume that both countries receive the same level and growth rate shocks. As asserted by Aguiar and Gopinath (2007), emerging market economies have a different productivity shock composition compared to advanced economies. Following their steps, in the "asymmetric" benchmark calibration of the model, I modify the standard deviations of the shocks in the foreign country (emerging market) such that shocks to level productivity are "less important" and shocks to the growth rate of productivity are "more important". Although, this could be a vital part of a differentiation between an emerging market and an advanced economy, it is by no means complete. Especially, assuming that both countries have the same level of effect on the prices would not be realistic. Therefore, introducing size differences among the countries, as in Mendoza (1995), could be a natural feature to add

Parameter	Value	Description
$\beta(\bar{C})$	0.98	steady state discount factor
γ	0.36	consumption component (utility)
σ	2	risk aversion
η	0.001	elasticity of discount factor
δ	0.05	depreciation rate
θ	0.36	share of capital
λ	0.001	convergence parameter
φ	4	adjustment cost
\bar{g}	0.0055	long-run growth rate

Table 2.2: Baseline model calibration

to the asymmetric version of the model. However, since the nature of this study is more qualitative than quantitative, it is more important to understand what different productivity shock compositions can deliver in terms of cyclicity of portfolio flows, when everything else is constant. One could think of the asymmetric pair of countries as US-E7 or G7-E7, which have similar sizes, but completely different productivity processes.

Table 2.2 summarizes the parameter specifications that are common to both the symmetric and the asymmetric models analyzed. $\beta(\bar{C})$ is the steady state value of the endogenous discount factor in accordance with quarterly data. Using the steady state value of consumption for each country and equating η to 0.001, I pick the proper ω value. The following parameters are specified as in Aguiar and Gopinath (2007). The exponent of consumption in the period utility function, γ , is set to 0.36, such that households spend one-third of their time working in the steady state. The coefficient of relative risk aversion, σ , is set to 2 for both countries. The share of capital in output, θ , is 0.36 and the depreciation rate, δ , is 0.05. The persistence parameters

Symmetric	ρ_z^H	ρ_g^H	ρ_z^F	ρ_g^F	σ_z^H	σ_g^H	σ_z^F	σ_g^F
	0.84	0.56	0.84	0.56	0.0055	0.0042	0.0055	0.0042
Asymmetric	ρ_z^H	ρ_g^H	ρ_z^F	ρ_g^F	σ_z^H	σ_g^H	σ_z^F	σ_g^F
	0.95	0.01	0.95	0.01	0.0088	0.0078	0.0281	0.0048

Table 2.3: Parameter values for productivity processes.

for the two types of productivity shocks are also as in Aguiar and Gopinath (2007). The cross-country convergence parameter for the growth processes, λ , is set at 0.001, and the long run mean growth rate, μ_g , is 0.0055 as in Nguyen (2010).

To assess the impact of different composition of the shocks on the economy and the financial flows, I study two different sets of volatility calibration. The first, "symmetric" calibration, imposes that the countries are similar to each other and both economies receive the same level and growth rate shocks. The persistence and volatility parameters are taken from Nguyen (2010) calibration for U.S. and G-6 countries. Standard deviation of transitory shock is the average of the estimated standard deviations of the shock for U.S. and G-6 countries. In the "asymmetric" specification, the persistence and volatility parameters are taken from Aguiar and Gopinath (2007) estimations for an advanced economy and an emerging market economy. In this second case, I assume that the home is the advanced economy and the foreign is the emerging market economy .

2.3.2 Solution Method

I use lower-case letters to denote detrended variables. For any variable X_t , the detrended variable x_t is defined as follows:

$$x_t = \frac{X_t}{\Gamma_{t-1}}$$

Note that the following variables are already stationary and do not need to be detrended: $A^{ij}, R^i, R^B, R_x, L^i$ for all $i, j = \{H, F\}$.

The solution approach is to take local approximation of the model around the non-stochastic steady state and solve the approximated model for locally accurate decision rules and laws of motion. However, it is well known that in this class of models, the asset holdings A^{ij} are indeterminate in both the non-stochastic steady state and in first-order approximation of the model. I address this challenge by using the solution technique of Devereux and Sutherland (2008) (henceforth, DS). DS show how to characterize asset holdings in a "near-non-stochastic" steady state by examining the implications of a second-order approximation of the households' first-order conditions for asset holdings, together with a first-order approximation of the rest of the model. In a companion paper Devereux and Sutherland (2010a), DS also show how to derive first-order variation in asset holdings ("portfolio dynamics") by looking at higher-order approximations of the model. I apply both techniques, identifying both the near-non-stochastic steady state asset holdings as well as the

first-order portfolio dynamics.

2.3.3 General Equilibrium Dynamics

Figure 2-1 displays the the impulse response of the general economy to the positive 1% level and growth rate productivity shocks, under the symmetric model calibration. When there is positive shock to the home productivity level, output increases. This impact effect is the same under the productivity growth rate shock, however the duration and the persistence of the increase is different across the two shocks. When the shock is transitory, the highest increase in output is achieved right after the shock and the increase dies out eventually following that. Under the growth rate shock, relative home output rises on impact and continues to rise (above the initial impact level) as the shock to the growth rate has effects in output that goes beyond near future.

As a result of the increase in output, home consumption rises relative to foreign country. Note, once again, the difference between the impacts of the two shocks. As the growth rate shock promises an output path that is going to be above the balanced growth path level far into the future, consumption smoothing incentive dictates agents to shift their consumption profile up. In contrast, the relative home consumption profile is roughly unchanged under the transitory shock. Capital and investment increase under both shocks; however the effect is short-lived under the transitory shock. The increase is more significant and lasts longer under the growth

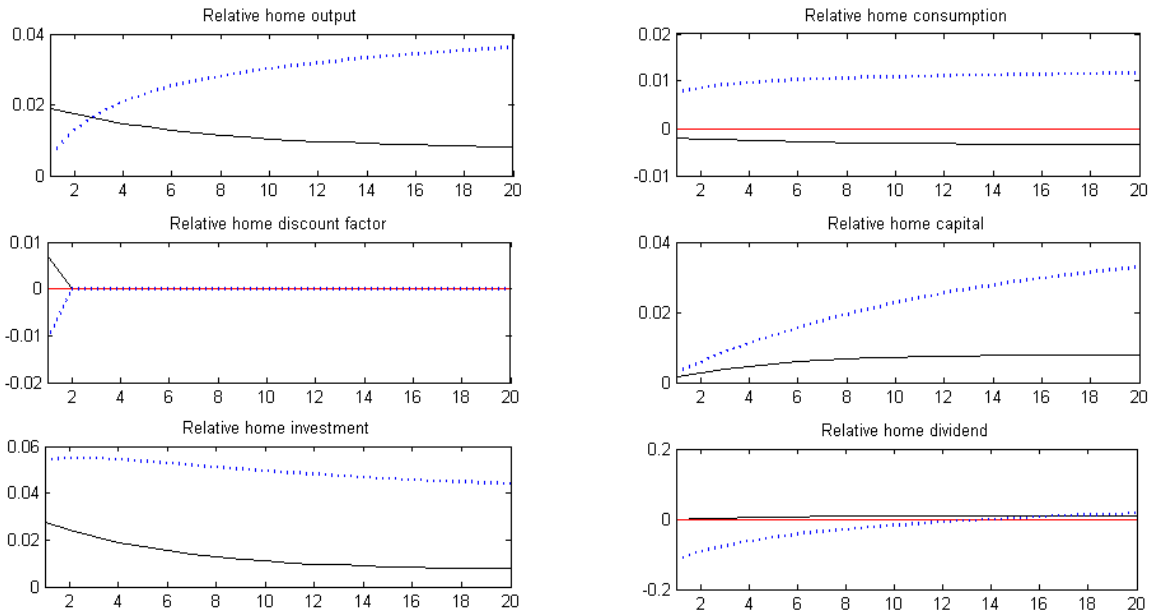


Figure 2-1: IRFs from the symmetric model with positive one standard deviation level and growth rate shock. The black solid line represents responses to the level shock, whereas the blue dashed line represents responses to the growth rate shock.

rate shock, as the investment is a function of expected future productivity.

Another key difference between these two shocks is in terms of their impact on labor supply. Figure 2-2 presents the impulse responses of relative home labor supply, relative home wage rate and relative and labor income. As the output increases, marginal productivity of labor also rises. The resulting wage hike and the gap between the home and foreign country wage rate intensifies when the shock is to the productivity growth rate and the gap shrinks after twenty periods under the transitory shock. Relative home labor income follows a similar path in response to shocks. The increase in wage rate causes the opportunity cost of leisure to increase, pushing the household

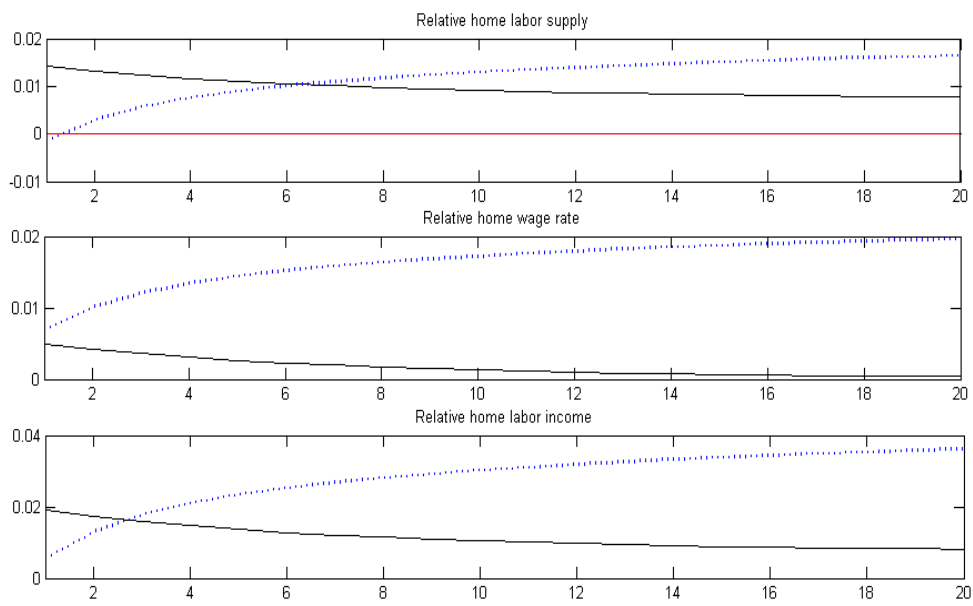


Figure 2-2: IRFs from the symmetric model with positive one standard deviation level and growth rate shock. The black solid line represents responses to the level shock, whereas the blue dashed line represents responses to the growth rate shock.

to work more. Simultaneously, due to the isoelastic preferences in consumption and leisure, an increase in consumption causes a decline in labor supply. When the shock is transitory, since the consumption profile is not altered significantly, the former dominates and relative home labor supply increases. When the shock is permanent, as the relative consumption profile shifts up, the latter effect dominates, causing a decline in the relative home labor supply.

In summary, two results stand out in comparison to transitory increases in productivity. Permanently higher productivity and, thus output, causes upwards shift of consumption profile and induces the income effect to dominate in labor supply choice, causing households to work less. Following the growth shock, investment experiences a prolonged boom. Both of these results imply a much larger and long-lasting increase in domestic absorption after a growth shock in contrast to the limited and short-lived increase experienced after a level shock.

2.3.4 Dynamics of External Financial Positions

The impulse responses displayed in Figure 2-3 are from the symmetric model with 1% standard deviation positive shocks, as in the preceding subsection. Before proceeding to interpret the figures, it is useful to define the measures of portfolio flows the graphics contain. Each asset category (bond vs. equity) is measured in two different ways. The first set of measures identify the changes in the net holdings of the assets. Net foreign equity assets (NEQ) for home country household are defined as the

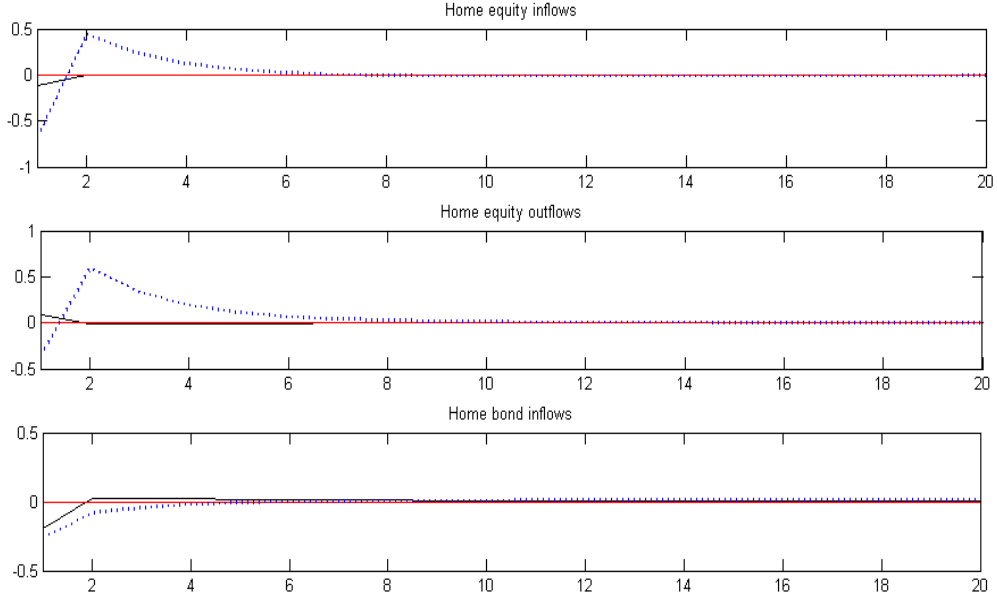


Figure 2-3: IRFs from the symmetric model with positive one standard deviation level and growth rate shocks. The black solid line represents responses to the level shock, whereas the blue dashed line represents responses to the growth rate shock. All variables are represented as a share of GDP.

difference between home holdings of foreign equity (gross foreign equity assets) and foreign holdings of home equity (gross foreign equity liabilities), $(P_t^F A_t^{FH} - P_t^H A_t^{HF})$.

Home net bond assets at the end of period t are $P_t^B B_t^H$. Sum of net foreign equity assets and net bond assets is net foreign assets.

Net equity inflows for home country are defined as $P_t^H(A_t^{HF} - A_{t-1}^{HF})$ and net equity outflows as $P_t^F(A_t^{FH} - A_{t-1}^{FH})$, similar to Evans and Hnatkovska (2005). Debt inflows are measured as $(P_t^B B_t^H - B_{t-1}^H)$. The definitions are similar for the foreign country portfolio flows measures. Foreign country net equity inflows are the foreign

firm equities owned by the home household, $P_t^F(A_t^{FH} - A_{t-1}^{FH})$, net equity outflows are home firm equities purchased by foreign household, $P_t^H(A_t^{HF} - A_{t-1}^{HF})$. Debt inflows are represented by $(P_t^B B_t^F - B_{t-1}^F)$. Note that, home country net equity inflows are equal to foreign country net equity outflows, and, similarly, home bond inflows are equal to foreign bond outflows. For this reason I only discuss bond inflows.

Home current account is specified as $P_t^F(A_t^{FH} - A_{t-1}^{FH}) - P_t^H(A_t^{HF} - A_{t-1}^{HF}) + (P_t^B B_t^H - B_{t-1}^H)$. Comparing the measures of change in net foreign assets and current account, it is understood that they are not equivalent and the difference is the capital gains and losses incurred on the existing holdings from past period due to changes in the asset prices. Those valuation effects are defined as $A_{t-1}^{FH}(P_t^F - P_{t-1}^F) - A_{t-1}^{HF}(P_t^H - P_{t-1}^H) + B_{t-1}^H(P_t^B - P_{t-1}^B)$. Adding the current account and the valuation effects gives the change in net foreign assets, which could equivalently be expressed by adding the change in net foreign equity assets and the change in net bond assets.

The positive transitory shock causes a decline in home equity inflows and an increase in home equity outflows. The transitory productivity hike causes a one-time investment boom. This boom initially causes a decline in dividends, which later increases due to increase in the capital stock. As the home dividend rises slightly above foreign dividend, price of the home firm equity also rises relative to foreign equity price. The relative home dividend overall doesn't change too much in response to the transitory shock. Since the investment boom is short-lived and the home consumption profile stays roughly the same relative to its foreign counterpart, the

increase in domestic absorption is less than the increase in output. So the windfall is saved by investing in the foreign firm equity, which is an attractive hedge against the home productivity shock. Although the net export is in surplus, the bond position is negative meaning that to finance foreign equity purchases they are borrowing in bonds.

At a first glance to the economy dynamics following the growth rate shock, two major differences stand out. First difference between the level and growth rate shocks is that almost all the impact effects are larger for the growth rate shock due to its permanent nature. Second noticeable difference is the plunge in both home equity inflows and outflows on impact. Even after the second period, both equity flows follow a similar pattern up, above their trend level, in contrast to the initial downwards impact. This symmetry in dynamics of equity flows results from the high expected future productivity and the proceeding hike in domestic absorption that were not present under the transitory level shock. Home households still enjoy the hedging potential of foreign equity, while home equity becomes very attractive for foreign households due to its promising future dividend stream. The downward impact effect on home equity outflows stems from the dissaving of home households to finance the consumption profile shift and the investment boom. Equity outflows plunge on impact as foreign households sell their holdings of home equity to realize capital gains due to the increase in the price of home equity.

Specification 1 Symmetric Model	Shocks to			Data
	z	g	z and g	
Correlations with GDP				
$\Delta(\text{Net foreign assets})$	0.11	0.01	-0.02	-0.22
$\Delta(\text{Net foreign equity assets})$	0.16	-0.00	-0.04	-0.02
$\Delta(\text{Net bond assets})$	-0.05	0.01	-0.01	-0.24
Net equity inflows	0.00	-0.02	-0.03	0.10
Net equity outflows	0.09	-0.02	-0.02	-0.03
Net bond inflows	-0.67	0.38	0.26	0.01

Table 2.4: Symmetric model. Data is from Table 4 of Contessi et al. (2009), which show the correlations with log output of different components of portfolio flows. All measures of capital flows are expressed as a share of GDP.

2.3.5 Numerical Results

Tables 2.4 and 2.5 display the predicted correlations for home country and foreign country portfolio flows under both the symmetric and asymmetric parameter specifications. The comparison data for the advanced country change in net foreign assets, net foreign equity assets and bond assets are from Coeurdacier, Kollmann, and Martin (2010) estimates for G7 countries. Data for inflows and outflows are Contessi, De Pace, and Francis (2009) estimates. Since in the asset structure employed here, there is no distinction between foreign direct investment and portfolio equity flows, to find correlations for net equity iflows and outflows, I calculated averages of foreign direct investment and foreign portfolio investment correlations.

The model captures the fact that advanced countries have countercyclical changes in their net foreign assets; that is, as the economy enters a period of high output, net foreign equity and bond holdings decline. I have shown in the previous subsection

that, although level productivity shocks imply improving equity outflows, growth rate shocks result in declines in both inflows and outflows. With only transitory shocks, the model predicts procyclical changes in net foreign assets. The sign of the correlation changes as growth rate shocks are added to the model. In a similar fashion, the model generates countercyclical net equity inflows and outflows. This prediction is consistent with data for net equity outflows, however the correlation coefficient is positive for net equity inflows. The model is successful in terms of matching the sign of the cyclicity for bond flows only when there are also growth rate shocks; however the countercyclicity predicted for change in net bond assets is not strong enough and the correlation coefficient predicted for bond inflows is too strong.

Table 2.5 displays the results for asset inflows and outflows from the asymmetric model. The comparison data values for the emerging market economy are also from 1992-2005 estimates of Contessi, De Pace, and Francis (2009) Table 4. Home country represents the advanced economy, whereas the foreign country represents the emerging market economy. The advanced country predictions are similar to the results from Table 2.4. Emerging market economies experience countercyclical equity inflows, which is matched closely by the model. Similarly, the direction of the cyclicity for bond inflows is generated by the model, only after including the growth rate shocks.

Overall, the model generates countercyclical equity inflows and outflows, along with procyclical bond inflows. The results support the Aguiar and Gopinath (2007) argument that advanced economies and emerging market economies experience dif-

Specification 2 Correlations with GDP	Shocks to			Data
	z	g	z and g	
Advanced				
Net equity inflows	0.01	-0.07	-0.03	0.10
Net equity outflows	0.04	-0.07	-0.00	-0.03
Net bond inflows	0.53	-0.05	0.28	0.01
Emerging				
Net equity inflows	z	g	z and g	Data
Net equity inflows	0.04	-0.07	-0.00	-0.05
Net equity outflows	0.01	-0.07	-0.03	0.04
Net bond inflows	-0.53	0.05	0.55	0.13

Table 2.5: Asymmetric model. Data is from Table 4 of Contessi et al. (2009), which show the correlations with log output of different components of portfolio flows. All measures of capital flows are expressed as a share of GDP.

ferent combinations of transitory and permanent shocks. The transitory shock model predictions are more consistent with the observed cycles for advanced economy net foreign equity inflows. I have also established that predictions for GDP correlations of portfolio asset flows are remarkably different across different combinations of shocks, making differentiation and examination of growth rate shocks versus transitory shocks a necessary and useful improvement in the study of international portfolio flows, especially between emerging markets and advanced economies.

2.4 Conclusion

This paper studied the time varying portfolio flows and their cyclical properties in the presence of productivity growth rate shocks. Growth shocks seem to play an important role in terms of influencing the direction of financial flows. Different stochastic

properties of shocks affect the choice of whether to lend or borrow, as well as the preferences of agents in terms of assets chosen to carry out lending and borrowing. Future work calls for a finer parameter calibration and estimation of the model for particular country cases.

Imposing observed home equity bias in contrast to the foreign equity bias present in this study is required to achieve more realistic results. Although various shocks such as demand shocks, fiscal shocks and investment efficiency shocks started to take their place alongside productivity shocks recently, most efforts are limited to the analysis of equilibrium portfolio allocations. Complementary analysis of time-varying portfolio flows would benefit economic literature tremendously. Specifically, in forming economic policy relating to external accounts, understanding patterns and determinants of portfolio flows play a crucial role.

2.5 Appendix

2.5.1 Equilibrium Conditions of the Normalized Model

Let $u_{c^H,t} = \frac{\partial U(c_t^H, l_t^H)}{\partial c_t^H}$ and $m_{t,t-1}^H = \beta(c_{t-1}^H) \frac{u_{c^H,t}}{u_{c^H,t-1}} = \beta(c_{t-1}^H) \frac{(c_t^H \gamma (1-l_t^H)^{1-\gamma})^{1-\sigma}}{(c_{t-1}^H \gamma (1-l_{t-1}^H)^{1-\gamma})^{1-\sigma}} \frac{c_{t-1}^H}{c_t^H} \left(\frac{A_{t-1}^H}{A_{t-2}^H} \right)^{\gamma(1-\sigma)} = \beta(c_{t-1}^H) \frac{(c_t^H \gamma (1-l_t^H)^{1-\gamma})^{1-\sigma}}{(c_{t-1}^H \gamma (1-l_{t-1}^H)^{1-\gamma})^{1-\sigma}} \frac{c_{t-1}^H}{c_t^H} \left(e^{g_{t-1}^H} \right)^{\gamma(1-\sigma)}$.

Home households' budget constraint and first-order conditions:

$$c_t^H + nfa_t^H = w_t^H l_t^H + \frac{R_t^B nfa_{t-1}^H}{e^{g_{t-1}^H} \pi_{t-1}^\lambda} + d_t^H + \frac{R'_{x,t} \tilde{\alpha}_{t-1}}{e^{g_{t-1}^H} \pi_{t-1}^\lambda}$$

$$l_t : \frac{c_t^H}{\gamma} = \frac{w_t^H (1-l_t^H)}{1-\gamma}$$

$$nfa_t : 1 = E_t m_{t+1,t}^H R_{t+1}^H$$

$$\alpha_t : E_t m_{t+1,t}^H R_{t+1}^F = E_t m_{t+1,t}^H R_{t+1}^H$$

Home country firms' budget constraint and first-order conditions

$$d_t^H = y_t^H - w_t^H l_t^H - (k_{t+1}^H e^{g_t^H} \pi_t^\lambda - (1-\delta)k_t^H) - \frac{\varphi}{2} \left(\frac{k_{t+1}^H}{k_t^H} e^{g_t^H} \pi_t^\lambda - e^{\bar{g}} \right)^2 k_t^H$$

$$\begin{aligned}
l_t^H & : w_t^H = (1 - \theta) \frac{y_t^H}{l_t^H} \\
k_{t+1}^H & : \left(1 + \varphi \left(\frac{k_{t+1}^H}{k_t^H} e^{g_t^H} \pi_t^\lambda - e^{\bar{g}} \right) \right) \\
& = E_t \left[m_{t+1,t}^H \left(\begin{aligned} & e^{z_{t+1}^H} \theta k_{t+1}^{H\theta-1} l_{t+1}^{H \ 1-\theta} \left(e^{g_{t+1}^H} \right)^{1-\theta} \\ & + 1 - \delta + \frac{\varphi}{2} \left(\left(\frac{k_{t+2}^H}{k_{t+1}^H} e^{g_{t+1}^H} \pi_{t+1}^\lambda \right)^2 - (e^{\bar{g}})^2 \right) \end{aligned} \right) \right]
\end{aligned}$$

Market clearing conditions:

$$\begin{aligned}
y_t^H + y_t^F & = c_t^H + c_t^F + (k_{t+1}^H e^{g_t^H} \pi_t^\lambda - (1 - \delta) k_t^H) + (k_{t+1}^F e^{g_t^F} \pi_t^\lambda - (1 - \delta) k_t^F) \\
& \quad + \frac{\varphi}{2} \left(\frac{k_{t+1}^H}{k_t^H} e^{g_t^H} \pi_t^\lambda - e^{\bar{g}} \right)^2 k_t^H + \frac{\varphi}{2} \left(\frac{k_{t+1}^F}{k_t^F} e^{g_t^F} \pi_t^\lambda - e^{\bar{g}} \right)^2 k_t^F
\end{aligned}$$

$$\left[R_{t+1}^H = \frac{(p_{t+1}^H + d_{t+1}^H)}{p_t^H} e^{g_t^H} \pi_t^\lambda \quad R_{t+1}^F = \frac{(p_{t+1}^F + d_{t+1}^F)}{p_t^F} e^{g_t^F} \pi_t^\lambda \quad R_{t+1}^B = \frac{1}{p_t^B} \right]$$

$$0 = b_t^H + b_t^F$$

$$1 = A_t^{HH} + A_t^{HF}$$

$$1 = A_t^{FH} + A_t^{FF}$$

$$nfa_t^H + nfa_t^F = 0$$

$$\tilde{\alpha}_t^H + \tilde{\alpha}_t^F = p_t^F$$

Chapter 3

Current Account Dynamics, Valuation Effects, and Nontradable Goods

3.1 Introduction

Since the beginning of the last recession, the U.S. is no longer borrowing from abroad at an accelerating pace. After peaking at 6% of GDP in 2006, the U.S. current account deficit declined steadily over the next three years, to 2.7% of GDP in 2009. This contrasts with ballooning external deficits during the major expansions of 1997–2000 and 2001–2006. A broader look at the data confirms this pattern: the U.S. current account balance has generally deteriorated during expansions and improved

during recessions (see Figure 3-1).

This paper analyzes the link between macroeconomic shocks and the current account in an open economy macro model. Of the shocks considered, transitory shocks to the nontradable goods sector fit the U.S. pattern most closely. The importance of changes in labor productivity in the nontradable sector to the total productivity of the country is documented. For example, Guerrieri, Henderson, and Kim (2005) present a thorough assessment of sectoral breakdown of 1990's U.S. labor productivity from alternative data sources and claim that all measurements confirm the significance of the advancement of labor productivity in the nontradable sector during the expansion in that decade. Productivity changes in nontradable goods sector are also known to impact external accounts of countries. Cova, Pisani, Batini, and Rebucci (2008) show that productivity developments in advanced countries and specifically the productivity increase in the nontradable sector in U.S. are one of the major reasons of the worsening U.S. trade balance since 1998.

Current account deficits reduce a country's net foreign assets. However, the international macroeconomics literature over the past decade has highlighted a second important determinant of net foreign assets: valuation effects.¹ Valuation effects capture the change in market value of a country's (existing) gross foreign assets, less the change in value of (existing) foreign liabilities. These capital gains and losses, in turn, stem from changes in asset prices and exchange rates. Gourinchas and Rey

¹See, for example, Lane and Milesi-Ferretti (2007), Gourinchas and Rey (2007), and Devereux and Sutherland (2010b).

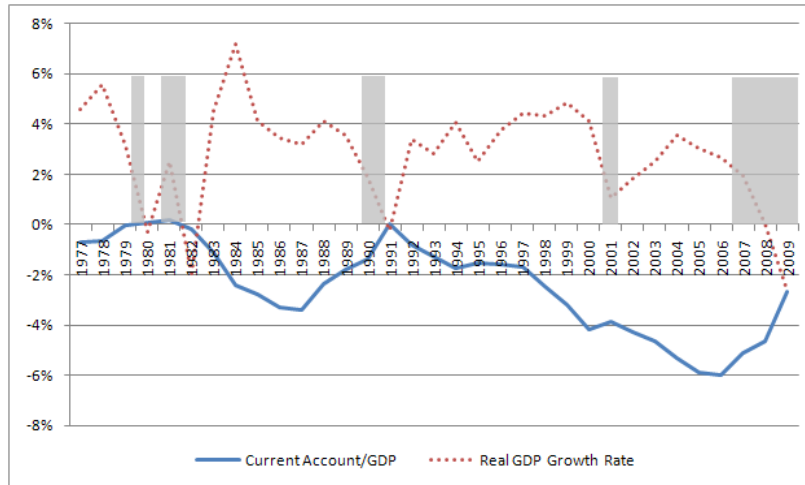


Figure 3-1: U.S. current account balance as a share of GDP, plotted alongside the growth rate of U.S. real GDP. Shaded bars indicate NBER recessions.

(2007) find that for the U.S., valuation effects are large and tend to mitigate cyclical changes in the current account. To analyze net foreign assets more broadly, our model incorporates international portfolio choice, which in turn yields meaningful valuation effects. Temporary shocks to the nontradable goods sector generate valuation effects that move inversely with the current account, consistent with Gourinchas and Rey (2007).

A two-country, four-good open economy macroeconomic model is analyzed. Each country is endowed with a time-varying supply of tradable and nontradable goods. Households like to consume “baskets” of domestic and foreign tradable goods, as well as domestic nontradable goods. Following Hnatkovska (2010), households view nontradable goods and tradable baskets as complements, but they view home and foreign tradable goods as substitutes within the tradable baskets. Loosely speaking,

U.S. households like to consume houses and furniture together, but they choose between U.S.-manufactured and foreign-manufactured furniture based on price. When the prices of home and foreign tradable goods are the same, households tilt their consumption towards domestic tradable goods (consumption home bias). Crucially, financial markets are incomplete. Households in both countries trade equity claims to the two tradable endowments, but they cannot trade claims to the nontradable endowments. This arrangement leads to nonzero capital flows and time variation in the relative welfare of each country.

Three types of country-specific shocks are considered: transitory shocks to the tradable endowment, transitory shocks to the nontradable endowment, and trend shocks that affect both endowments. The transitory shocks are persistent but temporary (AR(1)), while the trend shocks are permanent. Recent advances in international macroeconomics suggest the importance of modeling a stochastic trend. In particular, Aguiar and Gopinath (2007) show that a trend shock to total factor productivity can generate a countercyclical current account in a small open economy production model, but a transitory shock cannot. In our model, a positive trend shock does generate a current account deficit. Together with our specification for preferences, trend shocks yield another desirable feature: equity home bias. In particular, in the long run, households hold more than half of their financial wealth in the domestic equity.

In response to a positive, transitory shock to its tradable good endowment, the

home country runs a current account surplus and experiences large negative valuation effects. In response to a positive, transitory shock to its nontradable good endowment, the home country runs a current account deficit. At the same time, the home country experiences a positive valuation effect that partially (but not completely) offsets the deficit. The intuition for these results is as follows. Home tradable and nontradable goods are complements, so an increase in the supply of nontradable goods (“nontradables”) increases home’s demand for home tradable goods (“tradables”). Because this demand is relatively inelastic, the price of home tradables must rise a lot, increasing home’s desired consumption expenditures. Due to incomplete risk-sharing, home’s income does not rise by the full amount of desired consumption expenditures, and home’s marginal utility exceeds the marginal utility abroad. However, because the shock is transitory, home’s situation is expected to improve next period. As a result, home households smooth consumption by borrowing. In the model, the only vehicle for saving and borrowing is via foreigners, so the home country runs a current account deficit. The offsetting positive valuation effect stems from a small decline in the relative price of the home equity, which reduces the value of home’s foreign liabilities.

This study contributes to the theoretical literature on net foreign assets and valuation effects. Important work in this literature include Devereux and Sutherland (2010b), Ghironi, Lee, and Rebucci (2009), and Coeurdacier, Kollmann, and Martin (2010). Relative to these, the analysis here adds investigation of productivity shocks

in nontradable good sector and trend shocks. In a small open economy model, Aguiar and Gopinath (2007) show that trend and transitory shocks can have opposing effects on the current account. Their approach is extended to a two-country model and used to analyze a large open economy (the U.S.). Nguyen (2010) contrasts the effects of transitory and trend shocks on the current account in a two-country production model. However, his model features a single tradable good and no nontradable sector. In the model analyzed in this study, nontradable goods are key to generating a countercyclical current account.

The structure for preferences is similar to Hnatkovska (2010); however, her paper does not consider trend shocks. The focus is also different: Hnatkovska (2010) seeks to explain the low level and high volatility of cross-border equity holdings, while here focus is on the cyclical properties of the current account and valuation effects. In terms of methodology, the solution approach described in Devereux and Sutherland (2010a) is used to solve for equilibrium portfolios (up to first-order accuracy) under incomplete markets.²

The rest of the chapter proceeds as follows. Section 3.2 describes the model. Section 3.3 discusses calibration and presents results in the form of impulse response functions. Section 3.4 concludes.

²Tille and Van Wincoop (2010) and Evans and Hnatkovska (2007) develop alternative techniques to solve for equilibrium portfolios with incomplete markets.

3.2 Model

The model is a two-country, four-good endowment economy with trend and transitory endowment shocks. Denote the countries as “home” (H) and “foreign” (F).

3.2.1 Endowments

Each country is endowed with stochastic streams of two perishable goods: a tradable good (T) and a nontradable good (N). The endowments of tradable and nontradable goods in country $i \in \{H, F\}$ are given by:

$$y_t^{i,T} = e^{z_t^{i,T}} \Gamma_t^i \quad (3.1)$$

$$y_t^{i,N} = e^{z_t^{i,N}} \Gamma_t^i \quad (3.2)$$

where $z_t^{i,T}$ and $z_t^{i,N}$ are AR(1) processes affecting the endowments of tradable and nontradable goods, respectively, in country i . Γ_t^i is a cumulative growth process that affects the endowments of both tradable and nontradable goods in country i . The stochastic endowment processes have two components: trend and transitory shocks. The first component is an AR(1) process (z) and it represents the transitory changes in the level of the endowment. The second component is the cumulative product of growth rate shocks (Γ) and it represents transitory changes to the growth rate of the endowment, which in turn implies permanent changes in the level of the endowment.

The Γ processes are defined recursively as follows:

$$\Gamma_t^H = \Gamma_{t-1}^H e^{g_t^H} \pi_t^\lambda \quad (3.3)$$

$$\Gamma_t^F = \Gamma_{t-1}^F e^{g_t^F} \pi_t^{-\lambda} \quad (3.4)$$

Certain restrictions on preferences and technology are sufficient for the existence of balanced growth path in small open economy models with trend growth. However, in a two-country model framework, additional restriction pertaining to the countries' total factor productivity (TFP) processes are needed. In particular, the ratio of the TFP levels across countries has to be stationary.³ Here, π_t is a convergence process, defined as in Nguyen (2010), which keeps track of the ratio of the growth rate shocks and guarantees that it converges to one in the long run. The speed of convergence depends on the choice of parameter λ .⁴ π_t is defined as follows:

$$\pi_t \equiv \frac{\Gamma_{t-1}^F}{\Gamma_{t-1}^H} = e^{g_{t-1}^F - g_{t-1}^H} \pi_{t-1}^{1-2\lambda} \quad (3.5)$$

$z_t^{i,T}$, $z_t^{i,N}$, and g_t^i evolve as follows:

³See Rabanal, Rubio-Ramirez and Tuesta (2009) for further information on cointegration of productivity processes in two-country models.

⁴When $\lambda > 0$, the convergence process π_t makes the endowment processes cointegrated across countries, which keeps the model stationary. A small λ means long convergence.

$$z_t^{i,T} = \rho_z z_{t-1}^{i,T} + \epsilon_t^{z,i,T} \quad (3.6)$$

$$z_t^{i,N} = \rho_z z_{t-1}^{i,N} + \epsilon_t^{z,i,N} \quad (3.7)$$

$$g_t^i = (1 - \rho_g) \bar{g} + \rho_g g_{t-1}^i + \epsilon_t^{g,i} \quad (3.8)$$

where \bar{g} is the (common) long-run growth rate of the endowment. ϵ_t , defined below, is a vector of iid, mean-zero shocks with variance-covariance matrix Σ .

$$\epsilon_t \equiv (\epsilon_t^{z,H,T}, \epsilon_t^{z,F,T}, \epsilon_t^{z,H,N}, \epsilon_t^{z,F,N}, \epsilon_t^{g,H}, \epsilon_t^{g,F})'$$

$\epsilon_t^{z,i,T}$ and $\epsilon_t^{z,i,N}$ are “transitory” shocks, and $\epsilon_t^{g,i}$ is a “trend” shock.

3.2.2 Asset Markets

Households can trade two equity securities internationally. Each equity’s net supply is normalized to 1. The equity issued by country i is a claim to the future stream of the *tradable* good originating in country i . Let $p_t^{T,i}$ denote the price of the tradable good originating in country i , and let q_t^i be the ex-dividend price of the equity issued by country i . All prices, asset holdings, and returns are expressed in terms of a numeraire, to be defined shortly. The return on the equity issued by country i , r_t^i , is given by:

$$r_t^i = \frac{q_t^i + p_t^{T,i} y_t^{i,T}}{q_{t-1}^i} \quad (3.9)$$

3.2.3 Households

There is a unit mass of households in each country. Households within a country are all identical, but preferences vary across countries. Households' preferences in country i depend on a two-tiered, country-specific consumption index, as in Hnatkovska (2010):

$$c_t^i = \left[\omega_T^{\frac{1}{\psi}} \left(c_t^{i,T} \right)^{\frac{\psi-1}{\psi}} + (1 - \omega_T)^{\frac{1}{\psi}} \left(c_t^{i,N} \right)^{\frac{\psi-1}{\psi}} \right]^{\frac{\psi}{\psi-1}} \quad (3.10)$$

$$c_t^{i,T} = \left[\omega_D^{\frac{1}{\phi}} \left(c_t^{i,T,i} \right)^{\frac{\phi-1}{\phi}} + (1 - \omega_D)^{\frac{1}{\phi}} \left(c_t^{i,T,j} \right)^{\frac{\phi-1}{\phi}} \right]^{\frac{\phi}{\phi-1}} \quad (3.11)$$

for $i \in \{H, F\}$ and $i \neq j$. The top-level index, c^i , is a CES bundle of domestic nontradable goods, $c^{i,N}$, and a basket of tradable goods, $c^{i,T}$. The basket of tradable goods, in turn, is a CES bundle of domestic tradable goods, $c^{i,T,i}$, and foreign tradable goods, $c^{i,T,j}$. The notation $c^{i,T,j}$ refers to country i 's consumption of the tradable good originating in country j , and $c^{i,N}$ refers to country i 's consumption of its own nontradable good. ψ is the elasticity of substitution between domestic nontradable goods and the basket of tradable goods, and ϕ is the elasticity of substitution between domestic and foreign tradable goods. As in Hnatkovska (2010), preferences over tradable goods

exhibit consumption home bias. $\omega_D > 0.5$ is the weight that households place on the domestic tradable good within the basket of tradable goods, and ω_T is the weight that households place on the tradable basket within the top-level consumption index.

A representative household in country i solves the following problem:

$$\begin{aligned} \max E_t \left[\sum_{j=0}^{\infty} \beta_{t+j}^i \frac{1}{1-\gamma} (c_{t+j}^i)^{1-\gamma} \right] \\ \text{s.t. } \alpha_t^{i,H} + \alpha_t^{i,F} = \alpha_{t-1}^{i,H} r_t^H + \alpha_{t-1}^{i,F} r_t^F + p_t^{N,i} y_t^{i,N} - p_t^{i,c} c_t^i \end{aligned} \quad (3.12)$$

for $i \in \{H, F\}$. γ is the coefficient of relative risk aversion. $\alpha_t^{i,j}$ denotes the market value of country i 's holdings of the j -issued equity at the start of period t .⁵ $p_t^{N,i}$ is the price of domestic nontradable goods, and $p_t^{i,c}$ is the consumer price index in country i . It is convenient to define country i 's financial wealth at the start of period t : $w_t^i \equiv \alpha_t^{i,H} + \alpha_t^{i,F}$. The budget constraint for country i can then be rewritten as follows:

$$w_t^i = w_{t-1}^i r_t^F + \alpha_{t-1}^{i,H} (r_t^H - r_t^F) + p_t^{N,i} y_t^{i,N} - p_t^{i,c} c_t^i \quad (3.13)$$

The preference parameters discussed so far are assumed to be the same across

⁵That is, $\alpha_t^{i,j}$ equals the number of shares of j -issued equity held by country i , times the price per share.

countries. To avoid random walk in model dynamics, an endogenous discount factor specific to country i , β_t^i , is used, as in Schmitt-Grohé and Uribe (2003) and Devereux and Sutherland (2008). As the rate of impatience rises with the level of aggregate consumption, a stationary consumption distribution is possible.⁶ It is defined recursively as follows:

$$\beta_t^i = \beta_{t-1}^i \cdot \chi \left(\frac{C_{t-1}^{i,A}}{\Gamma_{t-2}^H} \right)^{-\eta} \quad (3.14)$$

The A superscript denotes aggregate consumption, which households take as given. Consumption is detrended by the cumulative productivity growth from previous period (Γ_{t-2}^H).

3.2.4 Price Indices and Numeraire

The consumer price index in each country, $p_t^{i,c}$, is given by:

$$p_t^{i,c} = \left[\omega_T \left(p_t^{i,T} \right)^{1-\psi} + (1 - \omega_T) \left(p_t^{N,i} \right)^{1-\psi} \right]^{\frac{1}{1-\psi}} \quad (3.15)$$

$p_t^{i,T}$ is the price index of the basket of tradable goods consumed by country i , given by:

⁶When $\eta > 0$, the endogenous discount factor keeps the (detrended) model stationary; see Schmitt-Grohé and Uribe (2003) for details.

$$p_t^{i,T} = \left[\omega_D \left(p_t^{T,i} \right)^{1-\phi} + (1 - \omega_D) \left(p_t^{T,-i} \right)^{1-\phi} \right]^{\frac{1}{1-\phi}} \quad (3.16)$$

Because of consumption home bias in tradable goods, $p_t^{i,T}$ will vary across countries.⁷

The numeraire is an equally-weighted geometric average of the home and foreign consumer price indices:

$$\left(p_t^{H,c} \right)^{\frac{1}{2}} \left(p_t^{F,c} \right)^{\frac{1}{2}} = 1 \quad (3.17)$$

3.2.5 Market Clearing

Goods market-clearing requires:

$$c_t^{i,T,i} + c_t^{-i,T,i} = y_t^{i,T} \quad (3.18)$$

$$c_t^{i,N} = y_t^{i,N} \quad (3.19)$$

Since equities are in unitary net supply, asset market-clearing requires:

⁷Note that $p_t^{i,T}$ and $p_t^{T,i}$ are different variables. $p_t^{i,T}$ is the price index of the *basket* of tradable goods that country i consumes; $p_t^{T,i}$ is the price of the tradable good originating in country i .

$$\alpha_t^{i,i} + \alpha_t^{-i,i} = q_t^i \quad (3.20)$$

3.2.6 First-Order Conditions

The first-order conditions (one set for each country) can be written as follows:

$$\frac{c_t^{i,N}}{c_t^{i,T}} = \frac{1 - \omega_T}{\omega_T} \left(\frac{p_t^{i,T}}{p_t^{N,i}} \right)^\psi \quad (3.21)$$

$$\frac{c_t^{i,T,-i}}{c_t^{i,T,i}} = \frac{1 - \omega_D}{\omega_D} \left(\frac{p_t^{T,i}}{p_t^{T,-i}} \right)^\phi \quad (3.22)$$

$$E_t \left[\chi \left(\frac{c_t^{i,A}}{\Gamma_{t-1}^H} \right)^{-\eta} \cdot (c_{t+1}^i)^{-\gamma} (p_{t+1}^{i,c})^{-1} r_{t+1}^F \right] = (c_t^i)^{-\gamma} (p_t^{i,c})^{-1} \quad (3.23)$$

$$E_t \left[(c_{t+1}^i)^{-\gamma} (p_{t+1}^{i,c})^{-1} r_{t+1}^H \right] = E_t \left[(c_{t+1}^i)^{-\gamma} (p_{t+1}^{i,c})^{-1} r_{t+1}^F \right] \quad (3.24)$$

3.2.7 Current Account and Net Foreign Assets

The home country's current account balance can be written as follows:

$$ca_t^H = p_t^{T,H} c_t^{F,T,H} - p_t^{T,F} c_t^{H,T,F} + \left(\frac{\alpha_{t-1}^{H,F}}{q_{t-1}^F} \right) p_t^{T,F} y_t^{F,T} - \left(\frac{\alpha_{t-1}^{F,H}}{q_{t-1}^H} \right) p_t^{T,H} y_t^{H,T} \quad (3.25)$$

The first two terms on the right-hand side of (3.25) are the home country's trade

balance. The second two terms are the home country's net dividend income (dividends received from home holdings of the foreign equity, minus dividends paid on foreign holdings of the home equity). Home's valuation effect is defined as the capital gain on home's (existing) gross foreign assets, minus the capital gain on home's (existing) foreign liabilities:

$$ve_t^H = \frac{\alpha_{t-1}^{H,F}}{q_{t-1}^F} (q_t^F - q_{t-1}^F) - \frac{\alpha_{t-1}^{F,H}}{q_{t-1}^H} (q_t^H - q_{t-1}^H) \quad (3.26)$$

The home country's net foreign assets are equal to home's gross foreign assets minus home's foreign liabilities:

$$nfa_t^H = \alpha_t^{H,F} - \alpha_t^{F,H} \quad (3.27)$$

It is straightforward to show that the change in net foreign assets must equal the sum of the current account balance and the valuation effect:

$$\Delta nfa_t^H \equiv nfa_t^H - nfa_{t-1}^H = ca_t^H + ve_t^H \quad (3.28)$$

3.2.8 Relative Prices and Stochastic Discount Factors

The following relative prices are also analyzed. The home country's terms of trade is defined as the price of the home country's exports (home tradable good) divided by the price of its imports (foreign tradable good):

$$tot_t = \frac{p_t^{T,H}}{p_t^{T,F}} \quad (3.29)$$

The home country's real exchange rate is defined as the price of a consumption basket in the home country divided by the price of a consumption basket in the foreign country:

$$rer_t = \frac{p_t^{H,C}}{p_t^{F,C}} \quad (3.30)$$

Define the stochastic discount factor for country i as follows:

$$m_t^i = \chi \left(\frac{c_{t-1}^i}{\Gamma_{t-2}^H} \right)^{-\eta} \left(\frac{c_t^i}{c_{t-1}^i} \right)^{-\gamma} \left(\frac{p_t^{i,C}}{p_{t-1}^{i,C}} \right)^{-1} \quad (3.31)$$

Under this definition, one can think of $E_t[m_{t+1}^i]$ as the price, in country i , of a hypothetical risk-free bond delivering one unit of the numeraire next period. The ratio

of (realized) stochastic discount factors is a useful measure of equilibrium risk-sharing across countries:

$$m_t^{H,F} = \frac{m_t^H}{m_t^F} \tag{3.32}$$

The Appendix explains how the model is detrended, formally defines the equilibrium, and briefly discusses the solution approach, which is based on Devereux and Sutherland (2010a).

3.3 Results

3.3.1 Calibration

Table 3.1 summarizes the baseline calibration of the model. Most of the parameter values are borrowed from Hnatkovska (2010) or Nguyen (2010). The calibration represents the U.S. versus the rest of the world. Countries are assumed to be symmetric. Following Hnatkovska (2010), nontradable goods and tradable baskets are complements, while home and foreign tradable goods are substitutes within the tradable baskets. The elasticity of substitution between home and foreign tradable goods (ϕ) is 1.1, and the elasticity of substitution between nontradable and tradable goods (ψ) is 0.74. The households' weight on tradable baskets (ω_T) is 0.5, and the weight on domestic goods within the tradable baskets (ω_D) is 0.72, also following Hnatkovska

(2010).

Following Nguyen (2010), the long-run growth rate (\bar{g}) is set to 0.0055, the persistence of the transitory shocks (ρ_z) to 0.84, the persistence of the trend shocks (ρ_g) to 0.56, and the standard deviation of the trend shocks to 0.0042. The standard deviation of the transitory shocks is 0.0055 for both tradable and nontradable endowments. This value is about halfway between the estimated standard deviations of transitory shocks to output for the U.S. and the rest of the world, as reported in Nguyen (2010). Given these parameters, the coefficient of relative risk aversion (γ) is calibrated to generate a near-non-stochastic steady state portfolio (NNSS) in which 75% of households' wealth is allocated to the domestic equity and 25% to the foreign equity.⁸ The coefficient that generates this split is 1.07. Finally, in the baseline calibration, the convergence parameters η and λ are equal to 0.001.

Next, impulse response functions to the three types of shocks in the model are analyzed: transitory shocks to the tradable endowment, transitory shocks to the nontradable endowment, and common trend shocks to both endowments. Only the results for home country are examined. Similar results hold for the foreign country, due to symmetry.

⁸The NNSS portfolio reflects the exact portfolio in a world with an arbitrarily small amount of stochastic noise. See (Devereux and Sutherland 2010a) for details.

Parameter	Value	Description
ψ	0.74	Elasticity of substitution between T/N goods
ϕ	1.1	Elasticity of substitution between H/F goods
ω_T	0.5	Consumption weight on tradable baskets
ω_D	0.72	Consumption weight on domestic tradables
γ	1.07	Coefficient of relative risk aversion
χ	0.99	Discount factor
\bar{g}	0.0055	Long-run growth rate
ρ_z	0.84	Persistence of transitory shocks
ρ_g	0.56	Persistence of trend shocks
$\sigma_{z,t}$	0.0055	Std dev of transitory, tradable shocks
$\sigma_{z,n}$	0.0055	Std dev of transitory, nontradable shocks
σ_g	0.0042	Std dev of trend shocks
η	0.001	Convergence parameter for endogenous discount factor
λ	0.001	Convergence parameter for trend shocks

Table 3.1: Baseline calibration.

3.3.2 Transitory Shocks to the Tradable Good Endowment

Figure 3-2 shows impulse responses to a positive, one standard deviation shock to the tradable endowment in the home country ($\epsilon_t^{z,H,T}$). The home country runs a current account surplus on impact that declines monotonically to zero over time. On impact, the valuation effect on home's net foreign assets is sharply negative – more than offsetting the current account surplus. As a result, home's net foreign assets temporarily fall. However, starting next period, the home country's valuation effect is positive, declining monotonically to zero over time. So after the first period, the positive valuation effect reinforces the current account surplus, and net foreign assets rise. In the long run, net foreign assets are permanently higher – even though the original shock was transitory.

The impulse responses in Figure 3-3 provide additional insight into the effects of the shock. The increased supply of home tradable goods causes home's terms-of-trade (price of exports divided by price of imports) to fall. Home's real exchange rate, which is the price of a consumption basket at home divided by the price of a consumption basket abroad, also falls. Crucially, because markets are incomplete, the two countries are unable to completely share the risk associated with the shock. In this case, home's realized stochastic discount factor drops below its foreign counterpart for one period; this corresponds to an unexpected increase in the relative consumption index at home.⁹

In this model, capital investment is zero, so one can think of the current account balance as a country's national saving. To understand the effect of the tradable endowment shock on the current account, it's useful to imagine how the home country would react in the absence of *any* financial assets. Since the shock is transitory, home's income and consumption (relative to trend) would fall next period. In the absence of any saving instruments, home's *expected* stochastic discount factor would be high, reflecting a pent-up desire to smooth consumption by transferring some income from the present to the future. When asset trade is introduced, the home country becomes a net saver: i.e., it runs a current account surplus.

The sharp fall in home's valuation effect on impact is the result of a stock market

⁹Note that there is an inverse relationship between today's consumption and the *realized* stochastic discount factor. If financial markets were effectively complete, then (the logarithm of) the ratio of realized stochastic discount factors would always be zero.

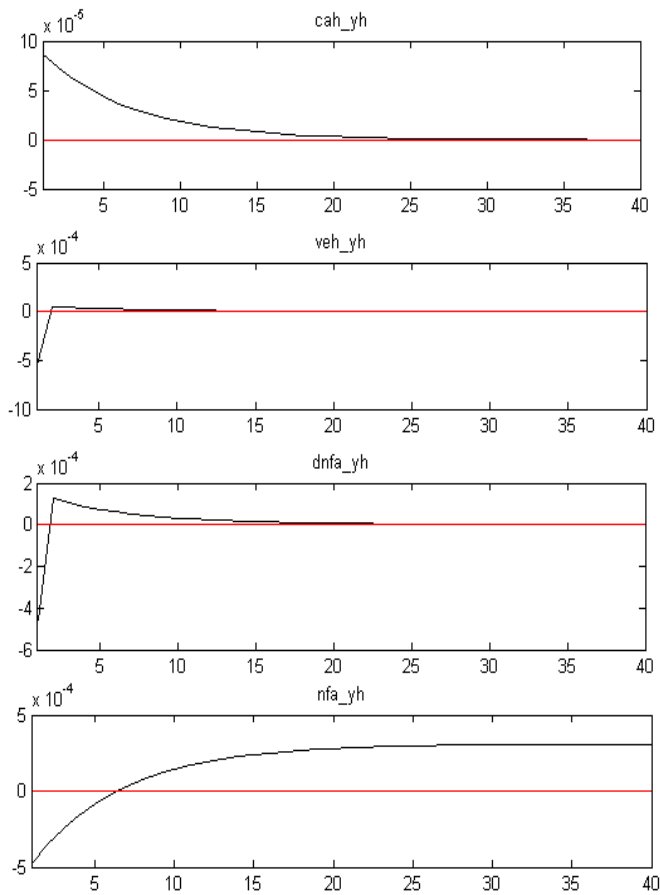


Figure 3-2: Impulse responses to a positive, one standard deviation shock to the tradable endowment in the home country ($\epsilon_t^{z,H,T}$). *cah_yh* is the home country's current account balance, *veh_yh* is the valuation effect on the home country's net foreign assets, *dnfa_yh* is the change in the home country's net foreign assets, and *nfa_yh* is the level of the home country's net foreign assets. All are expressed as shares of home country output (tradable plus nontradable endowment).

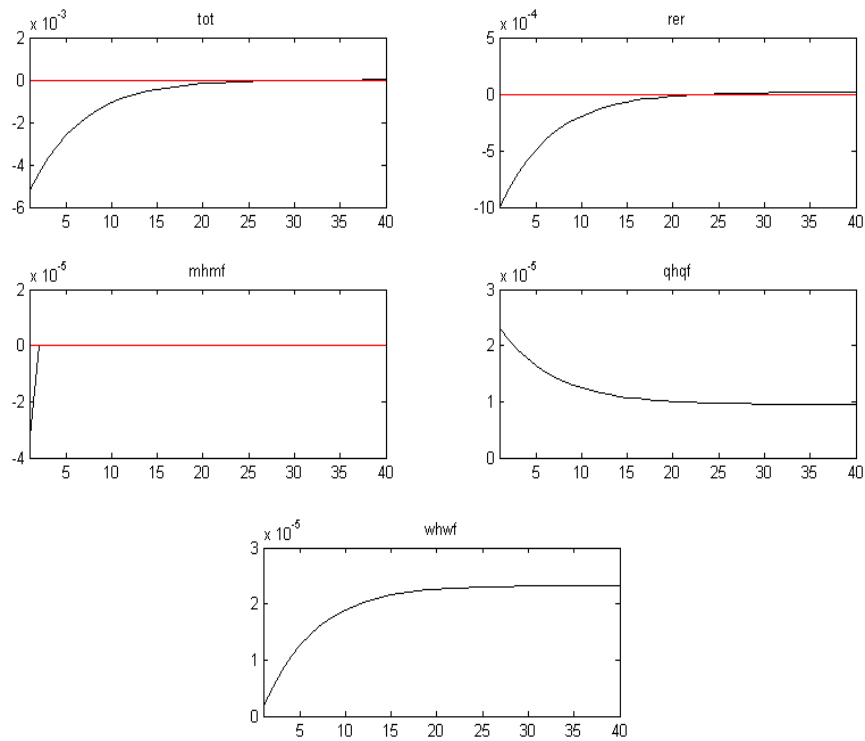


Figure 3-3: Impulse responses to a positive, one standard deviation shock to the tradable endowment in the home country ($\epsilon_t^{z,H,T}$). *tot* is the home country's terms-of-trade (price of exports divided by price of imports), *rer* is the home country's real exchange rate (price of a consumption basket in the home country divided by price of a consumption basket in the foreign country), *mhmf* is home's realized stochastic discount factor divided by the foreign realized stochastic discount factor, *qhqt* is the price of the home equity divided by the price of the foreign equity, and *whwf* is home's financial wealth divided by foreign financial wealth.

boom in the home country. In response to the positive shock, the expected capitalized stream of future dividends is higher for the home equity than for the foreign equity, which drives up the relative home equity price. This, in turn, drives up the value of home's foreign liabilities – that is, the value of home equity held by foreign households. After the first period, home's valuation effect becomes slightly positive, which is attributable to the gradual decay of the shock.¹⁰

The permanent increase in net foreign assets reflects the well-known non-stationarity of open economy macro models with incomplete markets (see, e.g., Schmitt-Grohé and Uribe (2003) and Devereux and Sutherland (2008)). In this case, the temporary shock to the home tradable endowment causes a permanent increase in home's relative financial wealth. When combined with an increased desire to save, this leads to a permanent increase in home's net foreign assets.

How do these results compare to the data? The current account surplus, in response to a positive output shock, seems broadly counterfactual for the U.S. In addition, with the exception of the first period, the valuation effect reinforces the current account. This runs counter to Gourinchas and Rey (2007), who argue that U.S. valuation effects tend to offset current account fluctuations.

¹⁰Starting next period, the value of the home dividend falls gradually as the shock dies out. Each period, as the dividend falls, the home equity price falls, gradually reducing the value of home's foreign liabilities: a positive valuation effect.

3.3.3 Transitory Shocks to the Nontradable Good Endowment

Figure 3-4 shows impulse responses to a positive, one standard deviation shock to the nontradable endowment in the home country ($\epsilon_t^{z,H,N}$). The home country now runs a current account deficit that increases monotonically to zero over time. On the other hand, home's valuation effect increases on impact and stays above trend for many periods. The current account effect is stronger, however, and home's net foreign assets decline. In the long run, home's net foreign assets are permanently lower.

The impulse responses in Figure 3-5 provide additional insight. The terms of trade and the real exchange rate move in opposite directions in the short run. On the one hand, the increased supply of home nontradable goods causes their price to fall. By itself, this reduces the relative price of a home consumption basket, driving down home's real exchange rate. On the other hand, the lower price of nontradables increases home's demand for home tradable goods, because the two goods are complements.¹¹ This drives up the price of home tradables in the short run, causing home's terms of trade to rise. The rise in the terms of trade partially (but not completely) offsets the fall in home's real exchange rate.

In contrast to the tradable shock case, home's realized stochastic discount factor

¹¹Foreign tradable goods are also complements of home nontradable goods. However, because households tilt their tradable consumption towards the domestic tradable good, home's increased demand for home tradables exceeds its demand for foreign tradables.

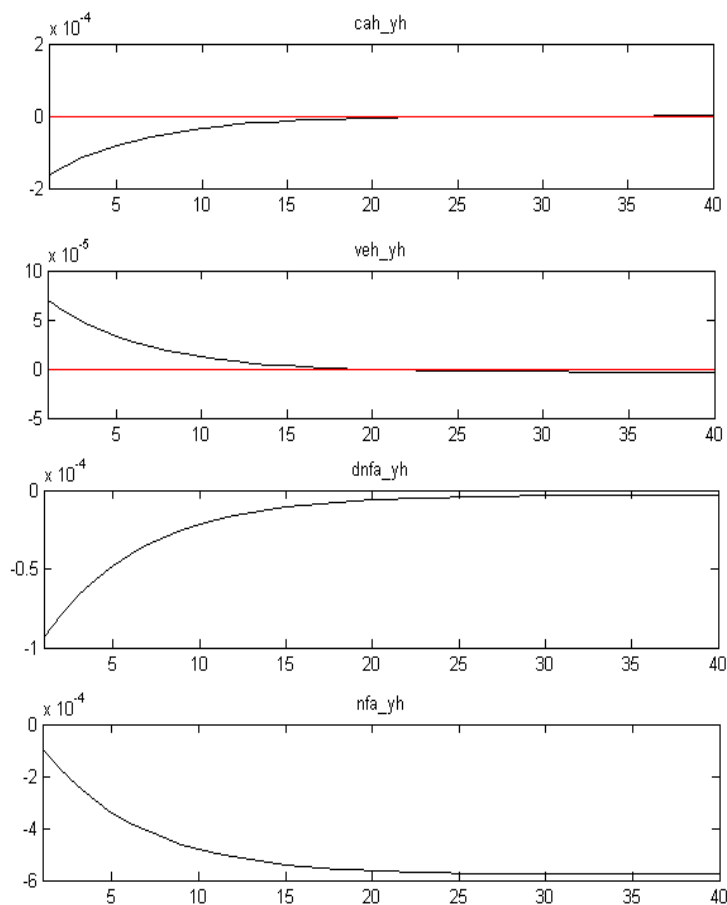


Figure 3-4: Impulse responses to a positive, one standard deviation shock to the nontradable endowment in the home country ($\epsilon_t^{z,H,N}$). *cah_yh* is the home country's current account balance, *veh_yh* is the valuation effect on the home country's net foreign assets, *dnfa_yh* is the change in the home country's net foreign assets, and *nfa_yh* is the level of the home country's net foreign assets. All are expressed as shares of home country output (tradable plus nontradable endowment).

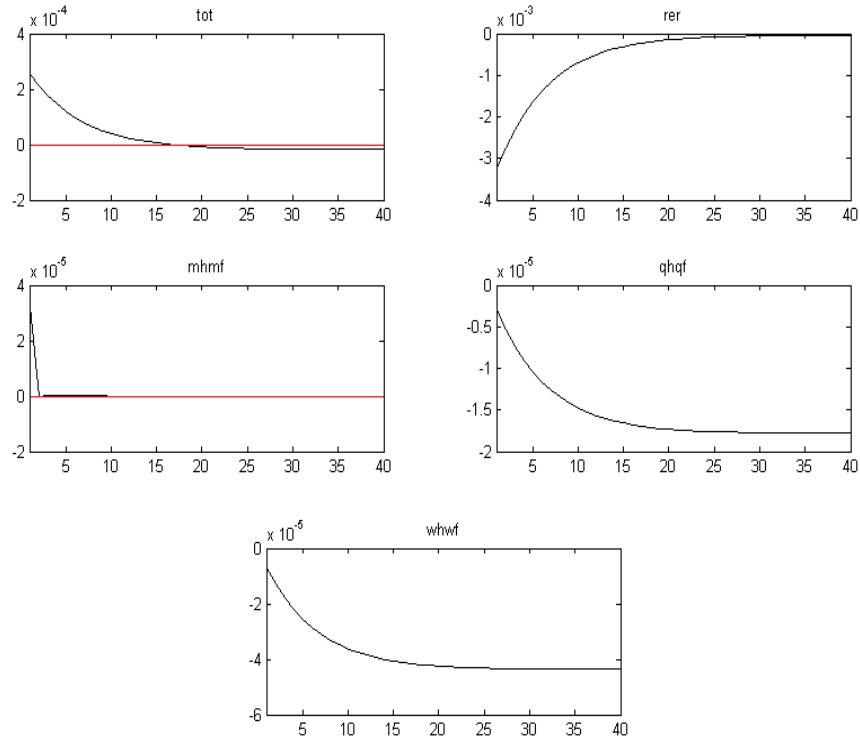


Figure 3-5: Impulse responses to a positive, one standard deviation shock to the nontradable endowment in the home country ($\epsilon_t^{z,H,N}$). *tot* is the home country's terms-of-trade (price of exports divided by price of imports), *rer* is the home country's real exchange rate (price of a consumption basket in the home country divided by price of a consumption basket in the foreign country), *mhmf* is home's realized stochastic discount factor divided by the foreign realized stochastic discount factor, *qhcf* is the price of the home equity divided by the price of the foreign equity, and *whwf* is home's financial wealth divided by foreign financial wealth.

rises above its foreign counterpart for one period, corresponding to an unexpected fall in home's relative consumption index. Since the shock is transitory, home's relative consumption index is expected to rise next period. In the absence of any saving instruments, home's expected stochastic discount factor would be low, reflecting a pent-up desire to smooth consumption by transferring some income from the future to the present. With financial assets available, the home country becomes a net borrower: i.e., it runs a current account deficit.

Loosely speaking, imagine that the U.S. experiences a housing boom (positive shock to the nontradable endowment). U.S. households seek out more furniture (tradable goods) to adorn their bigger houses. However, furniture supply has not changed, so the price of furniture rises sharply; and the total amount that U.S. households must spend on furniture increases. In order to finance higher furniture expenses, U.S. households must borrow from abroad (run a current account deficit).

The home country also experiences a small, positive valuation effect in the short run – the result of a small decline in the relative price of the home equity (and therefore a fall in home's foreign liabilities). The fall in the price of the home equity stems from a small but permanent long-run decrease in the terms of trade: after about fifteen periods, home's terms of trade falls below trend indefinitely. This reduces the expected value of the capitalized dividend stream associated with the home equity.¹²

The results from the transitory shock to the nontradable endowment are a better

¹²The permanent fall in the terms of trade is a result of permanently lower financial wealth in the home country, which reduces the relative demand for home tradables.

qualitative match with U.S. data. The current account now moves inversely with output, as it does in the data. The valuation effect, though small, moves in the opposite direction of the current account – consistent with Gourinchas and Rey (2007).

3.3.4 Trend Shocks

Figure 3-6 shows impulse responses to a positive, one standard deviation shock to the trend endowment in the home country ($\epsilon_t^{g,H}$). The home country runs a current account deficit that continues to grow after the initial impact of the shock. The valuation effect on home's net foreign assets is sharply negative for a single period. The decline in valuation effects and current account balance together drive net foreign assets down. In the long run, home's net foreign assets are permanently lower.

The impulse responses in Figure 3-7 provide additional insight. Because the trend shock affects both the tradable and nontradable endowments, the supplies of home tradable and nontradable goods both increase, driving down home's terms of trade and real exchange rate. Compared to the transitory shock cases, the relative price of the home equity increases sharply. This drives up the value of home's foreign liabilities, creating a large negative valuation effect.

Although trend shock yields significant and prolonged current account deficit, it fails to produce the offsetting valuation effects. In contrast, trend shock increases the dividends of the tradable equity and causes capital loss for the home country. As a result, trend shock within this setup doesn't match the pattern of U.S. current

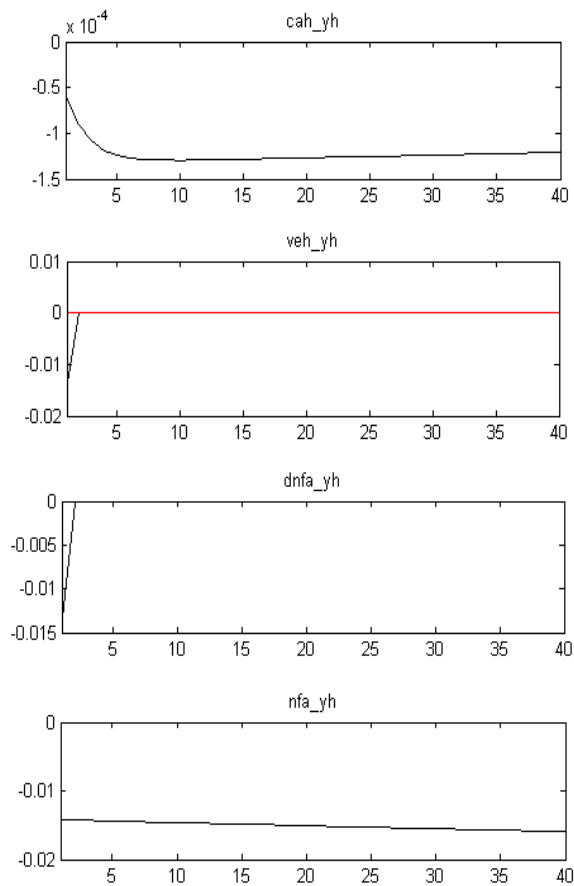


Figure 3-6: Impulse responses to a positive, one standard deviation shock to the trend endowment in the home country ($\epsilon_t^{g,H}$). *cah_yh* is the home country's current account balance, *veh_yh* is the valuation effect on the home country's net foreign assets, *dnfa_yh* is the change in home country's and *nfa_yh* is the level of home country's net foreign assets. All expressed as shares of home country output (tradable plus nontradable endowment).

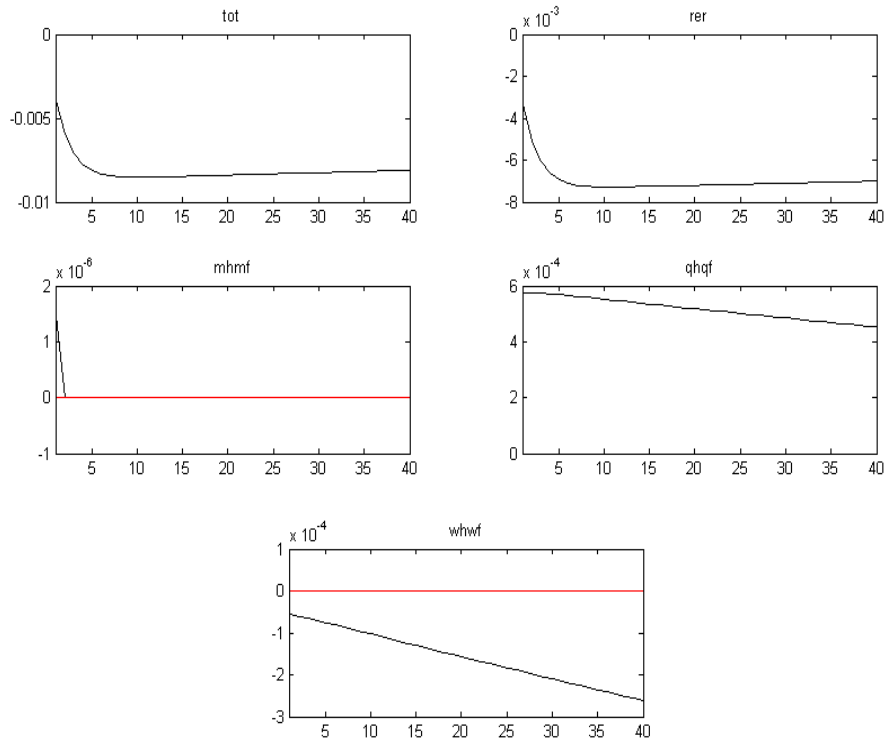


Figure 3-7: Impulse responses to a positive, one standard deviation shock to the trend endowment in the home country ($\epsilon_t^{g,H}$). *tot* is the home country's terms-of-trade (price of exports divided by price of imports), *rer* is the home country's real exchange rate (price of a consumption basket in the home country divided by a price of a consumption basket in the foreign country), *mhmf* is the home's realized stochastic discount factor divided by the foreign's realized stochastic discount factor, *qhcf* is the price of the home equity divided by the price of the foreign equity, and *whwf* is home's financial wealth divided by foreign financial wealth.

account and valuation effects. Among the shocks considered, transitory shocks to the nontradable good sector produces the best match to the U.S. data.

3.4 Conclusion

This chapter developed an open economy macro model to help understand two stylized facts: the U.S. current account is countercyclical, and the valuation effect on U.S. net foreign assets tends to move inversely with the current account. In our framework, transitory shocks to the nontradable endowment replicate both results. There are many possibilities for extensions and further research. First, it would be worthwhile to add a production sector to both countries. Second, one could look at alternative menus of assets; for example, bonds instead of (or in addition to) equities. Finally, it would be useful to estimate the stochastic properties of the different shocks using Generalized Method-of-Moments or Bayesian techniques.

3.5 Appendix

3.5.1 Detrending

To solve the model using locally accurate solution techniques, it is necessary to express it in detrended form. For any variable x_t , let $\hat{x}_t \equiv x_t/\Gamma_{t-1}^H$. The following variables have a stochastic trend and need to be detrended: $y_t^{i,T}$, $y_t^{i,N}$, w_t^i , $\alpha_t^{i,j}$, c_t^i , $c_t^{i,T}$, $c_t^{i,N}$, $c_t^{i,T,j}$, and q_t^i . The remaining variables are already stationary. In what follows, it is useful to define the following auxiliary variable:

$$h_t \equiv \frac{\Gamma_t^H}{\Gamma_{t-1}^H} = e^{g_t^H} \pi_t^\lambda$$

Detrended endowments are given by:

$$\hat{y}_t^{H,T} = e^{z_t^{H,T} + g_t^H} \pi_t^\lambda \tag{3.33}$$

$$\hat{y}_t^{H,N} = e^{z_t^{H,N} + g_t^H} \pi_t^\lambda \tag{3.34}$$

$$\hat{y}_t^{F,T} = e^{z_t^{F,T} + g_t^F} \pi_t^{1-\lambda} \tag{3.35}$$

$$\hat{y}_t^{F,N} = e^{z_t^{F,N} + g_t^F} \pi_t^{1-\lambda} \tag{3.36}$$

The return on the country i equity can be written:

$$r_t^i = h_{t-1} \left(\frac{\widehat{q}_t^i + p_t^{T,i} \widehat{y}_t^{i,T}}{\widehat{q}_{t-1}^i} \right) \quad (3.37)$$

The detrended budget constraint for households in country i can be written:

$$\widehat{w}_t^i = h_{t-1}^{-1} \widehat{w}_{t-1}^i r_t^F + h_{t-1}^{-1} \widehat{\alpha}_{t-1}^{i,H} (r_t^H - r_t^F) + p_t^{N,i} \widehat{y}_t^{i,N} - p_t^{i,c} \widehat{c}_t^i \quad (3.38)$$

First-order condition (3.23) can be written as follows:

$$E_t \left[\chi \left(\widehat{c}_t^{i,A} \right)^{-\eta} \left(\widehat{c}_{t+1}^i \right)^{-\gamma} \left(p_{t+1}^{i,c} \right)^{-1} r_{t+1}^F \right] = \left(\widehat{c}_t^i \right)^{-\gamma} \left(p_t^{i,c} \right)^{-1} h_t^\gamma \quad (3.39)$$

The market-clearing conditions, the expressions for the CES bundles, and the remaining first-order conditions can be written in detrended form simply by replacing each nonstationary variable x_t with its detrended counterpart, \widehat{x}_t .

The detrended current account, valuation effect, and change in net foreign assets can be written as follows:

$$\widehat{c}a_t^H = p_t^{T,H} \widehat{c}_t^{F,T,H} - p_t^{T,F} \widehat{c}_t^{H,T,F} + \left(\frac{\widehat{\alpha}_{t-1}^{H,F}}{\widehat{q}_{t-1}^F} \right) p_t^{T,F} \widehat{y}_t^{F,T} - \left(\frac{\widehat{\alpha}_{t-1}^{F,H}}{\widehat{q}_{t-1}^H} \right) p_t^{T,H} \widehat{y}_t^{H,T} \quad (3.40)$$

$$\widehat{v}e_t^H = \frac{\widehat{\alpha}_{t-1}^{H,F}}{\widehat{q}_{t-1}^F} \left(\widehat{q}_t^F - \frac{\widehat{q}_{t-1}^F}{h_{t-1}} \right) - \frac{\widehat{\alpha}_{t-1}^{F,H}}{\widehat{q}_{t-1}^H} \left(\widehat{q}_t^H - \frac{\widehat{q}_{t-1}^H}{h_{t-1}} \right) \quad (3.41)$$

$$\Delta nfa_t^H = \left(\widehat{\alpha}_t^{H,F} - \widehat{\alpha}_t^{F,H} \right) - \left(\frac{\widehat{\alpha}_{t-1}^{H,F} - \widehat{\alpha}_{t-1}^{F,H}}{h_{t-1}} \right) \quad (3.42)$$

The stochastic discount factor in country i can be written as follows:

$$m_t^i = \chi \left(\widehat{c}_{t-1}^i \right)^{-\eta} \left(\frac{\widehat{c}_t^i}{\widehat{c}_{t-1}^i} \right)^{-\gamma} h_{t-1}^{-\gamma} \left(\frac{p_t^{i,C}}{p_{t-1}^{i,C}} \right)^{-1} \quad (3.43)$$

3.5.2 Equilibrium and Solution Approach

An equilibrium is a sequence of goods prices $\{p_t^{T,i}, p_t^{N,i}\}$, asset prices $\{\widehat{q}_t^i\}$, consumption $\{\widehat{c}_t^{i,N}, \widehat{c}_t^{i,T,j}\}$, asset holdings $\{\widehat{\alpha}_t^{i,j}\}$, returns $\{r_t^i\}$, and financial wealth $\{\widehat{w}_t^i\}$ such that goods and asset markets clear when all households in both countries behave optimally, taking prices as given.

The solution approach follows Devereux and Sutherland (2010a). It begins by solving the “non-portfolio” side of the model to a first-order approximation. This solution, combined with a second-order approximation of the detrended counterparts of (3.24), pins down the near-non-stochastic steady state (NNSS) portfolios, $\alpha^{i,j}$. Then one solves the non-portfolio side to a second-order approximation, taking account of

the NNSS portfolios. This solution, combined with a third-order approximation of the detrended counterparts of (3.24), pins down the first-order portfolio dynamics.

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