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To cite this version:

Nicolas Coeurdacier, Hélène Rey. Home Bias in Open Economy Financial Macroeconomics. Journal of Economic Literature, 2013, 51 (1), pp.63 - 115. 10.1257/jel.51.1.63 . hal-03473901

HAL Id: hal-03473901

https://sciencespo.hal.science/hal-03473901v1

Submitted on 10 Dec 2021

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Journal of Economic Literature 2012, 51(1), 63–115
http://dx.doi.org/10.1257/jel.51.1.63

Home Bias in Open Economy Financial Macroeconomics

Nicolas Coeurdacier and Hélène Rey*

Home bias is a perennial feature of international capital markets. We review various explanations of this puzzling phenomenon highlighting recent developments in macroeconomic modeling that incorporate international portfolio choices in standard two-country general equilibrium models. We refer to this new literature as Open Economy Financial Macroeconomics. We focus on three broad classes of explanations: (i) hedging motives in frictionless financial markets (real exchange rate and nontradable income risk), (ii) asset trade costs in international financial markets (such as transaction costs or differences in tax treatments between national and foreign assets), and (iii) informational frictions and behavioral biases. Recent theories call for new portfolio facts beyond equity home bias. We present new evidence on cross-border asset holdings across different types of assets: equities, bonds and bank lending and new micro data on institutional holdings of equity at the fund level. These data should inform macroeconomic modeling of the open economy and a growing literature of models of delegated investment. (*JEL* E13, F41, G11, G12, G15)

1. *Introduction*

Home bias is a perennial feature of international capital markets. Nineteenth century economists called it the "disinclination of capital to migrate."[1] Standard finance theory predicts that investors hold a diversified portfolio of equities across the world if capital is fully mobile across borders. Because foreign equities provide great diversification opportunities, a point made early on in Grubel (1968), Levy and Sarnat (1970) and Solnik (1974), falling barriers to international trade in financial assets over the last thirty-years should have led investors across the world to rebalance their portfolio away from national assets toward foreign assets. The process of "financial globalization" fostered by capital account liberalizations, electronic trading, increasing exchanges of information across borders, and falling transaction costs has certainly led to a large increase in cross-border asset trade (Lane and Milesi-Ferretti 2003). However, investors seem still reluctant to reap the full benefits of international diversification and hold a disproportionate share

*Coeurdacier: SciencesPo and CEPR. Rey: London Business School, CEPR and NBER. Ebrahim Rahbari, Nelson Costa-Neto and Francesca Monti provided excellent research assistance. Coeurdacier thanks the Chaire d'Excellence de l'Agence Nationale pour la Recherche for financial support. Rey gratefully acknowledges the European Research Council grant number 210584 on "Countries' external balance sheets, dynamics of international adjustment and capital flows" for financial support.

[1] Reported in Flandreau (2006).

of local equities, a phenomenon referred to as the "home bias in equities." Since the seminal paper of French and Poterba (1991), the home bias in equities has continuously intrigued and fascinated financial economists and international macroeconomists. Despite better financial integration, the home bias has not decreased sizably: in 2007, U.S. investors still hold more than 80 percent of domestic equities, a much higher proportion than the share of U.S. equities in the world market portfolio. Indeed, home bias in equities is still observed in most countries and tends to be higher in emerging markets.

Many explanations have been put forward in the literature to explain this very robust portfolio fact. We do not intend to provide a definite answer nor choose among alternative explanations, as they probably all contribute to part of the gap. Our goal is to review where theory has led us, provide relevant empirical facts and take a stand at what might be the next challenges ahead. We distinguish between three broad classes of explanations: (i) hedging motives in frictionless financial markets (real exchange rate and non-tradable income risk), (ii) asset trade costs in international financial markets (such as transaction costs, differences in tax treatments between national and foreign assets or differences in legal frameworks), and (iii) informational frictions and behavioral biases. We will review these explanations, highlighting important recent developments in macroeconomic modeling of the open economy, referred to as *Open Economy Financial Macroeconomics*. We will also discuss asymmetric information models, including the recent literature with endogenous information acquisition.

We put some emphasis on recent developments in the macroeconomics literature, which has embedded nontrivial portfolio choices in standard two country general equilibrium macro models. Explaining equity home bias has been one of the main motivations for this literature, which has first focused on models with equities only. But the importance of considering portfolio choices across a broader class of assets (bonds, corporate debt, equity . . .) is now widely recognized. We develop a standard two country/two good Dynamic Stochastic General Equilibrium (DSGE) model with endogenous portfolio choice and allow for *equity trade* in first instance, as in the early literature, and then generalize the set up to accommodate trade in *bonds and equity*. This allows us both to present recent methodological developments to fully characterize portfolios in this class of models and to show the limitations of the early literature. These new models also call for new portfolio facts. Accordingly, we present some new evidence on international holdings across different types of assets: equities, bonds, and banking assets. We focus on portfolio investment and abstract from Foreign Direct Investment, as its determinants may be of a different nature and are studied extensively in the trade literature. Finally, we present some new micro data on institutional holdings of equity at the fund level. These data should inform macroeconomic modeling of the open economy as well as models of delegated investment, which belong to a fast-growing literature: a large share of international investment is intermediated.

In section 2, we present the standard definition of home equity bias and some recent measures across countries and across time. In section 3, we focus on the recent methodological developments in the macroeconomics literature. In section 4, we focus on the role of hedging motives as a source of equity home bias. We use standard dynamic models of the *Open Economy Financial Macroeconomics* literature. In section 5, we present the literature on trade costs in financial markets (transaction costs, international taxation, legal frameworks). In section 6, we review the finance literature on information asymmetries and behavioral biases.

In section 7, in line with recent theoretical work, we present some new evidence on aggregate portfolio holdings across a wider range of assets. We also present new portfolio facts at the fund level and discuss leads for future research. Section 8 concludes.

2. *The Equity Home Bias: Definition and Measure*

2.1 *Definition*

French and Poterba (1991) were the first to our knowledge to document domestic ownership shares across countries. Using data for the United States, Japan, the United Kingdom, France, and Germany, they show that investors hold a disproportionate share of domestic assets in their equity portfolios. In 1989, 92 percent of the U.S. stock market was held by U.S. residents. Analogous numbers for Japan, the United Kingdom, France, and Germany are respectively 96 percent, 92 percent, 89 percent, and 79 percent. They label this lack of cross border diversification the equity home bias.[2] This is a well-known puzzle in international finance: in a world with frictionless financial markets, the most basic International Capital Asset Pricing Model (CAPM) model with *homogenous* investors across the world would predict that the representative investor of a given country should hold the world market portfolio. In other words, the share of his financial wealth invested in local equities should be equal to the share of local equities in the world market portfolio, a prediction that contradicts the most casual observation of the data on portfolio holdings. As a result, the measure of equity home bias (EHB) that is most commonly used is the difference between actual holdings of domestic equity and the share of domestic equity in the world market portfolio:[3]

$$(1) \quad \mathrm{EHB}_i = 1 - \frac{\text{Share of Foreign Equities in Country } i \text{ Equity Holdings}}{\text{Share of Foreign Equities in the World Market Portfolio}}.$$

When the home bias measure for country i EHB_i is equal to one, there is full equity home bias; when it is equal to zero, the portfolio is optimally diversified according to the basic International CAPM.

2.2 *Evidence across Time and across Countries*

While one could argue that, at the end of the 1980s, international capital markets were far from being frictionless and this could contribute to rationalize home bias, this line of explanation seems more doubtful today. Despite increased financial integration, the equity home bias remains a pervasive phenomenon across countries and across time (classic surveys include Lewis 1999 and Karolyi and Stulz 2003). See also Sercu and Vanpée (2008) for recent evidence). In figure 1, we show the evolution of home bias measures in developed countries across regions of the world: it has decreased over the last twenty years with the process of "financial globalization" but remains high in most countries (see also table 1 for a recent snapshot of home bias measures for selected

[2] Bohn and Tesar (1996) estimate the share of foreign equities in the U.S. portfolio to be still very low in 1995, equal to 8 percent. Ahearne, Griever, and Warnock (2004) estimate it to be slightly above 10 percent in 2000.

[3] See, for instance, Ahearne, Griever, and Warnock (2004). Another commonly used measure in finance is a deviation from a benchmark mean–variance portfolio. Benchmark portfolio weights are calculated from a mean variance optimization problem with sample estimates of the means and variance–covariance matrix of returns. The main issue in the existing literature adopting the finance approach are how to measure returns and covariance matrices. Papers differ in the extent to which they use real or nominal returns, how they estimate expected returns, and how they deal with structural breaks and nonstationarity. As a result, there is a degree of heterogeneity in the estimates of expected returns and second moments.

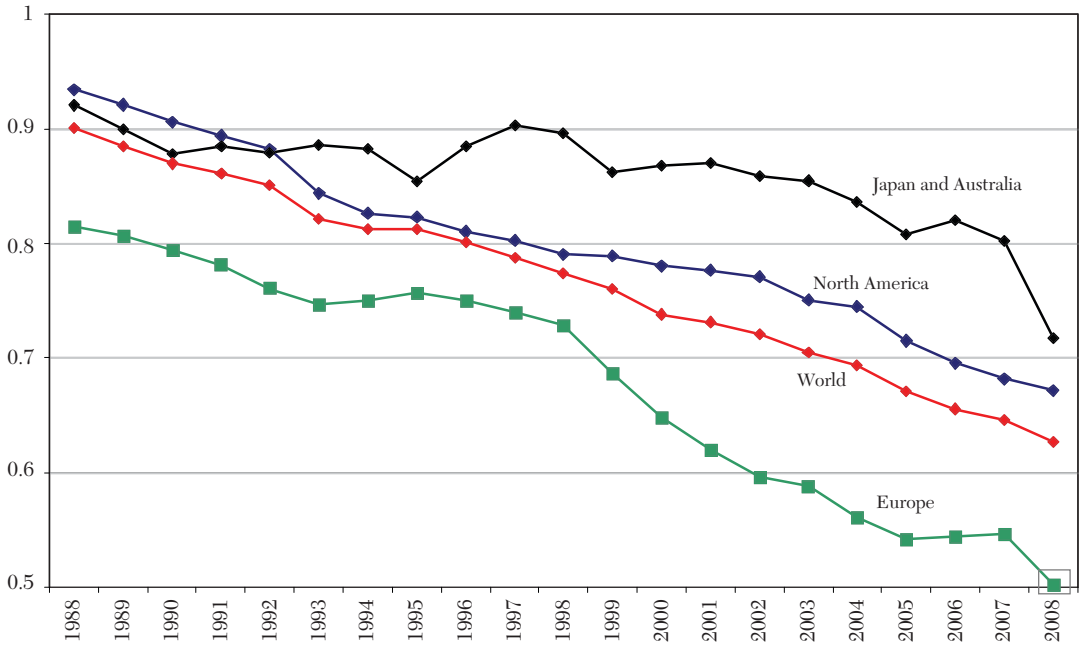

Figure 1. Home Bias in Equities Measures across Developed Countries

Note: The country measure EHB_i is market capitalization-weighted for each region.

Sources: Authors' calculations. International Financial Statistics and World Federation of Exchanges Database. Countries: *Australia and Japan*; *Europe* (Austria, Belgium, Denmark, Finland, France, Germany, Italy, Netherlands, Spain, Sweden, Switzerland, United Kingdom); *North America* (Canada and United States).

countries). On average, the degree of home bias across the world is 0.63 (lower in Europe where monetary union after 1999 seem to have had an effect).[4] For the developed world, this means that the share of foreign equities in investors' portfolios is roughly a third of what it should be if the benchmark is the basic International CAPM. In figure 2, we construct a similar indicator for emerging markets. Emerging markets have less diversified equity portfolios than developed countries and do not exhibit any clear downward trend in home bias. The average degree of home bias in these countries is 0.9 (smaller in emerging Asia and larger in Latin America) and investors in these countries hold one-tenth of the amount of foreign equities they should be holding according to the basic International CAPM model.

This robust stylized fact has received considerable attention from both the finance literature and the macroeconomics literature. The main difference between these two sets of literature relies on some modeling assumptions. To simplify, the traditional finance literature has tried to rationalize the

[4] See Coeurdacier and Martin (2009) and Fidora, Fratzscher, and Thimann (2007) for studies on the impact of the Monetary Union on cross-border equity diversification. Kalemli-Ozcan, Papaioannou, and Peydro (2010) show that the euro's impact on financial integration was primarily driven by eliminating the currency risk.

TABLE 1
HOME BIAS IN EQUITIES IN 2008 FOR SELECTED COUNTRIES

Source country	Domestic market in % of world market capitalization (1)	Share of portfolio in domestic equity in % (2)	Degree of equity home bias $= EHB_i$ (3)
Australia	1.8	76.1	0.76
Brazil	1.6	98.6	0.99
China	7.8	99.2	0.99
Canada	2.7	80.2	0.80
Euro Area	13.5	56.7	0.50
Japan	8.9	73.5	0.71
South Africa	1.4	87.8	0.88
South Korea	1.4	88.5	0.88
Sweden	0.7	43.6	0.43
Switzerland	2.3	50.9	0.50
United Kingdom	5.1	54.5	0.52
United States	32.6	77.2	0.66

Note: For Euro Area countries, within Euro Area cross-border equity holdings are considered as Foreign Equity Holdings.

Sources: Authors' calculations. International Financial Statistics, Consumer Portfolio Investment Survey and World Federation of Exchange.

equity home bias in multicountry models of portfolio choice where asset prices and their second moments are given (in particular in these models the risk-free interest rate is exogenously given). The macro literature has tried to integrate international portfolio decisions in otherwise standard DSGE models of the international economy. These models have a fully general equilibrium structure and asset prices and their second moments are endogenously determined.[5] The motivation is however the same: foreign equities seem to offer diversification benefits that are not reaped by investors and both financial economists and macroeconomists are intrigued by this fact.[6]

3. *Open Economy Financial Macroeconomics*

The theoretical macroeconomic literature points toward potential gains from international diversification to hedge national production risk. In the presence of imperfectly correlated productivity shocks or output shocks across countries, owning foreign

[5]The dichotomy, which historically seems relevant, appears increasingly artificial as more papers bridge the two strands of literature.

[6]The finance literature tends to focus on the diversification gains looking at asset price data and to evaluate how an increase in the share of foreign equities would improve the portfolio performance based on some criteria. The macro-finance literature tends to use consumption data to measure the potential welfare gains from international risk-sharing. See section 6 for a discussion.

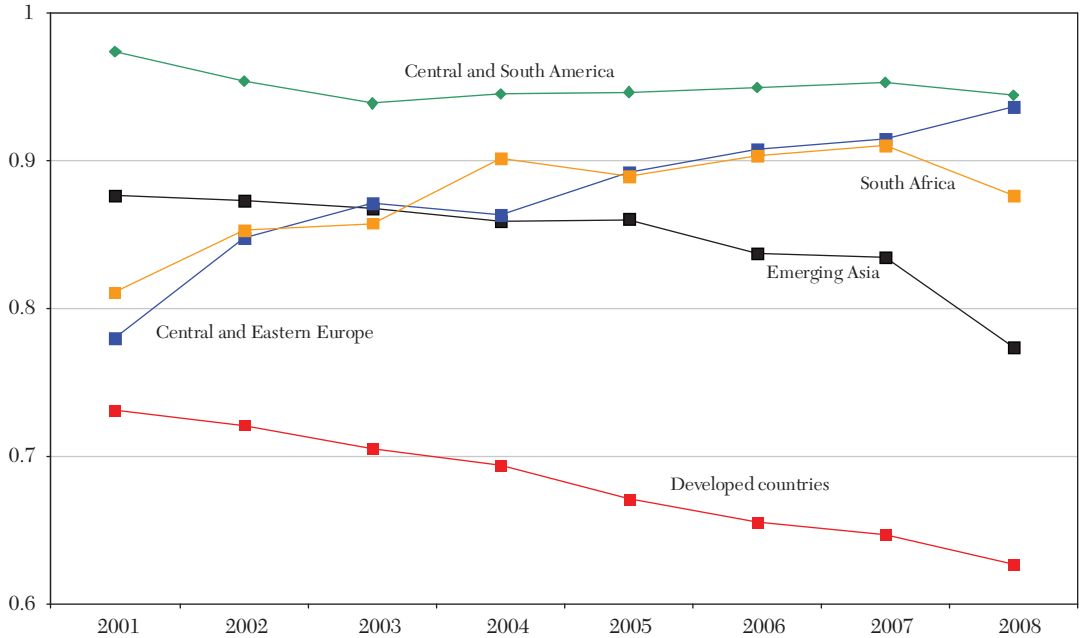

Figure 2. Home Bias in Equities Measures across Emerging Countries
Note: The country measure EHB_i is market capitalization-weighted for each region.

Sources: Authors' calculations. International Financial Statistics and World Federation of Exchanges Database. Countries: *Central and South America* (Argentina, Bolivia, Brazil, Chile, Colombia, Ecuador, Mexico, Peru); *South Africa; Central and Eastern Europe* (Bulgaria, Czech Republic, Hungary, Latvia, Lithuania, Moldova, Poland, Romania, Ukraine); *Emerging Asia* (Hong Kong, Indonesia, South Korea, Malaysia, Philippines, Singapore, Thailand, Armenia, Kazakhstan, Israel, Bangladesh, India).

equity could help to smooth consumption. This is most obvious in the context of a two country model with one single tradable good, as, e.g., in Lucas (1982): in such a world, domestic and foreign investors hold an identical portfolio of claims to output (equities), the market portfolio, thus diversifying optimally national output risks. As in the textbook finance portfolio theory, in such a world the home bias in equities is seen as a failure of the standard diversification motive. However, one should be cautious: investors across the world would hold the same portfolio, only if they were *homogeneous*. In reality, heterogeneity across investors from different countries leads to departure from the world market portfolio and potentially a bias toward national assets. Various sources of heterogeneity leading to equity home bias have been explored in the macro literature. They fall in two broad classes of explanations: (i) hedging motives (real exchange rate risk and nontradable income risk) and (ii) asset trade costs in international financial markets (such as transaction costs, differences in tax treatments, in legal framework and other policy induced barriers to foreign investment).

We will review in details these two explanations in sections 4 and 5. We now present

how recent methodological developments in Open Economy Financial Macroeconomics allow us to solve for (nontrivial) portfolio decisions in DSGE models.

3.1 *Methodological Breakthrough*

Until recently, most macroeconomic models of the international economy relied mostly on the following asset structures: either one noncontingent bond traded internationally or complete asset markets through Arrow–Debreu securities. None of these models could say anything about gross foreign asset holdings and the extent to which tradable assets could be used to share risks internationally. Recent methodological advances have allowed a much richer structure of asset trade to be examined.

Building on perturbation methods (see Judd 1998), Devereux and Sutherland (2011) develop a solution method that allows standard linear solution techniques for macroeconomic models to be adapted to solve for models with portfolio choice. Standard linear solution techniques cannot directly be applied since these methods rely on a first-order approximation around a deterministic steady state: to a first order approximation, assets are perfect substitutes, as they deliver the same expected return, so portfolio choice is not pinned down. Devereux and Sutherland's work relies on several insights. Firstly, building on earlier work by Judd and Guu (2001) and Samuelson (1970), they show that the steady state portfolio can be derived as the portfolio in a noisy environment and letting the noise go to zero. Secondly, they show that in order for the steady state portfolio to be well defined, a second-order approximation of the portfolio equations (Euler equations) needs to be considered, while only the first-order dynamics of the other equations of the model are required to pin down steady state portfolios (also called *zero order portfolio*). Finally, the authors show that the first-order dynamics of the model only depends on the steady-state portfolio. In addition to these conceptual insights, Devereux and Sutherland (2011) also provide a formula that can be used to compute portfolios analytically in a fairly general class of models. In a companion paper, Devereux and Sutherland (2010), the authors show that in order to solve for the first order dynamics of the portfolio, a second-order approximation of the nonportfolio equations of the model is needed, while the portfolio equations need to be approximated to the third order. Portfolio changes (around the steady-state portfolios) are driven by changes in second moments (third-order terms), which determine changes in expected returns across assets. It is then also true that the second-order dynamics of the model depends on the first-order dynamics of portfolios. The authors show that approximate portfolios can be computed analytically in many cases.

In simultaneous work, Tille and van Wincoop (2010) develop a solution technique that is analogous to the one presented in Devereux and Sutherland (2011). The main difference is that Tille and van Wincoop (2010) rely on numerical iterations to solve for portfolios. This requires more computational effort, but also implies that their solution method can be applied to a wider class of models. To compute steady-state portfolios, they linearize nonportfolio equations up to the first-order for a given portfolio. They then solve for the endogenous portfolio as a fixed-point in a second-order approximation of the portfolio (Euler) equations. As in Devereux and Sutherland (2010), they show how going one order further in the approximation allows to investigate portfolio dynamics. They apply their method to a two country/two good model with one stock in each country and show how portfolio dynamics relates to the time variation of expected returns and second moments. In particular, they investigate the predicted capital

outflows and inflows, relate them to portfolio growth and portfolio reallocation,[7] and assess the performance of the model looking at balance of payments statistics on capital flows. Other recent work that tackles the challenge of solving for portfolio choice are Evans and Hnatkovska (2006 and 2008) and Judd, Kubler, and Schmedders (2002). The methods developed in Evans and Hnatkovska (2008) and Judd, Kubler, and Schmedders (2002) can be applied to very general classes of models, but are quite complex and present significant departures from standard DSGE solution methods.

3.2 *Shortcomings and Extensions*

The main advantage of the perturbation methods developed by Devereux and Sutherland (2011) and Tille and van Wincoop (2010) are: (1) they are very easy to implement as they are close to standard approximation methods used in DSGE models; (2) they can be applied to a broad range of environments (complete and incomplete markets models, a potentially large number of shocks and/or securities); and (3) they provide (approximate) closed-form expressions for portfolios in many cases. These methods face however some limitations as they rely on local approximations around the deterministic steady state: as any local methods, they are valid around the point of approximation, which is problematic when there are large deviations away from this point. This can arise for instance in presence of large shocks (such as disaster risks, see, e.g., in Barro 2006) or when the problem is nonstationary. For example, in incomplete markets models, the distribution of wealth across countries may have a unit-root and therefore the solution may wander away from the approximation point. Since the methods are mainly based on first- and second-order approximations, they may also be inaccurate in models that exhibit strong nonlinearities, such as models with borrowing constraints. Lastly, the approximation of the decision rules in these methods is made around the deterministic steady state. However, the deterministic steady state might not be the stationary steady state of the model in presence of risk. Coeurdacier, Rey, and Winant (2011) use perturbation methods around the "risky steady state," defined as the point where agents choose to stay at a given date if the realization of shocks is 0 at this date but if they *expect future risk*.[8] The welfare implications for risk-sharing can be quite different from the standard ones around the risky steady state since uncertainty directly affects steady-state variables. While still local, such a method should be more accurate when decision rules in presence of risk are significantly different from the ones obtained when risk goes toward zero (as in Devereux and Sutherland 2011). The question of accuracy of these solution methods is not easily tackled however as for most models for which they are implemented, one cannot provide exact numerical methods. Exceptions of two-country/two goods models where solutions can be found without approximations are models with log-linear preferences as in Pavlova and Rigobon (2007, 2009, 2010).[9]

Ultimately, one should expect the development of global methods to emerge in order to solve portfolio choice models with multiple agents, multiple goods and multiple securities. Developing global methods would be useful as they would potentially be

[7] See also Kraay and Ventura (2000, 2003) for a similar terminology.

[8] For early work on the risky steady state, see Julliard and Kamenik (2005). For another application of the risky steady state concept in a different context, see Gertler, Kiyotaki, and Queralto (forthcoming).

[9] See also Devereux and Saito (2006). As Pavlova and Rigobon (2007, 2009, 2010), Devereux and Saito (2006) use a continuous time framework that allows some analytical solutions to be derived, but it can only be applied to a restricted class of models.

adequate in environments where standard perturbation methods fail and they could also provide insights on the accuracy of perturbation methods. Recent work in that direction includes Dumas and Lyasoff (2011) in finite-horizons models and Chien, Cole, and Lustig (2011) in a one-good closed economy model with multiple agents. Extending these methods to standard international macro models is a next important step.

Despite their limitations, perturbation methods constitute a major improvement that makes it possible to incorporate nontrivial portfolio choice in models of the open macroeconomy. These methodological improvements have given a new life to the literature investigating the origins of portfolio biases. A first generation of models of Open Financial Macroeconomics has looked at the hedging of real exchange rate risk and nontradable income risk as a source of portfolio biases in models with *equities only*. A second generation of models has emphasized the importance of describing portfolios with a richer menu of assets and has developed models with multiple asset classes (*bonds and equities*). We review these two strands of literature sequentially in the next section.

4. *Hedging Motives in Open Economy Financial Macroeconomics*

Hedging motives lead to departure from the benchmark model of Lucas (1982) where homogeneous investors across the world hold identical portfolios. By hedging, we mean choosing financial claims that help insulate investors from sources of risk affecting their income streams. The sources of risk developed in the literature are the following:

- Real exchange rate risk: the prices of investors' consumption goods fluctuate and this affects the purchasing power of their income.
- Nontradable income risk: investors receive a part of their income (wages in particular) that cannot be traded in financial markets.[10]

In other words, because investors in different countries have different exposure to real exchange rate risk and/or to nontradable income risk, they will hold different equity portfolios in equilibrium. It is important to understand that in these cases, equity portfolio "biases" are neither inefficient nor the consequence of some frictions in financial markets. The hedging of domestic sources of risks leads to different optimal portfolios across borders but perfect (or almost perfect) risk-sharing is preserved.

In order to analyze how these hedging motives affect equity portfolios, we present a benchmark two-country/two-good model where the only traded assets are equities of both countries. We show how log-linearization techniques can be used to derive (zero-order) steady-state portfolios. We also revisit some of the results of the literature regarding the hedging of real exchange rate risk and nontradable income risk in an *equity only* model. In particular, we show the difficulties to rationalize the equity home bias in such a framework. In section 4.2, we will show how a multiple asset class model provides an answer to most of these difficulties.

4.1 *Hedging Motives in a Benchmark Model with Equities Only*

4.1.1 *Set-up and First-Order Conditions*

There are two symmetric countries, Home (H) and Foreign (F), each with a representative household. Country $i = H, F$ produces one good using labor and capital. We assume that capital is fixed for now and will allow for

[10]The presence of government spending shocks can also generate a source of nontradable income risk due to tax changes.

endogenous capital accumulation in the subsequent section 4.2. All markets are perfectly competitive.

Preferences

Country i is inhabited by a representative household that has the following lifetime utility function:

$$(2) \qquad E_0 \sum_{t=0}^{\infty} \beta^t \left(\frac{C_{i,t}^{1-\sigma}}{1-\sigma} - \frac{l_{i,t}^{1+\omega}}{1+\omega} \right),$$

where ω is the Frish-elasticity of labor supply ($\omega > 0$) and σ the relative risk aversion parameter ($\sigma > 0$). $C_{i,t}$ is i's aggregate consumption in period t and $l_{i,t}$ is labor effort. $C_{i,t}$ is a composite good given by:

$$(3) \quad C_{i,t} = \left[a^{1/\phi} (c_{i,t}^{i})^{(\phi-1)/\phi} + (1-a)^{1/\phi} (c_{j,t}^{i})^{(\phi-1)/\phi} \right]^{\phi/(\phi-1)}, \quad \text{with } j \neq i,$$

where $c_{j,t}^{i}$ is country i's consumption of the good produced by country j at date t. $\phi > 0$ is the elasticity of substitution between the two goods. In the (symmetric) deterministic steady state, a is the share of consumption spending devoted to the local good. We assume a preference bias for local goods[11], $\frac{1}{2} < a < 1$.

The welfare based consumer price index that corresponds to these preferences is:

$$(4) \quad P_{i,t} = \left[a(p_{i,t})^{1-\phi} + (1-a)(p_{j,t})^{1-\phi} \right]^{1/(1-\phi)}, \quad j \neq i,$$

where $p_{i,t}$ is the price of good i.

[11] This "consumption home bias" is assumed exogenously. It has been extensively studied in the trade literature since the classic paper of McCallum (1995).

Technologies and Firms' Decisions

In period t, country produces $y_{i,t}$ units of good i according to the production function

$$(5) \qquad y_{i,t} = \theta_{i,t} (k_0)^{\alpha} (l_{i,t})^{1-\alpha},$$

with $0 < \alpha < 1$. k_0 is the country's initial stock of capital. It is *fixed*. Total factor productivity (TFP) $\theta_{i,t} > 0$ is an exogenous random variable.

There is a (representative) firm in country i that hires local labor and produces output, using technology (5). Due to the Cobb–Douglas technology, a share $1 - \alpha$ of output at market prices is paid to workers. Thus, the country i wage incomes are:

$$(6) \qquad w_{i,t}\, l_{i,t} = (1-\alpha) p_{i,t}\, y_{i,t},$$

where $w_{i,t}$ is the country i wage rate.

A share α of country i output at market prices is paid as a dividend $d_{i,t}$ to shareholders:

$$(7) \qquad d_{i,t} = \alpha p_{i,t}\, y_{i,t}.$$

Financial Markets and Instantaneous Budget Constraint

Financial markets are frictionless. There is international trade in stocks. The country i representative firm issues a stock that represents a claim to its stream of dividends $\{d_{i,t}\}$. The supply of shares is normalized at unity. Each household fully owns the local stock, at birth, and has zero initial foreign assets. Let $S_{j,t+1}^{i}$ denote the number of shares of stock j held by country i at the end of period t. At date t, the country i household faces the following budget constraint:

$$(8) \quad P_{i,t} C_{i,t} + p_{i,t}^{S} S_{i,t+1}^{i} + p_{j,t}^{S} S_{j,t+1}^{i} = w_{i,t} l_{i,t} + (d_{i,t} + p_{i,t}^{S}) S_{i,t}^{i} + (d_{j,t} + p_{j,t}^{S}) S_{j,t}^{i}, \quad j \neq i,$$

where $p^S_{i,t}$ is the price of stock i.

Household Decisions and Market Clearing Conditions

Each household selects portfolios, consumptions and labor supplies that maximize her lifetime utility (2) subject to her budget constraint (8) for $t \geq 0$. The following equations are first-order conditions of that decision problem:

$$(9) \qquad c^i_{i,t} = a\left(\frac{p_{i,t}}{P_{i,t}}\right)^{-\phi} C_{i,t},$$

$$c^i_{j,t} = (1-a)\left(\frac{p_{j,t}}{P_{i,t}}\right)^{-\phi} C_{i,t},$$

$$l^{\omega}_{i,t} = \left(\frac{w_{i,t}}{P_{i,t}}\right) C_{i,t}{}^{-\sigma}$$

$$(10) \quad 1 = E_t\left[\beta\left(\frac{C_{i,t+1}}{C_{i,t}}\right)^{-\sigma} \frac{P_{i,t}}{P_{i,t+1}} \frac{p^S_{j,t+1} + d_{j,t+1}}{p^S_{j,t}}\right]$$

$$\text{for } j = H, F.$$

Equation (9) represents the optimal allocation of consumption spending across goods, and the labor supply decision. Equation (10) shows the Euler equations with respect to the two stocks.

Market-clearing in goods and asset markets requires:

$$(11) \quad c^H_{H,t} + c^F_{H,t} = y_{H,t}, \quad c^F_{F,t} + c^H_{F,t} = y_{F,t},$$

$$(12) \qquad S^H_{H,t} + S^F_{H,t} = S^F_{F,t} + S^H_{F,t} = 1.$$

4.1.2 *Zero-Order Equilibrium Portfolios*

Equilibrium portfolio holdings chosen at date $t\,(S^i_{i,t+1}, S^i_{j,t+1})$ are functions of state variables at date t. Devereux and Sutherland (2011) show how to compute Taylor expansion of the portfolio decision rules, in the neighborhood of the deterministic steady state. In this section, we provide closed form solutions for "zero-order portfolios" (denoted by variables without time subscripts) S^i_i, S^i_j, i.e., portfolio decision rules evaluated at steady-state values of state variables. These portfolios can be determined by linearizing the model around its deterministic steady state. We show that the asset structure (two assets with two exogenous shocks) is locally complete in the sense that up to a first-order linear approximation, the consumption allocation is efficient (in other words there is perfect risk sharing up to a first-order approximation of the model). The method we use to solve for portfolios is then slightly different from Devereux and Sutherland (2011) as it does not require a second-order expansion of the Euler equations (equation 10). We simply derive the portfolio that replicates the efficient allocation up to a first-order approximation of the nonportfolio equations. This method is simpler but less general than Devereux and Sutherland (2011) as theirs can also be applied in models with incomplete financial markets.

Log-Linearization of the Model

In what follows, $z_t \equiv \frac{z_{H,t}}{z_{F,t}}$ denotes the ratio of Home over Foreign variables; $\widehat{z}_t \equiv (z_t - z)/z$ denotes the relative deviation of a variable z_t from its steady-state value z.

The Home country's CPI-based real exchange is $RER_t \equiv \frac{P_{H,t}}{P_{F,t}}$. Linearizing this expression gives (using (4)):

$$(13) \quad \widehat{RER}_t = \widehat{P_{H,t}} - \widehat{P_{F,t}} = (2a-1)\,\widehat{q}_t,$$

where $q_t \equiv p_{H,t}/p_{F,t}$ denotes the country H terms of trade. Due to consumption home bias ($a > \frac{1}{2}$), an improvement of Home terms of trade generates an appreciation of the Home real exchange rate (without home bias in consumption, the real exchange rate is constant).

In an equilibrium with locally complete markets, the ratio of Home and Foreign marginal utilities of aggregate consumption is proportional to the consumption-based real exchange rate (Backus and Smith 1993; Kollmann 1995). Linearization of this risk sharing condition gives:

$$(14) \quad -\sigma(\widehat{C_{H,t}} - \widehat{C_{F,t}}) = (2a-1)\,\widehat{q}_t.$$

Using intratemporal first-order condition for consumption (9) and market-clearing condition (11), one can show that when (14) holds, relative world consumption demand is given by $y_t = y_{H,t}/y_{F,t} \equiv (c^H_{H,t} + c^F_{H,t})/(c^F_{F,t} + c^H_{F,t})$ and satisfies in log-linearized terms:[12]

$$(15) \quad \widehat{y}_t = -\left[\phi(1-(2a-1)^2) + (2a-1)^2\frac{1}{\sigma}\right]\widehat{q}_t \equiv -\lambda\widehat{q}_t,$$

where $\lambda \equiv \phi(1-(2a-1)^2) + \frac{(2a-1)^2}{\sigma} > 0$. Thus Home terms of trade worsen when the relative supply of Home goods increases as Foreign goods are scarcer.

Ex ante symmetry implies that the zero-order portfolios have to satisfy these conditions: $S \equiv S^H_H = S^F_F = 1 - S^F_H = 1 - S^H_F$; S describes the (zero-order) equilibrium equity portfolio. Note that S denotes a country's holdings of local stock.

We will show that there exists a unique portfolio S, which, for consumptions consistent with the linearized risk-sharing condition (14), satisfies the following "static" budget constraint:

$$(16) \quad P_{i,t}C_{i,t} = w_{i,t}\,l_{i,t} + Sd_{i,t} + (1-S)d_{j,t}, \quad \text{for } i = H, F.$$

[12] See Coeurdacier (2009) and Coeurdacier, Kollmann, Martin (2008) for similar expressions.

Up to the first order, country i's efficient consumption spending at date t equals date t wage income, $w_{i,t}l_{i,t}$, plus the financial income generated by the equity portfolio S.[13]

Subtracting the "static" budget constraint of country F from that of country H and using the risk-sharing condition (14) yields the following log-linearized "static" budget constraint:

$$(17) \quad (\widehat{P_{H,t}C_{H,t}} - \widehat{P_{F,t}C_{F,t}}) = \left(1-\frac{1}{\sigma}\right)\underbrace{(2a-1)\,\widehat{q}_t}_{\widehat{RER}_t} = (1-\alpha)\widehat{w_t l_t} + (2S-1)\,\alpha\widehat{d}_t,$$

where $\widehat{w_t l_t} \equiv \widehat{w_{H,t}l_{H,t}} - \widehat{w_{F,t}l_{F,t}}$ denotes relative labor income and $\widehat{d}_t \equiv \widehat{d_{H,t}} - \widehat{d_{F,t}}$ denotes the relative dividend.

This expression shows the changes in country H income (relative to the income of F) necessary to finance the changes in consumption consistent with efficient risk-sharing (up to first order).

Partial Equilibrium Zero-Order Portfolios

The "static" budget constraint is useful to derive the equilibrium portfolio as a function of variance/covariance ratios. Taking the covariance with $\widehat{d}_t$ in (18) gives the following portfolio (we implicitly assume that the equity portfolio supports efficient risk-sharing up to a first-order, which is verified below):

$$(18) \quad S = \frac{1}{2} - \frac{1}{2}\frac{(1-\alpha)}{\alpha}\frac{\mathrm{cov}(\widehat{w_t l_t}, \widehat{d}_t)}{\mathrm{var}(\widehat{d}_t)} + \frac{1}{2}\frac{(1-\frac{1}{\sigma})}{\alpha}\frac{\mathrm{cov}(\widehat{RER}, \widehat{d}_t)}{\mathrm{var}(\widehat{d}_t)}.$$

[13] Kollmann (2006b) and Coeurdacier, Kollmann, and Martin (2010) shows that if this "static" budget constraint holds, then the present value budget constraint of country i is likewise satisfied, up to a first order.

This expression holds in many classes of models (with equity only) as we only need the budget constraints and generic first-order conditions to derive it. It is the departure of many empirical studies. The same expression also holds in terms of returns instead of income flows.

The portfolio departs from the fully diversified one with weights 1/2 in both equities (as in Lucas 1982) in presence of labor income risk and/or real exchange rate risk. It indicates that investors would favor local equity if:

(i) Relative dividends covary negatively with (relative) labor income (term $\frac{\mathrm{cov}(\widehat{w_t l_t}, \widehat{d_t})}{\mathrm{var}(\widehat{d_t})}$). This term is referred as the hedging of nontradable income risk.

As labor income accounts for more than two-thirds of total income, this term might lead to potentially large portfolio biases, the covariance term being multiplied by $\frac{1-\alpha}{\alpha}$. Households cannot trade financial claims on their labor incomes and will use existing financial assets to hedge this nontradable income risk. Intuitively, households want to insure themselves against a fall in their labor incomes and in the returns to their human wealth by holding financial assets that pay more in these bad states. If local equities have higher returns (than abroad) when local returns to nontradable wealth are lower (than abroad), households will bias their portfolio toward local equities.

(ii) Relative dividends covary positively with the real exchange rate if $\sigma > 1$ (term $\frac{\mathrm{cov}(\widehat{RER}, \widehat{d_t})}{\mathrm{var}(\widehat{d_t})}$). This term is referred as the hedging of real exchange rate risk.

The optimal hedging of real exchange rate risk depends on two forces going in opposite directions: when local goods are more expensive, consumers need to generate more income in order to stabilize their purchasing power. On the other hand, since local goods are more expensive, households could be better off consuming when goods are cheaper. The dominating effect depends on how much households want to smooth their consumption across states. For consumers sufficiently risk-averse ($\sigma > 1$), the former effect dominates and households want to increase their income when their consumption goods are more expensive. Thus, they build their portfolio by choosing assets with a high pay-off when local goods are expensive. For the log-investor ($\sigma = 1$), the two effects cancel out and the hedging term disappears.

General Equilibrium Zero-Order Portfolios

Note that equation (18) is a partial equilibrium expression. In general equilibrium macro models, the above variance/covariance terms can be expressed as a function of the underlying parameters of the model. Since labor income and dividends are a constant share of output ((6) and (7)), relative labor income ($\widehat{w_t l_t}$) and dividends ($\widehat{d_t}$) are equal and given by: $\widehat{w_t l_t} = \widehat{d_t} = \widehat{q_t} + \widehat{y_t}$.

Substituting into (17) and using (15) gives:

$$(19)\quad \left(1 - \frac{1}{\sigma}\right)(2a-1)\,\widehat{q_t} = \{(1-\alpha) + \alpha(2S-1)\}(\widehat{q_t} + \widehat{y_t}) = \{(1-\alpha) + \alpha(2S-1)\}(1-\lambda)\widehat{q_t}.$$

The asset structure supports full risk-sharing, up to first-order, if (19) holds for all realizations of the (relative) exogenous productivity shocks ($\widehat{\theta_t}$) (or equivalently all realizations of the terms-of-trade $\widehat{q_t}$). The following portfolio S ensures that (19) holds for arbitrary realizations of $\widehat{q_t}$:

$$(20)\quad S = \frac{1}{2} - \frac{1}{2}\frac{(1-\alpha)}{\alpha} - \frac{1}{2}\left(1 - \frac{1}{\sigma}\right)\frac{(2a-1)}{\alpha(\lambda-1)}.$$

The equilibrium portfolio is the sum of three terms:

(i) The first term $\frac{1}{2}$ is a pure diversification term. It would prevail if there were no hedging motives as in Lucas (1982). In the absence of heterogeneity across investors, there is full diversification of national output risk. We derive the Lucas portfolio when $\alpha \to 1$ (no human capital risk) and when $a = 1/2$ (no real exchange rate risk).

(ii) The second term $-\frac{1}{2}\frac{(1-\alpha)}{\alpha}$ is the hedging of nontradable income risk (as in Baxter and Jermann (1997)): changes in output driven by productivity shocks are shared in constant proportion (Cobb–Douglas production). This leads to a perfect correlation between labor incomes and capital incomes: households should short the local stock to hedge human capital risk. Note that in the present model, the portfolio is exactly the one of Baxter and Jermann (1997) in the absence of real exchange rate risk ($a = 1/2$).

(iii) The third term $-\frac{1}{2}(1-\frac{1}{\sigma})\frac{(2a-1)}{\alpha(\lambda-1)}$ is the hedging of real exchange rate risk. This term is the same as the one derived in Coeurdacier (2009) and Kollmann (2006b) in the absence of human capital risk ($\alpha \to 1$). This term cancels out for a log-investor ($\sigma = 1$). As explained above (see equation 18), investors bias their portfolio toward equities that have high returns when local goods are more expensive (if $\sigma > 1$). The appropriate portfolio depends on the value of λ i.e., on the elasticity of substitution ϕ. Three different cases emerge:

(a) $\lambda > 1$ (i.e., an elasticity of substitution ϕ roughly above unity): the hedging of real exchange rate risk generates a Foreign equity bias. The reason is the following: a (relative) fall in local output driven by a bad productivity shock triggers a moderate increase in the Home terms-of-trade, a moderate appreciation of the Home real exchange rate together with a decrease in Home equity returns: Foreign equities are more valuable since they have higher (relative) returns despite the Home real exchange rate appreciation.

(b) $\lambda < 1$ (i.e., elasticity of substitution ϕ, roughly below unity): a (relative) fall in local output triggers a stronger improvement of the Home terms-of-trade and a stronger appreciation of the Home real exchange rate. As the relative price response is stronger, Home equity excess returns increase. Home investors exhibit Home equity bias as Home equity have higher returns when the Home real exchange rate appreciates. This is the case emphasized by Kollmann (2006b).

(c) $\lambda = 1$: Any increase in local output is perfectly offset by a fall in the terms-of-trade. Both equities are perfect substitutes and there is portfolio indeterminacy. This is an extension of Cole and Obstfeld's (1991) result.

4.1.3 *Related Literature Hedging Real Exchange Rate Risk*

As appears clearly in the previous model, optimal portfolios are structured to hedge the risk arising from real exchange rate

fluctuations. This is at the heart of the potential divergence of portfolios across investors in the partial equilibrium portfolio choice models with real exchange rate risk. The key issue is whether local equities are a good hedge against relative price (real exchange rate) fluctuations, i.e., whether local equities have higher returns when local goods are (relatively) more expensive. If this is the case, then local investors should favor local equities. Early examples of this hypothesis are Solnik (1974), Adler and Dumas (1983), Krugman (1981), Braga de Macedo (1983), de Macedo, Goldstein, and Meerschwam (1985) and Stulz (1981). Cooper and Kaplanis (1994) start with the premise that for equity home bias to be rooted in a desire to hedge against relative inflation, equity returns need to be positively correlated with inflation. They test for such a correlation and reject it for all countries considered. These early papers take relative prices (and the real exchange rate) and asset returns as given while in the present model and, more generally in the recent Open Economy Financial Macroeconomics, the dynamics of goods prices and asset returns is endogenous, as is the covariance between the two.

In the more recent literature, some contributions focus on the hedging of the relative price of tradables (terms-of-trade, as in the present model) and some focus on the hedging of the relative price of nontradable goods. In their influential contribution, Obstfeld and Rogoff (2001) argue that trade costs in goods markets help to solve the equity home bias puzzle. The above model (in line with Coeurdacier 2009)[14] shows the opposite result for most parameter values (in particular for ϕ and σ above unity). Indeed, in Obstfeld and Rogoff (2001), the coefficient of risk aversion is below unity (and equal to the inverse of the elasticity of substitution between the two goods), which allows to solve the model in closed-form. With such preferences, agents prefer to hold local equities which pay less when local consumption is expensive. A similar point is made by Uppal (1993) in a two-country/one-good model in continuous time with trade costs: he shows that home bias only arises for the coefficient of relative risk aversion smaller than one. One can potentially restore the argument of Obstfeld and Rogoff (2001) in the present model if σ is above 1 but the elasticity of substitution between goods ϕ is below unity. In that case, a fall in Home supply triggers a very large increase in the Home terms-of-trade such that Home equity returns are high when prices of Home goods are high. Hence, investors would rather hold local equities (see Kollmann 2006b). In this class of models, equity home bias relies on the response of relative prices, i.e., on the elasticity of substitution between local and foreign products. While time series macro data estimating the response of trade to exchange rate changes suggests a low elasticity of substitution, between 0.5 and 1.5 (see Hooper and Marquez 1995, Backus, Kehoe, and Kydland 1994, and Heathcote and Perri 2002), bilateral sectoral trade data suggests a large elasticity—above 5 for most sectors (see Harrigan 1993, Hummels 2001 and Baier and Bergstrand 2001 among others).[15] The parameter uncertainty makes it hard to get a conclusive answer from this class of models. It is also important to note that output fluctuations in all these classes of models are driven by supply shocks. In the presence of demand shocks, equilibrium portfolios could turn out to be different: when local demand

[14] The model presented features home bias in preferences instead of trade costs. A functional transformation of trade costs would however make the two types of models isomorphic.

[15] Imbs and Mejean (2009) claim that the discrepancy between macro and micro estimates comes from an aggregation bias; correcting for this bias, they find an elasticity of up to 7.

is high, both prices of local goods and payoffs of local firms increase. Hence, demand shocks can generate positive comovements between local equity returns and the price of local goods (see Pavlova and Rigobon 2007). In order to be able to consume when demand is high, local investors would prefer local equities.

Similarly, the presence of nontradable consumption exposes domestic agents to real exchange rate risk (driven by fluctuations in the relative price of nontradable goods). Stockman and Dellas (1989) develop a two-country model with endowment economies. Each country has random endowments of a (single) traded good and a nontraded good. There is trade in equities of tradable and nontradable goods firm. With utility separable in tradable and nontradable consumption, optimal portfolios imply that domestic agents hold all of the equity of domestic nontradable firms. By holding all of the equity of nontraded goods, domestic agents hold an asset whose return is perfectly correlated with their expenditure on nontraded goods. Domestic agents hold the same share of Home and Foreign equity of tradable firms, implying perfect diversification in the tradable sector as in Lucas (1982). Thus, this model generates home bias in equity positions, and the home bias increases in the share of nontradable consumption in total output. Various papers have extended this framework to more general preferences, investigating in particular the nonseparability between tradable and nontradable consumption together with multiple tradable goods (see Baxter, Jermann, and King 1998, Serrat 2001,[16] Obstfeld 2007, Matsumoto 2007, and Collard et al. 2007).[17] In these papers, the presence of nontradable consumption interacts with tradable consumption and some degree of home bias in nontradable equities obtains. The precise structure of portfolios is strongly dependent on preference parameters, in particular the substitution elasticities between tradable and nontradable goods (and also between domestic and foreign tradable goods). The mechanism at the heart of the home bias toward nontradable equity is however essentially similar to the one described in the previous model: investors want to hold equities whose payoff is high when the real exchange rate appreciates, i.e., when the consumption of nontradable goods is expensive. It turns out that for a sufficiently low elasticity of substitution between tradable and nontradable goods (roughly below unity as found in the empirical literature),[18] a fall in local nontradable output implies a strong increase in the relative price of nontradable goods together with an increase in local nontradable equity returns: hence, local nontradable equity returns comove positively with the price of nontradable goods (and the real exchange rate), leading to local equity bias in that sector.

On the empirical front, Pesenti and van Wincoop (2002) derive an expression that relates home bias to the correlation between equity returns and nontradable consumption

[16] See also Kollmann (2006a) for a comment.

[17] In earlier work, Eldor, Pines, and Schwartz (1988), in a general equilibrium model, study n countries, each producing a nontradable good and the single tradable good that is consumed in all countries. The assets traded are "real equities" for the tradable and nontradable good. Tradable equities pay one unit of the traded good in each state of the world, while nontradable equity pays out θ units of the nontradable good, where θ is state contingent nontradable output. They point out that for home bias to arise the returns of nontraded equities have to be positively correlated with the price of the nontradable good and derive conditions for the risk aversion parameter, the price elasticity of demand for tradable goods and the income elasticity of demand for tradable goods such that it would be the case.

[18] Typical values used for the elasticity of substitution between tradable and nontradable goods are: 0.44 (Stockman and Tesar 1995), 0.74 (Mendoza 1995), from 0.6 to 0.8 (Serrat 2001). Ostry and Reinhart (1992) provide estimates for developing countries in the range of 0.6 to 1.4. See Matsumoto (2007) for a more detailed discussion.

growth[19] and using data on fourteen OECD countries from 1970 to 1993, they find that, on average, nontradable consumption growth is positively correlated with the return on domestic capital. This would imply that home bias would arise if tradables and nontradable goods are complementary. The authors find, however, that even in those cases, hedging nontradable consumption could at best explain a relatively small fraction of the home bias observed in the data. Overall, there are two empirical difficulties with an explanation of the equity home bias relying on the presence of a nontradable sector. The first one is that the structure of portfolios is strongly dependent on preference parameters, which are not easy to estimate. The second one is that the home bias result relies on the ability of investors to hold separate claims on tradable and nontradable output: as most products contain both tradable and nontradable components, shares of firms automatically involve joint claims on tradables and nontradables. This difficulty is made all the more relevant by the fact that, when agents are allowed to trade separate claims on tradable and nontradable output, optimal equity positions are very different across the two sectors. This different structure of portfolios across traded and nontraded sectors seems inconsistent with casual empiricism as argued by Lewis (1999). More broadly, empirical analysis of this channel is also hindered by the difficulty to identify precisely nontradable consumption and tradable/nontradable equity.

There is yet another major empirical issue faced by this explanation of home bias. The hedging of real exchange rate risk leads to equity home bias if local equities have higher returns (than abroad) when local prices are higher (than abroad). In other words, equity home bias appears if excess local equity returns (over foreign) increase when the real exchange rate appreciates (the term $\frac{\mathrm{cov}(\widetilde{RER}, \widetilde{d}_t)}{\mathrm{var}(\widetilde{d}_t)}$ in equation 18). As shown by van Wincoop and Warnock (2010), the empirical correlation between excess equity returns and the real exchange rate is very low, too low to explain observed equity home bias. Furthermore, most of the fluctuations in the real exchange rate represent fluctuations in the nominal exchange rate: as explained in section 4.2, these could be hedged using positions in the forward currency market or the currency bond market. In other words, equities do not seem empirically to be an appropriate asset to insure investors against real exchange rate fluctuations. Hence, while these models are theoretically appealing, it is doubtful that the hedging of real exchange rate risk can account empirically for the equity home bias.

Hedging Nontradable Income Risk

In our model (see equation 18), hedging nontradable income risk implies picking stocks which have higher payoffs when labor income is low. The focus of the literature has been twofold: first, from a theoretical perspective, it has discussed the conditions under which standard macroeconomic models imply a negative or positive correlation between local equity returns and returns to nontradable wealth. Second, from an empirical perspective, a series of papers have provided estimates of the covariance between relative equity returns and relative returns to human wealth which is the key empirical counterpart of portfolio biases in this class of models.

The most influential contribution on these matters is Baxter and Jermann (1997), who argue that the presence of nontradable income risk worsens the equity home bias puzzle. Their argument goes as follows: in a standard multicountry real business cycle

[19] Their model also includes leisure, which drives another hedging motive.

model with a single tradable good and a Cobb–Douglas production function, changes in output are shared in constant proportion between capital and labor. Hence, labor and capital incomes are perfectly correlated. As investors are already strongly exposed to domestic risk due to their labor income, they should not hold local capital. Due to the relatively large labor share in all countries, the effects of hedging domestic human capital dominates the benefits of diversification: investors should short-sell local equities (term $-\frac{1}{2}\frac{1-\alpha}{\alpha}$ in equation 20). Hence, the equity home bias puzzle is worse than we think! The authors estimate a vector error correction model that allows the correlation between labor and capital returns to vary over time and be imperfect, while maintaining the assumption that the ratio of labor to capital income is stationary. Using data from the OECD National Accounts (1994) for Japan, the United Kingdom, Germany, and the United States for 1960–93, they find that within countries, labor and capital returns are highly correlated, while the correlation between domestic labor returns and foreign equity returns is quite low. Using the observed correlations, the authors then construct diversified portfolios and find that the optimal position in domestic equity is negative in all the countries considered.

Their empirical findings have been challenged by a series of papers. Bottazzi, Pesenti, and van Wincoop (1996) use a continuous time VAR model of portfolio choice and data on a large set of OECD countries and find that returns to domestic capital and human capital are negatively correlated for most countries but the United States and this can explain a fraction of equity home bias in these countries. Julliard (2002) argues that the Baxter and Jermann's (1997) empirical findings are due to an econometric misspecification: the correlation between returns to human capital and local equity returns is overstated because they implicitly assume that innovations to capital and labor incomes are independent across countries. Once the misspecification is corrected, considering human capital risk does not unequivocally worsen the home bias puzzle. Using micro-level data, Massa and Simonov (2006) show that nonfinancial income is uncorrelated with the market portfolio of financial assets, but actual investors' portfolios (which differ from the market portfolio) are more positively correlated with nonfinancial income than the market portfolio is. Thus, the authors cast doubt on the rationality of investors and on their desire to hedge nontradable income risk.

From a theoretical perspective, Heathcote and Perri (2007) show that Baxter and Jermann's (1997) result relies on very strong assumptions: one single and perfectly tradable good and a fixed capital stock. Relaxing those assumptions (in a two-country/two-good international real business cycle model à la Backus, Kehoe, and Kydland 1994) and introducing differentiated product across countries together with consumption/investment home bias changes drastically the picture and helps solve the EHB puzzle. Their result relies on two key elements: endogenous capital accumulation and a strong adjustment of relative prices.[20] The main intuition is the following. Suppose a positive (persistent) productivity shock hits the Home economy. This leads to:

(i) a fall in the relative price of Home goods (Foreign goods are scarcer).

(ii) an increase in Home investment (more than abroad) as Home investment uses more intensively cheaper Home goods (due to home bias in investment spending).

[20] Endogenous capital accumulation is crucial: despite multiple goods, Baxter and Jermann's (1997) results would survive if capital is fixed.

(iii) an increase in Home wages (more than abroad) and in the Home returns to nontradable wealth.

(iv) a decrease in the returns on Home capital (relative to Foreign) if the (relative) price response of Home goods is strong enough.

The main difference with Baxter and Jermann (1997) is the last point (iv): if the market price of Home goods falls sufficiently and Home investment is increasing, dividends distributed by Home firms (which are net of investment) are lower than abroad, and so are Home returns to capital. Hence the model generates negative comovements between Home (excess) returns to human wealth and Home (excess) returns to capital: hedging nontradable income risk implies home equity bias. Home bias in investment/consumption spending is important as it triggers a stronger response of investment at Home, thus a larger fall of Home dividends and a larger increase of Home wages. Importantly, the model generates a positive link between consumption home bias and equity home bias as found in the data.[21] Note that Heathcote and Perri (2007) focus on log-utility and unitary elasticity of substitution between Home and Foreign goods. Increasing the level of risk aversion introduces a real exchange rate risk motive as in Coeurdacier (2009) and Kollmann (2006b). Increasing the elasticity of substitution reduces the response of relative prices and makes the portfolio converge toward the one of Baxter and Jermann (1997).

4.2 *Hedging Motives in a Benchmark Model with Multiple Asset Classes (Bonds and Equities)*

4.2.1 *Hedging with Bond and Equities: The Role of "Conditional Risk"*

The first generation of papers presented above focus on equity positions to rationalize home bias. However, equities are only part of financial assets traded internationally. Debt securities (nominal bonds in different currencies, corporate bonds, bank deposits, . . .) are instruments that can also be used to share risks internationally (see section 7). They should not be excluded from our models, first for realism, since they constitute a large share of international asset flows but above all because there might be substitution across asset classes. Hence, equity positions derived in *equity only* models might be sensitive to the presence of other financial assets. Recent models with portfolio decisions have incorporated multiple assets (*equities and bonds*) to have more robust and realistic predictions.[22] Nominal bond returns differentials across countries are (almost) perfectly correlated with the real exchange rate (in developed countries, fluctuations in the nominal exchange rate account for most of the fluctuations in the real exchange rate). Hence, bonds are better suited than equities to hedge real exchange rate risk. But this is not the end of the story. The presence of bonds also affects the hedging properties of equities for nontradable income risk. Equities are used to hedge sources of risks that cannot be hedged through the bond positions, in particular the part of nontradable income risk that is orthogonal to bond returns. In

[21] Lane (2000), Aizenman (2004), and Heathcote and Perri (2007), among others, show a positive relationship between trade openness and foreign equity holdings looking at a cross section of countries. Portes and Rey (2005), Aviat and Coeurdacier (2007), and Lane and Milesi-Ferretti (2008) show that country equity portfolios are strongly biased toward trading partners.

[22] As described in section 4.2.5, recent contributions with multiple asset classes include Engel and Matsumoto (2009a, 2009b), Coeurdacier, Kollmann, and Martin (2008 and 2010), Coeurdacier and Gourinchas (2011), Berriel and Bhattarai (2008), and Devereux and Sutherland (2007 and 2008).

this new literature, the optimal equity position depends therefore on the correlation of returns on equity with returns on nontradable income, conditional on bond returns.

4.2.2 *Set-up of the Model*

We use a similar set up as in section 4.1 but we add two important ingredients to formalize our above discussion on hedging motives: *endogenous capital accumulation and trade in real bonds*. They allow us to overcome the limitations of the model presented in 4.1: first, endogenous investment in a two-good model breaks the perfect link between returns on physical capital and returns on human capital; second, bond trading modifies the hedging properties of equities. Bonds will be used to hedge fluctuations in the real exchange rate. Equities will be used to hedge nontradable income risk, conditionally on bond returns. This model is similar Coeurdacier, Kollmann, and Martin (2010), which extends Heathcote and Perri (2007) to multiple asset classes (bonds and equities).

In presence of productivity shocks only, we would face a portfolio indeterminacy in a first-order approximation of the nonportfolio equations since the number of available assets (bonds and equities in each country) would exceed the exogenous sources of uncertainty. We have to add an additional source of uncertainty. We choose to add shocks to the disutility of leisure for simplicity. As explained in Coeurdacier, Kollmann, and Martin (2010) and Coeurdacier and Gourinchas (2011), the nature of the additional shock used to alleviate portfolio indeterminacy is irrelevant for the portfolio and results would survive with other shocks commonly used (shocks to investment à la Greenwood, Hercowitz, and Huffman 1988, depreciation shocks, shocks to capacity utilization . . .).[23]

Hence, preferences are now defined by

$$(21)\quad E_0 \sum_{t=0}^{\infty} \beta^t \left(\frac{C_{i,t}^{1-\sigma}}{1-\sigma} - \chi_{i,t} \frac{l_{i,t}^{1+\omega}}{1+\omega} \right),$$

where $\chi_{i,t}$ is an exogenous shock to the disutility of labor.

Technologies and Capital Accumulation

As before, production in each country uses capital and labor with a Cobb–Douglas production function:

$$(22)\qquad y_{i,t} = \theta_{i,t}(k_{i,t})^{\alpha}(l_{i,t})^{1-\alpha}.$$

The law of motion of the capital stock is:

$$(23)\qquad k_{i,t+1} = (1-\delta)k_{i,t} + I_{i,t},$$

where $0 < \delta < 1$ is the depreciation rate of capital. $I_{i,t}$ is gross investment in country i at date t. In both countries, gross investment is generated using Home and Foreign inputs:

$$(24)\quad I_{i,t} = [a^{1/\phi}(i_{i,t}^{i})^{(\phi-1)/\phi} + (1-a)^{1/\phi}(i_{j,t}^{i})^{(\phi-1)/\phi}]^{\phi/(\phi-1)},$$

$$j \neq i,$$

where $i_{j,t}^{i}$ is the amount of good j used for investment in country i. We assume local bias for investment spending (identical to the one for consumption),[24] $\frac{1}{2} < a < 1$. The associated investment price index is the same as for consumption $P_{i,t}$ (see equation 4).

[23] Obviously, a different shock will have different business cycles implications but we are presently not interested in those.

[24] See Coeurdacier, Kollmann, and Martin (2010) and Castello (2009) for a model where bias in investment spending is different from the bias in consumption spending.

Firms' Decisions

A share $1-\alpha$ of output at market prices is paid to workers as in equation (6). A share α of country i output, *net of physical investment spending* is paid as a dividend $d_{i,t}$ to shareholders:

$$d_{i,t} = \alpha p_{i,t} y_{i,t} - P_{i,t} I_{i,t}. \tag{25}$$

The firm chose $I_{i,t}$ to equate the expected future marginal gain of investment to the marginal cost. This implies the following first-order condition:[25]

$$P_{i,t} = \beta E_t\big[(C_{i,t+1}/C_{i,t})^{-\sigma}(P_{i,t}/P_{i,t+1}) \times [p_{i,t+1}\theta_{i,t+1}\alpha k_{i,t+1}^{\alpha-1} l_{i,t+1}^{1-\alpha} + (1-\delta)P_{i,t+1}]\big]. \tag{26}$$

The firm chooses the Home and Foreign investment inputs $i_{i,t}^i, i_{j,t}^i$ that minimize the cost of generating $I_{i,t}$. This leads to the following intratemporal allocation for investment goods:

$$i_{i,t}^i = a\left(\frac{p_{i,t}}{P_{i,t}^I}\right)^{-\phi} I_{i,t}, \tag{27}$$

$$i_{j,t}^i = (1-a)\left(\frac{p_{j,t}}{P_{i,t}}\right)^{-\phi} I_{i,t}, \quad j \neq i.$$

Financial Markets and Instantaneous Budget Constraint

There is now international trade in stocks and (real) bonds. Stocks in country i represents a claim to its stream of dividends $\{d_{i,t}\}$. There is a bond denominated in the Home good, and a bond denominated in the Foreign good. Buying one unit of the Home (Foreign) bond in period t gives one unit of the Home (Foreign) good in all future periods. Both bonds are in zero net supply. We denote by $S_{j,t+1}^i$ the number of shares of stock j held by country i at the end of period t, while $B_{j,t+1}^i$ represents claims held by country i (at the end of t) to future unconditional payments of good j. At date t, the country i household now faces the following budget constraint:

$$\begin{aligned} P_{i,t} C_{i,t} + p_{i,t}^S S_{i,t+1}^i + p_{j,t}^S S_{j,t+1}^i \\ + p_{j,t}^B B_{j,t+1}^i + p_{i,t}^B B_{i,t+1}^i \\ = w_{i,t} l_{i,t} + (d_{i,t} + p_{i,t}^S) S_{i,t}^i \\ + (d_{j,t} + p_{i,t}^S) S_{j,t}^i \\ + (p_{i,t} + p_{i,t}^B) B_{i,t}^i \\ + (p_{j,t} + p_{j,t}^B) B_{j,t}^i, \quad j \neq i, \end{aligned} \tag{28}$$

where $p_{i,t}^S$ is the price of stock i and $p_{i,t}^B$ is the price of bond i.

Household Decisions and Market Clearing Conditions

Households' first-order conditions for that decision problem are still given by (9) and (10). One needs to add the Euler equations for the two bonds:

$$1 = E_t \beta \left(\frac{C_{i,t+1}}{C_{i,t}}\right)^{-\sigma} \frac{P_{i,t}}{P_{i,t+1}} \frac{p_{j,t+1}^B + p_{j,t+1}}{p_{j,t}^B} \quad \text{for } j = H, F. \tag{29}$$

Market-clearing in goods and asset markets now requires:

$$\begin{aligned} c_{H,t}^H + c_{H,t}^F + i_{H,t}^H + i_{H,t}^F = y_{H,t}, \\ c_{F,t}^F + c_{F,t}^H + i_{F,t}^F + i_{F,t}^H = y_{F,t}, \end{aligned} \tag{30}$$

$$\begin{aligned} S_{H,t}^H + S_{H,t}^F = S_{F,t}^F + S_{F,t}^H = 1, \\ B_{H,t}^H + B_{H,t}^F = B_{F,t}^F + B_{F,t}^H = 0. \end{aligned} \tag{31}$$

[25] Note that we use the intertemporal marginal rate of substitution of the country i household for investment decisions in country i. This assumption is however irrelevant here since up-to the degree of the approximation, the intertemporal marginal rate of substitution of the country i household and the country j household are the same.

4.2.3 *Zero-Order Equilibrium Portfolios*

As in section 4.1, equilibrium portfolio holdings $(S^i_{i,t+1}, S^i_{j,t+1}, B^i_{i,t+1}, B^i_{j,t+1})$ can be determined by linearizing the model around its deterministic steady state. With the asset structure here (four assets with four exogenous shocks), efficient risk sharing can be replicated up to the first-order (locally complete markets).

Linearization of the Model

We use the same notation as in section 4.1. Equations 13 and 14 still hold.

Linearization of the relative demand for investment $y_{I,t} \equiv \frac{i^H_{H,t} + i^F_{H,t}}{i^F_{F,t} + i^H_{F,t}}$ gives (using the intratemporal allocation across investment goods (27)):

$$(32)\quad \widehat{y_{I,t}} = -\phi\left(1-(2a_I-1)^2\right)\widehat{q}_t + (2a-1)\widehat{I}_t,$$

where $I_t \equiv I_{H,t}/I_{F,t}$ is relative real aggregate investment. Holding constant the terms of trade, the relative demand for Home investment goods, $y_{I,t}$, increases with relative real investment in the Home country, I_t, since Home aggregate investment is biased toward the Home good ($a > \frac{1}{2}$).

The relative demand for consumption $\widehat{y_{C,t}}$ is still defined by (from (15)):

$$(33)\quad \widehat{y_{C,t}} = -\left[\phi(1-(2a-1)^2) + (2a-1)^2\frac{1}{\sigma}\right]\widehat{q}_t \equiv -\lambda\widehat{q}_t.$$

The market clearing condition for goods (30), together with (32) and (33) implies:

$$(34)\quad (1-s_I)\widehat{y_{C,t}} + s_I\widehat{y_{I,t}} = -\mu\widehat{q}_t + s_I(2a_I-1)\widehat{I}_t = \widehat{y}_t,$$

where

$\mu = \phi(1-(2a-1)^2) + (1-s_I)\frac{(2a-1)^2}{\sigma} > 0$ and $s_I \equiv \frac{P^I_H I_H}{p_H y_H} = \frac{P^I_F I_F}{p_F y_F}$ is the steady-state investment/GDP ratio.

Not surprisingly, Home terms of trade worsen when the relative supply of Home goods increases, for a given amount of relative Home country investment. Home terms of trade improve when Home investment rises (due to home bias in investment spending), for a given value of the relative Home/Foreign output.

Ex ante symmetry implies that the zero-order portfolios have to satisfy the following conditions: $S \equiv S^H_H = S^F_F = 1 - S^F_H = 1 - S^H_F$; $B \equiv B^H_H = B^F_F = -B^F_H = -B^H_F$. The pair $(S; B)$ thus describes the (zero-order) equilibrium portfolio. B denotes a country holdings of bonds denominated in its local good. $B > 0$ means that a country is long in local-good bonds (and short in foreign good bonds).

As before, there exists a unique portfolio $(S; B)$ that satisfies the following "static" budget constraint, for consumptions that are consistent with the linearized risk sharing condition (14):

$$(35)\quad P_{i,t}C_{i,t} = w_{i,t}l_{i,t} + Sd_{i,t} + (1-S)d_{j,t} + B(p_{i,t} - p_{j,t}), \quad \text{for } i = H, F.$$

Country i's efficient consumption spending at date t equals date t wage income, $w_{i,t}l_{i,t}$, plus the financial income generated by the portfolio $(S; B)$.

Subtracting the "static" budget constraint of country F from that of country H and linearizing gives:[26]

[26] We assume $\alpha > s_I$ to have strictly positive dividends in the steady state.

$$(36)\quad (1-s_I)(\widehat{P_{H,t}C_{H,t}} - \widehat{P_{F,t}C_{F,t}})$$
$$= (1-s_I)\left(1-\frac{1}{\sigma}\right)\underbrace{(2a-1)\,\widehat{q}_t}_{\widehat{RER}_t}$$
$$= (1-\alpha)\widehat{w_t l_t} + (2S-1)(\alpha - s_I)\widehat{d}_t + 2b\,\widehat{q}_t,$$

where $b = \frac{B}{\bar{y}}$ denotes holdings of debt denominated in local good, divided by steady-state GDP.

Partial Equilibrium Zero-Order Portfolios

Like in the previous model, one can derive from the "static" budget constraint (36) a partial equilibrium portfolio that expresses the hedging terms in terms of covariance–variance ratios. This expression holds in a large class of models with bonds and equities.

Projection of (36) on $\widehat{d}_t$ and $\widehat{q}_t$ gives the following expression for the portfolio of bonds and equities (S, b):

$$(37)\quad S = \frac{1}{2}\left[1 - \frac{1-\alpha}{\alpha - s_I}\frac{\mathrm{Cov}_{\hat{q}}(\widehat{w_t l_t}, \widehat{d}_t)}{\mathrm{Var}_{\hat{q}}(\widehat{d}_t)} + \left(1-\frac{1}{\sigma}\right)\left(\frac{1-s_I}{\alpha - s_I}\right)\frac{\mathrm{Cov}_{\hat{q}}(\widehat{RER}_t, \widehat{d}_t)}{\mathrm{Var}_{\hat{q}}(\widehat{d}_t)}\right]$$

$$(38)\quad b = \frac{1}{2}\left[(1-s_I)\left(1-\frac{1}{\sigma}\right)\frac{\mathrm{Cov}_{\hat{d}}(\widehat{RER}_t, \widehat{q}_t)}{\mathrm{Var}_{\hat{d}}(\widehat{q}_t)} - (1-\alpha)\frac{\mathrm{Cov}_{\hat{d}}(\widehat{w_t l_t}, \widehat{q}_t)}{\mathrm{Var}_{\hat{d}}(\widehat{q}_t)}\right],$$

where $\mathrm{Cov}_{\widehat{z}_t}(\widehat{x}_t, \widehat{y}_t)$ is the covariance between $\widehat{x}_t$ and $\widehat{y}_t$ conditional on the pay-off $\widehat{z}_t$.

The bond and equity portfolios depend on the hedging of the two sources of risk: real exchange rate risk $(\widehat{RER}_t)$ and nontradable income risk $(\widehat{w_t l_t})$. Each portfolio (S and b) is structured such that investors exploit covariances of the assets payoffs with the two sources of risk. However, there is a key difference with the previous model with equities: the covariance of asset payments with the real exchange rate risk and labor income risk is conditional on payments of the other assets. This finding has two main implications.

First, real exchange rate hedging is done via the bond position since bond return differentials across countries are almost perfectly correlated with the real exchange rate (see Coeurdacier and Gourinchas 2011). In the present model with real bonds, the correlation is perfect and the real exchange rate hedging term on the equity position $\left(\mathrm{Cov}_{\hat{q}}(\widehat{RER}_t, \widehat{d}_t)/\mathrm{Var}_{\hat{q}}(\widehat{d}_t)\right)$ will be exactly zero.

Second, while the covariance of local equity returns with returns on nontradable wealth can be positive (as in Baxter and Jermann 1997), this has no implication for the equity portfolio, only the covariance conditional on bond returns matters. As discussed below, it turns out that the latter tends to be negative in the data.

General Equilibrium Zero-Order Portfolios

We now turn to the zero-order portfolio as a function of the model parameters. Relative labor income $(\widehat{w_t l_t})$ is still given by: $\widehat{w_t l_t} = \widehat{q}_t + \widehat{y}_t$. Due to the presence of endogenous investment, relative dividends $(\widehat{d}_t)$ are now given by (using (25)):

$$(39)\quad \widehat{d}_t = \frac{\alpha}{\alpha - s_I}(\widehat{q}_t + \widehat{y}_t) - \frac{s_I}{\alpha - s_I}(\widehat{P_{H,t}I_{H,t}} - \widehat{P_{F,t}I_{F,t}})$$
$$= \frac{\alpha}{\alpha - s_I}(\widehat{q}_t + \widehat{y}_t) - \frac{s_I}{\alpha - s_I}\left((2a-1)\,\widehat{q}_t + \widehat{I}_t\right).$$

Hence, using (34), we can reexpress (36) as follows:

$$(40)\quad (1-s_I)\left(1-\frac{1}{\sigma}\right)(2a-1)\,\widehat{q}_t$$
$$= [(1-\alpha)+\alpha(2S-1)]((1-\mu)\widehat{q}_t$$
$$+ s_I(2a-1)\widehat{I}_t)$$
$$- s_I(2S-1)[(2a-1)\,\widehat{q}_t+\widehat{I}_t]+2b\widehat{q}_t.$$

The asset structure supports full risk sharing, up to first-order, if (40) holds for all realizations of the two (relative) exogenous shocks $(\widehat{\theta}_t, \widehat{\chi}_t)$. To solve for that portfolio, we do not have to solve for output and investment, as a unique pair of terms of trade and relative real investment $(\widehat{q}_t, \widehat{I}_t)$ is associated with each realizations of $(\widehat{\theta}_t, \widehat{\chi}_t)$.

The following portfolio (S, b) ensures that (40) holds for arbitrary realizations of $(\widehat{q}_t, \widehat{I}_t)$:

$$(41)\quad S=\frac{1}{2}\left[1+\frac{(2a-1)(1-\alpha)}{1-(2a-1)\alpha}\right]>\frac{1}{2},$$

$$(42)\quad b=\frac{1}{2}\left[(1-s_I)\left(1-\frac{1}{\sigma}\right)(2a-1)\right.$$
$$\left.+\frac{(1-\alpha)\,[\mu-1+s_I(2a_I-1)^2]}{1-(2a-1)\alpha}\right].$$

The equity portfolio features home bias and is the sum of two terms only. The hedging-term for the real exchange rate is indeed zero in this model since relative price movements are fully hedged by the appropriate (real) bond position (cross-country differentials in bond payments are perfectly correlated with the real exchange rate).

(i) The first term $\frac{1}{2}$ is still the Lucas (1982) term which prevails in the absence of nontradable income risk $(\alpha \to 1)$

(ii) The second term $\frac{(2a-1)(1-\alpha)}{1-(2a-1)\alpha}$ is the hedging of nontradable income risk conditionally on bond payments: this term is unambiguously positive and drives home equity bias in the model. To understand this term, assume a combination of shocks $(\widehat{\theta}_t, \widehat{\chi}_t)$ such that relative investment $\widehat{I}_t$ increases but leaves the terms-of-trade (bond payments differential) $\widehat{q}_t$ unchanged. Such a combination of shocks will increase labor demand and labor incomes since investment spending is using more intensively local goods $(a > 1/2)$.[27] In the mean time, dividends net of investment spending are falling. This generates negative comovements between labor income and dividends *holding relative prices constant* (or equivalently conditional on bond payments differentials).

The equity portfolio is the same as in Heathcote and Perri (2007)[28] but holds for all values of the preference parameters. In their benchmark case, parameters are such that $\sigma = \phi = \mu = 1$. In that case, only fluctuations in investment matters for the equity portfolio, for two reasons: (i) fluctuations in output are hedged through terms-of-trade movements (as in Cole and Obstfeld 1991) due to $\mu = 1$; (ii) $\sigma = 1$ cancels out any real exchange rate hedging term. As a consequence, the equity portfolio is the same as in the present model. In contrast to the *equities-only* model, the equity portfolio in our model with bonds and equity is remarkably stable to changes in preference parameters (see Coeurdacier and Gourinchas 2011).

The bond portfolio b is also the sum of two terms:

[27] Note that with $a = 1/2$, this term is equal to zero since increases in domestic investment changes do not increase more domestic demand than foreign. Wages increase as much in both countries.

[28] They consider the same model but with equities and productivity shocks only.

(i) The first term $\frac{1}{2}(1-s_I)(1-\frac{1}{\sigma})(2a-1)$ is the hedging of real exchange rate risk. This is the desired exposure to real exchange rate in the absence of nontradable income risk ($\alpha \to 1$). This term is unambiguously positive since local bonds have higher payoffs when local goods are more expensive.

(ii) The second term $\frac{(1-\alpha)\left[\mu-1+s_I(2a_I-1)^2\right]}{1-(2a-1)\alpha}$ is the hedging of nontradable income risk conditionally on relative dividend payments: this term can be positive or negative. Roughly speaking, it is negative if relative wages are positively (resp. negatively) correlated with the terms-of-trade, which happens for low values of μ, i.e., low elasticity of substitution ϕ (resp. for high values of μ, i.e., high elasticity of substitution ϕ).

4.2.4 *Empirical Evidence on the Hedging of Nontradable Income Risk*

In order to show the relevance of conditioning for bond returns, we now present some empirical evidence on the hedging of nontradable risk (see Coeurdacier, Kollmann, and Martin 2010 for similar evidence[29]). The evidence is based on the expression of the portfolio in terms of variance/covariance ratio (equation 37)

We use national accounts data for G7 countries to compute the conditional covariance–variance ratio $\left(\mathrm{Cov}_{\hat{q}}(\widehat{w_t l_t}, \widehat{d_t})/\mathrm{Var}_{\hat{q}}(\widehat{d_t})\right)$ for each country. Data are quarterly over the period 1980Q1–2008Q3. Data are taken from OECD National Accounts Data and from the IFS for exchange rates and price indices (see Coeurdacier and Gourinchas 2011 for a precise description of the data). We compute relative labor income deviations $\widehat{w_t l_t}$ and relative dividend deviations $\widehat{d_t}$ for each country with respect to the other six countries (wages are computed for each country as the share of output going to labor and dividends are computed as the share of output going to capital net of investment spending).[30] Deviations are either first-difference of the variables or HP-filtered data (smoothing parameter 1600). We compute bond payments differentials $\hat{q}$ using the (trade-weighted) real exchange rate of one country with respect to the other six. Note that results are virtually the same when using nominal exchange rate instead of the real exchange rate (i.e., considering nominal bonds instead of real bonds). We also report the unconditional covariance–variance ratio $\left(\mathrm{Cov}(\widehat{w_t l_t}, \widehat{d_t})/\mathrm{Var}(\widehat{d_t})\right)$, the one that matter in an *equity-only* model (see equation 18). As shown in table 2, conditioning for exchange rate movements has a strong impact on the hedging properties of equities for nontradable income risk: unconditionally (lines 1 and 3), wages and dividends comove positively for all countries, which would lead to a large foreign equity bias in the equity-only model of section 4.1. Conditionally (lines 2 and 4, wages and dividends comove negatively for all countries, which lead to a home equity bias in our equity-bond model. The presence of bonds makes the international diversification puzzle better than you think, both in the model and in the data!

4.2.5 *Related Literature*

Coeurdacier and Gourinchas (2011) show, in a two-country, two-good, two-period endowment economy with trade in equities and bonds, how bond trading cast doubt on earlier findings of *equities only* models. They show that in many theoretical environments,

[29] In a revised version, Heathcote and Perri (2007) also provides similar empirical evidence.

[30] We follow Gollin (2002) to allocate mixed-incomes from the national accounts to labor or capital. We assume that the share of mixed income going to labor is equal to the share of labor income in value added.

TABLE 2
The Hedging of Nontradable Risk: Conditional and Unconditional Covariance-Variance Ratios

		CA	FR	GE	IT	JP	UK	US
(1)	$\frac{\mathrm{Cov}(\widehat{w_t l_t}, \widehat{dt})}{\mathrm{Var}(\widehat{dt})}$	0.16	0.28	0.32	0.58	0.42	0.49	0.37
		(0.041)	(0.064)	(0.067)	(0.065)	(0.052)	(0.057)	(0.065)
(2)	$\frac{\mathrm{Cov}_{\hat{q}}(\widehat{w_t l_t}, \widehat{dt})}{\mathrm{Var}_{\hat{q}}(\widehat{dt})}$	−0.015	−0.128	−0.095	−0.076	−0.080	−0.122	−0.051
		(0.014)	(0.015)	(0.025)	(0.030)	(0.019)	(0.026)	(0.020)
(3)	$\frac{\mathrm{Cov}(\widehat{w_t l_t}, \widehat{dt})}{\mathrm{Var}(\widehat{dt})}$	0.08	0.47	0.33	0.33	0.46	0.39	0.55
		(0.035)	(0.085)	(0.073)	(0.031)	(0.045)	(0.043)	(0.075)
(4)	$\frac{\mathrm{Cov}_{\hat{q}}(\widehat{w_t l_t}, \widehat{dt})}{\mathrm{Var}_{\hat{q}}(\widehat{dt})}$	−0.032	−0.139	−0.135	−0.011	−0.097	−0.084	−0.070
		(0.009)	(0.023)	(0.031)	(0.015)	(0.015)	(0.018)	(0.022)

Notes: (1) and (2): in first-difference; (3) and (4): HP filter. Standard errors in parentheses.

Sources: Authors' computations. OECD National Accounts Statistics and International Financial Statistics.

bonds are an excellent hedge for real exchange rate fluctuations. They provide evidence in line with table 2 based on returns data. Using data on G7 countries, they show that the unconditional correlation between returns on equity and returns on nontradable wealth is very different from the conditional one: while the former is positive for all countries (as in Baxter and Jermann 1997), the latter is negative (or nonsignificant) for all countries, rationalizing the degree of home bias observed in G7 countries. Their findings echo the empirical results of van Wincoop and Warnock (2010) who show that equities are a very poor hedge for real exchange risk, and even more so when trade in nominal bonds (currency forwards) is allowed.

A similar theoretical point is made in Engel and Matsumoto (2009a) in the specific case of a two-country/two-good DSGE model with monopolistic competition and sticky prices. Assets traded are domestic and foreign equity and positions in currency forward markets (which are equivalent to nominal bonds). Uncertainty is driven by productivity shocks and money supply shocks. Due to price rigidity, nominal exchange rate fluctuations are related to real exchange rate fluctuations and the forward positions are used to hedge the nominal exchange rate changes, leaving only a part of the relative price risk to be hedged by equity positions. The authors show that sufficient degrees of price rigidity can generate substantial home bias in equity positions, as domestic returns to human wealth and domestic equity returns are negatively correlated, conditional on nominal exchange rate changes. With monopolistic competition and price rigidities, output is partly demand determined in the short run. Following a local positive productivity shock, labor demand falls. Wages also fall, leading to a fall in domestic labor income. Mark-ups and profits increase, as, for the same level of production, labor costs go down. As price rigidities become smaller, we have two effects lowering home bias. Firstly, prices fall more following a positive productivity shock, increasing output and pushing up labor demand and wages. Secondly, the nominal and the real exchange rate become less closely related, making forward contracts less able to hedge fluctuations in relative prices. In the extreme case

of full price flexibility, we go back to Baxter and Jermann (1997): labor incomes and profits are perfectly correlated and investors do not take any forward position as they do not want any exposure to purely nominal risk. Engel and Matsumoto (2009b) generalize the results above to the cases of local bias in consumption, producer currency pricing, and wage rigidity.

Rabhari (2009) develops a two-country DSGE model with price stickiness, endogenous capital accumulation, trade in nominal bonds and equities, and endogenous monetary policy. In his setting, equity home bias is again driven by the motive to hedge human capital risk. Real exchange rate risk is mainly hedged through bond positions due to price stickiness. He also shows that the combination of price stickiness and endogenous capital accumulation can produce relative equity returns that are unconditionally positively correlated with human capital returns, but conditionally negatively correlated (controlling for bond returns). This correlation pattern is confirmed using U.S. data.

Devereux and Sutherland (2007, 2008) develop a two-country, two-good DSGE model with nominal rigidities à la Calvo, producer currency pricing, and endogenous monetary policy. The monetary authority sets the nominal interest rate in response to changes in producer price inflation. There is no local bias in consumption and productivity shocks are assumed to be persistent. The authors consider different asset market structures (portfolio autarky, trade in nominal bonds and trade in nominal bonds and equity). They can generate home bias in equities for the same reason as Engel and Matsumoto (2009a). They also find that monetary policy assumes an additional role in these models. By changing the returns on nominal bonds, monetary policy affects portfolios and thus risk sharing. Interestingly, they find that while monetary policy has no impact on portfolios with trading in nominal bonds *and* equities, in the case of bond trading only, there is an additional motive for price stability. With price stability, cross-country nominal bonds returns differentials become more correlated with the real exchange rate, which improves international risk sharing.

Lastly, Berriel and Bhattarai (2008) solve for equity and nominal bonds portfolios in a standard two-country general equilibrium model in presence of government spending shocks and nominal shocks (shocks to the price level): they investigate a new source of nontradable income risk, namely tax changes. In order to hedge fluctuations in taxes, households exhibit home bias toward local (government) nominal bonds and local equities. The main mechanism goes as follows: price level shocks at home (increase in home inflation) lowers the value of home government debt and the government can lower taxes (while still satisfying its intertemporal constraint). Hence, returns on domestic nominal bonds and local taxes comove positively and the household prefers to hold local nominal bonds. Government spending shocks lead to an increase in taxes. In the meantime, as government expenditures are biased toward local goods, the relative price of locally produced goods increase and so does the pay-off of the claim to local output (local equity). Hence, returns on local equity and taxes comove positively and households will optimally bias their portfolio toward local equity.

4.3 *Extensions and Shortcomings*

4.3.1 *Other Assets?*

The recent literature has shown the importance of extending existing models to a larger menu of assets. Due to substitution across asset classes, the hedging role of an asset is modified by the presence of other available types of assets. Thus, an important issue is why we should restrict our attention

to bonds and equities instead of considering an even larger set of assets. There is no simple answer to this question: potentially any asset that is traded publicly could affect the equity portfolio if it has some hedging properties in addition to what bonds and equities can achieve. Note that the empirical tests of these hedging properties based on covariance-variance ratios could be potentially extended to a larger menu of assets, one just needs to *condition* for returns on these other assets. In particular, including housing as an additional asset seems a natural extension of existing work.

A related question is the role of corporate debt in these models. We have ignored debt as a way to raise capital for firms and have focused on firms that are fully financed through equity. Coeurdacier, Kollmann, and Martin (2010) tackle this issue by allowing for an exogenous financial structure of firms in a world of "locally complete" markets. They show that, in an environment where the financial structure is irrelevant for the value of the firm (when the Modigliani–Miller theorem applies), the presence of corporate debt has no impact on investment decisions and the equilibrium consumption allocation (up to the first order) since markets are complete. Moreover, the equilibrium equity portfolio is also not affected by the presence of corporate debt. They show that domestic investors will hold a fraction of the corporate debt issued by domestic firms that is equal to the fraction of stocks of the same firms that they hold. Hence, *if the model delivers home bias in equity, it will also deliver home bias in corporate debt in the same proportion*. The reason is simple: when the Modigliani–Miller theorem applies, investors want a certain exposure to the total value of the firm, which is independent of its financial structure. In particular, the fraction of the value of the firm they hold optimally is pinned down in the case where firms are fully financed through equity. When firms are partially financed through debt, holding the same fraction of debt and equity guarantees that investors have their optimal exposure to the value of the firm. One shortcoming though is that such a result might not hold if the Modigliani–Miller theorem does not apply or if financial markets are incomplete. We are not aware of any models that pins down international portfolios in a world where the financial structure of firm, optimal or not, affects the value of the firm and matters for the real allocation.

4.3.2 *Exchange Rates and Asset Prices*

While the models described above can claim some success in replicating some features of aggregate portfolio data, they cannot replicate realistic moments of asset prices and exchange rates (see Lewis 2011 for a recent survey on international asset pricing puzzles). They do not solve the standard puzzles in the finance literature regarding the equity premium and the volatility of asset prices and exchange rates. This is an important limitation since portfolios should be the mirror of asset prices as both are determined in equilibrium. This does not mean that the mechanisms highlighted would not survive in more general environments able to generate realistic asset prices but this remains to be seen. First attempts in that direction include Stathopoulos (2008, 2011) who introduces habit formation and Benigno and Nistico (2009) who model ambiguity aversion. Interestingly, Benigno and Nistico (2009) show that, taking into account long run consumption risk, which is correlated with the real exchange rate, changes the properties of the pricing kernel and rationalizes home bias. We believe that explaining asset prices moments should help disentangling across the different potential channels generating portfolio biases.

An important related shortcoming of this class of models with endogenous portfolio decisions is that the allocation under perfect

risk-sharing is replicated, or at least up to the degree of the approximation. This implies an equality between the ratio of marginal utilities of consumption and the real exchange rate in all states of nature. With standard CRRA preferences, this leads to a perfect correlation between real exchange rate changes and relative consumption growth (Home relative consumption falls when Home relative prices are higher; see equation 14 in the previous models). In the data, this is strongly rejected, the correlation is close to zero and if anything Home relative consumption increases when Home relative prices are higher: this is the famous consumption-real exchange rate anomaly (Kollmann–Backus–Smith puzzle; see Backus and Smith 1993 and Kollmann 1995). In the previous models, the asset structure and the dimension of uncertainty are such that one can replicate the efficient allocation (up to first order). One could believe that adding additional sources of uncertainty such that markets are incomplete even locally would help to solve the consumption-real exchange rate anomaly. It turns out to be extremely hard to lower the correlation between relative consumption and the real exchange rate in models with endogenous portfolio decisions despite imperfect spanning of risks (see Coeurdacier, Kollmann, and Martin 2008 and Benigno and Küçük-Tuğer 2008). In most existing models with endogenous portfolio choice, international risk-sharing is still far above what consumption data suggests and this remains an important challenge for future work.

4.3.3 *Dispersion of Home Bias across Time, Countries, and Assets*

Data on home bias exhibit substantial variations across time and across countries (see figures 1 and 2 and table 1). Most of the work has been dedicated to match the average degree of home bias observed in developed countries (Collard et al. 2007 and Heathcote and Perri 2007 are notable exceptions: in line with model predictions, they match the degree of equity bias to the degree of trade openness of countries). Since more data on aggregate foreign asset holdings are now available, both in the time series and in the cross-section, it seems natural to extend theories to heterogeneous countries. This would provide more accurate tests of the different theories available. Exploiting the bilateral dimension of the data using a multicountry framework could also help in that matter. Indeed, using the CPIS data provided by the IMF since 2001, one can now observe equity holdings between country pairs. Most of the theoretical literature has so far limited its attention to models with two symmetric countries, which does not allow to exploit the bilateral and cross-sectional variations of the data.

A similar point can be made regarding the currency exposure of international portfolios. As shown by Lane and Shambaugh (2010a, 2010b), the currency denomination of foreign assets and liabilities are very heterogeneous across countries. While, on average, the advanced countries are (in net terms) borrowing in foreign-currency, some major countries have very large negative domestic-currency debt positions (most notably the United States). Models including bond positions denominated in different currencies should be also tested against such data. In section 7, we also provide some evidence on the cross-sectional dispersion of home bias for other asset classes (bonds and banking assets).

5. *Asset Trade Costs in International Financial Markets*

So far, we have focused on hedging motives as a source of heterogeneity in portfolios assuming *frictionless* financial markets. Another strand of the macroeconomics literature considers frictions in financial markets as the main source of heterogeneity across

investors. Portfolio home bias is the natural outcome of these frictions. Such frictions could include fixed or proportional transaction costs in foreign portfolio investments, difference of tax treatments across domestic and foreign portfolio incomes and other policy induced restrictions on foreign investments (such as limits to foreign investment, capital controls, differences in legal frameworks) (see French and Poterba 1991, Lewis 1999, and Dahlquist et al. 2003). Other important frictions to international investments are informational frictions. The role of information has been extensively investigated in the finance literature but less so in the Open Financial Macroeconomics literature (Hatchondo 2008; Tille and van Wincoop 2009; and Dumas, Lewis, and Osambela 2011 are recent notable exceptions). For this reason, we will review the literature on informational frictions (and behavioral biases) in a separate section (see section 6).

5.1 *Transaction Costs Would Need to Be Very Large to Explain Equity Home Bias . . .*

There is a wide debate on the importance of transaction costs to explain international portfolio decisions. French and Poterba (1991) initially argue in a mean-variance framework that these costs must be much larger than the one typically observed if one wants to rationalize equity home bias. Using stock returns data from 1975 to 1989 for the United States, Japan, the United Kingdom, France, Germany, and Canada, the authors use estimates of a covariance matrix of returns together with an optimal portfolio rule that is implied by constant relative risk aversion in order to back out the differences in expected returns needed to explain actual portfolio shares for these countries. The implicit excess return on domestic equity implied by observed portfolio holdings is then interpreted as a measure of the cost of international asset trading needed to generate the observed home bias: they find an order of magnitude for these costs of several hundred basis points, too big to be true! Numerous subsequent studies have provided such indirect estimates of the costs. Jeske (2001) calculates the implicit costs on foreign assets necessary to skew the portfolio allocation away from the optimal (based on a mean variance model) toward the observed allocation. These costs are very large ranging from 150 to 700 basis points across countries. Most studies are in line with French and Poterba's (1991) results and argue that costs need to be very large to explain portfolio holdings (see Cooper and Kaplanis 1994, among others). A notable exception is Sercu and Vanpée (2008) who find that, once they control for many factors (currency risk, inflation hedging, fixed-interest investments, round-tripping, and omitted countries) and allow for time varying covariances, the implicit inward investment costs are much lower than in earlier studies in developed markets (in the order of magnitude of 0.10–0.20 percent per annum). It is however important to note that the associated costs estimated from stock returns data suffer from potential statistical uncertainty: due to the high volatility of stock returns, estimates of expected returns based on past data are imprecise. Hence, when testing whether optimal portfolios weights are statistically different from the observed ones, results have been quite inconclusive (see Bekaert and Urias 1996, Gorman and Jorgensen 2002, Britten-Jones 1999, and Lewis 1999, among others). In other words, estimated costs to rationalize portfolio allocations have large standard errors and in many cases one cannot reject that the observed home biased portfolio allocation is not statistically different from the optimal one.[31]

[31] Pástor (2000) goes one step ahead and examines whether an investor that updates his views on the distribution of domestic and foreign returns in a Bayesian fashion may choose a strongly home biased portfolio. This will be true if the investor holds a strong biased prior toward the domestic asset. But greater uncertainty on foreign stock returns can induce him to pay more attention to the data and move away from this prior.

Another piece of evidence pointing that transaction costs cannot rationalize portfolio holdings is Tesar and Werner (1995): transaction costs based explanation of the equity home bias should in general imply that turnover should be lower for foreign equity holdings than for domestic ones (unless they apply only to dividend repatriation). Tesar and Werner (1995) find that turnover is in fact higher for foreign holdings.[32]

5.2 . . . *Unless Diversification Benefits Are Very Small*

As stated above, transaction costs are often assumed to be small although direct measures of these costs do not often exist (see below). However, as shown by Martin and Rey (2004) and Coeurdacier and Guibaud (2009), even small transaction costs may lead to sizable home bias when Home and Foreign stocks are close substitutes: any small transaction cost is amplified if the benefits of diversification provided by foreign assets are small.

Indeed, small diversification benefits is a crucial ingredient for the transaction costs based story to work. A key contribution in this literature is Cole and Obstfeld (1991), who show in the context of a two country/two good model that gains from international risk sharing are probably quite small, as changes in the terms of trade help to share risk internationally even with portfolio autarky. The intuition is simple. Assuming Cobb–Douglas preferences over the consumption of the two good, an increase in local output triggers an equivalent fall in their relative prices as local goods are now more abundant (terms-of-trade adjustment). In this economy portfolio autarky implies perfect correlation of marginal utilities—the complete market outcome. It is worth noting, however, that this argument implies that a portfolio would be indeterminate if trade in equities were possible since home and foreign stocks would be perfect substitutes. Cole and Obstfeld (1991) show that the equivalence between portfolio autarky and complete markets also obtains in a setting with investment under the following assumptions: (i) unitary elasticity of substitution between the two goods, (ii) unitary elasticity of intertemporal substitution, and (iii) full depreciation. For the no-investment case, the authors calculate welfare gains of moving from autarky to perfect international risk-sharing. They find small welfare gains for a broad range of values of the elasticity of substitution between the two goods. Since the seminal paper of Cole and Obstfeld (1991), a large number of papers using consumption data have computed welfare gains from international risk sharing with quite a lot of variation across studies. Van Wincoop (1999) documents the extent to which the results are strongly sensitive to assumptions about preferences (the coefficient of relative risk-aversion and the elasticity of substitution between traded and nontraded goods), the assumed "autarky" consumption process, the implicitly chosen risk-free interest rate and the horizon of calculations. Without closing the debate, he tries to narrow the range of reasonable estimates and does find significant gains from risk sharing among OECD countries over a long horizon: 1.1 to 3.5 percent of permanent consumption for a fifty-year horizon, and 2.5 to 7.5 percent for a one-hundred-year horizon.

Overall though, explicit consumption based calculations of the welfare cost of underdiversification tend to imply low costs. These results are very often driven by the low variability of consumption in the data. In contrast, costs of underdiversification based on stock returns data are usually much larger, due to the much larger volatility of

[32] Rowland (1999) and Amadi and Bergin (2008) construct models that can generate higher turnover for foreign asset holdings than for domestic ones, in the former case with proportional trading costs, while the latter use fixed trading costs.

stock returns. This point is clearly made by Lewis (2000): she finds that moving from portfolio equity autarky toward an optimally diversified portfolio (efficient frontier in a mean-variance framework with a relative risk aversion of 2 leads to a gain of 10 to 30 percent of current wealth while moving from autarky consumption to perfect international risk-sharing leads to an increase in permanent consumption of less than 1 percent. The gap between the two metrics remains an open question; one will need to reconcile risk-sharing gains using consumption and asset prices data to fully evaluate the impact of transaction costs on international portfolios.

Finally, another argument in the literature has been that domestic multinationals already provide benefits of diversification by being active in many countries, reducing the gains from international diversification. However, Lewis (1999) and Rowland and Tesar (2004) argue that the correlation between the returns of multinational and their national stock indices is quite high, thus limiting the diversification benefits they can actually offer.

5.3 *Direct Measures of the Costs?*

It is important to note that most existing work provides indirect measures of transaction costs using stock returns data and observed portfolio allocation (as in French and Poterba 1991). There are no papers we are aware of that presents an extensive measure of actual costs in investing in foreign assets. While directly observed transaction costs on the stock markets are typically very low, they might not be the appropriate measure for these asset trade costs. For instance, most households go through financial intermediaries to invest in stock markets (pension funds, mutual funds . . .) but there is so far very little empirical evidence investigating the difference in fees collected for foreign investments compared to domestic ones.

The question of the role of international taxation also remains opened. For simplicity, we abstract from taxation issues within multinationals and the effects on international taxation on Foreign Direct Investment and focus on the taxation of portfolio incomes. When considering the rules of international taxation, one could expect some large impact on home portfolio biases. First, dividends when repatriated are subject to non-negligible withholding taxes (of a magnitude of roughly 10 percent in developed countries). Even if many bilateral tax treaties lead to some exemptions of these withholding taxes (through tax credits schemes), this is not true for all investors and these exemptions are often subject to some ceilings. Second, most developed countries have dividend imputation schemes: capital incomes (profits) are indeed taxed twice in most countries, at the corporate tax level and at the income tax level (when profits are distributed to shareholders). To avoid this double-taxation, shareholders receive a tax rebate. The tax rebate is such that, on net, investors end up paying the income tax only. Such dividend imputation schemes do not apply to foreign asset holdings. This drives an additional significant differential in the taxation of capital incomes coming from domestic or foreign firms (see Gordon and Hines 2002 and chapter 10 of the Griffith, Hines, and Sørensen 2010 for excellent surveys). However, as argued by Gordon and Hines (2002), these tax differentials might not be effective in practice since this is very difficult for governments to enforce the taxation on foreign asset incomes. Tax evasion on income from foreign securities through foreign financial intermediaries (in tax havens in particular) might be an issue if one wants to measure exactly the costs associated to international taxation. Hence, while most papers tend to argue that taxation differentials between domestic and foreign asset incomes cannot fully account for the size of portfolio biases, it remains very

hard to provide a quantitative estimate of their impact on portfolio decisions. Studying optimal taxation of capital in a model where home bias is endogenous would be a very natural extension of the literature. Gordon and Gaspar (2001) provide an interesting treatment of optimal tax policies in a partial equilibrium model where home bias in equity or bonds is endogenously generated.

6. *Informational Frictions and Behavioral Biases*

6.1 *Informational Frictions*

6.1.1 *Exogenous Information Sets*

The impact of informational asymmetries on portfolio decisions has been first studied in the finance literature.[33] In this literature, domestic and foreign investors differ on their (exogenously given) information sets regarding future domestic and foreign stock returns. Gehrig (1993) and Brennan and Cao (1997) develop a simple two country noisy rational expectations model with one stock per country. They assume that agents in each country receive a signal on the future performance of each stock but the signal on the foreign asset is less precise. Hence, domestic investors perceive the foreign stock as riskier and reduce their foreign stock holdings, which leads to equity home bias. Moreover, Brennan and Cao (1997) show that less well informed foreign investors respond more strongly to public signals on domestic stocks conveyed by stock prices. Hence, foreign investors buy more of the domestic stocks when the domestic market performs well. The authors find evidence for this "return chasing" effect in the data. Brennan et al. (2005) extend their initial work by developing a noisy expectations model where investors receive public and private information signals. The private signal is less precise for foreign investors. The authors show that there is a link between information disadvantages and the expectations (degree of bullishness) about a market: foreign investors tend to become more bullish about a certain market following a positive return on that market. Glassman and Riddick (2001) quantify what should be the perceived riskiness of foreign assets (due to lower information quality) in order to generate the observed home bias of U.S. investors. They find that investors would have to scale up standard deviations of returns by a factor from 2 to 5 depending on risk aversion and conclude that these scaling factors are implausibly high. Albuquerque, Bauer, and Schneider (2007) solve for international equity flows when a set of home and foreign investors have superior information. They argue that this informational heterogeneity *within* the foreign set of investors is more important than informational heterogeneity across countries to explain international equity trades. In line with the data, the model explains why (i) U.S. investors trade in waves, with simultaneous buying and selling; (ii) U.S. investors change their foreign equity positions gradually; and (iii) U.S. investors increase their equity position in a country following a raise in its stock price.

The finance literature described above had a recent impact on more standard general equilibrium macro models along the lines of the Open Economy Financial Macroeconomics approach. Hatchondo (2008) builds a single good two country model and two assets per country with two departures from standard models. Firstly, he assumes that only local investors receive informative signals about local assets. This informational advantage induces agents to invest in the good local asset. Secondly,

[33] Contrary to the standard DSGE macro models, the finance literature described here relies on some partial equilibrium assumptions: stock returns characteristics (risk and expected returns) are exogenously given and the risk-free asset is in infinite supply.

engaging in short selling is assumed to be costly. When the signal is sufficiently informative and short selling costs are high enough, agents do not sell the bad local asset short in order to invest more in the good local asset but rather reduce their holdings of foreign assets. This leads to equity home bias in equilibrium. Gordon and Bovenberg (1996), present a small open economy model where home bias results from information asymmetries, which decrease the return home investors get on their foreign capital investment. In such a set up, subsidizing capital imports is optimal. Razin, Sadka, and Yuen (1999) assume that domestic investors can observe the productivity of domestic firms before making their loan decisions, while foreign investors cannot. This results in foreign underinvestment and domestic oversaving. Building on a similar asymmetric information set up but adding the possibility of liquidity shocks, Goldstein and Razin (2006) study the trade-off between FDI and portfolio investment, the latter being more liquid than the former.

Tille and van Wincoop (2009) apply the noisy rational expectations framework from the finance literature to a standard two-country/one-good DSGE model. They depart from standard open macro models by introducing information dispersion across investors. Each investor receives a private signal on the future fundamentals (productivity) of domestic and foreign stock, the signal on its own stock being more precise (as in Gehrig 1993 and Brennan and Cao 1997). The noise is introduced in the form of (unobserved) stochastic transaction costs to invest abroad which generates portfolio shifts toward or away from foreign assets. This makes sure that stock prices cannot fully aggregate private signals in equilibrium. These transaction costs generate equity home bias in equilibrium but this is not the purpose of the paper. They show that dispersed private information disconnects stock prices from the currently observed fundamental values but also international capital flows (gross and net). Moreover, capital flows should help forecast future fundamentals. They find some empirical support for their results.

6.1.2 *Endogenous Information Acquisition*

The early noisy rational expectations literature when applied to international portfolio choice relies on exogenous information structures. A recent challenge has been to extend it by allowing for endogenous information acquisition. In this line of research, information is a tool to reduce the conditional variance of the asset payoffs. Using a model of rational inattention introduced by Sims (2003), Van Nieuwerburgh and Veldkamp (2009) build a model where a tiny information advantage is enough to generate significant home bias if investors have a limited capacity to process information. In this model, agents are endowed with a small informational advantage on the local asset, which lowers its perceived riskiness. Thus, the investor will tend to hold more of the local asset. However, this effect is amplified as the more of an asset the agent owns, the more attractive it becomes to learn about the asset. Endogenous and costly acquisition of information amplifies the initial small informational advantage and leads to specialization in local stocks. Learning turns out to amplify information asymmetries instead of reducing them. In their set up, countries which are learnt about a lot by investors should have lower returns compared to the prediction of a standard CAPM model, as lower uncertainty goes hand in hand with a lower return. Van Nieuwerburgh and Veldkamp (2010) apply variations of their rational inattention model to explain investment strategies of investors, varying the specification of the preferences or of the information constraint that they face. Depending on the convexity of the objective function of investors, they can rationalize concentrated or diversified

portfolios. Mondria (2010) allows rationally inattentive investors to decide not only on the precision but also on the *structure* of the information they process. In equilibrium, agents choose to learn not only about individual assets but also about linear combination of assets, i.e., indices. Such a learning strategy makes sense as the structure of the signal the agents choose in equilibrium depends on their objective function. Since investors will choose to hold a somewhat diversified portfolio in equilibrium, they choose to process information about combinations of assets (they are interested not only in the volatility of each asset but also in their covariance). Mondria and Wu (2010) use a similar framework to explain the time series of home bias. When financial liberalization takes place in the developed economies in the 1980s, investors start to be able to diversify their portfolios and home bias decreases but only gradually as investors have an initial information advantage on domestic assets. The authors show that persistence of asset pay-offs and increases in information processing capacity tends to magnify home bias. By looking at the interaction of capital openness and learning strategies, they are able to reproduce the time series of home bias.[34]

6.1.3 *Empirical Evidence on Informational Frictions*

A number of papers regress portfolio holdings or measures of home bias directly on factors that proxy for information asymmetries. Portes and Rey (2005) show that physical distance affects international equity flows and holdings very significantly: doubling the distance reduces cross-border equity flows by half. Coval and Moskowitz (1999) find that U.S. mutual fund managers prefer to invest in nearby firms even within a country. Ahearne, Griever, and Warnock (2004) find that U.S. holdings of foreign equities are significantly biased toward countries that have a higher share of their stock market listed on U.S. stock exchanges. Chan, Covrig, and Ng (2005) find that stock market development and familiarity variables have a significant impact on home bias for a sample of mutual funds spanning twenty-six developed and developing markets. They aggregate the investments of these funds at the country level. Grinblatt and Keloharju (2001) emphasize the key role of distance, language, and cultural similarities in international asset allocation. Aviat and Coeurdacier (2007) revisit the impact of distance on cross-border equity holdings (and bank loans). They find that the impact of distance is drastically reduced once we control for bilateral goods trade: countries' portfolios are strongly biased toward trading partners (see also Lane and Milesi-Ferretti 2008). Using instrumental variables, they show that the causality goes essentially one-way: reducing barriers to trade in goods enhances cross-border asset holdings. However, one cannot reject the role of goods trade in fostering information flows across borders. Since a lot of information on stocks come through the accounts of firms, it is to be expected that different accounting standards would act as information barriers. Bradshaw, Bushee, and Miller (2004) find that firms exhibiting higher levels (changes) of U.S. GAAP conformity have greater levels (changes) of U.S. institutional ownership. This positive relation holds regardless of a firm's visibility to U.S. investors (e.g., American Depositary Receipt listing, stock index membership, analyst following, firm size). Finally, using survey data on Italian investors, Guiso and Jappelli (2006) find that investors who spend more time to acquire information also tend to hold less diversified portfolios as implied by models of endogenous information acquisition.

Most models of information asymmetries though also imply that domestic investors should earn a higher return than foreign

[34] For a very nice exposition of the applications of rational inattention to invesment choice, see Veldkamp (2011).

investors. However, the empirical evidence on this matter is mixed. Coval and Moskowitz (1999), Hau (2001), Dvorak (2005), and Choe, Kho, and Stulz (2005) find that domestic investors do in fact earn higher returns, while Grinblatt and Keloharju (2000) and Huang and Shiu (2006) find the opposite.

6.2 *Behavioral Biases*

Some recent papers have put forward a behavioral explanation for the equity home bias. Using departures from rational expectations and maximization of standard von Neumann–Morgenstern utility functions used in standard macro literature, this literature has highlighted some behavioral biases consistent with the data on international portfolio allocation. The seminal paper of French and Poterba (1991) already considers overconfidence toward local assets as a potential explanation: if investors systematically have higher expectations of relative returns for domestic equities, this difference in expected returns, while inconsistent, can overturn any perceived diversification gains. In the same vein, Shiller, Kon-Ya, and Tsutsui (1991) document large differences in expected returns of Japanese and U.S. investors for the same stock markets. They find that Japanese investors tend to expect relatively higher returns for Japanese stocks, while U.S. investors expect higher returns on U.S. equity. A similar argument can be applied to estimated variances (either the standard deviation of domestic equity is systematically believed to be lower or correlations with foreign equities are overestimated). Studies by Gur Huberman (2001), Benartzi (2001), and Karlsson and Norden (2007) (see also Barberis and Thaler 2003 for a survey) suggest that "familiarity" might be the main determinant of portfolio choice: investors choose "familiar" assets while ignoring the principles of portfolio theory. Graham, Harvey, and Huang (2009) investigate the role of self-assessed trading competences on portfolio home bias. They show how home bias can emerge when investor feels incompetent in understanding the benefits and the risks of investing in foreign assets. However, it remains difficult to disentangle empirically informational frictions linked to distance and/or institutional differences from behavioral biases such as "familiarity" and/or "competence" effects. Solnik (2006) explains the equity home bias by the Regret Theory: investors use the domestic portfolio as a benchmark and feel the pain when their foreign investments underperform. Morse and Shive (2011) find that home bias is empirically related to measures of patriotism. Amonlirdviman and Carvalho (2010) study the effect of loss aversion or home bias.

To our knowledge, building on Dumas, Kurshev, and Uppal (2009), Dumas, Lewis, and Osambela (2011) are the first ones to develop a standard two-country general equilibrium model (in continuous time) where investors exhibit behavioral biases in the form of differences in their beliefs. Investors have access to the same information set (no asymmetric information) but differ in their beliefs about the information contained in economic public signals: local investors trust more the information contained in local signals and incorrectly believe that the information in the foreign signal is partly noise. These asymmetric beliefs help the authors to solve for some anomalies at the international level: investors exhibit home equity bias, asset prices are the combination of a local CAPM and an international CAPM (in line with the empirical evidence of Bekaert and Harvey 1995) and as in models of asymmetric information (see Brennan et al. 2005), capital flows toward a country covary positively with returns in that country. Their model with differences in beliefs is indeed observationally equivalent to existing models of segmented markets due to asymmetric information.

7. *New Portfolio Facts*

7.1 *Aggregate Data on Portfolio Holdings*

The Open Economy Financial Macroeconomics models have implications for international bond holdings as well as international equity holdings. Hence, we provide some measure of the extent of risk-sharing through international bonds holdings (public and private) for a large cross section of countries by using data on cross-border bond holdings. For completeness we also present some data on international bank lending, as we expect that the Open Economy Financial Macroeconomics will soon incorporate formally bank intermediation in their models. For these data, we rely on CPIS and IFS data from the IMF and the data from the BIS (see appendix for a detailed description of the data).

7.1.1 *Cross-Border Bond Holdings*

We use data from IFS and BIS to compute international bond holdings for selected countries. Unfortunately, available data do not allow to disaggregate data of foreign bond holdings across types of bonds (corporate versus public, across maturities, across currency denomination)[35] and we had to focus on bond holdings aggregates.

To measure the degree of international diversification of bond portfolios, we compute a measure of home bias in bond holdings similar to the one we computed for equity holdings. Hence, our measure of Bond Home Bias for country i (BHB_i) is defined as follows:

$$\mathrm{BHB}_i = 1 - \frac{\text{Share of Foreign Bonds in Country } i \text{ Bond Holdings}}{\text{Share of Foreign Bonds in the World Bond Market Portfolio}}. \tag{43}$$

In figure 3, we show the evolution of bond home bias measures in developed countries across regions of the world: it has decreased over the last twenty years with the process of "financial globalization" but remains still very high in all countries. Portfolios exhibit a home bias in bond holdings of a slightly larger magnitude than the one documented for equity in section 2. On average, the degree of home bias across the world is 0.75 (just like for equities it is lower in Europe where monetary union seemed to have had an effect but higher in other countries),[36] meaning that the share of foreign bonds in investors portfolios is roughly a quarter of what investors would hold if they were holding the world bond market portfolio. Despite a large degree of home bias, these data indicates that some international risk-sharing occurs through bond holdings and it seems necessary to incorporate cross-border bond holdings in the theoretical portfolios model we are using. In figure 4, we show the degree of bond home bias for emerging markets: emerging markets have even much less diversified bond portfolios than developed countries and it has barely decreased over the last decade. Like for equities, there is a significant dispersion of bond home bias across countries (and across time) that could be helpful to guide future theoretical work.

7.1.2 *Cross-Border Bank Loans*

We use data from the BIS and the OECD to compute cross-border banking assets for selected countries. Like for bonds, available data do not allow to disaggregate data of foreign bank loans across types of loans and we had to focus on aggregate foreign asset holdings by banks.

To measure the degree of international diversification of banks' portfolios, we compute

[35] For more details on the currency denomination of foreign assets and liabilities, see Lane and Shambaugh (2010a, 2010b).

[36] See Lane (2006), Coeurdacier and Martin (2009), and Fidora, Fratzscher, and Thimann (2007) for studies on the impact of the euro on cross-border bond diversification.

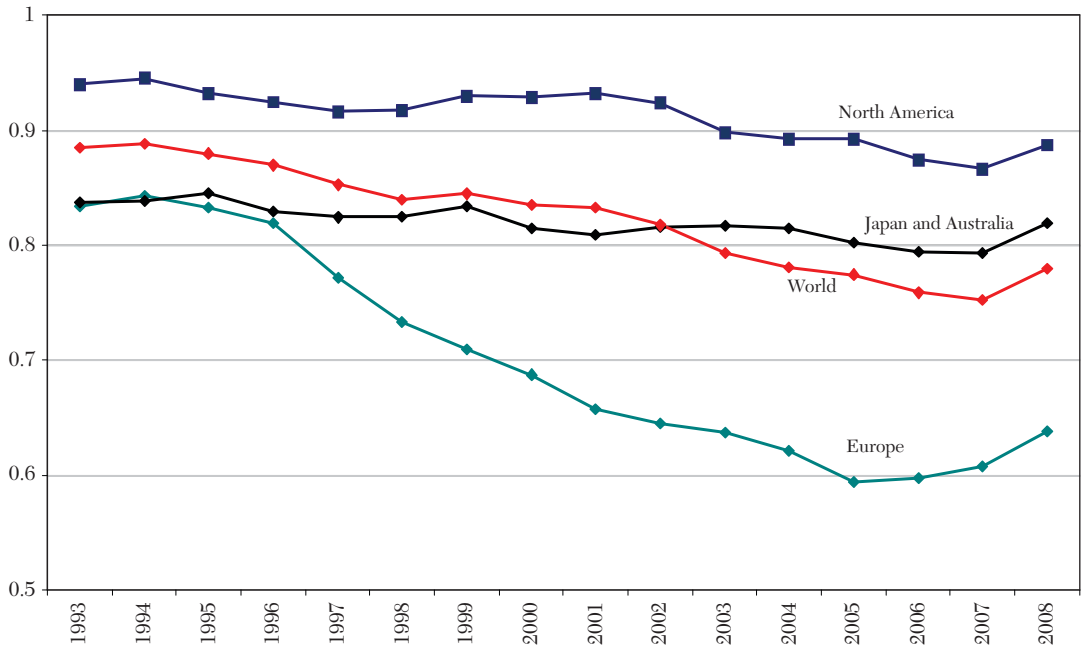

Figure 3. Measures of Home Bias in Bonds across Developed Countries

Note: The country measure BHB_i is market capitalization-weighted for each region.

Sources: Authors' calculations. Bank for International Settlements and International Financial Statistics. Countries: *Japan and Australia; Europe* (Austria, Belgium, Denmark, Finland, France, Germany, Iceland, Italy, Netherlands, Norway, Spain, Sweden, Switzerland, United Kingdom); *North America* (Canada and United States).

a measure of home bias in bank loans comparable to the one used for equities and bonds. Hence, our measure of Home Bias in Loans for country i (LHB_i) is defined as follows:

$$(44) \quad LHB_i = 1 - \frac{\text{Share of Foreign Banking Assets in Country } i \text{ Banking Assets}}{\text{Foreign Banking Assets as a share of Total Foreign Outstanding Loans}}.$$

In figure 5, we show the evolution of home bias in bank loans measures across OECD countries using OECD data. Figure 6 shows the same statistic but using BIS statistics (available for a larger number of countries but over a shorter time period; see appendix for a detailed description of the data). Despite an increased diversification, banking portfolios still exhibit a very strong home bias. The magnitude of the home bias in banking assets is similar to the one observed for equity holdings. Like for equities and bonds, the degree of Home Bias is the smallest in Europe (potentially due to the EMU) and the largest in emerging markets (here Latin America).

7.2 *Institutional Investors Home Bias Data*

An increasing share of capital flows are intermediated through institutional investors. For example, using the Survey of Consumer Finance, Polkovnichenko (2005)

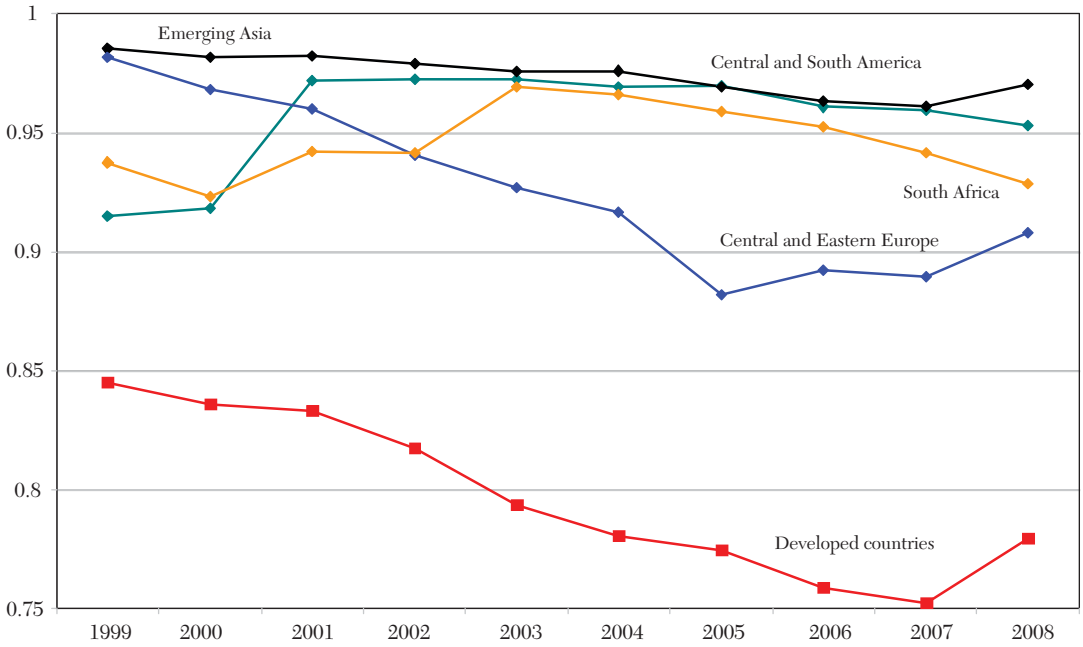

Figure 4. Measures of Home Bias in Bonds across Emerging Countries
Note: The country measure BHB_i is market capitalization-weighted for each region.

Sources: Authors' calculations. Bank for International Settlements and International Financial Statistics. Countries: *Developed* (Japan, Australia, Austria, Belgium Denmark, Finland, France, Germany, Greece, Iceland, Italy, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland, United Kingdom, Canada and United States); *Central and South America* (Argentina, Brazil, Chile, Colombia, Mexico, Peru); *South Africa; Central and Eastern Europe* (Croatia, Czech Republic, Hungary, Poland, Slovak Republic); Emerging Asia (India, Indonesia, Korea, Malaysia, Philippines, Singapore, Thailand, Turkey).

documents that, in 2001, 62 percent of all equity holdings by U.S. households were indirect holdings. Information asymmetries explanations of the home bias seem more plausible for households than for fund managers, who can devote a substantial amount of resources to gather relevant information. Also, if home bias can be explained by the degree of sophistication of investors regarding their investment strategies, one would expect that professional investors would be fully aware of the theoretical benefits of diversification. Furthermore, with delegated investment comes an agency problem and the incentives of the final investor and of the fund manager are not necessarily well aligned. It should therefore be informative to look at portfolio allocations at the fund level to understand better the determinants of home bias. Hau and Rey (2008) provides some descriptive statistics on domestic and foreign holdings of mutual funds in four countries. We use the same data set—data of global equity holdings from Thomson Financial Securities (TFS)—to estimate home bias at the fund level on a larger cross

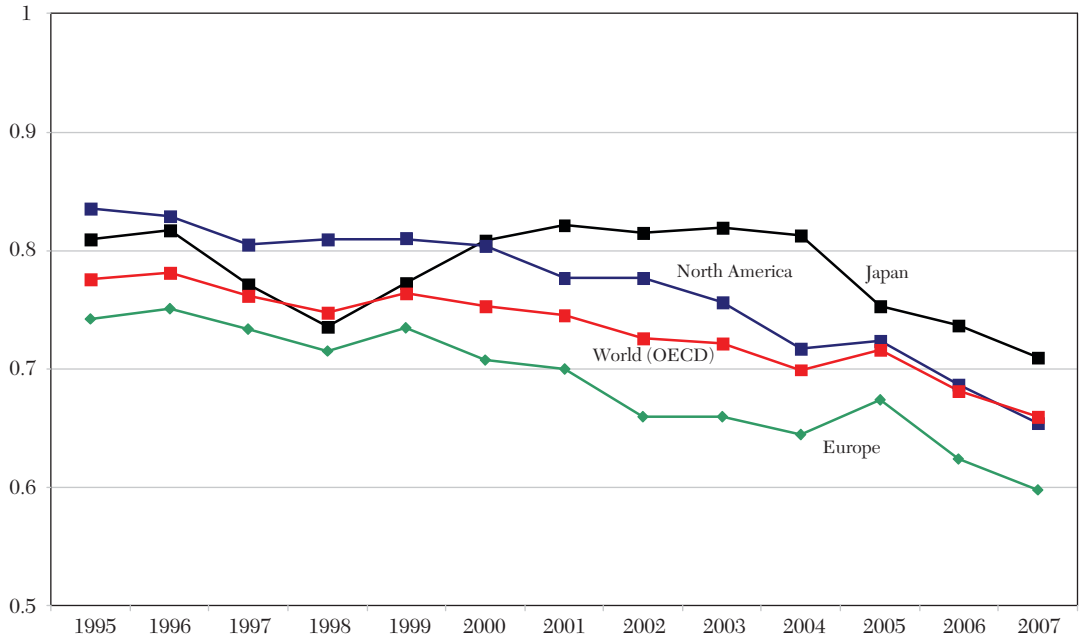

Figure 5. Measures of Home Bias in Banking Assets across OECD Countries

Note: In each region, the country measure LHB_i is weighted by the share of oustanding loans of the country in the region.

Sources: Authors' calculations. Bank Profitability: Financial Statements of Banks (OECD). Countries: *Japan and Australia; Europe* (Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland, United Kingdom); *North America* (Canada and United States).

section of countries. The data document individual mutual funds holdings at the stock level. TFS was created by the merger of The Investext Group, Security Data Company and CDA/Spectrum. The data cover the five-year period 1997 to 2002 and has an interesting cross-sectional and time series dimension.[37] The TFS holding data comprise fund number, fund name, management company name, country code of the fund incorporation, stock identifier, country code of the stock, stock position (number of stocks held), reporting dates for which holding data is available, security price on the reporting date and the security price on the closest previous days in case the reporting date had no price information on the security, total return index (including dividend reinvestments) in local currency, and daily dollar exchange rates for all investment destinations. Most funds report only with a frequency of six months. Reporting dates differ somewhat, but more than 90 percent of the reporting occurs in the last thirty days of each half-year. A limitation of the data is that they do not include any information on cash holdings, financial leverage, investments in fixed income instruments or investments in derivative contracts.

[37] Chan, Covrig, and Ng (2005) used a similar dataset—albeit only for one year. They aggregate the data across all funds to document home bias at the country level.

TABLE 3
MARKET CAPITALIZATION (Average for 1997:1 to 2002:2)—BN Dollars

United States	Germany	United Kingdom	Canada	Switzerland	France
2,851	225.8	174.6	84.81	74.18	53.43
Sweden	Hong Kong	Italy	Spain	Netherlands	Belgium
43.84	26.22	26.03	21.52	12.88	12.55
Japan	Singapore	Luxembourg	Ireland	South Africa	Norway
11.96	9.052	6.35	6.215	3.076	2.559

TABLE 4
NUMBER OF FUNDS (Average for 1997:1 to 2002:2)

United States	Germany	United Kingdom	Canada	Switzerland	France
3,165	1,223	495	353	140	212
Sweden	Hong Kong	Italy	Spain	Netherlands	Belgium
168	66	74	231	66	101
Japan	Singapore	Luxembourg	Ireland	South Africa	Norway
48	47	54	26	35	34

The portfolio characteristics we calculate therefore concern only the equity proportion of a fund's investment. Table 3 gives the breakdown of the average market capitalization over the sample in billions of dollars by country of fund origin. Table 4 gives the breakdown of the average number of funds also by country of fund origin.

Figure 7 presents the percentage of mutual funds based in a given country whose shares of domestic holdings in total asset holdings is 0 percent, strictly larger than 0 percent but smaller than 10 percent, between 10 and 20 percent, . . . , between 90 and 100 percent (but strictly below 100 percent) and equal to 100 percent. The numbers are averages for the 1997–2002 period. To simplify, we call these different shares of domestic holdings in total holdings "different degrees of home bias." For each country, the percentages are based on number of funds in a given home bias category out of the total number of funds for that country and on the share of the market capitalization of funds in a given category relative to the total market capitalization of funds of that country. Thus, funds may change from one home bias category to another over the course of the sample.

The most striking stylized fact may be that there is a great deal of heterogeneity both *across* countries and *within* country in the extent of domestic holdings in total holdings. For most countries, the distribution usually exhibits peaks at 0 percent and 100 percent (or between 0 and 10 percent and between 90 and 100 percent) indicating substantial specialization of funds into either (close to) fully domestic or (close to) fully international investment. But, interestingly, there is a nonnegligible part of

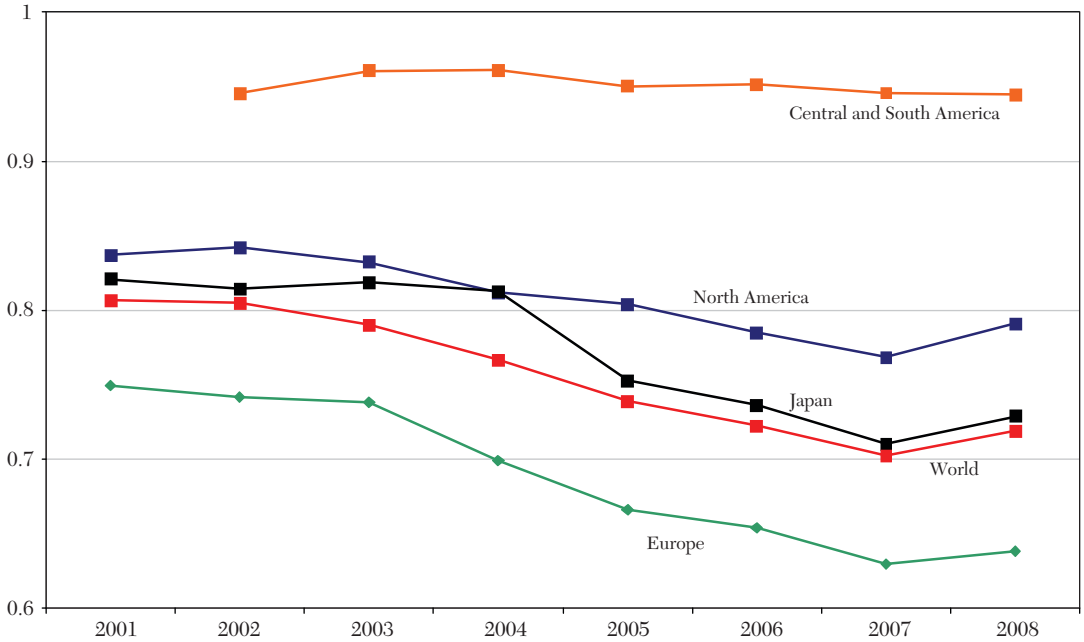

Figure 6. Measures of Home Bias in Banking Assets across Regions

Note: In each region, the country measure LHB_i is weighted by the share of oustanding loans of the country in the region.

Sources: Authors' calculations. Bank for International Settlements. Countries: *Europe* (Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, Netherlands, Portugal, Spain, Sweden); *North America* (Canada and United States); *Japan; Central and South America* (Brazil, Chile, Mexico); *World* (Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, Netherlands, Portugal, Spain, Sweden, Canada, United States, Japan, Brazil, Chile, Mexico, Malaysia, Panama, Turkey).

the distribution lying in between those two extremes, indicating a great deal of heterogeneity in diversification choices by the fund managers even *within* country. Thus one conjecture is that the observed investment pattern at the fund level reflects both some increasing returns in the information technology leading to some concentration in stock holdings of either domestic or foreign countries and a particular market structure inducing product differentiation at the fund level. As mentioned in Hau and Rey (2008), there is a positive correlation between the number of sectors and the number of countries funds invest in, suggesting that more diversified funds diversify both across sectors of activity and across countries. Larger funds tend also to be the most diversified. The role of fund mandates in the observed asset holdings is of course of great interest. We find that for example, in 2002, 701 funds out of our 1,291 U.S. funds had some kind of explicit mandates, which could range from "investing in world equities" to "primarily small cap North American companies" or "at least 80 percent in Latin American companies." These mandates seem to exhibit considerable variations across countries and are clearly not

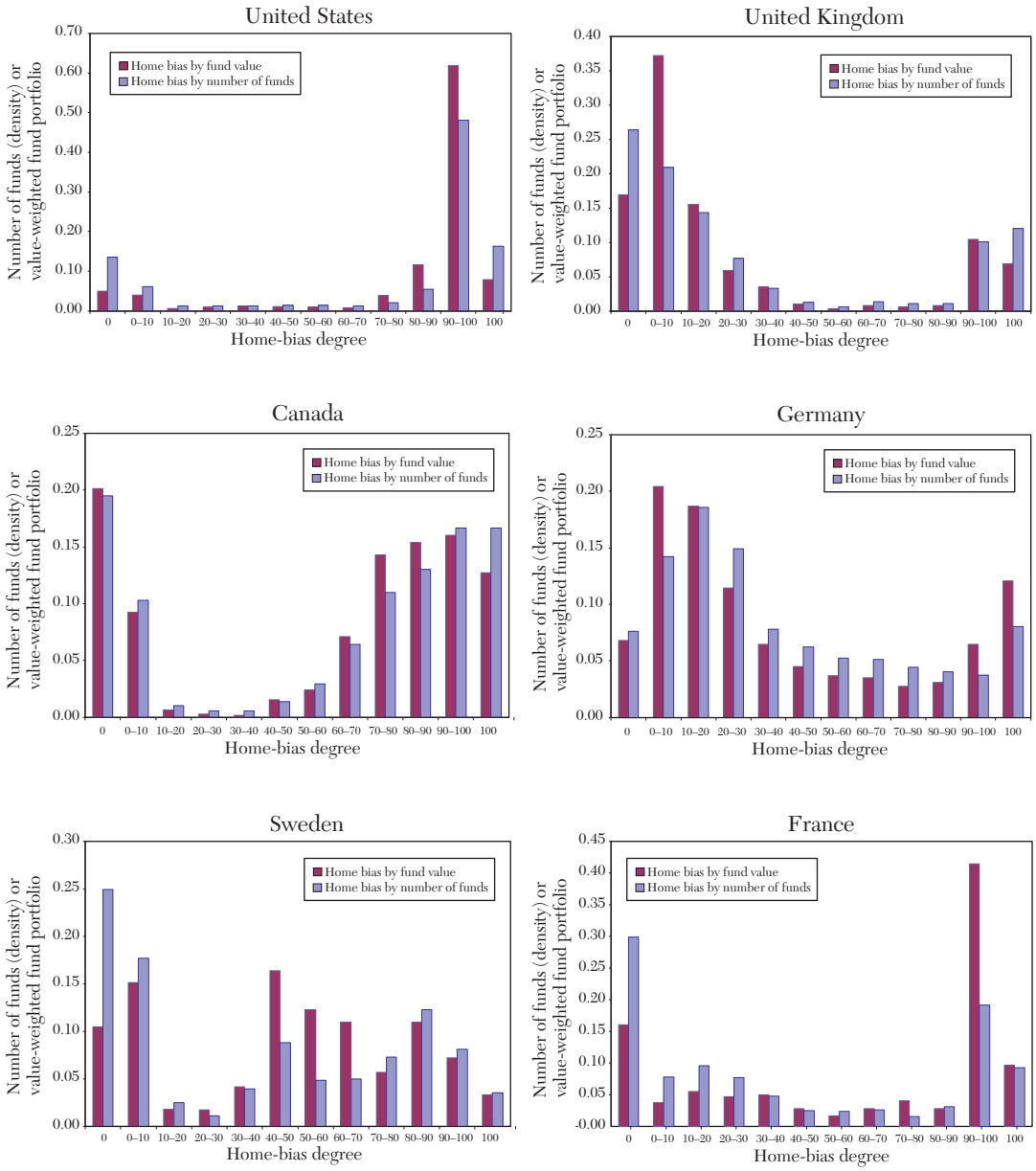

Figure 7. Home Bias is Measured by Shares of Domestic Holdings in Total Holdings

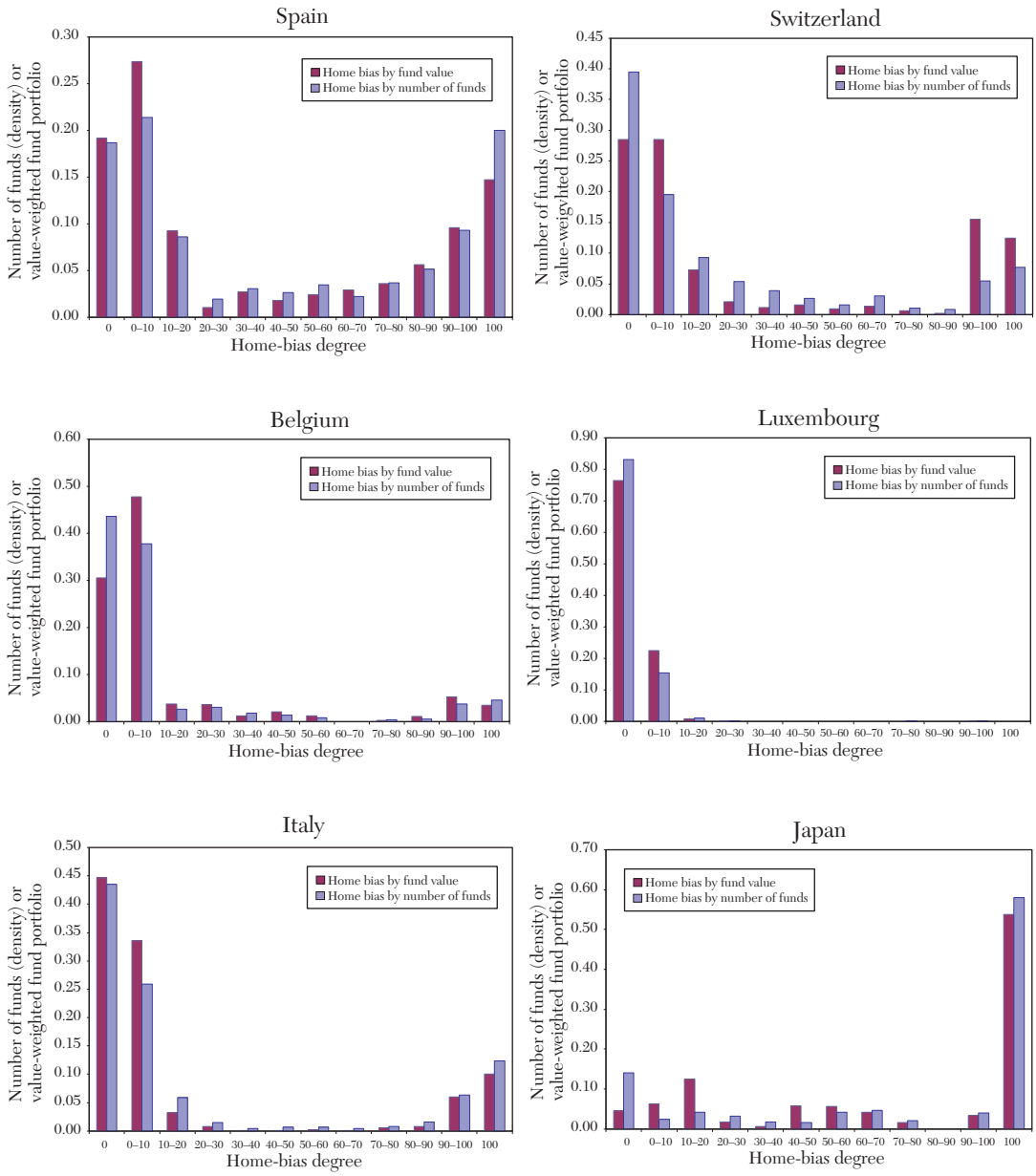

Figure 7. Home Bias is Measured by Shares of Domestic Holdings in Total Holdings (*continued*)

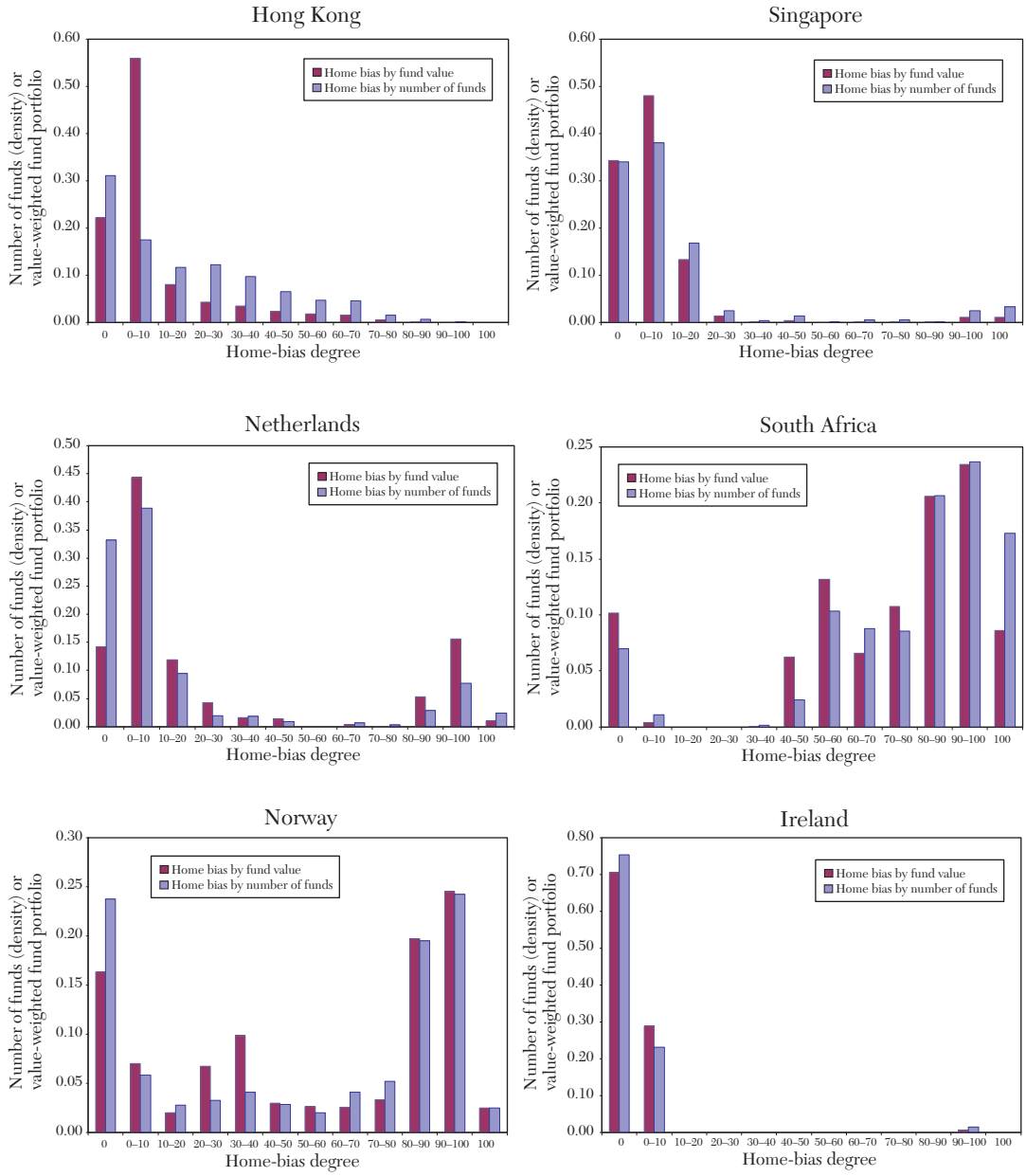

Figure 7. Home Bias is Measured by Shares of Domestic Holdings in Total Holdings (*continued*)

exogenous. They too result from the optimizing behavior of financial companies. Explaining home bias or indeed investment strategies at the fund level thus probably requires a theory of fund mandates.

8. *Conclusions and Leads for Future Research*

Our view is that the home bias puzzle is now less of a puzzle. From the literature we labeled "Open Economy Financial Macroeconomics" to the rational inattention models featuring endogenous information acquisition, notable progress has been made to understand the determinants of portfolio allocations. We may now be at a stage where we should be studying a broad array of implications of these new models rather than focusing only on the stylized fact of equity home bias. Confronting their predictions with a large set of other stylized facts on portfolio holdings will surely lead us to refine them further and ultimately assess their true explanatory power.

The Open Economy Financial Macroeconomics literature has an interesting set of predictions on the holdings of a broad menu of financial assets. It should be very fruitful to introduce in that literature some more detailed models of the capital structure of firms and to get finer empirical implications for equities and corporate/banking debt in particular. Applying corporate finance theory to model the capital structure of firms seems a natural extension of these models, all the more so since it has been shown to matter empirically to explain the home bias (see Dahlquist et al. 2003). One major issue going forward will also be the modeling of the official sector. Introducing an optimal monetary or fiscal policy and modeling their interactions with endogenous portfolio choices of the private sector is a major challenge. It is likely that as a first step focusing on realistic but not necessarily optimal monetary policy or fiscal rules will be the way to go. It is an important goal to have realistic and workable macroeconomic models of the open economy with endogenous portfolio choice, as large cross border holdings of assets (see Gourinchas and Rey 2007a) are likely to affect the channels of transmission of monetary and fiscal policy. Understanding the short run dynamics of the exchange rate, a formidable but crucial task, is also intimately linked to agents portfolio choices and gross external positions as shown in Gourinchas and Rey (2007b) and Della Corte, Sarno, and Sestieri (2012). Furthermore, a closer look at the maximization problems faced by Central Banks when they decide on their reserve holdings and by sovereign wealth funds would be warranted as both actors now account for a nontrivial share of international capital flows. The portfolio choice of the official sector is also an important determinant of the international use of a currency. The dollar market share in world transactions and the "exorbitant privilege" of the United States may be challenged by the new portfolio diversification strategies of emerging markets in general and China in particular. We have few models that can tackle these issues in a general equilibrium set up with a rich asset structure. The role of international currencies and their importance in determining portfolios and asset price movements is an area of active research (see Devereux and Shi 2009 or Gourinchas, Rey, and Govillot 2010).

As more detailed survey data on households become available, one will also be better able to test at the microeconomic level the empirical relevance of various hedging motives underlying the mechanism of these Open Economy Financial Macroeconomic models. Estimating the correlation of labor income risk with various asset returns at a disaggregated level—for instance according to levels of wealth—would probably enhance our understanding of the plausibility of the

mechanisms. Importantly, introducing models with heterogeneous agents in an international economics set up seems a priority to understand better some of the most stubborn puzzles of international economics such as the Consumption–Real Exchange Rate anomaly (Kollmann–Backus–Smith puzzle). Limited participation in asset markets is a promising way to help resolve some asset pricing puzzle as shown in particular in the context of a closed economy by Guvenen (2009). Some steps have been taken by Kollmann (2012) and by Coeurdacier, Ocaktan, and Rey (2010) in particular to introduce limited participation in an open economy set up. Furthermore, much like the closed economy macroeconomics literature, the modeling of financial intermediaries is a key missing building block in our current DSGE models of the open economy. As the literature stands, we have nothing interesting to say about leveraged intermediaries for example and their role in the international transmission of shocks.

If we want to take a more detailed microeconomic view of the home bias, we have to recognize the large heterogeneity of investment strategies both at the household level and at the fund manager level. A large share of household investment is not direct portfolio holdings but intermediated. In the United States, according to the Survey of Consumer Finance (see Polkovnichenko 2005), the share of equity held indirectly by households through mutual funds, pension funds or other investment vehicles has risen from about 46 percent in 1989 to close to 62 percent in 2001. The Federal Reserve Bulletin (2009) indicates that between 2004 and 2007, the fraction of families holding publicly traded stocks rose to 51.1 percent. Among families that held equity, either directly or indirectly, in 2007, ownership through a tax-deferred retirement account was most common (84 percent of families), followed by direct holdings of stocks (35 percent of families), direct holdings of pooled investment funds (21 percent of families), and managed investment accounts (8 percent of families). If we take a different angle and look at the total amount of equity, 37.8 percent was held in tax-deferred retirement accounts, 33.6 percent as directly held stocks, 22.1 percent as directly held pooled investment funds, and 6.5 percent as other managed assets. Strikingly if we look at the families holding stocks directly 36 percent of them hold only one stock and 48 percent hold between two and nine stocks. The typical portfolio of households who participate in the financial market is therefore very dichotomic: it contains a very small number of stocks, which are directly held and a more diversified stock portfolio, which is usually managed by a third party. It is still a major challenge for the existing literature to reproduce such a dual investment strategy at the household level. It is even more of a challenge to reproduce it together with the great heterogeneity in investment strategies at the fund level that we documented in graph 1. The endogenous information acquisition literature (see Van Nieuwerburgh and Veldkamp 2010) seems promising since in the presence of increasing returns to information acquisition, it is possible to generate concentrated portfolios, a prediction that accords well with the directly held portion of household equities. It should however probably be enriched with a model making explicit delegated portfolio management strategies. A first step in this direction has been taken by Dziuda and Mondria (2012). In their paper, asymmetrically informed households delegate their investment decisions to fund managers of stochastic abilities. Since domestic households know more about home country assets, they are better able to evaluate the performance of managers investing in home assets. Hence more highly skilled managers, who benefit from transparency, are more likely to operate in

domestic markets. Therefore a small information asymmetry at the household level is able to generate home bias due to the endogenous decision of skilled fund managers to operate in the domestic market. This framework however cannot generate the heterogeneous distribution of investment strategies observed at the fund level. It also does not have anything to say regarding the determinants of funds mandates and benchmarks. It would be interesting to explain the determinants of the distribution of funds mandates across countries for example, as it seems to exhibit considerable heterogeneity. It is likely that the literature on endogenous information acquisition and delegated investment still misses an important component of the incentives of fund managers, which could be marketing and product differentiation. More data on the number and type of distinct funds owned by each household would be necessary to fully understand the trade-offs. As pointed out in Veldkamp (2011, 101), investors may want to concentrate their portfolios with one fund manager if efficient pricing of investment services lead to quantity discount as in Admati and Pfleiderer (1990). There is little doubt however that understanding better delegated investment strategies and the constraints and incentives of fund managers would be an important step to study the extent and time series variation of international risk sharing, the international transmission of financial shocks and the propagation of crises. Recent work by Pavlova and Rigobon (2008) is a first step in that direction: they show how regulatory constraints and investment mandates can generate financial contagion through cross-border portfolio decisions. More generally, a promising avenue of research would be to study optimal regulatory or taxation policies in environment featuring endogenous asymmetric information or principal–agent problems due to delegated investment.

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