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ABSTRACT

This paper presents a model of international portfolios with real exchange rate and non-financial risks that account for observed levels of equity home bias. Bonds matter: in equilibrium, investors structure their bond portfolio to hedge real exchange rate risks. Equity home bias arises when non-financial income risk is negatively correlated with equity returns, *after controlling for bond returns*. Our framework allows us to derive equilibrium bond and equity portfolios in terms of directly measurable hedge ratios. An empirical application to G-7 countries finds strong empirical support for the theory. We are able to account for a significant share of the equity home bias and obtain an aggregate currency exposure of bond portfolios comparable to the data.

1. Introduction

Despite an unprecedented increase in cross-border financial transactions over the last 30 years, international portfolios remain heavily tilted toward domestic assets. This is the well-known equity home bias (see French and Poterba, 1991; Coeurdacier and Rey, 2011 for a recent survey). As of 2008, the share of U.S. stocks in U.S. investors' equity portfolios was 77.2%, despite the fact that U.S. equity markets account for only 32% of world market capitalization.[1]

Two important strands of literature aim to account for the observed bias. In both approaches, investors depart from the perfectly diversified portfolio of frictionless general equilibrium models à la Lucas, 1982, in order to insulate their consumption stream from asymmetric sources of risk. Generically, consider a risk-factor X that impacts *negatively* domestic wealth relatively more than foreign wealth. In equilibrium, the difference between domestic and foreign own-equity holdings (the degree of equity home bias) will be proportional to the following hedge ratio:

$$\frac{\text{cov}(X, R)}{\text{var}(R)}, \tag{1}$$

where R denotes the difference between domestic and foreign equity returns. Home equity bias arises when this relative equity return is *positively correlated* with X, that is, when domestic equities offer better protection to domestic investors against risk factor X.

The two strands of literature differ in the risk factor they consider. One approach, following Obstfeld et al. (2000), explores the link between consumption expenditures and international portfolios in stochastic general equilibrium models

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[1] The equity home bias is a general phenomenon. The share of home equities in other G-7 countries portfolios in 2008 are as follows: 80.2% in Canada, 73.5% in Japan, 66% in France, 53% in Germany and 52% in Italy. All these countries account for less than 10% of world market capitalization.

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where investors have different consumption baskets.[2] In their model, investors face real exchange rate risk: $X=(1-1/\sigma)\Delta\ln Q$ where $\Delta\ln Q$ is the rate of change of the real exchange rate (with the convention that an increase in Q denotes an appreciation), and σ is the coefficient of relative risk aversion. The hedge ratio takes the form $(1-1/\sigma)\text{cov}(\Delta\ln Q, R)/\text{var}(R)$. With a coefficient of relative risk aversion σ above unity, home equity bias arises when relative equity returns are *positively* correlated with the real exchange rate. The reason is simple: with $\sigma>1$, efficient risk sharing requires that domestic consumption expenditures increase with the real exchange rate.[3] If domestic equity returns are high precisely at that time, home equity bias follows. As shown by van Wincoop and Warnock (2010), this line of research faces a serious challenge: for many countries, the empirical correlation between excess equity returns and the real exchange rate is close to zero.

The second strand of literature focuses on the hedging properties of domestic stocks against fluctuations in domestic non-financial income (e.g. labor income).[4] The risk factor is $X=-R^n$, where R^n is the return to domestic non-financial income, relative to the rest of the world. The hedge ratio takes the form $-\text{cov}(R^n, R)/\text{var}(R)$: if returns on domestic equities are high precisely when returns on non-financial wealth are low, then domestic investors will favor domestic equities. This line of research also faces an important empirical challenge: Baxter and Jermann (1997) find that financial and non-financial returns are positively correlated. Optimal portfolios should then be biased towards *foreign* equity.[5]

The first contribution of this paper is to merge and improve upon these two strands of literature by showing that many of the earlier results are not robust to the introduction of domestic and foreign bonds, whether nominal or real. We establish this point in a generic setting, characterizing jointly the optimal equity and bond portfolios in environments with multiple sources of risk and different degrees of completeness of financial markets. Our approach allows us to characterize the optimal equity and bond portfolios in terms of *sufficient statistics* that can easily be estimated, in the spirit of Chetty (2009). These sufficient statistics take precisely the form of the hedge ratios of Eq. (1), extended to the case of multiple assets.

The key economic insight of our paper is that in most models of interest, as well as in the data, nominal or real relative bond returns are strongly positively correlated with real exchange rate fluctuations. As a result, it is optimal for investors to use bond holdings to hedge real exchange rate risks. In that sense, bonds matter. All that is left for equities is to hedge the impact of any *additional* source of risk on investors' wealth. The precise structure of these additional risk factors matters for optimal portfolio holdings, but the general portfolio structure can be estimated independently of the specificities of the model. Generically, equity home bias arises if non-financial income risk is negatively correlated with equity returns, *after controlling for bond returns*. This conditioning is important: to the extent that *unconditional* and *conditional* hedge ratios for non-financial income risk are different in the data, bonds also matter for the insurance properties of equities against fluctuations in non-financial wealth.

The mapping from hedge ratios to structural parameters depends on the details of the model. We illustrate such a mapping in a two-country two-good model with stochastic endowments and redistributive shocks between capital and labor. This particular example serves to illustrate starkly how the failure to allow for trade in bonds can lead to incorrect inference on the structure of optimal equity portfolios. The same model without bond trading predicts that investors should short domestic equities, as in Baxter and Jermann (1997). By contrast, the model with equity and bond predicts full home equity bias.

The second important contribution of this paper is to confront the theory to the empirical evidence. The paper shows how to estimate the hedge ratios—and hence predicted portfolios—from observable data on bond returns, real exchange rates and estimated returns to financial and non-financial wealth. This provides an important link between recent theoretical work on international portfolios and data on asset returns. Our empirical exercise uses quarterly data on market returns, non-financial and financial income for the G-7 countries since 1970 to ask whether asset returns are theoretically consistent with observed portfolios. Since returns on non-financial and financial wealth are not directly observed, the paper considers a number of different approaches, such as Campbell and Shiller (1988) (our benchmark estimation), Baxter and Jermann (1997) or Lustig and Nieuwerburgh (2008).

For all G-7 countries, and across all specifications, allowing bond trading is key to obtaining more reasonable equity positions. Without bonds, 'the international diversification puzzle is worse than you think' as Baxter and Jermann (1997) argued. However, with bond trading, our estimates predict significant levels of equity home bias for all G-7 countries, in line with the data. Finally, our empirical estimates also predict short but fairly small domestic currency positions for a reasonable degree of relative risk aversion.

Section 2 presents our basic framework and characterizes optimal equity and bond portfolios in terms of hedge ratios. Section 3 presents a fully-specified version of the model with endowment and redistributive shocks and characterizes the

[2] A non-exhaustive list of contributions—some of which precedes Obstfeld et al. (2000)—includes Dellas and Stockman (1989), Uppal (1993), Baxter et al. (1998), Serrat (2001), Kollmann (2006), Obstfeld (2007), Heathcote and Perri (2013), Coeurdacier et al. (2009), Collard et al. (2007), Coeurdacier (2009) and Benigno and Nistico (2012). See also Kouri and Macedo (1978), Krugman (1981) and the references in Adler and Dumas (1983) for an early derivation in partial equilibrium.

[3] Under efficient risk sharing, relative consumption expenditures satisfy $P_H C_H / P_F C_F = Q^{1-1/\sigma}$.

[4] A non-exhaustive list of contributions includes Bottazzi et al. (1996), Baxter and Jermann (1997), Julliard (2003), Heathcote and Perri (2013), Engel and Matsumoto (2009), Berriel and Bhattarai (2013) and Arespa (2015).

[5] Other empirical papers found more mixed results. See Bottazzi et al. (1996) and Julliard (2003).

equity-only and the full portfolios. Section 4 presents our empirical results. Section 5 concludes. An online appendix provides many derivations and robustness checks.

2. A benchmark model

This section presents the benchmark model and derives equilibrium portfolios.

2.1. Set-up

Preferences: We consider a two-period model ($t=0,1$) with two symmetric countries, Home (H) and Foreign (F), each with a representative household. Country i's representative household has standard Constant Relative Risk Aversion (CRRA) preferences, with a coefficient of relative risk aversion $\sigma \geq 1$ defined over a consumption index C_i, and a discount factor $0 < \xi \leq 1$:

$$U_i = \frac{C_{i,0}^{1-\sigma}}{1-\sigma} + \xi E_0\left[\frac{C_{i,1}^{1-\sigma}}{1-\sigma}\right], \tag{2}$$

where E_0 denotes expectations conditional on date $t=0$ information. The ideal consumer price index in country $i=H,F$ is denoted $P_{i,t}$ in terms of an arbitrary numeraire.

Financial markets and budget constraints: Trade in financial assets occurs in period 0. In each country there is a 'Lucas tree' whose supply is normalized to unity. In both periods, a cash-flow $d_{i,t}^f$ is distributed to owners of this financial asset (stockholders) as dividend. Another cash-flow $d_{i,t}^n$ is distributed to households of country i as non-financial income. At the simplest level, one can think of $d_{i,t}^n$ as representing 'labor income.' More generally, it describes all of country i's income sources that cannot be capitalized into financial claims.

Agents can also trade Home and Foreign one-period bonds. Both bonds are in zero net supply. Buying one unit of the bond of country i in period $t-1$ yields a cash-flow $d_{i,t}^b$ at date t. These bonds are risk-free but pay in different units. If the bonds are risk-free in real terms, a unit of country i's bond purchased at date $t-1$ yields $d_{i,t}^b = P_{i,t}$ at date t, i.e. enough resources to purchase one unit of country i's consumption index.

The representative household from country i enters period $t=0$ with an initial portfolio of stocks $\{S_{ij,0}\}$ and bonds $\{B_{ij,0}\}$ from country $j \in \{H,F\}$ and faces the following budget constraint:

$$P_{i,0}C_{i,0} + \sum_j \left(p_S^j S_{ij,1} + p_B^j B_{ij,1}\right) = d_{i,0}^n + \sum_j \left(S_{ij,0}\left(p_S^j + d_{j,0}^f\right) + B_{ij,0}d_{j,0}^b\right), \tag{3}$$

where p_S^j (resp. p_B^j) denotes the price of a stock (resp. of the bond) from country j at date 0. The right-hand side of Eq. (3) measures sources of funds, non-financial and financial. The left-hand side captures uses of funds: consumption and portfolio investment.

At date $t=1$, all income is spent:

$$P_{i,1}C_{i,1} = \sum_j \left(S_{ij,1}d_{j,1}^f + B_{ij,1}d_{j,1}^b\right) + d_{i,1}^n. \tag{4}$$

Lastly, markets for stocks and bonds of country $i \in \{H,F\}$ clear:

$$\sum_j S_{ji,t} = 1; \quad \sum_j B_{ji,t} = 0. \tag{5}$$

2.2. Equilibrium portfolios

Portfolios decisions: The optimal portfolio allocation results from maximizing Eq. (2) subject to Eqs. (3) and (4). The optimality conditions for stocks and bonds holdings in country i are given by the usual Euler equations:

$$E_0\left(\mathcal{M}_i R_j^f\right) = E_0\left(\mathcal{M}_i R_j^b\right) = 1; \quad i,\ j \in \{H,F\}, \tag{6}$$

where $R_j^f = d_{j,1}^f / p_S^j$ and $R_j^b = d_{j,1}^b / p_B^j$ denote the gross return on stocks and bonds respectively in country j and $\mathcal{M}_i = \xi(P_{i,0}/P_{i,1})(C_{i,1}/C_{i,0})^{-\sigma}$ is the stochastic discount factor in country i.

Log-linearization of the budget constraint: We can characterize approximate optimal consumption and portfolio decisions around the symmetric equilibrium where both countries have the same distribution of financial, non-financial and bond cash flows, households hold similar initial portfolios and have no initial net foreign asset positions, using standard log-linearization techniques as in Devereux and Sutherland (2006) and Tille and van Wincoop (2010).[6] Before doing so, let us

[6] Formally, we log-linearize around $d_{i,0}^l = \overline{d}_0^l$ and $E_0 d_{i,1}^l = \overline{d}_1^l$, and assume that $S_{ii,0} = S$ and $B_{ii,0} = B$ for $i \in \{H,F\}$ and $l \in \{n,f,b\}$. Appendix A.5 derives the more general case where countries are asymmetric ex ante. In that case, the optimal portfolio contains an additional intertemporal component.

introduce a bit of notation. First, Jonesian hats denote the log-deviation of a variable $x_{i,t}$ from its steady state value $\overline{x}_i$: $\hat{x}_{i,t} = \log(x_{i,t}/\overline{x}_i)$). Second, variables without country indices denote *differences* across countries: $\hat{x}_t = \hat{x}_{H,t} - \hat{x}_{F,t}$. Finally, the operator Δ denotes first differences: $\Delta\hat{x} = \hat{x}_1 - \hat{x}_0$.

Define the Home country real exchange rate as the foreign price of the domestic good, $Q \equiv P_H/P_F$, so that an increase in the real exchange rate represents a real appreciation. Log-linearizing yields: $\hat{Q}_t = \hat{P}_{H,t} - \hat{P}_{F,t}$.

Define aggregate nominal expenditures $X_{i,t} = P_{i,t}C_{i,t}$, and denote $1-\delta = \overline{d}^n_t/\overline{X}_t$ the steady state share of non-financial income in total expenditures, assumed common in both periods. Taking the difference between Home and Foreign budget constraints in both periods from Eqs. (3) and (4), log-linearizing around the symmetric equilibrium, and using the market clearing conditions (5) yields:

$$\hat{X}_t = (1-\delta)\hat{d}^n_t + (2S-1)\delta\hat{d}^f_t + 2b\hat{d}^b_t, \tag{7}$$

where $S = S_{ii,0} = S_{ii,1}$ and $B = B_{ii,0} = B_{ii,1}$ denote the (symmetric) optimal holdings of a country's own equities and real bonds and $b = B/\overline{X}_0$ denotes the steady state ratio of bond holdings to aggregate expenditures.

Define the (log-linearized) relative return on equities R^f, non-financial wealth R^n and bonds R^b as: $\hat{R}^f = \Delta\hat{d}^f - E_0\Delta\hat{d}^f$, $\hat{R}^n = \Delta\hat{d}^n - E_0\Delta\hat{d}^n$, and $\hat{R}^b = \Delta\hat{d}^b - E_0\Delta\hat{d}^b$. Taking first differences of Eq. (7), using the definition of the stochastic discount factor $\mathcal{M}_i = \xi(P_{i,0}/P_{i,1})(C_{i,1}/C_{i,0})^{-\sigma}$ and the fact that $\Delta\hat{X} = \Delta\hat{Q} + \Delta\hat{C}$ yields:

$$\Delta\hat{X} - E_0\Delta\hat{X} = \left(1-\frac{1}{\sigma}\right)\left(\Delta\hat{Q} - E_0\Delta\hat{Q}\right) - \frac{1}{\sigma}\left(\hat{\mathcal{M}} - E_0\hat{\mathcal{M}}\right) = (1-\delta)\hat{R}^n + (2S-1)\delta\hat{R}^f + 2b\hat{R}^b. \tag{8}$$

Eq. (8) is a key equation for our analysis. The first equality determines relative consumption expenditure growth as a function of the rate of change of the real exchange rate and the relative stochastic discount factor. The second equality expresses relative income growth for a given portfolio choice (S, b), as a function of the relative return on non-financial wealth, financial wealth and bonds.

Hedge ratios: If relative bond and equity returns are not perfectly correlated, it is always possible to 'project' the rate of change of the real exchange rate and the return on non-financial income on stock and bond returns.[7] This projection takes the form:

$$\begin{cases} \Delta\hat{Q} - E_0\Delta\hat{Q} & \equiv & \beta_{Q,b}\hat{R}^b + \beta_{Q,f}\hat{R}^f + u_Q \\ \hat{R}^n & \equiv & \beta_{n,b}\hat{R}^b + \beta_{n,f}\hat{R}^f + u_n \end{cases}, \tag{9}$$

where the residual terms u_i are orthogonal to asset returns $\hat{R}^j$, i.e. $E_0[u_i\hat{R}^j] = 0$ for $i \in \{Q, n\}$ and $j \in \{f, b\}$. The coefficients $\beta_{i,j}$ capture the loading of asset return $j = \{b, f\}$ on risk factor $i = \{Q, n\}$. These loading factors, also called *hedge ratios*, have the usual interpretation in terms of covariance–variance ratios:

$$\beta_{n,j} = \frac{\text{cov}_{\hat{R}^l}\left(\hat{R}^n, \hat{R}^j\right)}{\text{var}_{\hat{R}^l}\left(\hat{R}^j\right)}; \quad \beta_{Q,j} = \frac{\text{cov}_{\hat{R}^l}\left(\Delta\hat{Q} - E_0\Delta\hat{Q}, \hat{R}^j\right)}{\text{var}_{\hat{R}^l}\left(\hat{R}^j\right)},$$

where $j \neq l \in \{f, b\}$ and $\text{cov}_z(x, y)$ (resp. $\text{var}_z(x)$) denotes the covariance between x and y (resp. the variance of x), *conditional on z*. While these factor loadings are equilibrium objects and model-dependent, their empirical counterpart can be obtained simply from the reduced form Eq. (9) as regression coefficients, independently from the specifics of the model.

Equilibrium portfolios: From the Euler equation (6) of the investor problem, observe that the relative stochastic discount factor $\hat{\mathcal{M}}$ satisfies:

$$E\left[\hat{\mathcal{M}}\hat{R}^i\right] = 0 \quad \text{for } i \in \{b, f\}. \tag{10}$$

Using Eq. (10) to project the budget constraint (8) on relative asset returns $\hat{R}^f$ and $\hat{R}^b$, we obtain the following key property:[8]

Property 1 (*Optimal portfolios in terms of hedge ratios*). Under the rank condition of Appendix A.1 the optimal portfolio is unique and can be expressed in terms of the hedge ratios $\beta_{i,j}$ *as follows*:

$$b^* = \frac{1}{2}\left[\left(1-\frac{1}{\sigma}\right)\beta_{Q,b} - (1-\delta)\beta_{n,b}\right] \tag{11a}$$

$$S^* = \frac{1}{2}\left[1 + \frac{1-\frac{1}{\sigma}}{\delta}\beta_{Q,f} - \frac{1-\delta}{\delta}\beta_{n,f}\right]. \tag{11b}$$

[7] Appendix A.1 shows formally that a *rank condition* needs to be satisfied. This will generically be the case if the dimension of the underlying shocks is larger or equal to 2.

[8] The proof is relegated to Appendix A.1. It relies on observing that the relative stochastic discount factor is orthogonal to asset returns, using Eq. (10).

Property 1 has a key implication for our analysis: the hedge ratios $\beta_{i,j}$ provide *sufficient statistics* for the optimal portfolios. The structural details of a general equilibrium model will generically provide a mapping of the loading factors into the primitive characteristics of the model. Yet the portfolio predictions remain identical across models, conditional on a set of loading factors $\beta_{i,j}$.

Let us now discuss the structure of equilibrium portfolios implied by Property 1. Consider first the bond portfolio b^* in Eq. (11a). It contains two terms. The first term $(1-1/\sigma)\beta_{Q,b}/2$ reflects the role of bonds in hedging real exchange rate risk. When $\sigma>1$, the household's relative consumption expenditures $\hat{X}$ increase with the real exchange rate. If, after controlling for equity returns, domestic bonds deliver a high relative return when the currency appreciates (i.e. $\beta_{Q,b}>0$), domestic bonds constitute a good hedge against real exchange rate risk. The second term $-(1-\delta)\beta_{n,b}/2$ captures the role of bonds in hedging non-financial income risk. When domestic bonds and the return to non-financial wealth are positively conditionally correlated ($\beta_{n,b}>0$), investors want to short the domestic bond to hedge the implicit exposure to non-financial risks. Eq. (11a) indicates that investors will go long or short in their domestic bond holdings depending on the relative strength of these two effects.

Consider now the equilibrium equity position S^* in Eq. (11b). The first term inside the brackets represents the symmetric risk-sharing equilibrium of Lucas (1982): $S^*=1/2$. This is the optimal equity portfolio if equities are not useful to hedge real exchange rate or non-financial risk ($\beta_{Q,f}=\beta_{n,f}=0$).

The second term, $(1-1/\sigma)\beta_{Q,f}/\delta$, is similar to the term that has been emphasized in Coeurdacier (2009) or Obstfeld (2007), with one important difference. It represents the demand for domestic equity that arises from hedging real exchange rate risk, corresponding to the hedge portfolio in Eq. (1). If $\beta_{Q,f}$ is positive, domestic stock returns are relatively high when the currency appreciates, contributing to home bias. The important difference is that this hedge ratio is *conditional on bond returns*. As we will see, conditional and unconditional hedge ratios can differ greatly, with important implications for optimal portfolios.

The last term, $-(1-\delta)\beta_{n,f}/\delta$, determines how equity portfolios are structured to hedge non-financial risk. Investors optimally want to undo the endowed equity exposure implicit to non-financial risks, measured by $\beta_{n,f}$. To fix ideas, consider the case where bonds are risk-free in real terms so that $d^b_{i,t}=P_{i,t}$. In that case, it is immediate, using Eq. (9), that $\beta_{Q,b}=1$ and $\beta_{Q,f}=0$ since $\hat{R}^b=\hat{Q}-E_0\hat{Q}$. In the absence of non-financial income (i.e. when $\delta\to 1$), the optimal portfolios are the same as in Adler and Dumas (1983). Since bonds hedge perfectly real exchange risk, risky asset holdings are fully diversified: $S^*=1/2$. Eq. (11b) extends (Adler and Dumas, 1983) to the case with non-financial income ($\delta<1$):

$$S^*=\frac{1}{2}\left(1-\frac{1-\delta}{\delta}\beta_{n,f}\right). \tag{12}$$

This result is reminiscent of Baxter and Jermann (1997) who find that financial and non-financial returns are (*unconditionally*) positively correlated and conclude that the optimal portfolio should therefore be tilted towards foreign equities ($S^*<0.5$). However, unlike Baxter and Jermann (1997), Eq. (12) indicates that the relevant hedge ratio is *conditional on bond returns*. Our model predicts that home equity bias arises if $\beta_{n,f}<0$. To our knowledge, this condition has not been empirically investigated in the literature.[9]

Finally, observe that our approach is valid as long as equities and bonds are not redundant assets (the rank condition is satisfied), regardless of the degree of completeness of financial markets. Appendix A.1 shows that if an additional spanning condition is satisfied, markets are *locally* complete, in the sense that the efficient risk sharing condition of Backus and Smith (1993) holds locally:

$$\hat{\mathcal{M}}=-\sigma\Delta\hat{C}-\Delta\hat{Q}=0. \tag{13}$$

When this condition holds bonds and equities are sufficient to span the relevant sources of risk in the economy and the decomposition in Eq. (9) is exact: $u_i=0$.

3. Closing the model: the case of redistributive shocks

Proposition 1 established that the hedge ratios $\beta_{i,j}$ provide sufficient statistics for a full characterization of optimal portfolios. By fleshing out the remaining details of the model, these hedge ratios can be linked to the structural parameters of the model. While providing a full fledged theory of the factor loadings $\beta_{i,j}$ is beyond the scope of this paper, this section presents such a mapping in an illustrative and simple model with endowment and redistributive shocks.[10] Importantly, the main result of our paper is both more modest and more general: Property 1 shows how to map the—empirically observable

[9] Engel and Matsumoto (2009) also note that this is the relevant condition in the presence of bond holdings, or forward exchange contracts. See also Coeurdacier et al. (2009, 2010).

[10] The working paper version (Coeurdacier and Gourinchas, 2011) provides additional examples with, e.g., fiscal shocks, nominal shocks or non-traded goods. The case of redistributive shocks is similar to Coeurdacier et al. (2009) and Engel and Matsumoto (2009) with preset prices. The model in this section considers real bonds, which are by definition very effective at hedging real exchange rate risk. Nominal bonds can be less effective than real bonds to the extent that nominal shocks do not coincide with real shocks. This is discussed in more detail in the working paper version.

—hedge ratios into equilibrium portfolios, independently from the underlying model. Thus, readers only interested in the empirical implications of Section 2 can go directly to Section 4.

3.1. A model with endowment and redistributive shocks

The model borrows all the elements introduced in Section 2. In addition, we assume the following endowment and demand structure.

Endowments and shocks: Each country receives an endowment of a country-specific tradable good each period. The endowment in country i at date t is denoted $y_{i,t}$. $y_{i,0}$ is known while $y_{i,1}$ is stochastic and symmetrically distributed with mean $\overline{y}_1$ common to both countries. Denote $p_{i,t}$ the price at date t of country i's good in terms of the numeraire. At each date, the financial cash-flow represents a share $\delta_{i,t}$ of output at market value $p_{i,t}y_{i,t}$: $d^f_{i,t}=\delta_{i,t}p_{i,t}y_{i,t}$. $\delta_{i,0}=\delta$ is known while $\delta_{i,1}$ is stochastic and symmetrically distributed with mean δ. Shocks to $\delta_{i,t}$ represent redistributive shocks, i.e shocks to the share of total output distributed as financial income in country i.[11]

In each country the representative consumer enters period $t=0$ with a given financial portfolio of financial assets, receive financial and non-financial income as described in Section 2, consume and trade financial claims. In period $t=1$, stochastic endowments and stochastic shocks to δ are realized, households consume using the revenues from their financial portfolio and their non-financial endowment.

Preferences: Each representative household consumes both goods with a preference towards the domestic good. For $i,j\in\{H,F\}$ and $t=0,1$, the consumption index $C_{i,t}$ is a constant-elasticity aggregator: $C_{i,t}=\left[a^{1/\phi}c_{ii,t}^{(\phi-1)/\phi}+(1-a)^{1/\phi}c_{ij,t}^{(\phi-1)/\phi}\right]^{\phi/(\phi-1)}$, where $c_{ij,t}$ denotes country i's consumption of the good from country j at date t. ϕ is the elasticity of substitution between the two goods and $1\geq a\geq 1/2$ captures preference for the home good (mirror-symmetric preferences). With these preferences, the Fisher-ideal price index for consumption is:

$$P_{i,t}=\left[ap_{i,t}^{1-\phi}+(1-a)p_{j,t}^{1-\phi}\right]^{1/(1-\phi)}. \tag{14}$$

Financial and non-financial cash-flows: We assume that each country's bonds are risk-free in terms of that country's consumption index, that is $d^b_{i,t}=P_{i,t}$. With the notations of Section 2, financial and non financial cash-flows at date t are given by:

$$d^f_{i,t}=\delta_{i,t}p_{i,t}y_{i,t};\quad d^n_{i,t}=(1-\delta_{i,t})p_{i,t}y_{i,t};\quad d^b_{i,t}=P_{i,t}\quad \text{for } i\in\{H,F\}.$$

With these definitions of cash-flows, budget constraints can be written as in Eqs. (3) and (4) and portfolio equations as in Eq. (6).

Goods markets equilibrium: In each period, optimal intratemporal allocation of consumption requires:

$$c_{ii,t}=a\left(\frac{p_{i,t}}{P_{i,t}}\right)^{-\phi}C_{i,t};\quad c_{ij,t}=(1-a)\left(\frac{p_{j,t}}{P_{i,t}}\right)^{-\phi}C_{i,t}\quad \text{for } i\neq j. \tag{15}$$

Resource constraints are given by:

$$c_{ii,t}+c_{ji,t}=y_{i,t}\quad \text{for } i\in\{H,F\}, j\neq i. \tag{16}$$

Define q_t as Home's terms of trade, i.e. the relative price of the Home tradable good in terms of the Foreign tradable good: $q_t\equiv p_{H,t}/p_{F,t}$. An increase in q represents an improvement in Home's terms of trade. Using (15) together with the resource constraints (16) yields the following expression for relative output:

$$\frac{y_{H,t}}{y_{F,t}}=q_t^{-\phi}\Omega_a\left[\left(\frac{P_{F,t}}{P_{H,t}}\right)^{\phi}\frac{C_{F,t}}{C_{H,t}}\right], \tag{17}$$

where $\Omega_a(x)\equiv\left[1+x\left(\frac{1-a}{a}\right)\right]/\left[x+\left(\frac{1-a}{a}\right)\right]$. Without home bias in preferences ($a=1/2$), Eq. (17) simplifies to $y_{H,t}/y_{F,t}=q_t^{-\phi}$: the price elasticity of relative output is ϕ, independently of the distribution of relative expenditures. As emphasized by Obstfeld (2007), the term $\Omega_a(.)$ captures the Keynesian *transfer effects* due to consumption home-bias: with $a>0.5$, a reallocation of wealth towards the home country improves the domestic terms of trade since it shifts relative demand towards the domestic good.

Log-linearization of returns: Appendix A.1 shows that the model with independent endowment and redistributive shocks satisfies the rank and spanning conditions so that markets are locally complete. Formally, it implies that the Backus and Smith (1993) efficient risk sharing condition, Eq. (13), holds locally: $\Delta\hat{C}=-1/\sigma\Delta\hat{Q}$.

Log-linearizing the goods' market equilibrium condition Eq. (17) substituting the above expression, and using the fact that $\Delta\hat{Q}=(2a-1)\Delta\hat{q}$ from Eq. (14), yields a relationship between relative output and the terms of trade (or the real

[11] Our model considers exogenous redistributive shocks as in Ríos-Rull and Santaeulàlia-Llopis (2010). Fluctuations in income share can occur endogenously with a non-unitary elasticity of substitution between capital and labor, in the presence of capital and labor augmenting productivity shocks or biased technical change (Young, 2004).

exchange rate):

$$\Delta\hat{y} = -\lambda\Delta\hat{q} = -\lambda(2a-1)^{-1}\Delta\hat{Q}. \tag{18}$$

In this expression, $\lambda \equiv \phi\left(1-(2a-1)^2\right)+(2a-1)^2/\sigma > 0$ represents the equilibrium terms of trade elasticity of relative output. Without home bias in preferences ($a=1/2$), $\lambda=\phi$, the elasticity of substitution between Home and Foreign goods. When $a>1/2$, the additional term $(2a-1)^2(1/\sigma-\phi)$ captures the required change in the terms of trade needed to accommodate transfer effects.

Define aggregate nominal income $x_{i,t}=p_{i,t}y_{i,t}$. We can write the (log-linearized) relative return on equities $\hat{R}^f$, bonds $\hat{R}^b$ and non-financial income $\hat{R}^n$ as:

$$\hat{R}^f = \Delta\hat{\delta} - E_0\Delta\hat{\delta} + \Delta\hat{x} - E_0\Delta\hat{x} \tag{19a}$$

$$\hat{R}^n = -\frac{\delta}{1-\delta}\left(\Delta\hat{\delta} - E_0\Delta\hat{\delta}\right) + \Delta\hat{x} - E_0\Delta\hat{x} \tag{19b}$$

$$\hat{R}^b = \Delta\hat{Q} - E_0\Delta\hat{Q} \tag{19c}$$

Projection of risk factors on asset returns: Using Eq. (18), yields immediately that $\Delta\hat{x}=(1-\lambda)(2a-1)^{-1}\Delta\hat{Q}$. Substituting into asset returns, the following hedge ratios:

$$\beta_{Q,b}=1;\quad \beta_{Q,f}=0;\quad \beta_{n,b}=\frac{1-\lambda}{(1-\delta)(2a-1)};\quad \beta_{n,f}=-\frac{\delta}{1-\delta} \tag{20}$$

In this equation, two elements are essential: first, since investors can trade real risk-free bonds, relative bond returns and the real exchange rate are perfectly correlated ($\beta_{Q,b}=1$ and $\beta_{Q,f}=0$). Second and more importantly, despite positive co-movements between financial and non-financial returns driven by innovations to nominal income growth ($\Delta\hat{x}-E_0\Delta\hat{x}$), the loading of non-financial income risk on financial asset returns $\beta_{n,f}$ is always strictly negative because of the redistributive shocks.

Equilibrium portfolios: Substituting the equilibrium loadings Eq. (20) into Eq. (11), the optimal portfolio satisfies:

$$S^*=1;\quad b^*=\frac{1}{2}\left[1-\frac{1}{\sigma}+\frac{\lambda-1}{2a-1}\right]. \tag{21}$$

Since purely redistributive shocks only affect the distribution of total output, but not its size, the optimal hedge is for the representative domestic household to hold all the domestic equity. Consequently, the model implies full equity portfolio home bias.

Observe that this result does not depend upon the size of the redistributive shock. If $\upsilon^2=\sigma_\delta^2/\sigma_y^2$ denotes the relative variance of redistributive and endowment shocks, then the model predicts that $S^*(\upsilon)=1$ as long as $\upsilon>0$.[12]

The optimal bond position is the outcome of two forces: first, investors hedge real exchange risk when $\sigma\neq 1$. This is the term $(1-1/\sigma)/2$. Second, investors are fully exposed to domestic endowment shocks given their equity holdings. The bond portfolio makes sure that endowment risk is equally shared between home and foreign investors. This is the term $(2a-1)^{-1}(\lambda-1)/2$. The overall bond position can be long or short depending on whether $\lambda<1-(1-1/\sigma)(2a-1)$ or not, i.e depending on whether relative income growth co-move positively or negatively with relative bonds returns, or equivalently the real exchange rate.

3.2. The pitfalls of equity-only models

To illustrate the pitfalls of using equity-only models, consider what happens in the previous model if households can only trade equities. Following the same steps as in Section 2, one can derive the equilibrium equity-only optimal portfolio:

$$S^u(\upsilon)=\frac{1}{2}\left[1-\frac{1-\delta}{\delta}\beta^u_{n,f}+\frac{1-\frac{1}{\sigma}}{\delta}\beta^u_{Q,f}\right].$$

This equation is similar to Eq. (11b) except that the loadings $\beta^u_{i,f}=\mathrm{cov}(\hat{R}^i,\hat{R}^f)/\mathrm{var}(\hat{R}^f)$ are *unconditional* loadings. Consider now the limit of $S^u(\upsilon)$ as $\upsilon\to 0$, i.e. as redistributive shocks become vanishingly small. Intuitively, in that case financial and non-financial returns become positively correlated (see Eq. (19)) so that $\beta^u_{n,f}>0$.[13] In the limit of $\upsilon=0$, markets are locally complete again, and following the same steps as before, one can establish that:

$$\beta^u_{n,f}=1;\quad \beta^u_{Q,f}=(2a-1)/(1-\lambda). \tag{22}$$

[12] When $\upsilon=0$, portfolios are indeterminate: equity and bond returns are perfectly correlated and the model fails the rank condition of Appendix A.1.

[13] Appendix A.2 shows how to solve for the unconditional hedge ratios $\beta^u_{i,f}$ using the approach of Devereux and Sutherland (2006).

It follows that the optimal equity portfolio of the equities-only model satisfies:

$$S^u(0) = \frac{1}{2}\left[1 - \frac{1-\delta}{\delta} + \frac{1-\frac{1}{\sigma}}{\delta}\frac{(2a-1)}{1-\lambda}\right]. \tag{23}$$

As before, this portfolio is the sum of three terms: a Lucas pooled portfolio $(1/2)$, a term due to hedging of non-financial income risk $(-(1-\delta)/(2\delta))$ and a term hedging real exchange rate risk $(1-1/\sigma)(a-1/2)/(\delta(1-\lambda)))$. In the absence of bond trading, the hedging term for non-financial income risk always imparts a large foreign equity bias since $\beta^u_{n,f} = 1$. While in principle the last term can be positive or negative depending on parameters values, van Wincoop and Warnock (2010) show that the unconditional loading factor $\beta^u_{Q,f}$ is positive but small in the data, so that the portfolio $S^u(0)$ should typically exhibit foreign bias.[14] Thus, as in Baxter and Jermann (1997), the equity-only model cannot account for the home-equity bias for υ sufficiently small. With bond trading, the same model predicts full equity home bias, independently from model parameters. This striking example shows the crucial role of bond trading for the composition of equity portfolios.[15]

From an empirical perspective, our portfolio results are driven by the stark difference between *unconditional* and *conditional* hedge ratios: in the above example, $\beta^u_{n,f} > 0$ for small values of υ while $\beta_{n,f} = -\delta/(1-\delta) < 0$. If data were generated by such a model, measuring the *unconditional* hedge ratio would lead to the conclusion that the international diversification puzzle is worse than we think as in Baxter and Jermann (1997), while measuring the *conditional* hedge ratio would lead to the opposite conclusion.

More broadly, the message is that optimal equity portfolios depend on the menu of assets available to investors allowing them to diversify the risks they face.[16] Allowing for bonds is essential since they provide a very natural hedge against real exchange rate risk—a point also noted by Adler and Dumas (1983). Other tradable assets may be relevant besides risk-free bonds if they have attractive hedging properties: long term bonds, housing, derivatives. The empirical approach developed in the next section aims to maintain a parsimonious framework. Our results indicate that we can provide a reasonable account of observed equity portfolios simply by allowing for trade in short term bonds. This does not preclude more sophisticated models from achieving an even better fit with the data.

4. Estimating optimal portfolios

We now show how to use our theoretical results to construct optimal equity and bond portfolios. Doing so requires estimating the reduced-form loading factors $\beta_{Q,i}$ and $\beta_{n,i}$ for $i = f, b$ for the G-7 countries. According to Property 1, this is all we need to characterize equilibrium portfolios.

4.1. From theory to data

Two issues arise when mapping the theory into the data, one theoretical, the other empirical. On the theoretical side, one might wonder if our results, derived in a two-period environment survive in a dynamic setting. On the empirical side, our two period model does not allow for time-varying expected returns, an important feature of the data. Appendix A.6 shows that our results are robust to a dynamic environment with complete markets and i.i.d returns, in a continuous-time model à la Merton, 1990 (see Adler and Dumas, 1983). Optimal portfolios satisfy Property 1. The property holds with factor loadings computed on *total returns*, and thus including any time-varying expected return component—a finding that will matter when computing the empirical counterpart of returns on non-financial wealth.[17] In summary, our results hold in a static context with (locally) complete or incomplete markets, and also in a dynamic context, but under complete markets. Ideally, one would like to derive the equivalent of Property 1 for optimal portfolios in a dynamic model with incomplete markets, multiple agents and time-varying expected returns. This is a challenging task that is beyond the scope of this paper.[18]

[14] van Wincoop and Warnock (2010) estimate $\beta^u_{Q,f} = 0.32$.

[15] Appendix A.4 relaxes the assumptions that (a) markets are complete and (b) bond returns correlate perfectly with the real exchange rate by introducing a relative preference shock. Equilibrium portfolios now depend on the relative size of shocks. The results described above—that equity portfolio exhibits a significant home bias in the presence of bonds and foreign bias without bond trading—still holds for parameter values in a range consistent with the empirical evidence on factor loadings.

[16] Similarly, bond portfolios depend on the menu of assets. In our framework, if agents trade real bonds, the bond portfolio can be quite different in the presence of equity. However, in our set-up a single real bond would not be traded in equilibrium since under symmetry there is no intertemporal trade, only trade across states.

[17] In the dynamic model of Appendix A.6, returns are iid log-normal. Expected returns can be time-varying as long as returns of a given asset are driven by a *unidimensional* Brownian motion to preserve market completeness. Otherwise, the derived portfolio is only valid in the log-case.

[18] See for instance the discussion in Dumas and Lyasoff (2012).

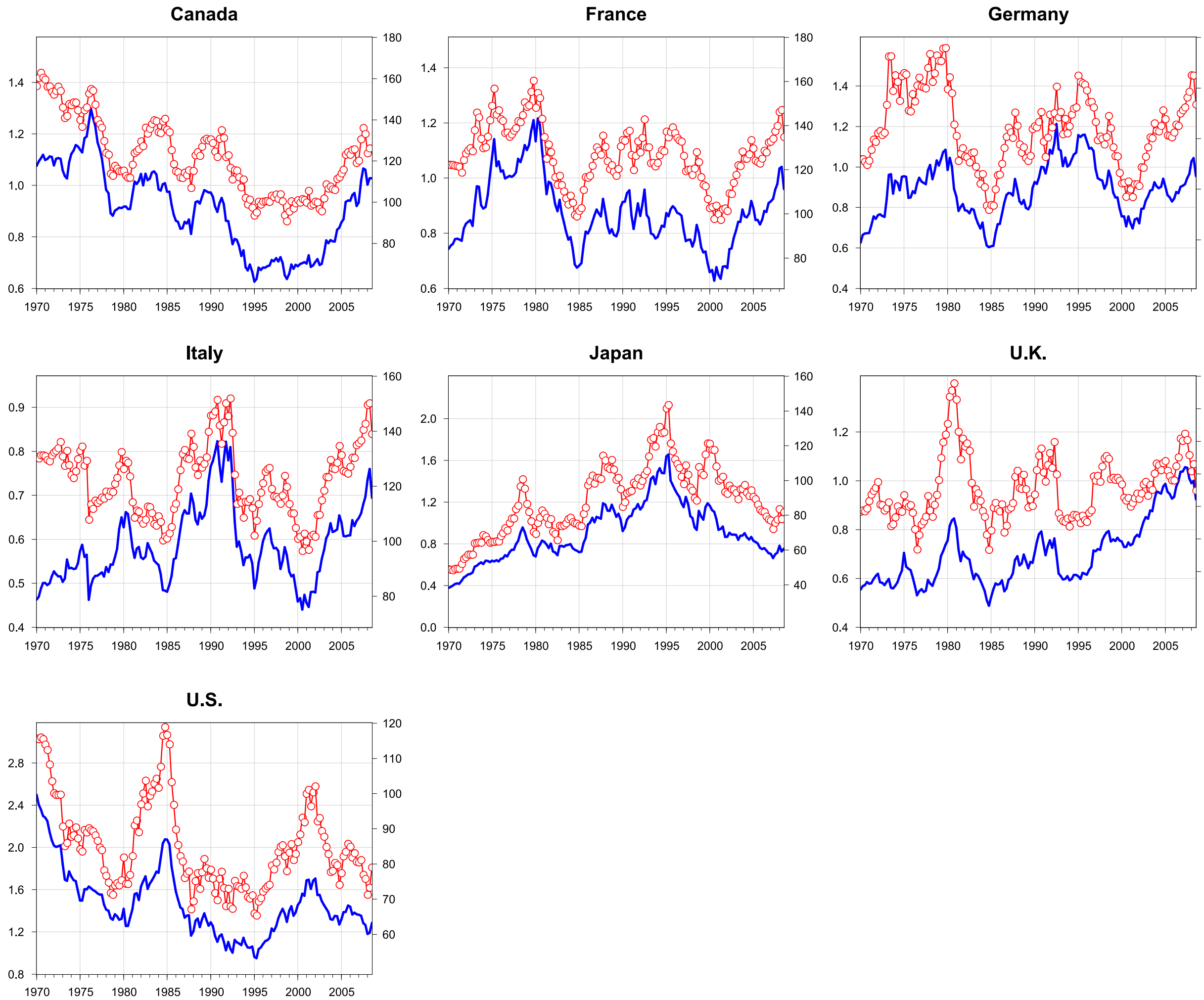

Fig. 1. Relative non-financial income (left) [–] and real exchange rate [-o-] (100 in 2001Q1, right), G-7 countries, 1970:1–2008:3.
Data sources: Global Financial Database, OECD Quarterly National Accounts and UN National Account Statistics. Authors' calculations.

4.2. *The data*

We collect quarterly data for all G-7 countries over the period 1970:1–2008:3, stopping short of the global financial crisis.[19] We consider each member of the G-7 as the Home country in turn, aggregating the remaining countries into a 'Foreign country'.

4.2.1. *The easy part: bond returns, real exchange rates, financial and non-financial income*

We measure gross real bond returns, R_i^b, as the ex-post gross return on 3-month domestic Treasury-bill converted in constant U.S. dollars. The (log) of the real exchange rate Q_i for country i is defined as the difference between the (log) of the consumer price index in country i, P_i, and the (log) of the consumer price index for the rest of the world, defined as a GDP-weighted average of the price indices of the remaining countries, where all price indices are converted into U.S. dollars: $\ln Q_i = \ln P_i - \sum_{j \neq i} \alpha_{ji} \ln P_j$, where α_{ji} represents the share of country $j's$ output in the rest of the world outside country i.[20] With this definition, an increase in Q_i represents a real appreciation of the currency of country i. Fig. 1 reports the real exchange rate for the G-7 countries, normalized to 100 in 2001Q1.

Next, we decompose each country's gross domestic product into a financial and a non-financial components using National Income Account data.[21] All variables are converted in U.S. dollars using nominal exchange rates.

[19] See Appendix B.1 for a detailed description of data sources.

[20] Short-term government bond yields and dollar nominal exchange rates are obtained from the *Global Financial Database*., Consumer Price Indices from the *OECD Main Economic Indicators*.

[21] Data is obtained from the OECD quarterly national income and from U.N. national account statistics. Details are in Appendix B.1.

Table 1
Estimates of the share of financial income in output δ (in %), defined as the share of financial income in output at product prices net of investment. The naive share is estimated as one minus the share of compensation of employees in output at factor prices.
Source: OECD Quarterly National Income and U.N. National Account Statistics. Authors' calculations.

	Canada	France	Germany	Italy	Japan	U.K.	U.S.	Average
δ	16.4	14.1	13.1	25.4	16.1	18.5	13.3	16.7
Naive-δ	39.9	39.9	40.5	50.9	43.5	36.7	37.8	41.3

Using these measures yields estimates of the share of financial income δ. Table 1 summarizes our estimates for the G-7 countries. These estimates range from 13.1% for Germany to 25.4% for Italy, with an unweighted average of 16.7%. For comparison, the table also reports the 'naive' estimate of δ, defined as one minus the share of compensation of employees in output measured at factor prices. It is much higher, with an average of 41.3%.

In what follows, financial and non-financial income are normalized by population, and expressed in constant U.S. dollars. Fig. 1 reports non-financial income per capita for each country relative to the non-financial income of the remaining G-7 countries. Relative non-financial income exhibits marked fluctuations over the period. For instance, for the U.S., it fluctuates between 0.9 and 2.4. It is also strikingly correlated with the real exchange rate, also reported on the same figure.[22]

4.2.2. The harder part: returns to financial and non-financial wealth

We now construct empirical counterparts to the return on financial and non-financial wealth since neither returns are directly observable. Consider first the return to financial wealth, R^f, where the country subscript i is omitted to ease notation. In general, that return is not equal to the return on aggregate equity R^e. In the model, the two are equal because financial wealth is entirely capitalized in the equity market. In practice, firms are levered, financed with a mix of equity and corporate debt, among other instruments.[23] What is needed is an estimate of the financial return to the firm. Our benchmark method looks at the liability side of the firms' balance sheet, using observable equity and corporate bond market data. Specifically, the gross return to financial wealth, R^f is constructed as a weighted average of the country's equity (R^e) and corporate debt (R^d) gross constant dollar returns, where the weight μ_t reflects the share of corporate debt in the total value of the firm. These weights are estimated for each country using balance sheet data for non-financial firms from Compustat.[24] Our measure of returns to financial wealth for each country is then:

$$r^f_{t+1} \equiv \log(R^f_{t+1}) = \log\left[(1-\mu_t)R^e_{t+1} + \mu_t R^d_{t+1}\right]. \qquad (24)$$

Section 4.6 presents alternative estimates of R^f as robustness checks.

Consider next the return to non-financial wealth, R^n. In a dynamic context, that return differs from the growth rate of real non-financial income per capita $\Delta \ln W$: the latter represents only the dividend component and not the total return on the corresponding asset.[25] Measuring the total return on non-financial wealth is a difficult issue. We tackle it from a variety of perspectives. Our benchmark approach follows the present-value method of Campbell and Shiller (1988). Under the assumption that the dividend-price ratio on non-financial wealth is stationary, and using lower case variable for logs, one can derive the following present-value relationship:

$$r^n_{t+1} - E_t r^n_{t+1} = (E_{t+1} - E_t)\sum_{s=0}^{\infty} \rho^s \Delta w_{t+1+s} - (E_{t+1} - E_t)\sum_{s=1}^{\infty} \rho^s r^n_{t+1+s}. \qquad (25)$$

In this expression, r^n_{t+1} denotes the (log) gross return on non-financial wealth and ρ is a scalar slightly smaller than 1.[26]

This expression makes clear that the innovation to the return on non-financial wealth depends positively upon revisions to the path of future expected real non-financial income growth—the *cash-flow* component represented by the first summation on the right hand side—and negatively upon revisions to the path of future expected real returns—the *discount* component represented by the second summation on the right hand side.

Our approach consists in constructing the empirical counterpart of Eq. (25) for each country using a Vector-Auto-Regression (VAR) in first differences of the following form:[27] $\mathbf{Z}_{t+1} = \mathbf{A}\mathbf{Z}_t + \epsilon_{t+1}$, where $\mathbf{Z}_t = \left(\tilde{r}_t, \Delta w_t, \Delta k_t, \Delta \ln Q_t, \mathbf{x}'_t\right)'$. In this expression, $\tilde{r}_{t+s}$ represents a possible proxy for the *expected* return on non-financial wealth at time $t+s$, in the sense that $E_t r^n_{t+s} = E_t \tilde{r}_{t+s}$. This proxy is necessary to construct the second summation on the right hand side of (25). Our benchmark

[22] The correlation ranges between 0.68 for Italy and 0.96 for Japan with an average of 0.85.
[23] Appendix A.3 shows that if firms' financing decisions are irrelevant for the value of the firm then the presence of corporate debt has no impact on equity portfolio decisions.
[24] See Appendix B.1 for details. The average share of debt in total liabilities is 67.1% (Canada), 75.2% (France), 75.3% (Germany), 76.2% (Italy), 70.7% (Japan), 59.2% (U.K.), 71.8% (U.S.). The country equity and corporate debt returns are obtained from the Global Financial Database. For Italy and Japan, corporate bond markets developed only in the late 1980s and the corporate debt return is proxied by the holding return on long-term government debt.
[25] See p. 175 of Baxter and Jermann (1997).
[26] One can show that $\rho = 1/(1+\phi)$ where ϕ is the steady state dividend price ratio for non-financial wealth. We set $\rho = 0.98$ in line with standard estimates in the literature. Our results are robust to changes in the value of ρ.
[27] Standard Akaike and Schwarz lag-selection criteria indicate that a VAR of order 1 is the preferred specification for all countries.

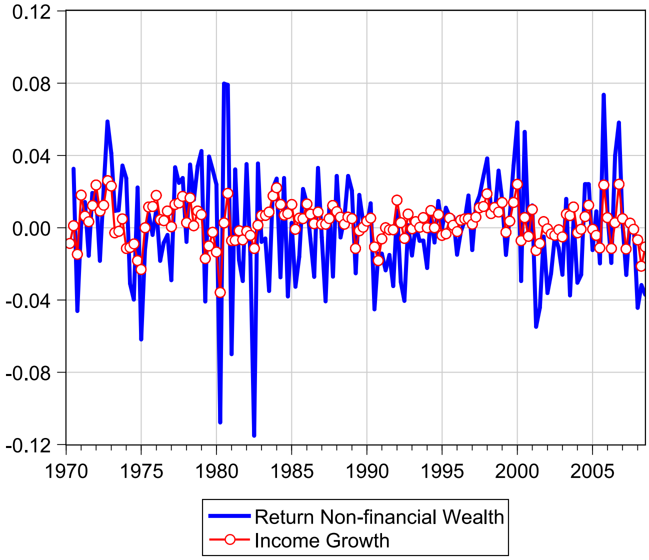

Fig. 2. Innovations to returns on non-financial wealth $r^n_{t+1} - E_t r^n_{t+1}$, and non-financial income growth Δw, US, 1970:1–2008:3.

approach sets $\tilde{r} = r^f$, that is, it assumes that expected financial and non-financial future returns are equal. $\Delta w_t, \Delta k_t$ and $\Delta \ln Q_t$ denote respectively the rate of change of non-financial income, financial income and the real exchange rate. Finally, $\mathbf{x}_t$ denotes a vector of additional controls used to forecast factor income growth and returns.[28]

Our VAR specification first-differences financial and non-financial income. Appendix B.3 discusses in detail why this is the appropriate empirical specification. In short, it shows that while we cannot reject the null hypothesis that w and k are integrated processes, there isn't any statistical evidence of a co-integration relationship between the two variables. This is a point of departure from Baxter and Jermann (1997) who estimate a Vector Error Correction Mechanism (VECM) on financial and non-financial income, imposing the cointegration relationship that $k - w$ is stationary. This assumption is appealing on theoretical grounds since the share of financial income is bounded between 0 and 1. The null of co-integration is, however, strongly rejected in the data, indicating a very persistent process for income shares, with no apparent error-correction term. Therefore, a stationary VAR in first-differences is appropriate.[29]

With estimates of $\mathbf{A}$ and ϵ_{t+1} in hand, the empirical counterpart to $r^n_{t+1} - E_t r^n_{t+1}$ can be obtained from (25) as:

$$r^n_{t+1} - E_t r^n_{t+1} = (\mathbf{e}'_{\Delta w} - \rho \mathbf{e}'_{\tilde{r}} \mathbf{A})(\mathbf{I} - \rho \mathbf{A})^{-1} \epsilon_{t+1}, \quad (26)$$

where $\mathbf{e}'_y$ is a row-vector that 'selects' variable y in $\mathbf{Z}$, i.e. such that $\mathbf{e}'_y \mathbf{Z} = y$. Fig. 2 reports the return to non-financial wealth $r^n_{t+1} - E_t r^n_{t+1}$ for the U.S., together with the growth rate of non-financial income Δw. The correlation between the two series is high (0.66), but the striking fact is that the return innovation exhibits much more volatility.[30]

The last step consists in measuring bond, financial and non-financial returns relative to the rest of the world. To this effect, define the relative returns $\hat{r}^l_i$ of country i as follows: $\hat{r}^l_{i,t+1} = \left(r^l_{i,t+1} - E_t r^l_{i,t+1} \right) - \sum_{j \neq i} \alpha_{ji} \left(r^l_{j,t+1} - E_t r^l_{j,t+1} \right)$, for $l \in \{b, f, n\}$, where α_{ji} is the output weight of country j in the rest of the world outside of country i.

4.3. *Estimating the loadings on the real exchange rate*

We are now in a position to estimate the key loading parameters in Eq. (9). The loadings on the real exchange rate, $\beta_{Q,j}$ for $j = f, b$, are estimated by the following simple regression for each country i:

$$\Delta \ln Q_{i,t} - E_{t-1} \Delta \ln Q_{i,t} \equiv \mathbf{e}'_{\Delta q} \epsilon_{i,t} = \beta^i_{Q,0} + \beta^i_{Q,b} \hat{r}^b_{i,t} + \beta^i_{Q,f} \hat{r}^f_{i,t} + u_{i,t}. \quad (27)$$

[28] Based on our reading of the literature on financial return predictability, a comprehensive set of potential controls for future asset returns is considered: consumption growth; the relative T-bill rate (the difference between the yield on 3-month T-bill rate and a 4-quarter moving average); the term premium (the spread between 10 year and 3 months government yields); the yield spread (the spread between the yield on long-term corporate bonds and that on 10-year government bonds); *cay*, the fluctuations in U.S. aggregate consumption-wealth ratio as measured by Lettau and Ludvigson (2001); and *nxa*, the Gourinchas and Rey (2007) measure of U.S. external imbalances, extended to 2008. These controls and their selection are described in Appendix B.3.

[29] As discussed in Appendix B.3, the assumption that $k - w$ is stationary is also rejected. Section 4.6 considers a VECM alternative, similar to Baxter and Jermann (1997)—results are largely unchanged.

[30] The standard deviation of the return innovations is 3.09% vs. 1.01% for non-financial income growth.

Table 2

Loadings on *real exchange rate changes*: $\Delta \ln Q_{i,t} - E_0 \Delta \ln Q_{i,t} = \beta^i_{Q,b} \hat{r}^b_{i,t} + \beta^i_{Q,f} \hat{r}^f_{i,t} + u_{i,t}$. Standard errors are in parenthesis. (***) (resp (**)) indicates significance at the 1% level (resp. 5%). Unconditional loadings impose $\beta_{Q,b} = 0$. Last column reports pooled fixed effect estimates. Constants are not reported. Sample: 1970:2 to 2008:3.

	Canada	France	Germany	Italy	Japan	U.K.	U.S.	Pooled
Panel A: Conditional loadings								
$\beta_{Q,f}$	−0.036	−0.011	0.007	−0.017	−0.030	0.064***	−0.013	0.006
(s.e.)	(0.025)	(0.024)	(0.026)	(0.018)	(0.028)	(0.022)	(0.038)	(0.009)
$\beta_{Q,b}$	1.003 ***	0.944 ***	0.946 ***	0.969 ***	1.012 ***	0.821 ***	0.944 ***	0.942 ***
(s.e.)	(0.033)	(0.028)	(0.031)	(0.026)	(0.034)	(0.039)	(0.040)	(0.012)
R^2	0.941	0.947	0.940	0.944	0.947	0.863	0.918	0.929
Panel B: Unconditional loadings								
$\beta^u_{Q,f}$	0.579 ***	0.591 ***	0.616 ***	0.447 ***	0.658 ***	0.376 ***	0.733 ***	0.554 ***
(s.e.)	(0.040)	(0.043)	(0.043)	(0.042)	(0.040)	(0.034)	(0.048)	(0.016)
R^2	0.579	0.557	0.573	0.424	0.641	0.453	0.611	0.535
Obs.	153	153	153	153	153	153	153	1071

where $u_{i,t}$ captures the fluctuations in the real exchange rate that are not spanned by relative bond and financial returns.[31]

Results of regression (27) for each countries are displayed in Table 2. Our empirical results confirm the results of van Wincoop and Warnock (2010) for all the countries in our sample: relative bond returns capture most of the variations of the real exchange rate. The coefficient on the relative bond returns in panel A, $\beta_{Q,b}$ is often not statistically different from 1, between 0.82 for the U.K and 1.01 for Japan. The R^2 of the regression is also very strong, between 0.86 for UK and 0.95 for France and Japan. Moreover, *conditional on bond returns*, the hedge ratio of financial returns for real exchange rate risk, $\beta_{Q,f}$ is almost never statistically different from zero.[32]

Panel B of the table reports the unconditional loading on the real exchange rate $\beta^u_{Q,f}$ obtained from a regression *only* on the relative financial return $\hat{r}^f$. The coefficients are significantly positive for all countries, between 0.38 (U.K.) and 0.73 (U.S.). This re-emphasizes the importance of properly conditioning on relative bond returns. Finally, the last column of the table reports the results from a pooled regression with country fixed effects. This can be interpreted as an average loading for all G-7 countries. The estimates, $\beta_{Q,b} = 0.94$ and $\beta_{Q,f} = 0.01$, confirm the strong correlation between relative bond returns and real exchange rates.

4.4. Estimating the loadings on the return to non-financial wealth

We now use the returns to non-financial wealth estimated for each country i to estimate the loadings of (relative) bond returns and (relative) returns to financial wealth by estimating the following equation:

$$\hat{r}^n_{i,t} = \beta^i_{n,0} + \beta^i_{n,b} \hat{r}^b_{i,t} + \beta^i_{n,f} \hat{r}^f_{i,t} + v_{i,t}, \tag{28}$$

where $v_{i,t}$ is attributed both to measurement error in the construction of the return on non-financial wealth, and to fluctuations in relative non-financial income risk not spanned by relative bond returns and relative returns to financial wealth.

Results of the regression (28) for each countries are shown in Table 3. Panel B reports the estimate of the unconditional loading factor $\beta^{i,u}_{n,f} = cov(\hat{r}^n_i, \hat{r}^f_i)/var(\hat{r}^f_i)$. This coefficient is positive and significant for all countries except Italy, with a pooled estimate of 0.41. This indicates that returns to non-financial wealth are positively correlated with returns to financial wealth as in Baxter and Jermann (1997) and the international diversification puzzle is 'worse than you think' when using equities only.

However, the loading factor conditional on bond returns $\beta^i_{n,f}$ reported in panel A is negative and strongly significant for all countries, except Germany. It varies between −0.05 (Germany) and −0.55 (Italy) with a pooled estimate of −0.23. As the previous analysis emphasized, this negative conditional hedge ratio indicates that in all these countries domestic equities constitute a good hedge against shocks to non financial wealth.

Moreover, the positive loadings of (relative) bond returns $\beta_{n,b} > 0$ implies that shorting the local currency bond, and going long in the foreign currency bond, constitutes a good hedge against fluctuations in returns to non-financial wealth (see Eq. (11)). This is not surprising: in our model, a potentially large part of relative non-financial income co-moves with the real exchange rate (see Fig. 1), and it is well-known that relative bond returns track almost perfectly the real exchange rate.

[31] It is important to note how Eq. (27) differs from a standard test of uncovered interest rate parity (Fama, 1984). Denote $\check{r}^b_{t-1}$ the ex ante real interest rate differential between $t-1$ and t, expressed in *local units*. Then $\hat{r}^b_t = \check{r}^b_{t-1} + \Delta \ln Q_t$ and the coefficient $\beta_{Q,b}$ will be close to 1 if most of the variation in ex post real interest rate differential $\hat{r}^b_t$ comes from movements in the real exchange rate, regardless of whether uncovered interest rate parity holds. However, under uncovered interest rate parity, $\check{r}^b_{t-1} = -E_{t-1}[\Delta \ln Q_t]$ so that $\hat{r}^b_t = \Delta \ln Q_t - E_{t-1} \Delta \ln Q_t$ measures the innovation to the rate of depreciation and $\beta_{Q,b} = 1$.

[32] The exception is the U.K. but even in this case $\beta_{Q,f}$ remains economically very small, less than 7%.

Table 3
Loadings on *non-financial returns*: $\hat{r}^n_{i,t} = \beta^i_{n,b}\hat{r}^b_{i,t} + \beta^i_{n,f}\hat{r}^f_{i,t} + v_{i,t}$. Standard errors are in parenthesis. (***) (resp (**)) indicates significance at the 1% level (resp. 5%). Unconditional loadings $\beta^u_{n,f}$ impose $\beta_{n,b} = 0$. Last column reports pooled fixed effect estimates. Constants are not reported. Sample: 1970:2 to 2008:3.

	Canada	France	Germany	Italy	Japan	U.K.	U.S.	Pooled
Panel A: Conditional loadings								
$\beta_{n,f}$	−0.186***	−0.327***	−0.053	−0.551***	−0.171***	−0.081**	−0.252***	−0.227***
(s.e.)	(0.072)	(0.057)	(0.062)	(0.098)	(0.053)	(0.036)	(0.099)	(0.026)
$\beta_{n,b}$	1.262***	1.122***	1.073***	1.295***	0.970***	0.967***	1.073***	1.096***
(s.e)	(0.094)	(0.069)	(0.075)	(0.140)	(0.065)	(0.062)	(0.103)	(0.034)
R^2	0.709	0.719	0.759	0.366	0.769	0.706	0.595	0.600
Panel B: Unconditional loadings								
$\beta^u_{n,f}$	0.588***	0.389***	0.637***	0.068	0.489***	0.286***	0.595***	0.411***
(s.e.)	(0.064)	(0.060)	(0.060)	(0.089)	(0.046)	(0.043)	(0.074)	(0.024)
R^2	0.362	0.219	0.429	0.004	0.428	0.223	0.300	0.213
Obs.	153	153	153	153	153	153	153	1071

Table 4
Implied Portfolio Equity (S) and bond (b) position for G-7 countries. Calculations are done under the assumption that $\delta = 0.19$ and $\sigma = 2$. (S) refers to the percentage of domestic stocks held by domestic residents (data for (S) are averaged over the period 2000–2008). ΔS refers to the difference between the implied S in a model with bonds and equity and the implied S with equities only. (b) refers to the net domestic currency exposure of bond portfolios (as a % of GDP). Data for (b) are computed from Lane and Shambaugh (2010) and refers to the average between net debt assets in domestic currency and net debt liabilities in foreign currency as a % of GDP (averaged over 2000–2004): $b = \frac{b_{HH} - b_{HF}}{2}$.

	Canada	France	Germany	Italy	Japan	U.K.	U.S.
Panel A: With bonds and equity							
Equity							
Baseline (Market cap weights)	5.13	7.30	5.67	3.30	15.71	12.35	50.53
Bias due to							
Q	−8.96	−2.72	1.77	−4.25	−6.64	14.59	−1.64
r^n	74.56	128.36	21.27	225.88	61.01	30.25	52.76
Total (S)	70.73	132.95	28.71	224.93	70.08	57.18	101.66
Data for (S) (2000–2008)	85.60	71.40	55.40	59.50	84.30	65.20	83.20
Bond							
Bias due to							
Q	47.58	43.74	44.59	46.85	42.65	35.99	23.35
r^n	−96.85	−84.11	−81.85	−101.33	−66.14	−68.55	−42.92
Total (b)	−49.27	−40.37	−37.26	−54.48	−23.49	−32.56	−19.57
Data for (b) (2000–2004)	9.30	9.90	8.90	−2.70	−12.70	−16.40	−10.90
Panel B: Equities only							
Baseline (Market cap weights)	5.13	7.30	5.67	3.30	15.71	12.35	50.53
Bias due to							
Q	145.25	142.53	143.62	108.09	144.20	90.82	104.86
r^n	−238.74	−151.72	−240.46	−26.71	−173.30	−111.90	−137.79
Total (S)	−89.35	−1.29	−85.91	88.97	−12.77	−13.33	12.44
ΔS	160.08	134.24	114.62	135.96	82.84	70.52	89.22

4.5. Implied equity and bond portfolios

The previous estimates allow us to back out the implied equity and bond positions using Eq. (11) when all countries are symmetric. Allowing for different country sizes, Eq. (11) must be rewritten as follows (see Appendix A.5):

$$\begin{cases} b^* = (1-\omega_i)\left(1-\frac{1}{\sigma}\right)\beta_{Q,b} - (1-\omega_i)(1-\delta)\beta_{n,b} \\ S^* = \omega_i + (1-\omega_i)\left(\frac{1-\frac{1}{\sigma}}{\delta}\beta_{Q,f} - \frac{1-\delta}{\delta}\beta_{n,f}\right) \end{cases} \quad (29)$$

where ω_i is the relative size of country i in world market capitalization.

The implied equity bias and bond portfolios are summarized in Table 4 using the loading coefficients from our baseline estimates. As Eq. (29) indicates, the optimal bond position requires an estimate of the degree of risk aversion σ. We consider the plausible value of $\sigma = 2$ in our benchmark calibration and use the average share of financial income across G-7 countries in the more recent period (2000–2008) for the share of financial income, yielding $\delta = 0.191$.

The model is very successful at predicting a significant degree of equity home bias for all countries when bond trading is allowed. Consider first panel B, which excludes bonds, as commonly done in the literature. The baseline refers to the first term in Eq. (29), that is, a predicted portfolio share equal to the share in world market capitalization ω_i. The second term (bias due to Q) reflects the contribution of the real exchange rate hedging component: $(1-\omega_i)(1-1/\sigma)\beta^{i,u}_{Q,f}/\delta$. Given the positive unconditional correlation between financial returns and exchange rates ($\beta^{i,u}_{Q,f} > 0$ in Table 2), this term is positive, indicating a potential source of home bias. The second term (bias due to r^n) reflects the contribution of the non-financial income hedging component: $-(1-\omega_i)(1-\delta)\beta^{i,u}_{n,f}/\delta$. Since $\beta^{i,u}_{n,f}$ is strongly positive (see Table 3), this term contributes negatively to the optimal equity portfolio and dominates the real exchange rate hedge. The result, as in Baxter and Jermann (1997) is a strong predicted foreign bias, $S^i - \omega_i$ ranging from -8.6% for France to -91.5% for Germany, in total contrast to the data.[33,34]

By contrast, Panel A shows that the estimated model accounts for a large share of observed equity home bias once bond trading is allowed. The hedge portfolio is now dominated by the non-financial income component. This term is strongly positive since $\beta^{i}_{n,f} < 0$ in Table 3. The predicted equity portfolio (S) is 29% for Germany, between 59% and 101% for Canada, Japan, U.K. and the U.S. and quite above 100% for France and Italy.[35] Available empirical evidence indicates a home equity position between 55% (Germany) and 85.6% (Canada).[36] Except for Germany, the equity bias predicted by the model is comparable to the amount of bias in the data. Using $\beta_{Q,f}$ and $\beta_{n,f}$ estimated on pooled data for all countries, equity portfolios are close to 90% for all countries, fairly close to the data.

The last line (ΔS) reports the change in the predicted equity position between the equity only and the full model. In all cases, the predicted equity position increases substantially, moving the model closer to the data. For instance, in the case of the U.S., in the model with equity only, investors should have a strong foreign bias ($S = 12\%$) while the full model predicts 101% domestic equity holdings, much closer to the empirical estimate (83.2%).

Panel A also reports the model predictions for bond holdings. As for equities, it decomposes the predicted bond position into a real exchange rate hedge component $((1-\omega_i)(1-1/\sigma)\beta_{Q,b})$ and a non-financial income component $(-(1-\omega_i)(1-\delta)\beta_{n,b})$.

We find a strong positive demand for local currency bonds arising from real exchange rate hedging, given the positive loading factor $\beta_{Q,b}$, but an even stronger incentive to borrow in local currency bonds to hedge non-financial income risk, given the positive $\beta_{n,b}$. While each of these components can be large relative to output, they offset each other and imply net currency exposure of bond portfolios of reasonable magnitude. The model predicts that countries' net currency exposure ranges between -19.6% (U.S.) and -54.5% (Italy) of domestic output, with a (size-weighted) average of -29% of GDP. Data regarding the net currency exposure in portfolio debt positions from Lane and Shambaugh (2010) indicates that G-7 countries are on average short in domestic currency, as predicted by the model, although the positions are both smaller than predicted by the model and more heterogenous. The (size-weighted) average net currency bond exposure is only $b = -7.9\%$ of GDP over 2000–2004, ranging from -16.40% (U.K) to 9.90% (France).[37] Overall, the fit of the benchmark model in terms of bond portfolios seems less impressive. In particular, the model is not able to match the heterogeneity in observed bond positions across countries with some countries long and some countries short in domestic currency exposure.[38]

4.6. Using different measures of returns to financial and non-financial wealth

A key element of our analysis is the construction of returns to financial and non financial wealth r^f and r^n. This section investigates the robustness of our results to various alternative measures of financial and non-financial returns.

[33] The exception is Italy, where the unconditional loading $\beta^{u}_{n,f}$ is insignificant and therefore the model predicts more home bias than observed.

[34] Our baseline estimates ignores time-variation of the equity home bias over the period considered. In our framework, a change in the equity home bias should come from changes in the hedge ratios. This hypothesis can be tested by splitting the sample into two, from 1970Q1 to 1989Q1 and from 1989Q2 to 2008Q3—and estimating hedge ratios over the two sub-samples. Our results suggest a very slight fall in the equity home bias over the period for the average country, although not statistically significant. We conclude that while the model can account for the cross section of equity home bias, it does not account for the decline in equity home bias in the time-series. Focusing on shorter time periods reduces variations in the data, which makes statistical inference harder and renders difficult any comparison across time-periods.

[35] The results for Italy are perhaps to be taken with some caution since the return on corporate bonds is proxied by the return on Italian T-bills.

[36] Data are from Coeurdacier and Rey (2011).

[37] In the data, countries often have leveraged external debt position. The counterpart of b in the model is $(b_{HH} - b_{HF})/2$ where b_{HH} denotes the net domestic currency debt exposure, that is, the difference between domestic currency denominated debt assets and domestic currency denominated debt liabilities—and b_{HF} denotes the net foreign currency debt exposure, that is, the difference between foreign currency debt assets and foreign currency debt liabilities. This counterpart generates the same wealth transfer towards a country whose currency depreciates by 1% with respect to all other currencies as in our model.

[38] The model assumes that there is no sovereign risk. While this is a reasonable assumption for G-7 countries, we note that sovereign risk is likely to reduce equilibrium portfolio bond holdings, forcing countries to rely more on equity holdings to hedge real exchange rate and non-financial income risk. While this would reduce observed bond holdings, it would also reduce home bias in equities. A full analysis of the model with sovereign risk is beyond the scope of this paper.

A first point of departure would be to construct returns to financial wealth using the same approach as for non financial returns, with national income data as in Baxter and Jermann (1997). This approach yields the following expression for the return to financial wealth:

$$r^f_{t+1} - E_t r^f_{t+1} = (E_{t+1} - E_t) \sum_{j=0}^{\infty} \rho^j \Delta k_{t+1+j} - (E_{t+1} - E_t) \sum_{j=1}^{\infty} \rho^j r^f_{t+1+s}. \quad (30)$$

Using the same VAR specification as in Section 4.2.2, the empirical estimates of the returns to financial wealth becomes:[39]

$$r^f_{t+1} - E_t r^f_{t+1} = (\mathbf{e}'_{\Delta k} - \rho \mathbf{e}'_{\tilde{r}} \mathbf{A})(\mathbf{I} - \rho \mathbf{A})^{-1} \epsilon_{t+1}. \quad (31)$$

The returns on the firm thus obtained may be noisy and imperfectly estimated. Our second approach instruments the returns in Eq. (31) with the country's equity and corporate debt returns, forcing the weights to sum to one. This is approximately equivalent to choosing different weights $\hat{\mu}$ in Eq. (24), measuring the leverage implied by national accounts data according to a first stage regression:

$$r^f_t = (1 - \hat{\mu}) r^e_t + \hat{\mu} r^d_t + \nu_t. \quad (32)$$

The predicted component $\left((1-\hat{\mu}) r^e_t + \hat{\mu} r^d_t\right)$ of (32) becomes our proxy for returns to financial wealth. This method identifies the variations in financial wealth estimated from national accounts that are reflected in market returns and is therefore potentially more robust to measurement error.

A third approach simply sets $\mu = 0$, equating the return to financial wealth with observed equity returns: $r^f_t = r^e_t$. This approach has the merit of simplicity, but as argued earlier, there are good theoretical reasons why equity returns may differ from the returns to the firm.

Lastly, we also consider three different approaches to constructing returns to non-financial wealth. The first one assumes that non-financial wealth is discounted using the holding return on long term government bonds, denoted r^{lb}. It follows the exact same methodology as in our benchmark estimates but sets $\tilde{r} = r^{lb}$ to construct estimates of returns to non-financial wealth.

The second approach borrows from Lustig and Nieuwerburgh (2008). The basic idea is to recover the unobserved innovation to non-financial wealth from the joint behavior of consumption and market returns, under the assumption that aggregate consumption satisfies the first-order condition of an optimizing representative household. The last approach imposes, as in Baxter and Jermann (1997), that financial and non-financial incomes are co-integrated and estimates a VECM. These last two approaches are detailed in Appendix B.3.

Results from regressions (27) and (28) are displayed in Tables 5 and 6 for the different specifications and for the different countries. Our empirical results confirm the previous results across all specifications: relative bond returns capture most of the variations of the real exchange rate and claims on financial income are not used to hedge real exchange rate changes (see Table 5). Moreover, *conditional on bond returns*, the loadings of non-financial wealth on financial wealth are negative across all specifications and significantly so for most of the countries, implying home bias in our model (see Table 6). This confirms the important role of bond holdings as an hedging instrument. Hence, qualitatively, results using these alternative measures of returns are very similar to our benchmark case.

Quantitatively, the magnitude of the loadings $\beta^i_{n,f}$ in Table 6 are similar to our benchmark case when using the projection of financial returns estimated from national accounts on market returns (panel B, the pooled estimate of $\beta^i_{n,f}$ is equal to -0.177), when using long term government bond returns to discount non-financial wealth (panel D, pooled estimate of $\beta^i_{n,f}$ equal to -0.245), when using the method of Lustig and Nieuwerburgh (2008) (panel E, pooled estimate of $\beta^i_{n,f}$ equal to -0.191) or when using a cointegration approach (panel F, pooled estimate of $\beta_{n,f} = -0.245$). As reported in Table 7, under all of these specifications, the amount of equity home bias generated by our estimates are in line with or even larger than the home bias data for most countries.

The results are marginally weaker when using national accounts data (panel A) or equity returns (panel C). More generally, one could also argue that these are noisier measure of financial returns causing attenuation bias on our estimates of the loadings. When using equity returns, the pooled estimates of $\beta^i_{n,f}$ is equal to -0.08 (panel C), roughly 40% of the value of our benchmark. Hence in this specification, the model can still explain a significant share of equity home bias (around 40%; see Table 7). The estimation using national account data to estimate returns to financial wealth performs qualitatively similarly as our benchmark, except for Italy.[40] When looking at the U.S. more specifically, Table 7 indicates that the equity portfolio implied by the model are respectively 82% of domestic equity when using national account data and 70% when using equity returns, only slightly below the measured ones.[41]

[39] The implementation still requires the use of observed market returns to form expectations of future returns. In practice, we use the returns on the firm constructed in the previous section as a proxy.

[40] In panel A, Italy is an obvious outlier with $\beta_{n,f} = 0.51$. However, recall for that country, we do not have a good measure of corporate returns which affects the way non-financial wealth is discounted. When dropping Italy from our pooled estimation, $\beta^i_{n,f}$ is equal to -0.1 and is highly significant.

[41] Like in our benchmark regression, the unconditional loadings (non-reported) for these two specifications are positive and highly significant ($\beta^{i,u}_{n,f} > 0$) implying a very large foreign bias in the model without bonds.

Table 5

Loadings on *real exchange rate changes* for alternative measures of returns: $\Delta \ln Q_{i,t} - E_0 \Delta \ln Q_{i,t} = \beta^i_{Q,b} \hat{r}^b_{i,t} + \beta^i_{Q,f} \hat{r}^f_{i,t} + u_{i,t}$. Standard errors are in parenthesis. (***) (resp (**)) indicates significance at the 1% level (resp. 5%). Last column reports pooled fixed effect estimates. Constants are not reported. Sample: 1970:2 to 2008:3.

	Canada	France	Germany	Italy	Japan	U.K.	U.S.	Pooled
Panel A: Financial returns estimated using national accounts								
$\beta_{Q,f}$	0.011	0.017	0.037	0.051	0.032	0.047***	0.000	0.027
(s.e.)	(0.010)	(0.010)	(0.014)	(0.012)	(0.013)	(0.019)	(0.019)	(0.005)
$\beta_{Q,b}$	0.954***	0.921***	0.911***	0.923***	0.953***	0.846***	0.934***	0.924***
(s.e.)	(0.022)	(0.019)	(0.025)	(0.019)	(0.022)	(0.035)	(0.027)	(0.009)
R^2	0.941	0.948	0.942	0.950	0.949	0.862	0.918	0.931
Panel B: Projection of returns from panel A on market returns								
$\beta_{Q,f}$	−0.050	−0.021	−0.001	−0.049***	−0.043	0.040	−0.010	−0.020
(s.e.)	(0.028)	(0.028)	(0.026)	(0.019)	(0.033)	(0.033)	(0.043)	(0.011)
$\beta_{Q,b}$	1.018***	0.953***	0.953***	1.008***	1.026***	0.843***	0.943***	0.968***
(s.e.)	(0.035)	(0.032)	(0.033)	(0.028)	(0.039)	(0.051)	(0.046)	(0.014)
R^2	0.941	0.947	0.939	0.946	0.948	0.857	0.918	0.929
Panel C: Financial returns based on equity returns								
$\beta_{Q,f}$	−0.003	0.003	0.008	0.011	−0.015	0.040***	−0.007	0.006
(s.e.)	(0.012)	(0.009)	(0.012)	(0.008)	(0.011)	(0.014)	(0.018)	(0.004)
$\beta_{Q,b}$	0.971***	0.935***	0.939***	0.946***	0.996***	0.878***	0.943***	0.946***
(s.e.)	(0.022)	(0.019)	(0.022)	(0.020)	(0.023)	(0.030)	(0.026)	(0.009)
R^2	0.945	0.953	0.935	0.941	0.944	0.889	0.924	0.932
Panel D: Non-financial returns using bond return discounting: $\tilde{r} = r^b$								
$\beta_{Q,f}$	−0.030	0.001	0.007	−0.018	−0.033	0.053**	−0.030	0.001
(s.e.)	(0.024)	(0.024)	(0.028)	(0.018)	(0.030)	(0.026)	(0.037)	(0.010)
$\beta_{Q,b}$	1.002***	0.929***	0.939***	0.971***	1.006***	0.769***	0.964***	0.937***
(s.e.)	(0.031)	(0.029)	(0.034)	(0.026)	(0.037)	(0.044)	(0.039)	(0.013)
R^2	0.947	0.944	0.931	0.945	0.939	0.807	0.924	0.921
Panel E: Non-financial returns estimated using (Lustig and Nieuwerburgh, 2008)								
$\beta_{Q,f}$	−0.027	−0.017	0.017	−0.008	−0.030	0.072***	−0.013	0.011
(s.e.)	(0.028)	(0.024)	(0.028)	(0.018)	(0.030)	(0.023)	(0.038)	(0.010)
$\beta_{Q,b}$	0.980***	0.947***	0.925***	0.958***	1.005***	0.802***	0.945***	0.931***
(s.e.)	(0.037)	(0.029)	(0.034)	(0.026)	(0.036)	(0.040)	(0.040)	(0.013)
R^2	0.927	0.944	0.927	0.945	0.940	0.855	0.918	0.923
Obs.	153	153	153	153	153	153	153	1071
Panel F: Vector error-correction mechanism								
$\beta_{Q,f}$	−0.037	−0.022	0.007	−0.013	−0.039	0.065***	−0.016	0.004
(s.e.)	(0.028)	(0.028)	(0.026)	(0.018)	(0.028)	(0.023)	(0.037)	(0.010)
$\beta_{Q,b}$	0.990***	0.934***	0.946***	0.967***	1.019***	0.819***	0.948***	0.939***
(s.e.)	(0.037)	(0.034)	(0.031)	(0.026)	(0.034)	(0.039)	(0.039)	(0.013)
R^2	0.926	0.922	0.939	0.946	0.947	0.861	0.922	0.925
Obs.	153	153	153	153	153	153	153	1071

As a final check, we consider the relative importance of the cash flow and discount components in Eq. (25). Unlike our benchmark result, Benigno and Nistico (2012) find that, for the U.S., returns to non-financial wealth are largely uncorrelated with financial returns, even after controlling for bond returns. Their approach ignores the contribution of revisions to the path of future expected real returns to the return on non-financial wealth—the second term in Eq. (25). Conceptually, it is not clear why one would wish to assume that the expected return to non-financial wealth remains constant given the large body of evidence on time-varying asset returns. Further, as the robustness checks presented above illustrates, our results are robust to many plausible alternative assumptions regarding expected future non-financial returns (equal to expected financial return, expected government bond return, or determined by consumption innovations). Lastly, our results are qualitatively robust to the restriction that expected non-financial returns are constant. Setting the second summation in (25) equal to zero, the conditional loading of non-financial returns on financial ones remains negative and significant for most countries, although not the U.S. or Germany, accounting perhaps for the findings in Benigno and Nistico (2012).[42]

[42] The estimates vary between 0.004 for Germany and −0.20 for France. Results available upon request from the authors.

Table 6

Loadings on *non-financial returns* for alternative measure of returns: $\hat{r}^n_{i,t} = \beta^i_{n,b}\hat{r}^b_{i,t} + \beta^i_{n,f}\hat{r}^f_{i,t} + v_{i,t}$. Standard errors are in parenthesis. (***) (resp (**)) indicates significance at the 1% level (resp. 5%). Last column reports pooled fixed effect estimates. Constants are not reported. Sample: 1970:2 to 2008:3.

	Canada	France	Germany	Italy	Japan	U.K.	U.S.	Pooled
Panel A: Financial returns estimated using national accounts								
$\beta_{n,f}$	−0.093***	−0.041	−0.074**	0.506***	−0.118***	−0.027	−0.149***	−0.004
(s.e.)	(0.027)	(0.026)	(0.034)	(0.062)	(0.025)	(0.031)	(0.047)	(0.015)
$\beta_{n,b}$	1.156***	0.847***	1.104***	0.459***	0.901***	0.900***	0.981***	0.877***
(s.e.)	(0.061)	(0.052)	(0.059)	(0.100)	(0.041)	(0.056)	(0.070)	(0.027)
R^2	0.718	0.662	0.765	0.470	0.786	0.698	0.603	0.572
Panel B: Projection of financial returns from panel A on market returns								
$\beta_{n,f}$	−0.149	−0.331***	−0.065	−0.256**	−0.219***	−0.094	−0.179	−0.177***
(s.e.)	(0.080)	(0.071)	(0.062)	(0.111)	(0.063)	(0.052)	(0.113)	(0.031)
$\beta_{n,b}$	1.224***	1.119***	1.089***	1.043***	1.019***	0.992***	1.021***	1.056***
(s.e.)	(0.102)	(0.079)	(0.166)	(0.074)	(0.081)	(0.119)	(0.069)	(0.031)
R^2	0.703	0.700	0.759	0.258	0.772	0.702	0.584	0.584
Panel C: Financial returns based on equity returns								
$\beta_{n,f}$	−0.109***	−0.053***	0.014	−0.125***	−0.076***	−0.028	−0.099**	−0.080***
(s.e.)	(0.043)	(0.020)	(0.033)	(0.023)	(0.026)	(0.026)	(0.049)	(0.012)
$\beta_{n,b}$	1.287***	1.032***	1.168***	1.240***	0.375***	0.995***	0.926***	0.952***
(s.e.)	(0.079)	(0.044)	(0.058)	(0.058)	(0.053)	(0.055)	(0.071)	(0.025)
R^2	0.678	0.805	0.762	0.751	0.256	0.726	0.571	0.600
Panel D: Non-financial returns using bond returns discounting: $\tilde{r} = r^b$								
$\beta_{n,f}$	−0.148***	−0.289***	−0.100	−0.590***	−0.259***	−0.079	−0.298***	−0.245***
(s.e.)	(0.074)	(0.083)	(0.071)	(0.120)	(0.060)	(0.061)	(0.095)	(0.032)
$\beta_{n,b}$	1.076***	0.951***	0.917***	1.076***	1.073***	0.981***	1.046***	1.012***
(s.e.)	(0.096)	(0.100)	(0.085)	(0.171)	(0.074)	(0.106)	(0.099)	(0.041)
R^2	0.634	0.459	0.612	0.212	0.732	0.457	0.577	0.451
Panel E: Non-financial returns estimated using (Lustig and Nieuwerburgh, 2008)								
$\beta_{n,f}$	−0.172***	−0.218***	−0.122***	−0.204***	−0.216***	−0.199***	−0.179***	−0.191***
(s.e.)	(0.042)	(0.037)	(0.052)	(0.037)	(0.037)	(0.028)	(0.040)	(0.014)
$\beta_{n,b}$	1.084***	1.141***	0.985***	1.163***	1.165***	1.113***	1.124***	1.116***
(s.e.)	(0.055)	(0.044)	(0.063)	(0.053)	(0.046)	(0.048)	(0.041)	(0.018)
R^2	0.836	0.884	0.765	0.814	0.906	0.815	0.920	0.853
Obs.	153	153	153	153	153	153	153	1071
Panel F: Vector error-correction mechanism								
$\beta_{n,f}$	−0.284***	−0.463***	−0.004	−0.531***	−0.150***	−0.127***	−0.228**	−0.245***
(s.e.)	(0.094)	(0.094)	(0.078)	(0.085)	(0.055)	(0.041)	(0.11)	(0.029)
$\beta_{n,b}$	1.369***	1.229***	0.994***	1.265***	0.946***	0.994***	1.012***	1.095***
(s.e.)	(0.123)	(0.114)	(0.094)	(0.122)	(0.068)	(0.072)	(0.033)	(0.038)
R^2	0.597	0.492	0.651	0.422	0.752	0.632	0.517	0.545
Obs.	153	153	153	153	153	153	153	1071

Table 7

Implied Portfolio Equity (S) and bond (b) position for G-7 countries under alternative methods to compute financial and non-financial returns. Calculations are done under the assumption that $\delta = 0.19$ and $\sigma = 2$. (S) refers to the percentage of domestic stocks held by domestic residents (data for (S) are averaged over the period 2000–2008). (b) refers to the net domestic currency exposure of bond portfolios (as a % of GDP). Data for (b) are computed from Lane and Shambaugh (2010) and refers to the average between net debt assets in domestic currency and net debt liabilities in foreign currency as a % of GDP (averaged over 2000–2004): $b = \frac{b_{HH} - b_{HF}}{2}$.

	Canada	France	Germany	Italy	Japan	U.K.	U.S.
Implied equity (S) under alternative estimation methods							
Baseline (Market Cap Weights)	5.13	7.30	5.67	3.30	15.71	12.35	50.53
Benchmark estimates	70.73	132.95	28.71	224.93	70.08	57.18	101.66
National Accounts	45.54	27.57	44.34	−191.01	64.94	33.08	81.77
Projection of financial returns	51.19	137.32	32.70	79.24	86.95	58.09	91.05
Equity returns	48.26	28.93	1.99	57.33	39.62	31.96	70.30
Bond returns discounting	57.43	121.10	47.52	240.61	100.76	53.90	109.01
Method of Lustig and Nieuwerburgh (2008)	67.46	88.67	58.63	84.81	86.32	102.79	86.39
Vector Error-Correction	109.92	183.60	9.07	217.43	60.70	74.23	96.12
Data for S (2000–2008)	85.60	71.40	55.40	59.50	84.30	65.20	83.20
Implied bond (b) under alternative estimation methods							
Benchmark estimates	−49.27	−40.37	−37.26	−54.48	−23.49	−32.56	−19.57
National Accounts	−18.43	−29.79	−17.49	−50.01	−26.99	−20.56	−13.11
Projection of financial returns	−45.32	−40.56	−38.34	−29.40	−26.85	−33.84	−18.31
Equity returns	−52.67	−34.02	−44.87	−51.26	16.39	−32.07	−13.71
Bond returns discounting	−35.04	−28.27	−25.68	−37.27	−30.77	−35.86	−17.99
Method of Lustig and Nieuwerburgh (2008)	−36.71	−41.62	−31.52	−44.69	−37.10	−43.78	−21.61
Vector Error−Correction Model	−58.14	−48.91	−31.23	−52.18	−21.55	−34.57	−17.06
Data for b (2000–2004)	9.30	9.90	8.90	−2.70	−12.70	−16.40	−10.90

5. Conclusion

What drives portfolio equity home bias? This paper merges and improves upon two strands of literature. The first strand focused on risks to non-financial wealth. It concluded that home equity positions should be even more tilted towards foreign equity since non-financial and financial returns appear to be positively correlated. The second strand looked at frictions in goods markets and emphasized real exchange rate risks. In this class of models, efficient risk sharing requires holding securities delivering high returns when the domestic currency appreciates. However, the correlation between stock returns and exchange rates is too low to generate significant portfolio biases. This class of models has thus been challenged for its lack of empirical support.

This paper shows that both strands of the literature are related, but incomplete. It starts from the observation that relative bond returns (nominal or real) are strongly correlated with real exchange rates. It follows that, in a world where investors can trade both equities and bonds, they will hedge real exchange rate risk with the latter. And once this is achieved, the equilibrium equity position will be a function of the residual risks that investors face, namely the risk to their non-financial wealth, *conditional* on bond returns. Equity home bias will arise if non-financial risk is negatively correlated with equity returns, after controlling for bond returns. The paper derives this prediction in a fairly general model and characterizes equilibrium portfolios as a simple function of hedge ratios that can easily be estimated from data on real exchange rates and returns on bonds, financial and non-financial wealth. This paper implements this empirical strategy for the countries of the G-7 and shows that under many reasonable specifications, the conditional correlation between financial and non-financial returns is such that it can empirically account for a significant share of the observed equity home bias. For most countries, the conditional correlation between financial and non-financial returns is negative and economically significant. In other words, the international diversification puzzle is not so puzzling anymore! The model also makes predictions about equilibrium bond positions. Here, although the overall currency exposure of bond portfolios is broadly in line with the empirical evidence, the model fails to capture the heterogeneity in currency exposure across countries.

It is possible to interpret our results in a broader perspective. Nominal exchange rates present a deep source of puzzles in international finance. They are too volatile and largely uncorrelated with their fundamental determinants—the exchange rate disconnect puzzle. To the extent that nominal exchange rate movements drive real exchange rate fluctuations, real exchange rates too, do not behave as predicted in our models—the Mussa (1986) puzzle. For instance, relative real consumption is not correlated with real exchange rate movements as models of risk sharing predict—the Backus and Smith (1993) puzzle. In the context of international portfolios, this implies that real exchange rates fluctuations are both uncorrelated with relative financial returns, and that relative financial and non-financial returns are positively correlated, since a given change in the nominal exchange rate affects both returns in the same direction. Our paper shows that, once currency fluctuations are controlled for through the use of nominal or real bonds, the structure of international equity portfolios conforms to the predictions of standard portfolio models. This provides a qualified success for the theory, since an empirically successful theory of exchange rate fluctuations remains elusive.

We left open an obvious step for future research. One would want to go back and enrich/discriminate among existing models to fully account for the hedge ratios we obtain from the data. Such a model would be consistent both with observed portfolios (quantities) and with their corresponding loadings, i.e the covariance structure of exchange rates and asset returns (prices). Going from the reduced form estimates to the structural parameters of the model requires taking a stand on the 'correct' model of the economy. A full-fledged structural estimation lies beyond what we attempt in this paper.

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Appendix A. Supplementary data

Supplementary data associated with this article can be found in the online version at http://dx.doi.org/10.1016/j.jmoneco.2016.07.005.

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