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Wages, profits and the international portfolio puzzle

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Abstract

This paper investigates the impact of fluctuations in the return to human capital on the composition of international asset portfolios. We adopt a continuous-time VAR model of international portfolio choice which allows for intertemporal interactions between wage rates and capital returns. Applying the model to a large set of OECD countries, our findings account for an average bias of about 30 percentage points toward domestic securities. The results are quantitatively similar both when a 'fundamentals' approach is adopted to compute the returns to domestic capital from data on aggregate operating surpluses, and when data on financial returns are used to evaluate the overall payoff of a claim on a country's productive resources.

JEL classification: C1 ; G11; J24; J30

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1. Introduction

The undisputed theoretical paradigm in modern international finance emphasizes the effectiveness of global diversification strategies for cash-flow stabiliza-

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tion and consumption risk-sharing purposes. Yet, virtually all available empirical evidence on international portfolio positions concludes in favor of a widespread lack of diversification across countries. According to the oft-cited estimates by French and Poterba (1991) and Tesar and Werner (1994), the percentages of aggregate stock-market wealth invested in domestic equities at the beginning of the 1990s were well above 90% for the US and Japan, and around 80% in the UK and Germany. To a lesser degree, home bias seems to characterize the net financial positions of small economies as well: for instance, Cooper and Kaplanis (1986) estimate domestic ownership shares of 56.5% for the Netherlands and 65% for Switzerland during the 1980s. At a somewhat more disaggregated level, Davis (1991) provides evidence on the international asset shares of institutional portfolios in six OECD countries in 1988; the reported estimates range from 0.4% (German pension funds) to 14.2% (Japanese life insurance funds), and they are consistently lower than 6% in the US, Germany, Canada and France. Using disaggregated data on Japanese firms' stock ownership, Kang and Stulz (1995) find that the share held by foreigners ranges from 1.21% for small firms to 6.97% for large firms. This pattern of asset holding is not restricted to equities, as Golub (1990) and Tesar and Werner (1995) document a home bias of similar magnitude for the bond market.

The consensus is that the observed portfolio bias cannot be primarily attributed to institutional restrictions and barriers to international capital movements, whose extent (at least in the OECD area) has been dramatically lessened within the process of financial liberalization and deregulation over the last decades. As thoroughly reviewed by Lewis (1995) and Obstfeld (1995), a number of possible explanations of the puzzle have been suggested (ranging from market inefficiencies to fluctuations in non-tradables consumption), yet none seems to be definitely persuasive. [1]

The interpretation we investigate in this paper hinges upon the role of human capital. To the extent that investors will attempt to hedge against adverse fluctuations in the return to human capital when choosing their portfolios of traded assets, the mere size of human capital in total wealth (roughly two thirds of overall wealth consists of claims on non-tradable labor incomes) makes its potential impact on international portfolios self-evident. However, it bears emphasizing that, at a first sight, the introduction of human capital is *not* expected to help rationalize the home bias puzzle. In fact, several contributions observe that the low extent of global diversification represents only part of the international portfolio *puzzle* and argue that, when the role of fluctuations in non-traded asset returns is

[1] The stylized facts are particularly striking given the evidence of significant potential welfare gains from international risksharing/portfolio diversification, as in van Wincoop (1994) and van Wincoop (1996).

explicitly taken into account, the effective discrepancy between theoretical prescription and actual management practice is much wider than commonly assessed.

The argument is well known. If the return to human capital is less correlated with the foreign stock market than with the domestic one, risk associated with non-traded assets can be more effectively hedged with foreign securities than domestic tradable assets. As a result, the equilibrium portfolio is (counterfactually) expected to be skewed toward *foreign* assets, possibly involving short positions in the home market. Cole (1988) concludes that ''this result is disturbing, given the apparent lack of international diversification that we observe'', although he does not attempt to address the question empirically. Brainard and Tobin (1992) draw the same conclusion, illustrated with a stylized example in which productivity shocks lead to a significant comovement between domestic wages and profits. Baxter and Jermann (1995) study the issue within the context of a general equilibrium two-country real business cycle model. As the model is driven entirely by productivity shocks, they reach the same conclusions as Cole (1988) and Brainard and Tobin (1992): ''the international diversification puzzle is worse than you think''.

On a theoretical basis, however, the outcome of optimal hedging strategies could also go in the opposite direction, towards domestic securities. Shocks that lead to a redistribution of total income between capital and labor will lower the correlation between the return on human and physical capital, making foreign securities a less attractive hedge against labor income uncertainty. If the relative magnitude of these random factors is sufficiently large, the *sign* of the correlation between wages and profits might be affected, leading to home bias. [2] To mention but a few possibilities, shocks that affect the bargaining power of workers (or unions) relative to firms, and (possibly related) shocks to the political business cycle are obviously expected to have a sizable and direct impact on the dynamics of income distribution; [3] their relevance has been emphasized, for instance, in the literature on the stagflation era. [4] To the extent that wages are less flexible than prices, positive demand shocks will affect asymmetrically real wages and real profits. Movements of the wage rate and the return to capital in opposite directions in response to terms of trade shocks are predicted by the Stolper–Samuelson theorem. The list could be easily extended, a typical case of *embarras de richesses*.

[2] Ghosh and Pesenti (1994) analyze the impact of redistributive shocks on international portfolio shares in the context of a two-country general equilibrium model of stochastic growth.

[3] Recently, work on distributive politics and growth (among others, Alesina and Rodrik (1991) and Bertola (1993)) has revisited the Kaldorian theory of income distribution and growth, suggesting that changes in wage–profit patterns over time may be understood as the endogenous outcome of majority rule voting.

[4] As pointed out by Bruno and Sachs (1985, ch. 8) in particular, rising labor shares, inflation bursts and terms-of-trade deterioration have been inter-linked phenomena over the past decades.

Ultimately, whether the return to human capital is more highly correlated with the return on domestic or foreign securities is an empirical question that, so far, has remained relatively unexplored. Most empirical studies concentrate on the correlation between domestic rate of returns on traded and non-traded wealth, [5] ignoring the international dimension of the issue. [6] This paper provides a systematic assessment of the international portfolio puzzle in the light of the considerations above. Our starting point is the design of an infinite horizon, continuous-time model of international portfolio choice in the presence of non-traded human wealth. Wage incomes (that is, human capital *dividends*) and the returns on financial securities are modelled as a continuous-time VAR process. This specification has the advantage of allowing for intertemporal *feedbacks* between the two sources of wealth, facilitating the comparison between our results and related studies in a closed-economy setup (as in Campbell (1996)).

To avoid the complex analytic problems associated with the determination of human wealth in the presence of unhedgeable sources of uncertainty, [7] we derive explicit (and intuitive) expressions for the domestic ownership share in the case of perfect spanning. [8] We therefore calibrate the model using estimates from VARs on real wages and capital returns for a set of sixteen OECD countries. Four measures of the economy-wide return to capital are considered: two fundamentals-based rates of return constructed from OECD data on aggregate profit rates, a leveraged stock return based on Morgan Stanley data on national stock market indexes and dividends, as well as a broad measure of financial return computed as a weighted average of equity returns, long-term government bond yields and money market rates.

The remainder of the paper is organized as follows. In section 2 we will have a preliminary look at the fundamentals data: wages and profits. A formal model of portfolio choice in continuous time is developed in section 3. The model provides an explicit expression for home bias as well as insights on how to approach

[5] Fama and Schwert (1977) (and more recently Jagannathan and Wang (1994)) compute the return to human capital in the US as the growth rate of wages, and find that the correlation with US financial returns is negligible. Campbell (1996), also for the US, finds a positive correlation of 0.42 between the present discounted value of wage innovations and the equity return, but does not consider the correlation with foreign equity returns. Rather than considering directly a measure of the return to human capital, Shiller (1993) computes instead the return on an asset that represents a perpetual claim on GDP.

[6] As an exception, Golub (1991) considers a simple model of international portfolio choice with human capital. He computes the return to human and physical capital by either detrending or taking first differences of real wages and corporate profits. He finds a negative correlation between Japanese corporate profits and Japanese labor incomes, and concludes that ''domestic corporate equities could be an excellent hedge for Japanese workers''. In the US case, however, he finds a relatively high correlation between labor incomes and US corporate profits.

[7] See for instance Svensson and Werner (1993).

[8] On the definition of spanning see, for instance, Duffie (1992, ch. 9).

empirically the international portfolio puzzle. Section 4 applies the model above to a set of OECD countries. Conclusions and suggestions for future research are outlined in the final section.

2. A preliminary look at the data

In this section we consider prima facie evidence on wages and profits in the OECD countries, without casting the analysis of these data within a formal model of international portfolio choice. The sample consists of annual data from 1970 to 1992 for a set of sixteen OECD countries. We use the variable RORB (rate of return in the business sector) from the OECD Economic Outlook database as our measure of the profit rate. It is defined as gross operating surplus, divided by gross non-residential capital stock. Our measure for the wage rate is computed as total employee compensation (from OECD National Accounts), divided by the price deflator of private final consumption expenditure, and normalized with respect to the number of employees. Further details on data sources can be found in the appendix.

Table 1 reports moments based on the wage and profit rates as well as the log of real GDP, after extracting quadratic time trends. [9] With very few exceptions, both the wage rate and the profit rate are procyclical. These results, however, should not be interpreted as 'stylized facts'. In fact, the extensive literature on the cyclicality of wages has shown that whether real wages are procyclical or countercyclical depends significantly on the particular country, sample period, definition of real wage (whether the CPI or the producer price index is used), method of detrending, level of aggregation and measure of the cycle (employment or output) considered. [10] Indeed, if we divide wages by the GDP deflator, and use employment as our measure of the cycle, the real wage rate is on average countercyclical during the 1970s.

What is remarkable about the results reported in Table 1 is that, even though both the wage and profit rates are procyclical for the vast majority of countries, their correlation is negative for all but four countries. Labelling movements in wages and profits which are independent of the business cycle as redistributive shocks *tout-court*, they appear to be strong enough to offset the positive comovement over the business cycle. Further evidence on the relevance of these shocks is

[9] Regarding the wage rate, first we take a log transformation, then we extract a quadratic trend from the log of the time series, and finally we convert the detrended series back to levels by taking an exponential transformation.

[10] See among others Otani (1978), Sachs (1979), Sachs (1983), Mocan and Topyan (1993), Geary and Kennan (1982), and in particular Michie (1987) which provides a thorough survey of this literature.

Table 1
Wage and profit rates in selected OECD countries [a]

	Correlations					Standard deviation labor share
	Wage rate, GDP	Profit rate, GDP	Wage rate, domestic profit rate	Wage rate, ROW profit rate	Labor share, ROW labor share	
Australia	−0.09	0.69	−0.28	−0.56	0.54	2.51
Austria	0.78	0.27	0.21	−0.38	0.87	2.76
Belgium	0.84	−0.07	−0.45	−0.41	0.72	3.16
Canada	0.54	0.52	−0.34	−0.29	−0.05	1.92
Denmark	−0.09	0.32	−0.19	−0.30	0.64	2.12
Finland	0.41	0.50	−0.49	−0.04	0.65	4.00
France	0.57	0.32	−0.16	−0.38	0.85	3.74
Germany	0.84	0.34	0.27	−0.26	0.80	2.18
Italy	0.47	0.37	−0.32	−0.28	0.07	2.00
Japan	0.54	−0.04	−0.82	0.12	0.53	4.46
Netherlands	0.86	−0.33	−0.49	−0.35	0.19	2.78
Norway	0.06	0.02	0.39	−0.31	−0.30	5.00
Sweden	−0.15	0.26	−0.75	−0.19	0.46	2.95
Switzerland	0.30	0.60	−0.31	−0.10	0.80	2.36
UK	0.27	0.40	−0.52	−0.32	0.30	2.46
US	0.71	0.82	0.87	0.29	0.52	1.05
Average	0.43	0.31	−0.21	−0.23	0.47	2.84

[a] The moments in this table are based on annual data from 1970 to 1992. The wage rate is real wage per worker, computed as total employee compensation (OECD National Accounts), divided by the private consumption price deflator (OECD National Accounts) and employment (Yearbook of Labour Statistics). The profit rate is the rate of return on business income from the OECD Economic Outlook. It is equal to operating surplus divided by the gross non-residential capital stock. GDP is gross domestic product at constant prices. The labor share is total employee compensation divided by net domestic product at factor cost (the sum of employee compensation and net operating surplus). The ROW profit rate and labor share refer to the 'rest of the world', using 1990 GDP as weights. A quadratic trend has been extracted from the profit rate and the logs of the wage rate and GDP. The wage rate and profit rate in the table are both in levels, while GDP is in logs. The labor share is in levels and not detrended.

contained in the last column of Table 1, which reports the standard deviations of the labor shares (equal to 2.84% on average). [11]

These findings are also illustrated in Figs. 1 and 2. Fig. 1 shows the detrended wage and profit rates over time. They are plotted on a comparable scale by setting

[11] Although not documented in Table 1, it is a well known stylized fact that the labor share varies countercyclically. Danthine and Donaldson (1994) consider a model of stochastic growth in which shareholders undertake all investment decisions while workers own exclusively human wealth. When optimal contracts between firms and employees are introduced, the risk-sharing equilibrium produces a labor share characterized by the correct countercyclical pattern and whose standard deviation is above that of the US but close to the standard deviation of several countries in our sample.

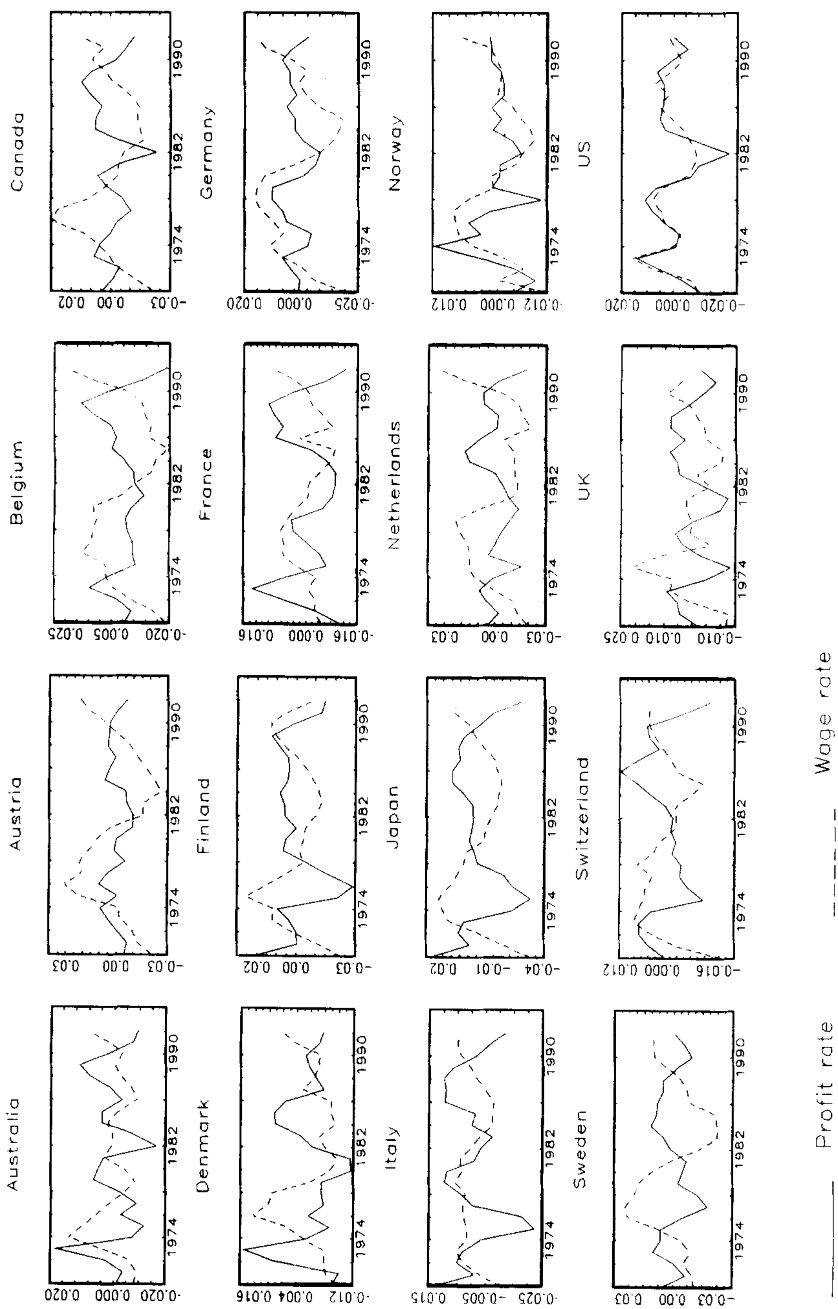

Fig. 1. Wage and profit rates in selected OECD countries.

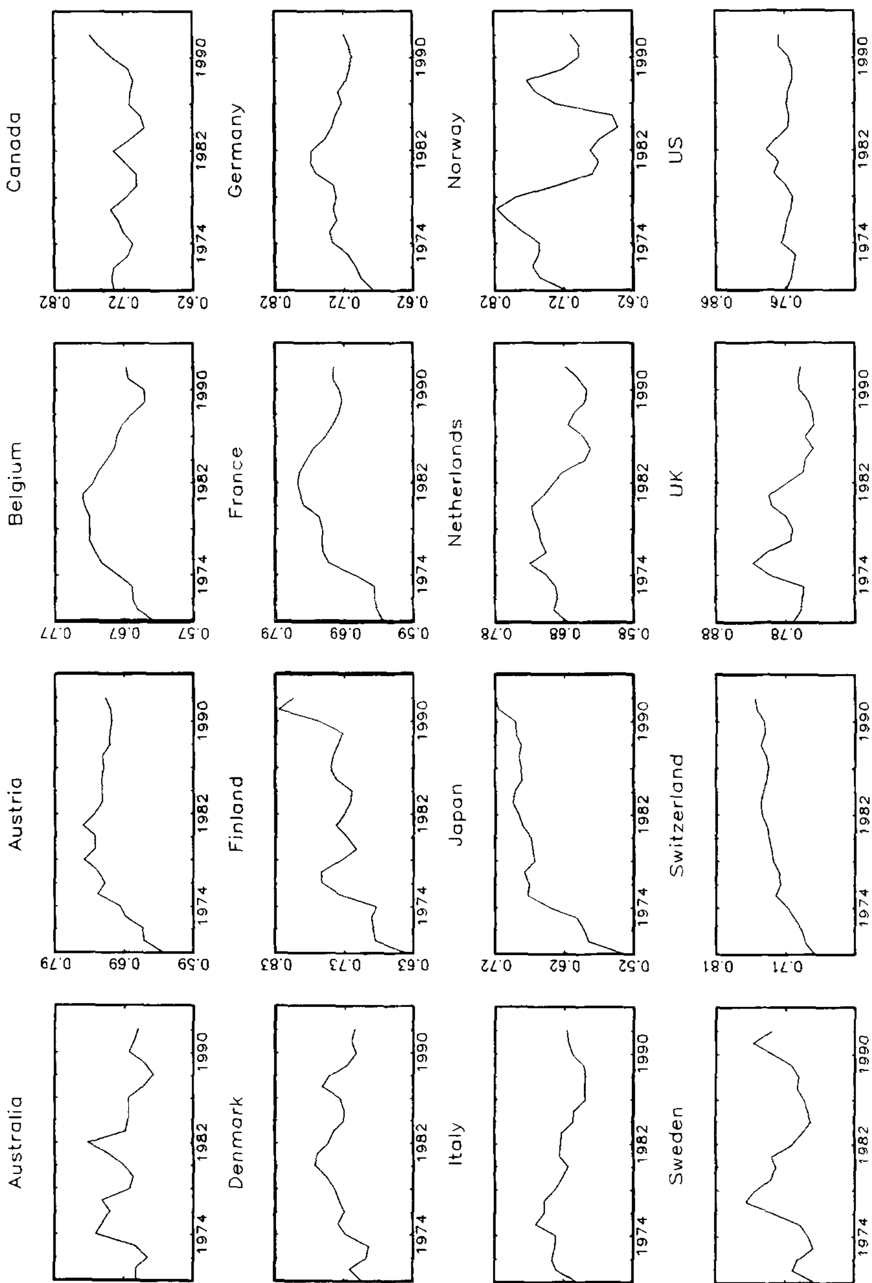

Fig. 2. Labor shares in selected OECD countries.

the ratio of the average wage rate to the average profit rate equal to the average ratio of employee compensation to the net operating surplus in each country. These appropriately scaled series have similar volatilities, and they are shown in terms of deviations from their means. In many countries we find striking opposite movements between wage and profit rates. Some of the best examples are Belgium, Japan, Sweden, Switzerland and the UK. The United States on the other hand represents a remarkable example of positive comovement between wages and profits, with a correlation of 0.87. During the 1970s, the two US series substantially overlap over the entire decade.

Fig. 2 illustrates the dynamics of the national labor shares over time. The length of all y-axes is set at 0.2, so that the volatilities are comparable across countries. In the United States the share is virtually constant over the entire sample period, a well known stylized fact. However, it bears emphasizing that the US case should not be taken as a paradigm for the OECD: if anything, Fig. 2 shows that the US represents a striking exception to the rule of large movements of the labor share, both at low and high frequencies. The excessive (and persistent) real wage growth beginning at the end of the 1960s and the profit squeeze following the oil shocks in the 70s in Europe represent the best known episodes of major shifts in income distribution during the stagflation years. [12] More recently, wage shares in a number of high-unemployment European countries have declined, falling in some cases below the fluctuation range that applied in the two preceding decades. [13] Real wages which rose in the aftermath of the first oil shock in the early 1970s, fell after 1979 in a number of countries (most notably Australia, Canada, Japan and Sweden). Overall, the 1980s are characterized by a narrowing of the gap between wage and price inflation, despite some pick-up in wage growth in the late 1980s in Australia, Finland, Italy and UK. [14]

[12] As Bruno and Sachs (1985) summarize, "in the late 1960s and early 1970s, a real wage explosion (particularly in Europe and Japan) caused a major shift in income distribution away from profits and toward labor. Even before the oil shocks, therefore, many OECD countries faced a major problem of declining profitability and slowing growth. In the second phase real wages did not decelerate (outside of the United States) to make room for the raw material price increases, so that the profit squeeze intensified. In the third phase...real wage increases were reduced, but so too was productivity growth, with the result that the excess of wages over full-employment productivity persisted into the early 1980s" (p. 166).

[13] See Elmeskov and McFarland (1993).

[14] The consensus is that the observed moderation in wage growth throughout the 1980s cannot be simply explained in terms of external factors such as the 'positive' oil shock in 1986. It is possible that inflationary expectations may have changed, reflecting a generalized credibility boost associated with the price-stabilizing efforts of monetary policy-makers in the OECD. The 1980s were also a period of reduced union militancy in most OECD countries, with a strong decline in both union coverage of the workforce and number of strikes. The impact of these trends on wage and profit behavior is self-evident. For details, see Table 4.1 and Annex A in OECD, Employment Outlook, 1991.

At this stage in our analysis, it would be obviously premature to suggest that the negative contemporaneous correlations between wage and profit rates in most countries supports home bias in international portfolios. First, the fourth column in Table 1 shows that the domestic wage rate is also negatively correlated with a weighted average of foreign profit rates (the so-called 'rest of the world' profit rate in the Table) for all but two countries. On average, the correlation between domestic wages and foreign (ROW) profit rates is two percentage points *lower* than between domestic wage and profit rates. Underlying this finding may be the fact that there is a significant common component in labor share movements across countries, particularly in Europe. The fifth column of Table 1 shows that the average correlation between a country's labor share and the 'rest of the world' labor share is 0.47. As shown below, to the extent that labor share movements are the result of global shocks, they should have no effect on the portfolio bias.

Second, the correlations reported in Table 1 may very well hide a more complex dynamic interaction between wages and profits. For example, if a rise in profits leads to a rise in wages with some time lag, the observed contemporaneous correlation might be negative, even though the returns to human and physical capital are positively correlated. In the next sections we will explicitly take such dynamic interactions into account.

3. Diversification, hedging and international portfolio choice

3.1. A continuous-time VAR model

In this section we consider a model of international portfolio selection in the presence of stochastic labor incomes. Domestic and foreign residents are assumed to produce and consume a single tradable good. [15] Labor is internationally immobile and inelastically supplied. Three financial assets are traded worldwide without institutional or technical restrictions: [16] domestic equity (claims on current and future domestic firms' earnings), foreign equity and an international bond. The bond yields an instantaneously riskless return, denoted by r. The riskfree bond is in zero net supply in the world economy, so that the return on equity can be interpreted as the return on the aggregate traded claim on a country's productive resources.

The returns on domestic and foreign equities are instantaneously stochastic:

$$\mathrm{d}R(t) = q(t)\mathrm{d}t + s_\omega \mathrm{d}\tilde{\omega} + s_z \mathrm{d}\tilde{z}, \tag{1}$$

$$\mathrm{d}R^*(t) = q^*(t)\mathrm{d}t - s_\omega^* \mathrm{d}\tilde{\omega} + s_z \mathrm{d}\tilde{z} \tag{2}$$

[15] For a related analysis in the presence of non-tradable goods, see Pesenti and van Wincoop (1996).

[16] We also rule out the possibility of psychological barriers, asymmetric information, prudential regulation and investors' 'pessimism' regarding capital profitability abroad; for a discussion of these topics, see French and Poterba (1991) and Ghosh and Pesenti (1994).

Here R is the cumulative return on the domestic asset, R^* the cumulative return on the foreign asset, q and q^* the expected returns per unit time on investment at home and abroad. Although q and q^* are known when consumption and portfolio decisions are made (that is, they are instantaneously deterministic), they need not be constant over time as specified below. The (instantaneous) stochastic components of asset returns are modelled as continuous-time white noise. To allow for the possibility of arbitrary correlations between returns, without loss of generality we can split them into two independent processes: a country-specific shock $\mathrm{d}\tilde{\omega}$, which is perfectly negatively correlated across countries, and a global shock $\mathrm{d}\tilde{z}$, which is perfectly positively correlated across countries.[17] The constant, positive parameters s_ω, s_ω^*, s_z index the covariances between asset returns and the two stochastic processes.[18]

Domestic and foreign cumulative wage incomes (in per capita terms) are respectively denoted W and W^*. Labor income flows per unit time are described by Eqs. (3) and (4):

$$\mathrm{d}W(t) = K(t)\left[m(t)\mathrm{d}t + a_\omega \mathrm{d}\tilde{\omega} + a_z \mathrm{d}\tilde{z}\right], \tag{3}$$

$$\mathrm{d}W^*(t) = K^*(t)\left[m^*(t)\mathrm{d}t - a_\omega^* \mathrm{d}\tilde{\omega} + a_z \mathrm{d}\tilde{z}\right]. \tag{4}$$

They are modeled as the product of two components: a trend $K(t)$ (domestically) or $K^*(t)$ (abroad), and a transitory shock (the term in square brackets). Given dynamic spanning, the stochastic components of wages are functions of the same sources of uncertainty that affect financial returns. The covariances with respect to country-specific and global shocks, that is the parameters a_ω, a_ω^* and a_z, are constant over time. We do not impose any restriction on their sign. The drifts (that is, the instantaneously forecastable components of wage incomes) are respectively denoted m and m^*. As described below, they are modelled as time-varying processes, jointly determined with q and q^*. The trends in labor incomes, reflecting growth in labor productivity over time, are simply deterministic state variables accumulated at the constant rate $g < r$:[19]

$$\frac{\mathrm{d}K(t)}{K(t)} = \frac{\mathrm{d}K^*(t)}{K^*(t)} = g\mathrm{d}t. \tag{5}$$

[17] The processes $\tilde{\omega}$ and $\tilde{z}$ are standard Brownian motions (Wiener processes) such that $\mathrm{d}\tilde{\omega} \equiv \lim_{\Delta t \to 0} \sqrt{\Delta t}\,\tilde{n}_\omega$ and $\mathrm{d}\tilde{z} \equiv \lim_{\Delta t \to 0} \sqrt{\Delta t}\,\tilde{n}_z$, where $\tilde{n}_\omega$ and $\tilde{n}_z$ are independent random variables, normally distributed with zero mean and unit variance. Throughout the paper, we will denote $\mathrm{Var}(\mathrm{d}X) \equiv (\mathrm{d}X)^2/\mathrm{d}t$, $\mathrm{Cov}(\mathrm{d}X, \mathrm{d}Y) \equiv (\mathrm{d}X\mathrm{d}Y)/\mathrm{d}t$ and $\mathrm{Corr}(\mathrm{d}X, \mathrm{d}Y) \equiv [(\mathrm{d}X\mathrm{d}Y)/\mathrm{d}t][\sqrt{(\mathrm{d}X)^2/\mathrm{d}t}\sqrt{(\mathrm{d}Y)^2/\mathrm{d}t}]^{-1}$.

[18] Note that the covariance of asset returns with the global shock, s_z, is equal across countries. This parameterization does not entail any loss of generality.

[19] If we allowed for a common stochastic trend in wage incomes in the two countries, possibly reflecting undiversifiable risk stemming from technological progress worldwide, the home bias results reported below would go through unchanged. Therefore, its omission here is merely due to algebraic convenience and it is theoretically inessential.

We now denote domestic *financial* wealth with $A(t)$. It is the sum of domestic residents' positions in the home equity, the foreign equity and the international bond (without short sale constraints). Thus, human capital is *not* accounted as a component of $A(t)$. The share of domestic financial wealth invested in domestic equity is indexed by n, the share of domestic financial wealth invested in foreign equity is indexed by n^* and the residual percentage $(1-n-n^*)$ represents international net loans as a fraction of domestic residents' assets. Denoting domestic consumption per capita $C(t)$, and dropping time indexes for notational thrift, the law of motion of financial wealth is given by

$$\mathrm{d}A = \left[n\mathrm{d}R + n^*\mathrm{d}R^* + (1-n-n^*)r\mathrm{d}t \right] A + \mathrm{d}W - C\mathrm{d}t. \tag{6}$$

As anticipated above, we want to model the dynamics of the expected components of asset returns and wages without imposing unnecessary structural constraints (besides spanning) regarding the intertemporal *feedbacks* between the two variables. An analytically rich, yet tractable, parameterization is the following continuous-time VAR process:

$$\begin{bmatrix} \mathrm{d}m \\ \mathrm{d}q \end{bmatrix} = \Theta \begin{bmatrix} m-\overline{m} \\ q-\overline{q} \end{bmatrix} \mathrm{d}t + \Sigma \begin{bmatrix} \mathrm{d}\tilde{\omega} \\ \mathrm{d}\tilde{z} \end{bmatrix} \tag{7}$$

where

$$\Theta \equiv \begin{bmatrix} \rho_{mm} & \rho_{mq} \\ \rho_{qm} & \rho_{qq} \end{bmatrix}, \quad \Sigma \equiv \begin{bmatrix} b_\omega & b_z \\ c_\omega & c_z \end{bmatrix}. \tag{8}$$

The parameters $\overline{m}$ and $\overline{q}$ index the steady-state means of m and q. The elements on the diagonal of the transition matrix Θ are negative, as well as the eigenvalues associated with Θ. Expected wage rates and financial returns abroad follow a similar (appropriately modified) VAR specification. [20]

Summarizing, both the expected rate of return on domestic securities and the expected (detrended) wage rate exhibit mean reversion toward their steady-state means $\overline{q}$ and $\overline{m}$. If ρ_{mq} and ρ_{qm} are both zero, wages and returns follow continuous-time autoregressive (Ornstein–Uhlenbeck) processes: a positive shock that raises the expected return on equity above its 'normal' level $\overline{q}$ is expected to have no effects in the long run (to the extent that ρ_{qq} is different from zero), although during the transition to steady state the expected return will remain above its long-run average. The smaller (in absolute value) ρ_{qq}, the slower the transition and the higher the degree of persistence of the shock. Similar considerations apply to the behavior of the expected wage rate m. More complex (and empirically

[20] In particular, the matrix Σ is replaced by

$$\Sigma^* \equiv \begin{bmatrix} -b_\omega^* & b_z \\ -c_\omega^* & c_z \end{bmatrix}$$

relevant) dynamic interactions arise if the transition matrix is full and q and m are jointly determined. For instance, if ρ_{mq} is negative, a stock market boom is associated, other things equal, with expectations of a future drop in the wage rate.

3.2. The optimal portfolio bias

Domestic residents determine optimal consumption and portfolio plans by maximizing the present discounted value of their utility stream. Assuming time separability in utility, and defining the (undiscounted) value function $F(t)$ as

$$e^{-\delta t}F(A, K, q, q^*, m, m^*) \equiv \max_{\{C(t), n(t), n^*(t)\}} \int_t^{\infty} e^{-\delta\tau} E_t U(C(\tau))\,d\tau \tag{9}$$

where δ is the rate of time preference, the optimal consumption/portfolio choice solves the Bellman equation

$$\delta F(t) = \max_{C, n, n^*} U(C(t)) + (E_t dF(t))/dt \tag{10}$$

subject to the appropriate budget constraints and boundary conditions. The problem is algebraically tedious but otherwise straightforward in a framework characterized by perfect spanning. [21] In fact, the value function is (educatedly) conjectured to be equal to $F = f(A + \Gamma K, q, q^*, m, m^*)$, where Γ is a linear function of the expected components of wages and returns only:

$$\Gamma = \Gamma_0 + \Gamma_q q + \Gamma_{q^*} q^* + \Gamma_m m + \Gamma_{m^*} m^*. \tag{11}$$

The interpretation of ΓK is straightforward. It is the price at which the consumer would be willing to hold a claim on current and future labor incomes in her portfolio, were it a traded asset; in other words, it is the value of human capital, so that $A + \Gamma K$ denotes *total* wealth. Note that the value of human capital is simply determined in terms of a no-arbitrage pricing rule, thus independent of the particular specification of the utility function. [22]

We can now solve for the domestic ownership share n under two assumptions. First, we evaluate the portfolio share at $q = q^* = \bar{q}$, the long-run average level of equity returns. Thus, we leave backstage in the computation of our 'steady-state' portfolio measure the effects of transitory fluctuations in the expected return

[21] We refer to the conference version of the paper for all algebraic details of the solution.

[22] In the absence of spanning, Γ would be a function of market participants' wealth A, and its functional form would depend on the parameterization of the utility function. Under spanning, the Bellman equation can be split into two equations, one which depends on all state variables and the particular structural form of the utility function $U(C)$, and a second one, the *fundamental valuation* equation of human capital, which determines the value of Γ independently of preference-related parameters.

differential.[23] Second, we evaluate n at the level of the borrowing/lending rate r such that the country's net position in the riskfree bond is zero ($n + n^* = 1$). This allows us to focus exclusively on the international composition of the portfolio of risky assets representing traded claims on national productive resources. Under these assumptions, it can be shown that

$$n - \frac{s_\omega^*}{s_\omega + s_\omega^*} = -\frac{K}{A}\left(\frac{a_\omega + \Gamma_m b_\omega - \Gamma_{m^*} b_\omega^* + \Gamma_q c_\omega - \Gamma_{q^*} c_\omega^*}{s_\omega + s_\omega^*}\right) \equiv bias. \quad (12)$$

The left-hand side of Eq. (12) represents the difference between the percentage of stock-market wealth invested domestically and the hypothetical steady-state percentage of domestic equity in a well-diversified international portfolio. The expression on the right hand (hereinafter referred to as *bias*) measures correctly the degree of portfolio bias due to hedging against fluctuations in wage incomes. It is worth emphasizing that global shocks do not play any role in the determination of the portfolio bias.

Since expression (12) is at the core of this contribution, it is worth interpreting it from two complementary vantage points: one which focuses on the role of the dynamic feedback parameters in Eq. (8), and a second one which emphasizes the comovements between financial and human capital returns.

Under the first approach, we compute the (algebraically complex) expression *bias* by solving the equation for human capital (11) and substituting the relevant parameters Γ_m, Γ_{m^*}, Γ_q and Γ_{q^*} into Eq. (12). For illustrative purposes, we briefly discuss the simple formula obtained under the assumption of full symmetry between domestic and foreign asset returns.[24] In this case, Eq. (12) can be rearranged as

$$bias = -\frac{1}{2}\frac{K}{A}\left[\frac{a_\omega \Phi + \rho_{mq} c_\omega + (r - g - \rho_{qq}) b_\omega}{s_\omega \Phi}\right]\left(\frac{1}{1+D}\right) \quad (13)$$

where

$$\Phi \equiv (\rho_{mm} - r + g)(\rho_{qq} - r + g) - \rho_{mq}\rho_{qm}, \quad (14)$$

$$1 + D = \frac{s_\omega \Phi + \rho_{qm} b_\omega + (r - g - \rho_{mm}) c_\omega}{s_\omega \Phi}. \quad (15)$$

Since $r > g$ and the eigenvalues of Θ are negative, both terms in brackets in Eq. (14) are negative and the sign of Φ is necessarily positive. The coefficient D,

[23] Changes in $q - q^*$ might affect possible 'swings' over time in the portfolio bias, whose empirical relevance is highlighted by Stulz (1994). Of course, in the presence of systematic misperception of the average profitability of investment abroad, the expected return differential would play a key role in the determination of the home bias even in steady state.

[24] Under symmetry, the parameters are such that $s_\omega = s_\omega^*$, $a_\omega = a_\omega^*$, $b_\omega = b_\omega^*$, $c_\omega = c_\omega^*$, $\Theta = \Theta^*$. This implies $\mathrm{Var}(\mathrm{d}R) = \mathrm{Var}(\mathrm{d}R^*) = s_z^2 + s_\omega^2$ and $\mathrm{Cov}(\mathrm{d}R, \mathrm{d}R^*) = s_z^2 - s_\omega^2$.

defined in (15), is a measure of persistence of country specific asset return innovations. It is discussed in greater detail below. Assuming without loss of generality $s_\omega > 0$ and $1 + D > 0$, consistent with the empirical evidence in the next section, we see that the direction of the home bias is determined by the sign of the numerator of (13) within square brackets. The term $a_\omega \Phi$ in the numerator reflects the optimal degree of hedging against *instantaneous* shocks to labor incomes: there will be home bias, ceteris paribus, to the extent that innovations to wage incomes and financial returns are instantaneously negatively correlated. Of course, if (broadly defined) redistributive shocks are ruled out a priori, cyclical comovements in factor incomes will make a_ω positive and $n - n^*$ negative, as emphasized by Brainard and Tobin (1992). To the extent that shocks to wages are persistent, any bias is reinforced through the last term in the numerator.

It should be stressed that the two parameters measuring the dynamic interaction between wages and asset returns, ρ_{mq} and ρ_{qm}, play a very different role in the home bias formula. The first parameter has a quite direct effect on the extent of home bias: a negative value of ρ_{mq} implies a drop in expected future wages in response to a positive asset return innovation, and therefore, intuitively, a negative covariance between the returns on human capital (the present discounted value of wage incomes) and financial assets which by itself leads to home bias. This shows up through the second term in the numerator of (13), $\rho_{mq} c_\omega$. The effect of ρ_{qm} is more subtle and indirect. If $\rho_{mq} = 0$, it can be seen immediately from (13) that ρ_{qm} does not affect the sign of numerator, and therefore of *bias*. In other words, the parameter ρ_{qm} measures the response of future expected asset returns to a change in current wages; such response will affect future expected wages, and therefore the home bias, only to the extent that there is a dynamic link *back* from asset returns to wages, as measured by ρ_{mq}. It is, after all, the covariance of the return to human capital with the *instantaneous* returns on assets that matters for the direction of the portfolio bias, not the covariance with *future* asset returns.

To clarify the remark above, the *bias* formula can be expressed in a more convenient (and perhaps familiar) way under the second approach. Returning to Eq. (12) in the more general asymmetric case, we define the processes H, V and V^* as the present discounted values of, respectively, detrended domestic wages, and domestic and foreign returns:

$$\begin{bmatrix} H(t) \\ V(t) \\ V^*(t) \end{bmatrix} \equiv \int_t^\infty \mathrm{e}^{-(r-g)(\tau-t)} E_t \begin{bmatrix} m(\tau) - \bar{m} \\ q(\tau) - \bar{q} \\ q^*(\tau) - \bar{q} \end{bmatrix} \mathrm{d}\tau + \int_0^t \begin{bmatrix} a_\omega & a_z \\ s_\omega & \sigma_z \\ -s_\omega^* & \sigma_z \end{bmatrix} \begin{bmatrix} \mathrm{d}\tilde{\omega}(\tau) \\ \mathrm{d}\tilde{z}(\tau) \end{bmatrix}. \tag{16}$$

It is now possible to show that Eq. (12) can be written as

$$bias = -\frac{K}{A}\left(\frac{\mathrm{Cov}[\mathrm{d}H, \mathrm{d}(R - R^*)]}{\mathrm{Var}[\mathrm{d}(R - R^*)]}\right)\frac{1}{1+D} \tag{17}$$

where

$$D \equiv \frac{\mathrm{Cov}[\mathrm{d}(V-R) - \mathrm{d}(V^* - R^*), \mathrm{d}(R-R^*)]}{\mathrm{Var}[\mathrm{d}(R-R^*)]}. \tag{18}$$

Heuristically, the expression in brackets in Eq. (17) can be thought of as the coefficient of regression of the present discounted value of (detrended) wages on the differential rate of return on capital. In the *bias* formula, such coefficient is appropriately 'adjusted' to take into account the persistence of country-specific equity return innovations, as indexed by the expression D in Eq. (18). Here, $\mathrm{d}(V-R)$ is the innovation to the present discounted value of *future* domestic returns, and by the same token $\mathrm{d}(V^* - R^*)$ is the innovation to the present discounted value of *future* foreign returns. The coefficient D can be either positive or negative. If for example D is positive, so that a current rise in equity return leads to higher expected equity returns in the future, the bias (in either direction) is reduced.

To understand the 'dampening' role of D, consider the case where domestic equity is a better hedge against wage uncertainty than foreign equity, so that there is home bias: a drop in the present discounted value of wages ($K\mathrm{d}H$) then tends to be associated with a rise in $\mathrm{d}R - \mathrm{d}R^*$. If this return differential persists over time (so that $q - q^*$ is positive), $n - n^*$ will rise in the future. This raises the implicit value of human capital today (effectively by lowering the risk premium) since the covariance between $\mathrm{d}H$ and $\mathrm{d}R$ is lower than between $\mathrm{d}H$ and $\mathrm{d}R^*$. The drop in the value of human capital due to lower expected wages is dampened by the lower risk premium, thus reducing the volatility in the value of human capital.

As a last cosmetic touch before we apply our model to the data, we define Γ as the 'average' ratio of human capital to trend productivity, the latter representing the permanent component of wage incomes. It can be obtained by evaluating Eq. (11) at its steady-state average value, and it is equal to the mean (detrended) wage rate $\overline{m}$ minus the steady-state risk premium, divided by $r - g$. This parameter is approximated by $\overline{m}(\overline{q} - g)^{-1}$, where $\overline{q}$ can be thought of as the sum of the riskfree rate and the average risk premium. We now define the variable $\mathrm{d}R_H$ as $\mathrm{d}H/\overline{\Gamma}$, and the ratio h as $\overline{\Gamma}K/A$: the former provides a measure of the *return* to human capital, while the latter defines the average ratio of human to financial wealth. Under these innocuous notational improvements, the expression *bias* (Eq. (17)) can be expressed in empirically intuitive terms as

$$bias = h\frac{\sigma_{R_H}}{\sigma_R}\left(\frac{(\sigma_{R^*}/\sigma_R)\mathrm{Corr}(\mathrm{d}R_H, \mathrm{d}R^*) - \mathrm{Corr}(\mathrm{d}R_H, \mathrm{d}R)}{1 + (\sigma_{R^*}^2/\sigma_R^2) - 2(\sigma_{R^*}/\sigma_R)\mathrm{Corr}(\mathrm{d}R, \mathrm{d}R^*)}\right)\left(\frac{1}{1+D}\right) \tag{19}$$

where $\sigma_R^2 \equiv \mathrm{Var}(\mathrm{d}R)$, $\sigma_{R^*}^2 \equiv \mathrm{Var}(\mathrm{d}R^*)$ and $\sigma_{R_H}^2 \equiv \mathrm{Var}(\mathrm{d}R_H)$. Note that the direction of home bias cannot be determined by simply comparing $\mathrm{Corr}(\mathrm{d}R_H, \mathrm{d}R)$ with

$\text{Corr}(\mathrm{d}R_H, \mathrm{d}R^*)$. Intuitively, if we consider the foreign country as the (integrated) rest of the world, and the foreign asset as a diversified portfolio of national claims, foreign asset returns are expected to be less volatile than domestic asset returns. This means that the domestic asset is more important as a hedge, and the correlation of $\mathrm{d}R_H$ with the domestic asset return receives a higher weight than that with the foreign asset return.

4. Wages, returns and the home bias puzzle in the OECD countries

In this section we apply our model to a large set of OECD countries. Using the results from the previous section, [25] we compute our measure of home bias for each country following a three-step procedure. First, for a given measure of the return to capital (hereinafter referred to as ΔR, the empirical equivalent of $\mathrm{d}R$) and a measure of the (detrended) wage rate (ΔW), for each country we estimate the following VAR process: [26]

$$\Delta W_{t+1} = \alpha_1 \Delta W_t + \alpha_2 \Delta W_{t-1} + \alpha_3 \Delta R_t + \alpha_4 \Delta R_{t-1} + \epsilon_{w,t+1}, \tag{20}$$

$$\Delta R_{t+1} = \beta_1 \Delta W_t + \beta_2 \Delta W_{t-1} + \beta_3 \Delta R_t + \beta_4 \Delta R_{t-1} + \epsilon_{r,t+1}. \tag{21}$$

Second, using the results from the VAR, we compute

$$\Delta H_t = \sum_{s=0}^{\infty} (E_t - E_{t-1}) \frac{\Delta W_{t+s}}{(1+r-g)^s} = \lambda_1 \epsilon_{wt} + \lambda_2 \epsilon_{rt}, \tag{22}$$

$$\Delta V_t = \sum_{s=0}^{\infty} (E_t - E_{t-1}) \frac{\Delta R_{t+s}}{(1+r-g)^s} = \theta_1 \epsilon_{wt} + \theta_2 \epsilon_{rt}. \tag{23}$$

The λ's and θ's measure the effect of wage rate and capital return innovations on the expected present discounted value of wages and returns. They are approximated numerically by computing the effect of innovations in ΔW and ΔR on their future levels up to 1000 years into the future. Given ΔH, the return to human capital is computed as $\Delta R_H = \Delta H/\bar{\Gamma}$, where $\bar{\Gamma} = \overline{\Delta W}/(\bar{q} - g)$ and $\overline{\Delta W}$ is the unconditional mean of ΔW. The foreign country is always defined as the rest of the world and we evaluate ΔV^* as a weighted average of ΔV in all other countries; similarly for ΔR^*. The weights are based on 1980 GDP in US dollars. Finally, in the last step we use data on ΔR, ΔR_H, ΔV, ΔR^* and ΔV^* to compute the various moments entering the home bias formula (19).

In the implementation of this three-step procedure we consider several different measures of the return to capital. The measure of home bias derived in the

[25] The notation of this section follows the one introduced in Section 3. Minor discrepancies between continuous-time and discrete-time specifications should be self-explanatory.

[26] Needless to say, in the 'translation' of our model from continuous to discrete time, it is appropriate to adopt a richer specification for the autoregressive components of the stochastic processes.

previous section is based on a (one-country–one-asset) aggregate measure of the return to national capital. Without ignoring that any choice of a comprehensive measure of the nation-wide return to capital necessarily entails a high degree of arbitrariness, we will consider two different methodologies, and two measures for each approach. The first is a 'fundamentals' approach, based on data on aggregate operating surplus per unit of capital. This strategy has the advantage of being consistent with the measurement of the return on human capital, which is necessarily based on a fundamentals approach. The second methodology focuses on measures of aggregate financial returns obtained by aggregating over hedged stock returns, government bond returns and money market rates. We will now consider each of these approaches in turn.

4.1. The 'fundamentals' approach

There are in principle many ways to compute a broad measure of fundamental return on capital using data on the aggregate operating surplus. We consider here two different measures, respectively denoted ΔR_1 and ΔR_2, reflecting two different sets of assumptions on the nature of the adjustment costs. Several other possible measures can be thought of as intermediate cases spanned by the two suggested methods. The first *rough-and-ready* measure is

$$\Delta R_{1,t} = RORB_t. \tag{24}$$

This is the same OECD measure of the rate of return in the business sector we considered in Section 2; it is worth recalling that it refers to the economy-wide gross operating surplus, divided by the gross non-residential capital stock. Hypothetically, ΔR_1 would represent the correct measure of capital return in a one-good world in which international investors were allowed to allocate their funds among a set of national 'workshops', converting capital into consumption goods at zero cost. [27] Advantages and drawbacks of this 'naive' specification are discussed in Christiano (1990). The main disadvantage of ΔR_1 hinges of course on its inability to take into account capital gains, by far the most relevant component of capital returns.

The opposite extreme case emphasizes instead the role of adjustment costs and the associated capital gains or losses. The measure is based on a valuation procedure similar to what Brainard et al. (1980) call the constant-capital intrinsic value of the firm. They assume that net investment is zero, so that the capital stock remains constant over time, and all capital vintages are assumed to earn the same rate of return. Since in our setup we allow for trend productivity, we (slightly) generalize this approach by assuming infinite adjustment costs to deviations from

[27] Cox et al. (1985) is the standard reference on general equilibrium asset pricing and portfolio choice within a similar 'zero adjustment cost' setup.

the constant growth rate of investment (and capital) g.[28] At time t, the market value of the claim on the aggregate stock of capital is given by

$$P_t = \sum_{s=1}^{\infty} E_t\left(RORB_{t+s} - \frac{I_{t+s}}{K_{t+s}} \right) K_t(1+g)^s \frac{u_{c_{t+s}}}{u_{c_t}} \tag{25}$$

where $u_{c_{t+s}}/u_{c_t}$ is the intertemporal marginal rate of substitution of consumption, χ is the depreciation rate and $I/K = \chi + g$ is the constant ratio of gross investment to capital. Assuming for simplicity a constant risk premium (as well as a constant riskfree rate), we can replace $u_{c_{t+s}}/u_{c_t}$ by $(1+\bar{q})^{-s}$, where $\bar{q}$, the unconditional mean of the net profit rate $RORB - \chi$, is equal to the constant riskfree rate plus the risk premium. To the extent that the discount rate affects all asset prices symmetrically, allowing the riskfree rate to vary over time, even stochastically, will not alter the home bias results, for the same reasons why, as seen above, global shocks ($d\tilde{z}$) have no effects on the composition of the portfolio of risky assets. Our second return measure is therefore $\Delta R_{2,t+1} = [P_{t+1} - P_t + K_{t+1}(RORB_{t+1} - \chi - g)]/P_t$. Linearization around $\bar{q} + \chi$ yields the approximation[29]

$$\Delta R_{2,t+1} = \bar{q} + (E_{t+1} - E_t) \sum_{s=0}^{\infty} \frac{RORB_{t+s+1}}{(1+\bar{q}-g)^s} \tag{26}$$

so that the innovation in the return is the present value of the unexpected changes in the future values of the profit rate, discounted at the rate $\bar{q} - g$.[30]

ΔR_2 is the only measure of capital return adopted in this paper that is not directly available. Moreover, ΔR_2 is by construction uncorrelated over time, so that we cannot estimate a VAR in ΔW and ΔR_2. Instead, both the return to human capital and ΔR_2 are computed using the results from the VAR for $\Delta R_1 (= RORB)$ and ΔW. This approach allows for dynamic interaction between wage and profit rates, not between the wage rate and the capital return.

The results from the VAR for ΔW and ΔR_1 are reported in Table 2. We use the same data as in Section 2 (16 countries, 1970–1992), again extracting

[28] Needless to say, it is the exogeneity (that is, the independence from capital profitability), not the constancy of the growth rate of investment that is essential here.

[29] In this formula we adopt the simplification $(1+g)^s(1+\bar{q})^{-s} \approx (1+\bar{q}-g)^{-s}$.

[30] As observed above, other 'fundamentals' measures of the return to capital generally fall somewhere in between ΔR_1 and ΔR_2. For example, Brainard et al. (1980) also consider a measure based on what they call the cash-out intrinsic value of the firm. It assumes that future investments in firms have zero economic rent, so that the value of the firm only reflects returns on existing capital. The methodology of computation in this case is similar to the one adopted for ΔR_2, but with a higher discount rate than $\bar{q} - g$.

Table 2
Parameter estimates from a joint VAR for wage and profit rates [a]

Country	α_1	α_2	α_3	α_4	β_1	β_2	β_3	β_4	λ_1	λ_2	θ_1	θ_2
Australia	1.12	−0.71	−0.00	−0.06	−0.68	−0.67	0.04	−0.43	1.89	−0.08	−1.76	0.81
	(0.20)	(0.22)	(0.08)	(0.08)	(0.51)	(0.56)	(0.19)	(0.18)				
Austria	0.80	−0.12	0.35	0.38	0.43	−0.58	0.33	−0.14	2.26	1.86	−0.30	0.98
	(0.20)	(0.18)	(0.17)	(0.19)	(0.22)	(0.19)	(0.19)	(0.21)				
Belgium	1.14	−0.34	−0.13	0.32	−0.26	−0.24	0.88	−0.67	3.08	0.68	−1.83	0.90
	(0.19)	(0.19)	(0.12)	(0.12)	(0.28)	(0.29)	(0.17)	(0.17)				
Canada	1.14	−0.31	0.13	−0.00	−0.08	−0.37	0.63	−0.54	3.99	0.56	−1.85	0.86
	(0.24)	(0.23)	(0.09)	(0.10)	(0.53)	(0.53)	(0.19)	(0.22)				
Denmark	0.93	−0.27	−0.01	0.13	0.25	−0.78	0.61	−0.53	2.41	0.30	−1.26	0.95
	(0.21)	(0.20)	(0.10)	(0.10)	(0.33)	(0.33)	(0.17)	(0.16)				
Finland	1.39	−0.61	0.28	−0.18	0.02	−0.85	0.53	−0.63	3.30	0.31	−2.31	0.72
	(0.19)	(0.21)	(0.11)	(0.11)	(0.28)	(0.30)	(0.15)	(0.16)				
France	0.61	0.01	−0.14	0.18	−0.60	−0.07	1.02	−0.66	2.19	0.13	−2.23	1.47
	(0.21)	(0.22)	(0.08)	(0.08)	(0.41)	(0.43)	(0.16)	(0.15)				
Germany	1.24	−0.41	0.29	−0.19	−0.04	0.01	0.75	−0.50	4.97	0.72	−0.20	1.32
	(0.20)	(0.17)	(0.13)	(0.13)	(0.35)	(0.29)	(0.22)	(0.23)				
Italy	1.12	−0.38	0.01	0.01	0.85	−2.22	0.75	−0.50	3.20	0.08	−5.19	1.21
	(0.19)	(0.18)	(0.04)	(0.04)	(0.66)	(0.62)	(0.15)	(0.15)				
Japan	1.40	−0.62	−0.01	0.01	−1.96	−0.33	0.39	−0.49	4.51	−0.00	−9.09	0.93
	(0.16)	(0.19)	(0.06)	(0.06)	(0.39)	(0.46)	(0.15)	(0.14)				
Netherlands	1.40	−0.63	0.10	−0.10	−0.63	−0.23	0.38	−0.34	4.15	0.02	−3.56	1.04
	(0.21)	(0.24)	(0.12)	(0.11)	(0.37)	(0.43)	(0.21)	(0.20)				

Norway	0.70	0.02	0.54	−0.10	0.15	−0.19	0.35	−0.18	3.03	1.53	−0.10	1.15
	(0.22)	(0.15)	(0.12)	(0.16)	(0.37)	(0.26)	(0.20)	(0.27)				
Sweden	1.36	−0.36	0.18	0.22	−0.58	−0.19	0.22	−0.50	4.09	1.21	−2.36	0.10
	(0.17)	(0.24)	(0.17)	(0.17)	(0.15)	(0.21)	(0.15)	(0.15)				
Switzerland	1.02	−0.26	0.03	0.06	−0.34	−0.59	0.54	−0.28	2.74	0.30	−3.20	1.00
	(0.18)	(0.17)	(0.12)	(0.10)	(0.30)	(0.28)	(0.20)	(0.17)				
UK	0.37	0.09	−0.23	0.50	−0.20	−0.25	0.67	−0.68	1.51	0.36	−0.65	0.87
	(0.19)	(0.19)	(0.17)	(0.16)	(0.22)	(0.21)	(0.19)	(0.18)				
US	0.16	−0.78	0.21	0.11	0.63	−0.85	0.63	−0.24	0.61	0.30	−0.17	1.55
	(0.27)	(0.27)	(0.10)	(0.11)	(0.82)	(0.81)	(0.30)	(0.32)				

[a] The table shows for each country the parameter estimates from a joint VAR for the detrended wage rate ΔW and the profit rate ΔR_1:

$\Delta W_{t+1} = \alpha_1 \Delta W_t + \alpha_2 \Delta W_{t-1} + \alpha_3 \Delta R_{1,t} + \alpha_4 \Delta R_{1,t-1} + \epsilon_{w,t+1}$ (wage rate);

$\Delta R_{1,t+1} = \beta_1 \Delta W_t + \beta_2 \Delta W_{t-1} + \beta_3 \Delta R_{1,t} + \beta_4 \Delta R_{1,t-1} + \epsilon_{r,t+1}$ (profit rate).

Standard errors are in parentheses. The λ's and θ's in the last four columns relate the innovations in the present discounted value of wages and the present discounted value of profits ΔV_1 to the innovations of the VAR:

$$\Delta H_t = \sum_{s=0}^{\infty} (E_t - E_{t-1}) \frac{\Delta W_{t+s}}{(1+r-g)^s} = \lambda_1 \epsilon_{wt} + \lambda_2 \epsilon_{rt} = \lambda' \epsilon;$$

$$\Delta V_t = \sum_{s=0}^{\infty} (E_t - E_{t-1}) \frac{\Delta R_{1,t+s}}{(1+r-g)^s} = \theta_1 \epsilon_{wt} + \theta_2 \epsilon_{rt} = \theta' \epsilon.$$

quadratic trends from the data. [31] While there might be very low frequency cycles in the time series, our dataset is too short to extract sufficient information about that aspect of the data. [32] For example, in several countries *RORB* is downward trending throughout the 1970s and upward trending throughout the 1980s. In other countries it has either an upward or downward trend throughout the sample. Such movements are quite possibly part of long cycles around a given mean, but our dataset does not allow us to quantify the stochastic features of such long cycles. Nonetheless, in the sensitivity analysis we will consider results under a 'minimalist' detrending approach, whereby *RORB* is not detrended and only a linear trend is extracted from wages.

To compute the θ's and λ's, we set g equal to 0.02, the average growth rate of the real wage rate over the sample. The average rate of return $\bar{q}$ is set at 0.07, the average of *RORB* during the sample, rescaled downward by the average ratio of depreciation to gross operating surplus. The home bias formula (19) requires the riskfree rate to be consistent with zero net holdings of the international bond. The precise choice of the level of r therefore depends on the specific solution for the value function, which in turn requires unwarranted parametric restrictions on the nature of the utility function. However, since sensitivity analysis shows that our results are virtually unaffected by the choice of r, we cut the Gordian knot by posing $\bar{q}=r$ throughout the entire exercise. [33] The main advantage of such normalization is that ΔR_2 is simply equal to ΔV as defined above.

The values for λ_1, λ_2, θ_1 and θ_2 are shown in the last four columns of Table 2. Wage rate innovations have a positive effect on expected future wages ($\lambda_1 > 1$), but always a *negative* effect on expected future profits ($\theta_1 < 0$). A positive profit innovation tends to have a positive effect on future wages ($\lambda_2 > 0$). Even though the sample is short, these findings are remarkably consistent across countries.

Table 3 reports standard deviations and correlations associated with innovations in the return to human and physical capital. On average, the volatility of the return to human capital is half that of ΔR_1, and one third that of ΔR_2. For the first capital return measure the average correlation with the human capital return is 0.26. This is slightly higher than the average 0.08 correlation between the innovations ϵ_w and ϵ_r (not reported). A positive profit innovation generally leads to higher expected future wages, thus raising the correlation between the return on

[31] Although the scaling of the wage rate does not affect our measure of human capital return, for the purpose of the VAR reported in Table 2 we have scaled wages such that $\Delta \overline{W}/\bar{q}$ equals the average ratio of employee compensation to net operating surplus.

[32] Unfortunately, it is not possible to increase the length of our sample without sacrificing an extremely large number of countries. For instance, from 1960 onward the RORB series is available for only five countries: Austria, Denmark, Germany, Italy, and the US.

[33] Even if we lower r to 3%, so that future wages are discounted at the rate $r-g=1\%$, the changes in our estimates are negligible because innovations in ΔW and ΔR die out quickly. The normalization $r=\bar{q}$ is also consistent with common findings of very small risk premia under time-separable preferences in the literature on the equity premium puzzle.

Table 3
Human and fundamental capital return moments and home bias [a]

Country	Standard deviations			Correlations				Home bias based on	
	ΔR_H	ΔR_1	ΔR_2	$\Delta R_H, \Delta R_1$	$\Delta R_H, \Delta R_1^*$	$\Delta R_H, \Delta R_2$	$\Delta R_H, \Delta R_2^*$	ΔR_1	ΔR_2
Australia	0.15	0.66	0.73	−0.18	−0.22	−0.75	−0.17	0.11	0.50
Austria	0.39	0.44	0.43	0.74	0.40	0.52	0.31	−1.55	−0.48
Belgium	0.33	0.46	0.67	0.38	0.36	−0.57	0.17	−0.48	1.01
Canada	0.32	0.65	0.83	0.16	0.29	−0.50	0.33	−0.03	0.84
Denmark	0.21	0.49	0.65	0.05	0.01	−0.54	0.11	−0.10	0.63
Finland	0.31	0.57	1.16	−0.34	0.39	−0.90	−0.05	0.47	0.73
France	0.15	0.45	0.63	0.54	0.29	−0.23	−0.06	−0.71	0.15
Germany	0.35	0.40	0.51	0.60	0.31	0.53	−0.13	−1.81	−1.22
Italy	0.22	0.48	1.00	−0.10	0.53	−0.76	0.09	0.29	0.48
Japan	0.31	0.46	1.80	0.02	0.43	−0.97	0.35	0.32	0.55
Netherlands	0.48	0.64	1.53	−0.18	0.09	−0.90	−0.34	0.53	1.14
Norway	0.35	0.47	0.53	0.87	−0.04	0.84	−0.11	−1.37	−1.13
Sweden	0.37	0.40	1.07	0.33	0.34	−0.96	0.12	−0.14	0.99
Switzerland	0.15	0.34	0.74	0.18	0.39	−0.79	0.14	0.16	0.49
UK	0.12	0.42	0.47	0.14	0.46	−0.39	0.13	0.28	0.38
US	0.06	0.57	0.87	0.96	0.54	0.96	−0.31	−0.18	−0.17
Average	0.27	0.49	0.85	0.26	0.29	−0.34	0.04	−0.26	0.31

[a] The moments reported in this table are based on wage and profit rate innovations from the VAR reported in Table 2: $\Delta R_H = \lambda'\epsilon / \bar{\Gamma}$, $\Delta R_1 = \epsilon_r$, $\Delta R_2 = \Delta V_1 = \theta'\epsilon$. ΔR^* refers to the innovation in the 'rest of the world' capital return, using 1990 GDP weights of the capital return innovations in individual countries. The last two columns report the bias towards domestic securities implied by the wage uncertainty, as a percentage of the total portfolio.

human and physical capital relative to the correlation between the instantaneous innovations. In terms of the notation in the previous section, this is captured by a positive ρ_{mq}, which enters into the numerator of Eq. (13).

When the second capital return measure (ΔR_2) is used, the correlation with the human capital return is quite negative for all but four countries, with an average of -0.34 as reported in Table 3. Since a positive wage innovation generally leads to lower expected future profits, it has a negative effect on the return to capital, leading to a negative correlation between the return to human and physical capital. This effect is apparently stronger than the lagged feedback from profits to wages, which still works towards a positive correlation between the two returns. It is worth stressing again that what matters here is the dynamic interaction between wages and profits, *not* between the wage rate and capital return. In other words, ΔR_2 is unpredictable and the negative feedback from wages to profits implies a negative *contemporaneous* correlation between the wage rate and capital return. [34] In terms of the notation in the previous section, ρ_{qm} and ρ_{mq} are both zero and the key variable underlying our result is the *negative* instantaneous correlation a_{ω}.

The four countries with a positive correlation between human and physical capital returns are the same countries for which we found a positive correlation between detrended wage and profit rates in Section 2: Austria, Germany, Norway and USA. Norway and the United States are the most notable outliers, with a positive correlation of, respectively, 0.84 and 0.96 between ΔR_H and ΔR_2, virtually identical to that under the ΔR_1 measure.

Table 3 also reports the correlation between ΔR_H and the 'rest of the world' capital return. We can now apply the formula for home bias (Eq. 19) derived in the previous section. [35] The ratio of human capital to financial capital is computed as $h = \bar{q}(\bar{q} - g)^{-1}\overline{m}K(\bar{q}A)^{-1}$, where $\overline{m}K(\bar{q}A)^{-1}$ is set equal to the average over all countries of the sample mean of the ratio of employee compensation to net operating surplus, equal to 2.6.

The results are shown in the last two columns of Table 3. The findings are somewhat mixed under the ΔR_1 measure, with a portfolio bias towards foreign assets in 9 cases, and towards domestic assets in 7 cases. On average, there is a bias of 26% towards foreign assets. However, under the ΔR_2 measure there is a bias towards domestic securities in twelve cases; for those countries, the average bias is 0.66, roughly consistent with the estimates of home bias in stock and bond portfolios. The four outliers are once again the countries mentioned above. Nonetheless, the foreign bias for the US is only 0.17, as a result of the low standard deviation (0.06) of the return to human capital.

[34] A rise in wages (ΔW) today leads to lower expected profits (ΔR_1) in the future and thus a drop in the *current* capital return ΔR_2.

[35] In the formula, the dampening factor D is zero when we use ΔR_2, since by construction shocks to asset returns are not persistent. When ΔR_1 is used instead, the dampening factor is computed as $\mathrm{Cov}(\Delta R_1 - \Delta R_1^*, \Delta(V_1 - R_1) - \Delta(V_1^* - R_1^*))/\mathrm{Var}(\Delta R_1 - \Delta R_1^*)$.

Some caution is appropriate in interpreting the results for the individual countries. The findings are very sensitive to the VAR estimates reported in Table 2, sometimes characterized by relatively large standard errors. The average home bias over all countries in the sample may therefore be more informative. We therefore compute the average home bias under different assumptions concerning the econometric specification, and the measure of the real wage rate. [36] Under the benchmark specification (based on the VAR regressions in Table 2) the average home bias is -0.26 and 0.31 for the two capital return measures.

When we use AR regressions on wages and profits individually, we do not find a significant average bias in either direction: -0.01 and -0.07 for the respective measures of capital return. The average portfolio bias (in either direction) documented in Table 3 stems almost exclusively from the dynamic interaction between wages and profits. Not surprisingly, when lagged profits are excluded from the regressions, the average home bias rises to 0.47 for the second return measure. This specific structure rules out the positive feedback from profits to future wages, which raises the correlation between human and physical capital returns. If instead there is only one lag for wages (and two lags for profits as before), the home bias drops to 0.14 for the ΔR_2 return measure, while we obtain a foreign bias of 0.58 under the first measure.

We also consider different detrending procedures. If we only extract linear trends from wage and profit rates, the average foreign bias is reduced to 17% for the first return measure and the home bias is practically unchanged at 28% for the second return measure. Under the 'minimalist' detrending procedure, whereby we only detrend wages linearly, the foreign bias is reduced to 14% for the first return measure, and the home bias is reduced slightly to 22% for the second return measure.

Finally, we explore different definitions of the real wage rate. It is worth emphasizing that our study focuses on wage uncertainty rather than unemployment uncertainty. Nonetheless, we make an attempt to capture aggregate unemployment risk by dividing total employee compensation by the labor force (rather than employment). [37] We find that the foreign bias is now up to 53% under the ΔR_1 measure, although the home bias under the second return measure remains practically unchanged (29%). Fama and Schwert (1977) and Campbell (1996) only divide aggregate wages by a price index. This does not significantly affect our

[36] A table with the averages across countries of the *bias* measure under these various assumptions, as well as the moments entering the formula, is available from the authors on request.

[37] Even if one wanted to assess wage risk for employed workers only, Solon et al. (1994) argue that using aggregate data leads to a countercyclical bias due to composition bias, as low-wage workers are more likely to become unemployed before high-wage employees during a cyclical downturn. If the normalization with respect to the labor force is adopted, this composition bias disappears. If anything, the real wage rate becomes 'too' procyclical as a measure of the real compensation of employed workers.

results. The average home bias is respectively -24% and 23% for the ΔR_1 and ΔR_2 measures.

Our last real wage measure is the hourly real wage rate, where total hours worked is defined as employment times hours worked per week. The inclusion of such measure allows us to control, in a stylized way, for agents' labor/leisure choice. Intuitively, if the number of hours worked per week drops, agents are not necessarily worse off. In fact, if the wage rate truly reflects the marginal utility of leisure relative to consumption, marginal changes in hours worked will have no effect on utility and therefore will not affect investors' hedging strategies. Using an hourly wage rate raises the home bias from 0.31 to 0.40 for the second return measure, and reduces the foreign bias to 0.22 for the first return measure.

4.2. *Financial returns and international diversification*

In this subsection we use data on financial returns from 1973 to 1992 for a set of ten countries. We consider both a broad measure of financial return and a leveraged stock return. The broad return measure aggregates the return on stock, long-term government bonds and short-term deposit rates. The weights on these returns are determined by data on stock market capitalization, long-term government debt, and the stock of *M2*. Details can be found in the Appendix. This broad measure of financial return represents an approximation of the overall payoff of financial claims on a country's productive resources. Lack of data availability prevents us from incorporating additional assets, including commercial bonds, real estate and long-term deposits. Our second financial return measure is based entirely on stock return data. This makes our work directly comparable to other studies mentioned in the introduction in which stock return data are used to compute the correlation between human and financial returns. Our definition of leveraged stock return is

$$\mu \Delta R_{\mathrm{STOCK}} + (1-\mu) r \tag{27}$$

where r is a constant riskfree rate, and μ is the (country-specific) ratio of stock market capitalization to total financial claims. The latter is approximated as the sum of the stock market value, long-term government debt and *M2*. [38] This approach considers stock as a residual claim that carries the entire risk associated with financial claims on a country's output.

For both asset return measures we compute the average quarterly hedged real return over a year. Since the forward discount is generally not equal to the inflation differential across two countries, the real return of investing in a

[38] As well known (see for example Solnik, 1991), the size of the stock market varies significantly across countries. Our estimate of μ varies from 7% in Italy (which has the most volatile stock return) to 38% in the UK (which has the least volatile stock return).

particular country differs across investors located in different countries. As a result, we obtain for each country a separate matrix of returns of investment in all countries in the sample. We then estimate VARs on wage rates and financial returns. We do not detrend the financial return, but still extract a quadratic trend from the log of the wage rate. The results are not very sensitive to the choice of the country from whose vantage point we compute the matrix of financial returns. Table 4 shows the results when the returns are computed from the perspective of US investors and we use the broad measure of financial returns. The results are quite similar with leveraged stock returns. In all but one country we observe a negative relationship between the wage rate and lagged financial return ($\alpha_3 + \alpha_4 < 0$). Therefore ΔH depends negatively on the financial return innovation ϵ_r ($\lambda_2 < 0$). Only for Germany is this relationship positive.

As analyzed above, this result contributes to a negative correlation between human capital and financial returns. Why should financial returns help predict future wages with a negative coefficient? Current changes in the general economic environment, ranging from budgetary/monetary policy announcements to swings in the relative price of imported materials to political events *tout-court*, may lead to expected changes in income distribution in the near future. This has an opposite effect on expected *future* wages and the *current* return on capital. In all countries but the US we also observe a negative relationship between financial returns and lagged wage rates. However, as discussed in section 3, this only affects the home bias indirectly.

Table 5 reports the standard deviations and correlations associated with innovations in the return to human and financial capital. In all countries the return to human capital is negatively correlated with the financial return innovation. The average is -0.43 for the broad measure of financial return and -0.39 for the leveraged stock return. The average correlation with the 'rest of the world' financial return is also negative, although by a lesser degree (respectively -0.23 and -0.19). If we compare the results with those in Table 3 for the ΔR_2 measure, we observe some remarkable similarities. Based on the fundamentals data, the average correlation between domestic human capital and asset returns is -0.34, quite similar to that with the financial return data. Japan is the country characterized by the most striking negative correlation between human and physical capital returns based on the fundamentals data, -0.97; if we use the broad measure of financial return this correlation is up to -0.80. Belgium and Canada represent other examples of countries with very negative correlations based on both financial and fundamentals return data. There are also a few differences though. Most relevant is the case of the US, where the correlation is respectively 0.96 and -0.38 for the fundamentals and financial return data. [39]

[39] Our finding of a relatively large negative correlation for the US contrasts with Fama and Schwert (1977), who find no significant correlation. However, their study assumes that the wage rate follows a random walk process, an hypothesis rejected by Baxter and Jermann (1995).

Table 4
Parameter estimates from a joint VAR for wage rate and financial return

Country	α_1	α_2	α_3	α_4	β_1	β_2	β_3	β_4	λ_1	λ_2
Belgium	0.96(0.25)	−0.38(0.22)	−0.000(0.011)	−0.018(0.011)	−11.01(4.33)	8.26(3.77)	0.13(0.19)	0.17(0.19)	2.73	−0.062
Canada	0.52(0.22)	−0.17(0.18)	−0.012(0.008)	−0.024(0.008)	1.83(5.68)	0.98(4.74)	0.08(0.22)	0.33(0.20)	1.26	−0.066
France	0.43(0.23)	−0.17(0.24)	−0.015(0.009)	−0.008(0.008)	−19.75(3.82)	10.65(3.98)	0.19(0.15)	0.06(0.14)	2.05	−0.058
Germany	1.31(0.26)	−0.52(0.20)	−0.001(0.013)	0.012(0.009)	−18.00(5.81)	10.34(4.37)	−0.24(0.28)	−0.15(0.21)	3.63	0.027
Italy	0.97(0.22)	−0.29(0.22)	−0.005(0.005)	−0.001(0.005)	−1.13(8.28)	2.20(8.23)	0.31(0.17)	0.22(0.18)	2.82	−0.032
Japan	0.36(0.26)	0.001(0.18)	−0.017(0.005)	−0.004(0.006)	−30.63(8.74)	15.27(6.00)	0.02(0.16)	−0.20(0.20)	2.55	−0.044
Netherlands	1.10(0.22)	−0.51(0.19)	−0.017(0.010)	0.005(0.010)	−7.30(4.09)	5.05(3.59)	0.026(0.19)	0.20(0.19)	2.66	−0.038
Switzerland	0.63(0.24)	−0.22(0.24)	0.000(0.005)	−0.005(0.005)	−27.16(6.79)	13.93(6.55)	−0.14(0.15)	0.03(0.14)	1.82	−0.007
UK	−0.10(0.14)	−0.37(0.14)	−0.005(0.003)	−0.014(0.003)	−1.94(4.91)	12.62(4.64)	−0.26(0.11)	0.28(0.11)	0.63	−0.011
US	0.80(0.17)	−0.50(0.18)	−0.006(0.006)	0.002(0.005)	−8.15(6.50)	−2.74(6.90)	−0.07(0.21)	0.15(0.18)	1.54	−0.006

[a] The table shows for each country the parameter estimates from a joint VAR for the detrended wage rate ΔW and the broad measure of financial return ΔR:

$$\Delta W_{t+1} = \alpha_1 \Delta W_t + \alpha_2 \Delta W_{t-1} + \alpha_3 \Delta R_t + \alpha_4 \Delta R_{t-1} + \epsilon_{w,t+1} \quad \text{(wage rate)};$$

$$\Delta R_{t+1} = \beta_1 \Delta W_t + \beta_2 \Delta W_{t-1} + \beta_3 \Delta R_t + \beta_4 \Delta R_{t-1} + \epsilon_{r,t+1} \quad \text{(financial return)}.$$

Standard errors are in parentheses. The results are only reported using the asset return matrix from the point of view of US investors. But they are quite similar from the vantage point of other countries. The λ's in the last two columns relate the innovations in the present discounted value of wages to the innovations of the VAR:

$$\Delta H_t = \sum_{s=0}^{\infty} (E_t - E_{t-1}) \frac{\Delta W_{t+s}}{(1+r-g)^s} = \lambda_1 \epsilon_{wt} + \lambda_2 \epsilon_{rt} = \lambda' \epsilon.$$

The bias towards domestic securities is documented in the last two columns of Table 5. Given the well known difficulty in replicating observed levels of return volatility with fundamentals data, in the last column we consider the experiment by Baxter and Jermann (1995), who set the *ratio* of the standard deviation of human capital and asset returns equal to that based on fundamentals data. To be precise, we rescale the wage innovation such that the average volatility of ΔR_H, relative to that of $\Delta(R - R^*)$, is the same as that under the fundamentals approach (Table 2), based on the VAR when ΔR_2 is the return measure. [40]

We obtain bias towards domestic securities in almost all countries. The only exception is Italy, and, under the broad measure of financial return, Japan. The surprising result for Japan is explained by a correlation of -0.68 between ΔR_H and ΔR^*, similar to that between ΔR_H and ΔR, combined with a foreign asset return more volatile than the domestic one. At any rate, given our short sample, the average home bias across countries is probably a more informative statistic. It is respectively 3% and 7% for the broad measure of asset return and the leveraged stock return. If we use the fundamentals data to determine the *ratio* of volatilities of human capital and asset returns, the average bias is respectively 24% and 35%. If we compare this to the 31% average home bias reported in Table 3 under the ΔR_2 return measure, we observe a striking similarity with the results under the fundamentals approach.

We again compute the average home bias under different assumptions concerning the econometric specification and the real wage rate. The home bias is reduced when using individual AR specifications for the wage rate and financial return, to respectively 10% and 24% for the broad measure of return and the stock return measure. This is not surprising since we found a negative relationship between the wage rate and lagged financial returns for almost all countries under the VAR specification, which contributes significantly to the negative relationship between human capital and financial returns under the VAR. This also explains why the home bias drops to respectively 14% and 20% when we take out the financial return lags from the VAR. On the other hand, if we include only one lag for wages (retaining two lags for returns), the home bias rises a bit under both measures.

The 'minimalist' detrending procedure, which only extracts a linear trend from wages, has practically no effect on the results. We also find the results not to be very sensitive to the different measures for real wages. Only if we do not deflate aggregate real wages by either employment or the labor force, we find a moderate drop in home bias to 19% for the stock return. But even in that case, the home bias is virtually unchanged at 25% for the broad measure of asset return.

[40] As mentioned earlier, we keep the discount rate constant when computing the innovation in the fundamentals return. While a time-varying discount rate should not affect the home bias results since it affects ΔR and ΔR^* by approximately equal magnitude, it does of course lead to an underestimation of the volatility of individual asset returns, but not necessarily of their differential $\Delta(R - R^*)$.

Table 5
Human and financial capital return moments and home bias [a]

Country	σ_{R_H}	σ_R	σ_{R^*}	Corr(ΔR_H, ΔR)	Corr(ΔR_H, ΔR^*)	Home bias	*Home bias*
Broad measure financial return							
Belgium	0.36	4.94	3.45	−0.48	0.11	0.07	0.51
Canada	0.15	5.36	3.48	−0.84	−0.67	0.15	1.07
France	0.15	4.64	4.36	−0.34	−0.03	0.02	0.14
Germany	0.19	4.17	3.47	−0.10	0.17	0.04	0.31
Italy	0.20	4.21	4.07	−0.44	−0.76	−0.04	−0.27
Japan	0.13	3.39	4.20	−0.80	−0.68	−0.01	−0.04
Netherlands	0.28	5.12	3.60	−0.13	0.05	0.06	0.43
Switzerland	0.10	4.17	3.23	−0.30	0.14	0.03	0.20
UK	0.03	6.43	4.81	−0.45	−0.37	0.00	0.03
US	0.06	6.08	3.80	−0.38	−0.26	0.01	0.07
Average	0.17	4.85	3.85	−0.43	−0.23	0.03	0.24
Leveraged stock return							
Belgium	0.37	2.03	2.26	−0.63	−0.14	0.18	0.85
Canada	0.14	3.59	2.17	−0.84	−0.64	0.39	1.82
France	0.14	0.81	2.36	−0.25	−0.06	0.01	0.02
Germany	0.19	3.75	2.10	−0.01	0.26	0.05	0.25
Italy	0.18	2.54	2.21	−0.27	−0.48	−0.09	−0.40
Japan	0.13	3.28	2.31	−0.52	−0.65	0.01	0.05
Netherlands	0.31	3.95	2.20	−0.14	−0.02	0.09	0.43
Switzerland	0.10	4.71	2.00	−0.38	0.16	0.04	0.18
UK	0.04	4.08	2.36	−0.47	−0.30	0.02	0.09
US	0.06	2.95	2.49	−0.40	−0.05	0.04	0.19
Average	0.17	3.17	2.25	−0.39	−0.19	0.07	0.35

[a] The moments reported in this table are based on wage rate and financial return innovations from a VAR with two year lags for the wage rate and financial retrun (reported in Table 5 for the broad measure of financial return). The leveraged stock return is the stock return times the ratio of stock market capitalization to M2 + long term government debt + stock market capitalization. The broad measure of stock return refers to the weighted average of the real return on stock, M2 (Eurocurrency rates) and long term government bonds. The final row under *Home bias* shows the home bias that results when the innovation in the human capital return is rescaled such that the average volatility of ΔR_H relative to that of $\Delta(R - R^*)$ is set equal to the average volatility of ΔR_H relative to $\Delta(R_2 - R_2^*)$ based on the VAR under the fundamentals approach (Table 2).

All results so far are based on financial returns hedged against exchange rate risk. This seems appropriate, taking into account the rapid proliferation of short-term hedging instruments in the currency markets during the years covered in our sample. [41] Nonetheless, as a final experiment we also consider the effects of using return data not hedged for exchange rate risk. In this case we find, quite

[41] French and Poterba (1991) and Tesar and Werner (1995) also base their findings on asset returns hedged for exchange rate risk.

remarkably, that the average correlations between the human capital return and either domestic or foreign asset returns are substantially unchanged. Not surprisingly, however, the exposure to exchange rate risk raises significantly the volatility of the return from investing abroad, thus giving more weight to the (negative) correlation between ΔR_H and ΔR^* in Eq. (19). As a result, the home bias disappears when the broad measure of return is used, and drops to 12% when stock returns are considered. Needless to say, unhedged exchange rate risk is expected to generate a bias towards domestic securities for reasons unrelated to wage uncertainty, thus not further explored or documented here.

5. Conclusions

The 'message' of this paper is rather straightforward. By explicitly considering the role of human capital, our results emphasize the relevance of redistributive shocks, unrelated to business cycle fluctuations, in the interpretation of the stylized facts of international wealth allocation. Defining the coefficient of portfolio bias as the domestic ownership share in excess of the hypothetical share in a well-diversified portfolio (in the absence of labor incomes uncertainty), our findings account for an average bias between 30 and 35 percentage points in favor of domestic securities. The results are strikingly similar both when a 'fundamentals' approach is used to compute the returns to national capital from data on aggregate operating surpluses, when data on equity returns are directly used and when data on stock returns, long-term government bond yields and short-term deposit rates are combined to evaluate the overall payoff of a claim on a country's productive resources.

There are of course relevant differences across countries, as well as a few exceptions to the rule. For instance, the fundamentals approach leads to counterfactual implications for the US and Germany, although data on leveraged stock returns are consistent with moderate home bias even in these countries. Vice versa, the fundamentals approach matches data on Japanese stock-market holdings, while calibration based on the broad measure of financial return does not fit available quantitative evidence. Yet, these are deviations from a pattern whose empirical validity seems satisfactorily robust.

The conventional wisdom holds that optimal financial portfolios should be skewed toward holding foreign securities; that is, a 'negative' home bias should be the outcome of rational investors' behavior in the presence of uncertain labor incomes. This is because risk associated with non-traded assets is believed to be more effectively hedged with foreign securities than domestic tradable assets. Underlying this view is the implicit assumption that the return to human capital within a country is highly correlated with the return on financial capital or, at least, is more correlated with domestic than foreign financial returns.

We believe that our results challenge this traditional opinion. At a minimum they do not provide empirical evidence in favor of a generalized, puzzle-enhancing 'negative' portfolio bias. However, by no means should our findings be interpreted as the 'solution' to the home bias puzzle. We are able to document that the presence of fluctuations in non-tradable labor incomes helps rationalize the direction of the bias, not its entire size. The links between income distribution, portfolio choice and international capital mobility are still relatively unexplored elements of a recent albeit promising intellectual agenda. If anything, we hope our results will stimulate the start of a new thread of empirical and theoretical research in this direction.

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Appendix A. Data sources

Below is a description of the data used in the paper. The fundamentals data (real wage rate, profit rate, real GDP and labor share) are annual, from 1970 to 1992 for 16 countries (Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Italy, Japan, Netherlands, Norway, Sweden, Switzerland, UK and US). The financial return data are annual averages of monthly observations of quarterly returns, from 1973 to 1992 for 10 countries (Belgium, Canada, France, Germany, Italy, Japan, Netherlands, Switzerland, UK and US).

A.1. Real wage rate

The real wage rate is defined as $W/p_c N$. W is compensation of employees paid by resident producers, from the OECD National Accounts. p_c is the price deflator of private final consumption expenditure, also from the OECD National Accounts. We use three different measures for N: *EM* (employment), *LB* (labor force) and *HW* (hours worked). Employment and labor force data are from the OECD Labour Force Statistics. *HW* is computed as employment times hours worked per week.

Data on hours worked per week are obtained from the Yearbook of Labour Statistics, International Labour Office. We use data on hours worked per week in non-agricultural sectors for Australia, France, Germany, Japan, Netherlands, UK, US. These data are not available for the entire sample for the remaining countries. For those countries we use hours worked per week in manufacturing. This is a good approximation since for the first set of countries the correlation between the two series is generally close to one. For Italy the data are only available until 1982. After that we use data on hours worked per month from ISTAT, Monthly Bulletin.

A.2. Profit rate

The profit rate is the variable *RORB* (rate of return in the business sector) from the OECD. We obtained it through the OECD Data Extraction Service. It is also published in the OECD Economic Outlook. It is equal to the gross operating surplus, divided by the gross non-residential capital stock. In the computation of *RORB* the gross operating surplus is defined as total value added at factor cost, minus labor income, which includes income imputed to self-employed persons.

A.3. Real GDP

Real GDP is obtained from the OECD National Accounts.

A.4. Labor share

The labor share is defined as W (compensation of employees paid by resident producers) divided by W plus OS (net operating surplus). Both are from the OECD National Accounts.

A.5. Leveraged stock return

We use the NL stock index from Morgan Stanley. This is a local currency index with dividend reinvestment net of withholding taxes. The data are monthly. We compute the average annual hedged return on stock as follows:

$$\Delta R_{\text{STOCK}} = \sum_{t=1}^{9} \frac{12}{9} \left[\frac{NL_{t+3} - NL_t}{NL_t} - FD_{t,3} - \frac{CPI_{t+3} - CPI_t}{CPI_t} \right].$$

Here NL is the stock index, FD_3 the 3-month forward discount, and CPI the consumer price index. The summation is over the 9 quarterly returns within a year (January–April, ..., September–December). Forward discount data are obtained from the Harris Bank weekly review. We would like to thank Chris Telmer for providing us access to this database. Monthly consumer price index data are obtained from Datastream. The leveraged stock return is defined as $\mu \Delta R_{\text{STOCK}}$ +

$(1-\mu)r$ in Eq. (27) in the text. μ is the country specific average of the ratio of stock market value to the sum of stock market value, long-term government debt plus $M2$ (see description below).

A.6. Broad measure of financial return

The broad measure of financial return is a weighted average of return on stock ($\Delta R_{\mathrm{STOCK}}$), on long-term government bonds ($\Delta R_{\mathrm{BONDS}}$) and Eurocurrency deposit rates (ΔR_{M2}). The computation of the weights is described below. The average annual hedged returns $\Delta R_{\mathrm{BONDS}}$ and ΔR_{M2} are computed similarly to the stock return above, with $(NL_{t+3}-NL_t)/NL_t$ replaced by respectively $r_{bonds,t}$ and the 3-month Eurocurrency deposit rate from the Harris Bank database. $r_{bonds,t}$ is an approximation of the 3-month local currency return on long-term government bonds. It is computed as follows. We use data on the yield to maturity on 10-year government bonds from the IFS. For Japan they are 7-year bonds, while for Italy we use the yield of maturity on Treasury bonds with a life between 2 and 3 years from the National Government Series, Datastream. We approximate the effective maturity of these bonds as 2 years for Italy, 5 years for Japan and Germany and 7 years for the other countries (these estimates are based on the common formula for effective maturity used in finance, setting the coupon rate equal to the yield to maturity). For most countries this is a reasonable representation of the average effective maturity on the entire long-term government debt (see Missale, 1991). Since we do not have data on the coupon rates for all countries, we treat the bonds as zero coupon bonds with a maturity equal to the effective maturity listed above. The price of the bond is then $1/(1+i)_T$, where i is the yield to maturity and T is the (effective) maturity. We then compute the 3-month return as

$$r_{bonds,t}=\frac{(1+i_t)^T}{(1+i_{t+3})^{T-1/4}}-1,$$

making the approximation that the yield to maturity on bonds with a maturity of $T-1/4$ is the same as that of bonds with a maturity of T, which is innocuous for large T.

A.7. Weights of financial returns

Financial returns are weighted by their share in financial markets. We compute for each country the sample average of the share of stock market capitalization, long-term government debt and $M2$ in their total. The stock market value is derived from Financial Times Market Indices (FTMI), published by DRI, available from 1988 onward. The market value of long-term government debt is obtained from a variety of sources. For most countries the data are obtained from the OECD Financial Statistics and the study by Missale (1991). We also used the Bollettino

Statistico, Banca d'Italia, for Italy, the Bank of England Quarterly Bulletin for the UK and the Treasury Bulletin for the US. The value of *M2* is also from various sources. Belgium, US: OECD Main Economic Indicators; Canada, Germany, Italy, Japan, Netherlands: National Government Series, Datastream; France, Switzerland, UK: sum of series 34, 35 from IFS. For each country the shares are computed as the average from 1988 to 1992.

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