The International Diversification Puzzle Is Worse Than You Think

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Despite the growing integration of international financial markets, investors do not diversify internationally to any significant extent. We show that this ''international diversification puzzle'' is deepened once we consider the implications of nontraded human capital for portfolio composition. While growth rates of labor and capital income are not highly correlated within countries, we find that the returns to human capital and physical capital are very highly correlated within four OECD countries. Hedging human capital risk therefore involves a substantial short position in domestic marketable assets. A diversified world portfolio will involve a negative position in domestic marketable assets. (*JEL* F30, G11, G12)

It is widely agreed that investors hold too little of their financial wealth in foreign securities. In the past, this could be explained by the general lack of international financial integration and national barriers to capital flows. However, the growth and integration of capital markets over the past 20 years has not led to similarly dramatic portfolio reallocations. For example, Kenneth French and James Poterba (1991) report that U.S. investors hold about 94% of their financial assets in the form of U.S. securities. For Japan, the United Kingdom, and Germany, the portfolio share of domestic assets in each case exceeds 85%. While recent years have witnessed an increase in international diversification, holdings of domestic assets are still far too high to be consistent with the standard theory of portfolio choice.

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We do not propose an explanation for this ''international diversification puzzle.'' On the contrary, we argue that the divergence between diversified portfolios and observed portfolios is much larger than is currently thought. This claim is motivated by the observation that, for a nation as a whole, the largest component of wealth consists of nontraded human capital. Labor's share in national income is about 60%—we use this as a rough benchmark of the share of human capital in total wealth. Our main finding is that the *returns* to human capital and physical capital are very highly correlated within countries, even though the growth rates of labor and capital income are not highly correlated. We show that a substantial short position in domestic marketable assets is consequently required to hedge human capital risk. As a result, individuals wishing to hold a diversified world portfolio will establish a short position in domestic marketable assets.

The paper is organized as follows. Section I presents a simple model with constant factor shares that illustrates the basic intuition of our main result. In Section II, we relax the assumption that factor shares are constant and estimate the returns to human capital and physical capital using techniques pioneered by John Y. Campbell and Robert J. Shiller (1988). Using data for four OECD countries, we find that human capital returns are very highly correlated with domestic capital returns. Section III discusses the relationship between factor income growth and factor returns, and demonstrates why our empirical results differ so markedly from those obtained previously by Eugene Fama and William Schwert (1977). Section IV shows how individuals can hedge nontraded human capital risk by using traded assets; and Section V determines the marketable-asset components of diversified portfolios for each country in our sample. Section VI concludes.

I. Human Capital and Portfolio Choice

This section develops a simple model of portfolio choice when there is a nontraded asset in the form of human capital. Labor income represents the flow return from this nontraded asset. This model illustrates the potential for domestic traded assets to act as a powerful tool for hedging the risk associated with nontraded human capital. Throughout the paper, we study a setup with frictionless trade in financial markets and no constraints on short sales of financial assets.

The world consists of J countries, indexed by $j = 1, 2, ..., J$. In each time period $t = 1, 2, ...$, each country produces a single good, (Y_{jt}), using two inputs: capital (K_{jt}) and labor (L_{jt}). The stocks of capital and labor are taken to be exogenous although not necessarily fixed over time. The production function is assumed to exhibit constant returns to scale, and is subject to country-specific and time-varying movements in total factor productivity (A_{jt}):

$$(1) \quad Y_{jt} = A_{jt} K_{jt}^{1-\alpha} L_{jt}^{\alpha} \quad \text{for } j = 1, 2, ..., J,\ t = 1, 2, ...$$

When the production function is Cobb-Douglas as in equation (1), factor shares are constant over time, with labor's share equal to α and capital's share equal to $(1 - \alpha)$. The constancy of factor shares means that the cash flows to labor and capital are perfectly correlated. If the cash flows to labor and capital are discounted at a common rate, the returns to labor and capital also are perfectly correlated. Further, the returns to labor and capital are equally volatile.

Many authors (e.g., Fischer Black, 1987 p. 79) have argued that the unlevered stock market return is the best available measure of the return to capital. In the present context, this means that the domestic stock market can be used to construct a perfect hedge for the nontraded human capital. Since the returns to human and physical capital are equally volatile in this model, the hedge is constructed by selling short \$1.00 of the domestic stock market for each dollar of human capital. If labor's share is 0.60 and capital's share is 0.40, and if all claims to capital are marketable, then domestic marketable assets represent a claim on 40% of total wealth. Thus, hedging the risk associated with human capital involves a short position in the domestic stock market equal to $0.60/0.40 = 1.5$ times the aggregate value of the stock market.

Having hedged the risk associated with nontraded human capital, the investor can then purchase his desired portfolio. Because mean-variance optimal portfolios are so sensitive to the historical time period used to compute expected mean returns, we focus instead on value-weighted (diversified) portfolios. Let π_j denote the fraction of the world portfolio of marketable assets accounted for by the assets of country j, with $\Sigma_{j=1}^{J} \pi_j = 1$. Then the fraction of domestic marketable assets demanded by residents of country j as part of a diversified portfolio is given by:[1]

$$(2) \quad \frac{\pi_j}{1-\alpha} - \frac{\alpha}{1-\alpha} .$$

For most countries, labor's share (α) exceeds one-half, and is closer to about two-thirds. No country represents more than one-half of the world portfolio: $\pi_j < 0.50$ for all j. Because labor's share exceeds the country's share in world equity markets for all countries, the portfolio weight on an individual's home country in a value-weighted portfolio must be negative.

Since the "hedging motive" always outweighs the "diversification motive" for holding

[1] See the Appendix (available from the authors upon request) for a detailed derivation of this formula.

domestic assets, investors wishing to hold diversified portfolios should hold negative positions in the marketable assets of their own country. This effect will be stronger, the smaller a particular country's share in world equity markets. For example, the United States is the largest of the world equity markets, representing about 48% of the world equity market in 1990. With labor's share equal to 0.60, a U.S. investor seeking a diversified world portfolio should have a net position in U.S. equities equal to (48%−60%) = −12% of his wealth. Since claims on physical capital represent a fraction 0.40 of total wealth, the negative position in the U.S. stock market is equal to −12% ÷ 0.40 = −30% of the value of the U.S. market. The United Kingdom represents only about 14% of world equity markets. Thus, a diversified U.K. investor would have a position equal to (14%−60%) ÷ 0.40 = −115% of the value of the U.K. stock market.

II. Measuring Factor Returns

The preceding section used a simple model to illustrate the idea that labor and capital returns are plausibly highly correlated, which implied that hedging human capital risk would involve substantial short positions in domestic capital markets. However, the assumption that there is no variation over time in factor shares implied that domestic labor and capital returns are *perfectly* positively correlated and equally volatile.

This section presents an empirical model that permits less-than-perfect correlation of labor and capital returns. Specifically, we permit rich, short-term variation in factor shares while retaining the long-run restriction that factor shares are stationary. This long-run restriction is suggested by the form of most production functions used in macroeconomic theory, as well as simple common sense. If labor and capital income are allowed to have independent trends (whether deterministic or stochastic), then the ratio of labor income to capital income will, with probability one, grow without bound (if labor income grows faster than capital income) or approach zero asymptotically (if capital income grows faster than labor income). Therefore, labor's share will, with probability one, approach either zero or one. This is contrary to what we observe in the data: while labor's share varies over time, it shows no tendency to converge to zero or one.

We performed a battery of econometric tests of the hypothesis that the ratio of labor income to capital income is a stationary random variable. These tests and their results are described in detail in the Appendix (available from the authors upon request). Unfortunately, as is frequently the case when testing for unit roots, it was not possible to generate decisive evidence on stationarity versus nonstationarity. This is because tests that take a unit root as the null hypothesis have low power against the alternative hypothesis that the variable is stationary but with a highly persistent temporary component.

Based on these considerations, we impose the econometric restriction that the ratio of labor income to capital income is stationary. This means that the log of labor income and the log of capital income are cointegrated, and that the cointegrating vector is **[1, −1]**. We then estimate the following vector error correction model (VECM) for labor and capital income:

$$(3)\quad \Delta d_{L,t+1} = \delta_L + \psi_{LL}(L)\Delta d_{Lt} + \psi_{LK}(L)\Delta d_{Kt} + \eta_L(d_{Lt} - d_{Kt}) + \varepsilon_{L,t+1}$$

$$(4)\quad \Delta d_{K,t+1} = \delta_K + \psi_{KL}(L)\Delta d_{Lt} + \psi_{KK}(L)\Delta d_{Kt} + \eta_K(d_{Lt} - d_{Kt}) + \varepsilon_{K,t+1},$$

where d_{Lt} denotes the log of labor income, d_{Kt} denotes the log of capital income, $\Delta d_{L,t+1} \equiv d_{L,t+1} - d_{Lt}$, $\Delta d_{K,t+1} \equiv d_{K,t+1} - d_{Kt}$, and $\psi_{LL}(L)$, $\psi_{LK}(L)$, $\psi_{KL}(L)$, $\psi_{KK}(L)$ are polynomials in the lag operator, L.

Equations (3) and (4) were estimated using annual data on labor income and capital income from the OECD National Accounts (1994) for Japan, Germany, the United King-

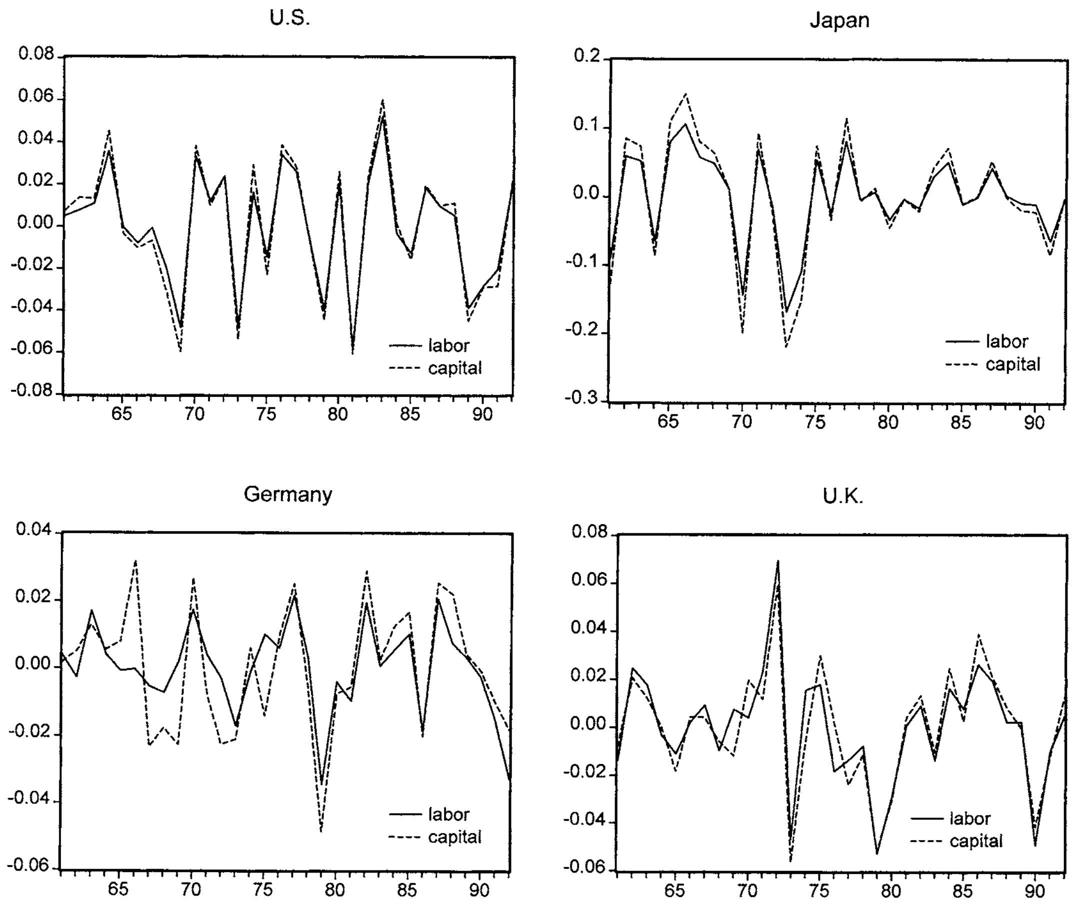

FIGURE 1. RETURNS TO LABOR AND CAPITAL IN FOUR OECD COUNTRIES

dom, and the United States over the period 1960–1993. Our measure of labor income is total employee compensation; our measure of capital income is GDP at factor cost minus employee compensation. The Akaike and Schwartz criteria both selected lag lengths of 1 for the polynomials $\psi_{LL}(L)$, $\psi_{LK}(L)$, $\psi_{KL}(L)$, $\psi_{KK}(L)$. However, our results are not sensitive to lag length, as we will illustrate below.

We follow Campbell and Shiller (1988) in assuming that expected returns are constant over time. Thus, equation (5) below defines the unexpected component of the return to labor from period t to period $(t+1)$ as the revision in the expected present discounted value of labor income growth. A similar interpretation applies to equation (6) for capital returns:

$$(5) \quad r^L_{t,t+1} - E(r^L_{t,t+1}) = (E_{t+1} - E_t)\left(\sum_{j=0}^{\infty} \rho^j \Delta d_{L,t+1+j}\right)$$

$$(6) \quad r^K_{t,t+1} - E(r^K_{t,t+1}) = (E_{t+1} - E_t)\left(\sum_{j=0}^{\infty} \rho^j \Delta d_{K,t+1+j}\right).$$

Figure 1 plots the unexpected components of labor and capital returns for each of the four OECD countries in our sample using 1 lag in

TABLE 1—CORRELATION AND STANDARD DEVIATIONS OF FACTOR RETURNS AND FACTOR INCOME GROWTH

Country/ return	Standard deviation of returns: percent per year	Standard deviation of income growth rates: percent per year	Japan r^L	Japan r^K	Germany r^L	Germany r^K	U.K. r^L	U.K. r^K	U.S. r^L	U.S. r^K
Japan: r^L	6.45	3.12		**0.99**	0.15	0.10	0.26	0.24	0.02	−0.02
Japan: r^K	8.83	5.31	**0.36**		0.14	0.09	0.25	0.23	0.02	−0.02
Germany: r^L	1.35	2.51	0.58	0.28		**0.78**	0.30	0.29	0.35	0.35
Germany: r^K	1.90	3.10	−0.07	0.37	**0.06**		0.16	0.22	0.40	0.43
U.K.: r^L	2.41	2.33	0.28	0.24	0.30	0.19		**0.93**	0.32	0.29
U.K.: r^K	2.45	5.59	−0.07	0.28	−0.03	0.51	**−0.01**		0.40	0.37
U.S.: r^L	2.73	2.12	0.16	0.55	0.30	0.47	0.24	0.48		**0.99**
U.S.: r^K	3.18	3.48	−0.03	0.09	−0.06	0.38	0.07	0.54	**0.54**	

Notes: Correlations of factor returns are above the diagonal; correlations of factor income growth rates are below the diagonal. Within-country correlations are indicated in boldface type. Correlations of factor returns are computed using local currency returns; 1 lag included in VECM; annual data, 1960–1993.

each polynomial in equations (3) and (4) with $\rho = 0.957$. Within each country, labor and capital returns are strongly, positively correlated. As shown above the diagonal in Table 1, the within-country correlations of labor and capital returns exceed 0.92 for the United States, the United Kingdom, and Japan; the correlation is 0.78 in the case of Germany. Factor returns across countries tend to be positively correlated, but not strongly so. The largest cross-country correlation is 0.43, and the median cross-country correlation is about 0.20.

The second column of Table 1 reports the standard deviations of factor returns. Factor returns in Japan are estimated to be somewhat more variable than in the other countries in our sample. In each country, however, the return to labor is less volatile than the return to capital—about three-fourths as volatile in the case of Japan and Germany, and somewhat higher, but still less than one, for the United States and the United Kingdom.[2]

III. Factor Income Growth versus Factor Returns

An implication of our approach to computing factor returns is that there is no necessary relation between growth rates of factor incomes and factor returns. That is: factor returns can be highly correlated within a country, as we saw in the prior subsection, while growth rates of labor and capital income are much less highly correlated. To see this in more detail, Table 1 reports the correlation of the growth rates of factor income below the diagonal. The largest within-country correlation of factor income growth rates is 0.54 (for the United States). The other countries in our sample exhibit much lower contemporaneous correlations of labor and capital income growth rates.

Table 1 illustrates that factor returns within a country are much more highly correlated than growth rates of factor incomes. This is a reflection of the fact that, in the short term, labor income growth may be largely unrelated to capital income growth. Over the longer

[2] Laura Bottazi et al. (1996) estimate equations for wages and profit rates without imposing a common trend—i.e., they do not impose econometric restrictions that guarantee that factor shares remain bounded away from zero or one. Further, they de-trend the data by removing a quadratic time trend before estimation. Given their very short sample period (1970–1992), the squared term in the time trend may have been given credit for important dynamics of labor and capital income. These considerations very likely explain why their results are qualitatively different from ours.

term, however, labor and capital income share a common stochastic trend, and it is the trend behavior of factor income growth that dominates factor returns.

We can use these results on the differences between factor income growth and factor returns to understand why our findings differ so markedly from those of Fama and Schwert (1977), who argued that human capital considerations were likely to be unimportant for asset pricing. In discussing the difficulties of measuring the return to a nontraded asset, Fama and Schwert (1977 p. 97) argue as follows:

> Whereas the payoff on a marketable asset includes both dividend and capital gain, the concept of a capital gain has no meaning for an asset which is completely non-marketable. Such an asset has no market value ..., and its return at t is just the income it produces at t.

This view is obviously incorrect. The capital gain component of the return to human capital is important for asset pricing so long as individuals choose consumption over time (optimally or otherwise) in response to market incentives. For example, individuals have a nontrivial decision concerning working (in order to consume the produced consumption good) versus not working (in order to consume leisure). The expected value of the wage rate will affect this decision. The investment decision, in turn, is affected by forecasts of the future productivity of capital, which depends directly on the amount of labor input supplied to the market.[3]

However, Fama and Schwert note that there is one special case in which the growth rate of labor income is the correct measure of the return to human capital; this case requires that the following conditions are satisfied. First, the log of labor income, d_L, must follow a random-walk process:

$$(7) \qquad d_{L,t+1} = \log(\gamma) + d_{Lt} + \varepsilon_{t+1},$$

where γ is the average growth rate of labor income and ε_t is i.i.d. Second, the discount factor θ used to discount future labor income must be constant over time. Under these assumptions, it is straightforward to show that the return to labor income is just the growth rate of labor income, up to a constant:

$$(8) \qquad r^L_{t,t+1} = \Delta d_{Lt} - \log(\theta\gamma).$$

However, our econometric evidence (e.g., the high R^2 coefficients in our VECMs, as reported in the Appendix, available upon request) showed that factor income growth was not a pure random walk. Most importantly, there are important predictable components to labor income growth. Since labor income does not follow a pure random-walk process, equation (8) is invalid as a measure of the return to human capital.

But suppose we did run the Fama-Schwert regression in the context of the empirical model of Section II—what result would we obtain? To investigate this question, we ran the following regression on U.S. data, where the left-hand-side variable is labor income growth and the right-hand-side variable is the return to capital that we estimated in Section II (Fama and Schwert used U.S. equity returns as their measure of the return to capital):

$$(9) \qquad \Delta d_{L,t+1} = k_0 + k_1 r^K_{t,t+1} + u_{t+1}.$$

Our estimate of k_1 was 0.22, with a standard error of 0.12. Thus, we fail to reject the hypothesis that $k_1 = 0$ at the 5% significance level. Further, the adjusted R^2 for the regression is 0.07; the return to capital explains little of the growth rate of labor income. These are exactly the same qualitative findings obtained by Fama and Schwert. These findings arise because labor income growth is not highly correlated with the returns to capital (the correlation is 0.32), even though the *returns* to labor are very highly correlated with the returns to capital (the correlation is 0.99). We

[3] A recent paper by Lars E. O. Svensson and Ingrid J. Werner (1993) argues that the value of a nontraded asset is related to the asset's shadow price. They study two cases in which they derive formulae for this shadow price and compute optimal portfolio composition with nontraded assets.

therefore conclude that Fama and Schwert's results are due to an inappropriate measure of the return to human capital.

IV. Implications for Hedging Human Capital Risk

Once we no longer assume that human capital returns are perfectly correlated with the returns to domestic marketable assets, a hedge for human capital risk cannot be undertaken using domestic marketable assets alone. We assume that the set of marketable assets worldwide provides perfect spanning. This means that there is a linear combination of domestic and foreign marketable securities that is perfectly correlated with the return to domestic human capital.[4] This portfolio is called a *hedge portfolio* because it can be used to perfectly hedge the risk associated with the nontraded human capital. Further, we choose units so that one unit of the hedge portfolio hedges the flow of income from \$1.00 of human capital.

Let h_{jk} denote the weight given to the marketable assets of country k in the hedge portfolio for \$1.00 of human capital owned by a resident of country j. Let $\boldsymbol{h}_j = [\boldsymbol{h}_{j1}, \boldsymbol{h}_{j2}, ..., \boldsymbol{h}_{jJ}]'$ denote the vector of country weights in the hedge portfolio for country j. Then $\boldsymbol{h}_j$ is given by the following:

$$\text{(10)} \qquad \boldsymbol{h}_j = \Sigma^{-1}\nabla_j,$$

where Σ is the $J \times J$ variance-covariance matrix of returns on the marketable assets of the J countries comprising the "world portfolio" and ∇_j is the $J \times 1$ vector of covariances of marketable asset returns with human capital returns in country j. Because a hedge portfolio is designed to mimic the return properties of a particular asset—in this case, \$1.00 of human capital for the resident of country j—there is no reason for the portfolio weights to add to one.

Table 2 shows the composition of the hedge portfolios for each of the four countries. To check robustness, we present results for returns denominated in the local currency and also for returns in the investor's home currency.[5] Further, we report results for various lag lengths in the VECM for factor income [equations (3) and (4)]. Evidently, the currency denomination of returns has minor implications for the portfolio that hedges human capital risk. While exchange rates contribute to the volatility of foreign returns, exchange rates have low correlation with domestic labor returns so that including these does not significantly affect the hedge portfolio. The results also are largely insensitive to lag length in the VECM.

Consider the U.S. investor, in the specific case of local currency returns and 1 lag in the VECM for factor income. The weight of 0.8582 for U.S. assets means that the hedge portfolio for a U.S. investor consists of \$0.86 U.S. stocks, \$0.01 Japanese stocks, −\$0.06 German stocks, and \$0.03 U.K. stocks. Clearly, domestic marketable assets form the most important component of the hedge portfolio for U.S. human capital—this is true for all the countries we study. These results are not very sensitive to lag length or to the use of local versus home currency returns.

Compared to the simple model of Section 1, in which \$1.00 of domestic marketable assets provided a perfect hedge for \$1.00 of human capital, the main difference in the present set-

[4] Because of the high correlation between within-country labor and capital returns, this assumption seems a reasonable one. In particular, we found that regressions of labor returns on the four countries' capital returns yielded R^2 statistics as follows: Japan: 0.99; Germany: 0.62; United Kingdom: 0.86; and United States: 0.99. Given the probable importance of measurement error in constructing income and returns, we view these results as encouraging for the assumption of perfect spanning as approximately correct in this empirical context. Bottazi et al. (1996) also assume perfect spanning, although their results imply that labor returns are not highly correlated with capital returns.

[5] Local currency returns assume that the investor does not face exchange-rate risk, which amounts to assuming that the exchange-rate risk has been perfectly hedged. Home currency returns are computed by converting the local currency returns to the investor's home currency using end-of-period exchange rates. With home currency returns, the investor faces exchange-rate risk as well as the risk associated with the underlying security. Data on exchange rates are from the *International Financial Statistics* (International Monetary Fund, 1994).

TABLE 2—HEDGING HUMAN CAPITAL

Investor nationality	# of lags in VAR	Composition of hedge portfolio (shares in each country's traded assets)			
		Japan	Germany	U.K.	U.S.
		A. Local currency returns			
Japan	1 lag	**0.7275**	0.0090	0.0315	−0.0113
	2 lags	**0.7100**	0.0117	0.0595	−0.0315
	3 lags	**0.7173**	−0.0117	0.0174	0.0077
Germany	1 lag	0.0055	**0.5368**	0.0715	−0.0119
	2 lags	−0.0215	**0.5974**	0.0359	−0.0197
	3 lags	−0.0217	**0.4637**	0.0726	0.0139
U.K.	1 lag	0.0105	−0.0419	**0.9255**	−0.0330
	2 lags	0.0107	−0.0747	**0.9503**	−0.0165
	3 lags	0.0095	−0.1947	**0.8919**	0.1500
U.S.	1 lag	0.0131	−0.0559	0.0277	**0.8582**
	2 lags	0.0095	−0.0179	0.0416	**0.8367**
	3 lags	0.0067	−0.0259	0.0275	**0.8420**
		B. Investor's home currency returns			
Japan	1 lag	**0.7321**	0.0092	0.0005	0.0053
	2 lags	**0.7124**	0.0061	0.0008	0.0022
	3 lags	**0.7185**	0.0051	0.0007	−0.0005
Germany	1 lag	0.0046	**0.5503**	−0.0217	−0.0041
	2 lags	−0.0113	**0.6069**	−0.0287	0.0044
	3 lags	−0.0092	**0.5109**	−0.0166	−0.0003
U.K.	1 lag	0.0069	0.0272	**0.8713**	−0.0234
	2 lags	0.0035	0.0541	**0.8472**	−0.0141
	3 lags	−0.0037	0.0645	**0.8856**	−0.0011
U.S.	1 lag	0.0125	0.0077	−0.0135	**0.8460**
	2 lags	0.0085	0.0105	−0.0099	**0.8495**
	3 lags	0.0065	0.0072	−0.0053	**0.8514**

ting is that hedging for \$1.00 of labor income now involves less than \$1.00 in domestic marketable assets. The reason is that labor returns are estimated to be less volatile than capital returns. For the United States, Table 1 shows that the return to labor is 2.73/3.18 = 0.86 times as volatile as the return to capital. If the returns to labor and capital were perfectly correlated, hedging \$1.00 of human capital risk in the United States would involve a short position in U.S. marketable assets of \$0.86. In fact, the returns to labor and capital are very highly correlated in the United States; Table 2 correspondingly shows that the U.S. component of the hedge portfolio is very close to \$0.86.

Labor and capital returns also are very highly correlated in Japan. Once again, we find that the weight on domestic marketable assets is very close to the relative volatility of labor income (from Table 1, the relative volatility of labor income is: 6.45/8.83 = 0.73). For Germany and the United Kingdom, the correlation of domestic labor and capital returns is weaker than for the United States and Japan, with the effect that the domestic component of the hedge portfolio is somewhat smaller than the figure implied by relative volatilities.

V. Forming a Diversified Portfolio

Having hedged the human capital risk, the next step is to choose a desired, "optimal" portfolio, which we will take to be a diversified world portfolio. As before, the diversified portfolio is then constructed by investing a fraction π_j of investor wealth in each country. The net demand by a resident of country j for

TABLE 3—FORMING A DIVERSIFIED PORTFOLIO

		Shares invested in marketable assets of:				Sum of portfolio holdings for each investor
		Japan	Germany	U.K.	U.S.	
		A. Portfolio shares as a fraction of domestic marketable assets				
Investor nationality:	Japan	−0.47	0.08	0.27	1.12	1.00
	Germany	0.54	−0.72	0.18	1.00	1.00
	U.K.	0.65	0.16	−1.04	1.23	1.00
	U.S.	0.64	0.18	0.30	−0.12	1.00
		B. Portfolio shares as a fraction of each country's marketable assets				
Investor nationality:	Japan	−0.47	0.53	0.53	0.63	
	Germany	0.08	−0.72	0.05	0.08	
	U.K.	0.34	0.56	−1.04	0.36	
	U.S.	1.13	2.18	1.03	−0.12	
Sum of demands for marketable assets of each country		1.08	2.55	0.56	0.95	

the assets of country k expressed as a fraction of home country (country j) marketable assets is given by the following (see the Appendix, available upon request, for the derivation):

$$(11)\qquad \pi_k\left(1+\frac{\alpha}{1-\alpha}\left(\sum_{k=1}^{J} h_{jk}\right)\right) - \frac{\alpha}{1-\alpha}h_{jk}.$$

The first term in (11) represents the diversification motive in country j for holding marketable assets of country k. The expression multiplying π_k reflects the funds generated by selling the investor's endowment of the claim to domestic physical capital and hedging the claim to domestic human capital. The second term in (11) reflects the hedging motive for holding assets of country k. To express portfolio holdings by residents of country j in the marketable assets of country k as a fraction of country k's marketable assets (rather than as a fraction of domestic marketable assets), (11) is multiplied by relative market sizes π_j/π_k.

What does (11) imply for portfolio composition in the four countries in our sample? Table 3 gives portfolio shares in a diversified portfolio for the case of local currency returns and 1 lag in the VECM for factor income. According to French and Poterba (1991), the U.S. share in the world portfolio is 0.48; Japan's is 0.27; Germany's is 0.04, and the U.K.'s is 0.14. These shares add up to 93% of the world portfolio; we renormalize these shares by dividing each π_j by 0.93 so that the shares add up to 1.00. We computed labor's share as the sample average of U.S. wage and salary income plus proprietor's income, divided by U.S. GNP, and arrived at a value of $\alpha = 0.60$.

The top panel of Table 3 expresses portfolio shares as a fraction of domestic marketable securities; these portfolio shares add up to 1.0 for each investor (i.e., adding up across each row). The bottom panel expresses portfolio shares as a fraction of each country's marketable assets—the total demand for a country's marketable assets is found by summing down each column.

The main finding in Table 3 is that, for each country, a diversified portfolio implies a substantial short position in domestic traded assets combined with long positions in each of the foreign assets. The relative importance of the hedging motive is stronger, the smaller is the country's share in the world portfolio (the smaller is π_j). For example, the United States and the United Kingdom had similar domestic components of the hedge portfolio, with about \$0.90 in marketable assets needed to hedge each \$1.00 of nontraded human capital. But the United States represents a much larger share of the diversified world portfolio than does the United Kingdom. Thus, the net position in U.S. assets of a U.S. investor is −12% of the U.S. market, while the net U.K. position for a U.K. investor is about −104% of the U.K. market. Based on these results, we view it as likely that *there is no country for which a diversified portfolio involves a positive position in domestic traded assets.*

The lower panel of Table 3 shows demands for the marketable assets of each of the four countries. These portfolio shares are measured as fractions of each country's marketable assets: these are computed by multiplying each entry in panel A by relative market sizes, π_j/π_k (notice that the entries on the diagonal, for which $j = k$, are unchanged). The demands for each country's assets do not sum to one, although they are close to one for Japan and the United States. The reason for this is the same as the reason why portfolio shares for investors following, for example, a mean-variance portfolio optimization strategy would not sum to one. Investors in both cases are taking asset returns and covariances as given and constructing a portfolio according to a particular strategy. Here, the strategy is to construct a diversified world portfolio, but constructing that portfolio involves marketable assets as part of a hedge portfolio. Because there are no natural constraints on the sums of weights in the hedge portfolio, there is no natural constraint on the sum of demands for each country's marketable assets.

VI. Conclusions

This paper investigated the implications of nontraded human capital risk for optimal portfolio choice. We noted that human capital represents a large share of national wealth and argued that the returns to human capital are likely to be highly correlated with the returns to domestic marketable assets. We demonstrated this intuition first in the context of a simple model and then provided more compelling evidence by computing returns to human capital and physical capital for four OECD countries. In each case, we found that domestic human capital returns were strongly correlated with the returns to domestic physical capital.

We then investigated the implications of measuring human capital returns as the growth rate of labor income, following earlier work by Fama and Schwert (1977). We showed that this approach to measuring human capital returns is valid only under particular econometric restrictions, and the data strongly reject these restrictions. We also showed that we can reproduce the Fama-Schwert results in the context of our empirical model: although labor returns and capital *returns* are highly correlated, labor income *growth* is not highly correlated with the return to capital.

Next, we showed that domestic marketable assets play an important role in hedging risk associated with nontraded human capital. Further, diversified portfolios will involve a substantial short position in domestic marketable assets combined with long positions in the marketable assets of foreign countries.[6] Although recent years have witnessed an increase in the degree of international portfolio diversification, our results suggest that the portfolio of the typical investor is still very far from representing a truly diversified world portfolio.

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[6] Campbell (1996) presents an alternative empirical approach to measuring returns on human capital. Like Baxter and Jermann, and like Fama and Schwert, he identifies the dividend to human capital with labor income. However, he assumes that the discount factor that prices human capital is equal to that implicit in the national stock market. Based on Table 4 of his paper, the conditional correlation between the return to human capital and the domestic stock market is 0.94, using monthly data for the United States. Thus, his findings seem in line with our basic results.

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