Hedging labor income risk at industry level: a normative approach

Carolina Fugazza*and Maela Giofré†

Very preliminary and incomplete, please do not quote or circulate.

June 1, 2007

Abstract

We adopt a normative approach to address the issue of the potential role of occupational pension funds to hedge labor income risk at industry level. We rely on the theoretical framework developed by Adler and Dumas (1983) and extended by Cooper and Kaplanis (1994) where deviations from PPP induce country specific optimal risky portfolios to hedge inflation risk. Following Coën (2001) extended version of the model including human capital as a non-traded asset, since differences in optimal investment portfolios may arise across investors who want to hedge labor income risk, we compare optimal portfolios suitable to hedge labor income risk at industry and aggregate level. The issue we address might be crucially important in normative terms for occupational pension funds: hedging labor income risk at industry level is particularly relevant since they allocate resources on the behalf of members facing common labor income shocks.

JEL: G11,G15,G23

Keywords: international asset pricing model, optimal portfolio choice, background risk hedging

* *Center for Research of Pensions and Welfare Policies* (CeRP)-*Collegio Carlo Alberto* (CCA), Via Real Collegio 30, Moncalieri (Turin), Italy;e-mail: fugazza@cerp.unito.it

† *Center for Research of Pensions and Welfare Policies* (CeRP)-*Collegio Carlo Alberto* (CCA), Via Real Collegio 30, Moncalieri (Turin), Italy;e-mail: giofre@cerp.unito.it

1 Introduction

In this paper we investigate the role of occupational pension funds in hedging labour income risks through an international diversification of the equity portfolio. In particular, our aim is evaluating through a normative analysis, whether the occupational pension fund – whose membership eligibility is often defined on an employment industry basis- is the financial institution natural candidate to exploit the possibility of hedging labor risk at industrial level.

Among institutional investors, pension funds deserve special consideration as they manage households' savings and, consequently, their assets represent a large fraction of household wealth[1], hence we want to investigate if precise connections between their investment strategies and household finance features may be designed to optimally hedge background risks faced by participants.

In traditional life cycle models labor income is treated as a dividend on human capital and the link between human wealth and the optimal asset allocation rests on the correlation structure between the financial assets returns and labour income. If the latter is riskless then the optimal individual's portfolio is tilted towards risky financial assets (Bodie et al. 1992). Otherwise, when labour income is realistically taken as risky, the optimal weight on financial risky assets is determined in order to exploit the diversification opportunities deriving from imperfect correlation with human wealth (see among others, Cocco et al., 2005, Heaton and Lucas, 2000 and Viceira, 2001).

It is well known that the inclusion of risky labor income as a return on human capital affects the optimal portfolio and consumption choice (since Merton, 1971 and Mayers,1972). In particular, if labour income is not completely spanned by traded assets, then the market portfolio is not universally efficient, because optimal portfolio composition accounts for an income risk-hedging component.

These effects have also been investigated in the financial literature on international diversification (see Baxter and Jermann,1997 and Bottazzi et

[1] John Campbell in the Presidential Address to the American Finance Association (2006) says households often fail to attain their objectives in planning financial decision (lack of participation in risky markets and of diversification of risky portfolios).

Bodie (2002) suggests that institutional investors may play a relevant role in helping individual and households to cope with these failures.

al.,1996, among others).In this literature the so called "home bias" has been widely documented: i.e., in the real world, individuals hold too much of their wealth in domestic assets with respect to CAPM prediction extended in an international framework[2]. In particular, in this framework, the explicit consideration of human capital, a large component of non-tradable assets, may affect the conclusion about the "home bias", by inducing an investor's specific asset demand which depends on the correlation among human capital returns with domestic and foreign equities. Using data on factor returns to human and physical capital, Baxter and Jermann (1997) find a very high positive correlation (0.99 for US) among domestic factor returns[3] computed as the revisions in the expected present discounted value of labor income growth and of capital income growth[4]. Moreover, Baxter and Jermann (1997) show that returns to human capital measured by the growth rate in per capita labour income display a lower correlation with their factor returns to capital (0.32 for US). Bottazzi et al. (1996) find that, for US, modelled human capital returns[5] display a high positive correlation with physical capital returns[6] (0.96), while they are negatively correlated with financial returns (-0.40)[7].

[2] Many attempts have been made to make the large holding in domestic assets rational. This is the case if domestic equities do better than foreign equities in hedging country-specific risks, such as deviations from the purchasing power parity or risks connected with domestic non traded assets.

[3] Baxter and Jermann (1997) derive returns to labor and capital in four OECD countries (U.S., Japan, Germany and U.K.). They estimate a vector error correction model for labor and capital income and, following Campbell and Shiller (1988), i.e. assuming constancy of expected returns, they compute the factor returns as the unexpected component of labour and capital returns.

[4] The revisions are made with respect to the expected components obtained according to what predicted by their estimates from an vector error correction model for labor and capital income.

[5] Bottazzi et al. (1996) adopt a continuos time VAR model which allow for intertemporal interaction between wage rates and capital returns and for redistributive shocks between labor and capital.

[6] Physical capital returns are measured through a "fundamental" approach which uses data on the aggregate operating surplus to obtain a measure of capital returns which corrects profits rate to take into account adjustment costs and the associated capital gains or losses (Brainard et al.,1980)

[7] Bottazzi et al. (1996) provide the empirical evidence on the correlation between modelled human capital returns and physical capital returns for numerous countries (measured with two alternative approaches from profit rates and from leveraged stock returns). For numerous countries they find a negative correlation among the labour and capital revenue, a result which is robust to the approach used to compute capital returns.

Here, following a common practice in financial literature, we use the rate of growth in per capita labor income to measure returns to human capital.[8]. Risks on human capital can be measured at different levels: at one extreme a broad measure of the risk associated to the average world income can be considered, at the other the specific risk faced by each individual worker. We adopt an intermediate solution considering labour income at industrial level: the importance of the industry factor in the labor income process and the evidence of persistence in the interindustry structure of wage differentials has been widely documented in literature (Krueger and Summers,1988) but far to be fully understood and so still investigated (Weinberg, 2001)[9]. As occupational pension funds' membership eligibility is often defined on an employment industry basis we aim at emphasizing their specific role in hedging labor income risks shared by their participants.

Given the progressive integration of international capital markets we allow for optimal portfolio strategies defined on global investment opportunities. This leads us to build our analysis on the Adler and Dumas (1983) model for international asset pricing, where optimal portfolios are constructed to hedge the investor's stochastic inflation and, consequently, are investor (country) specific. We adopt the continuous time approach (Merton,1971) to solve for optimal dynamic consumption and investment decisions with constant investment opportunities, in presence of unheadgeable uncertain labor income in addition to stochastic inflation. This corresponds to the Coen (2001) extension of the international asset pricing model that includes specifically the stochastic labour income as a factor against which the investor wants

[8] Actually, there is no consensus about using the rate of growth in per capita labor income as a proxy of human capital rewards. In particular, it is common in optimal portfolio literature (see Cocco, Gomes and Maenhout, 1999) to model the random component of the labor income process as the sum of idiosyncratic (transitory and permanent) and aggregate shocks, which implies that the random component of aggregate income follows a random walk. Moreover, Jagannathan and Wang (1996) provide support to the validity of the conditional CAPM with human capital by approximating its returns with the growth rate in per capita income. Palacios-Huerta (2001), instead, evaluates the conditional CAPM when different and more comprehensive measures of human capital returns are considered. He takes into account several relevant features of human capital markets (such as educational investments, skill premia and worker experience): some of these measures enhance the performance of the conditional CAPM in explaining asset returns, though none of them is able to capture all the labor market risks.

[9] The evidence of wage differentials across industries in the U.S. labor force it has long been documented (Dickens and Katz,1987a,b; Krueger and Summers, 1987, 1988; Katz and Summers, 1989).

to hedge. In the Coen (2001) version individuals in the same country face the same labor income risks (i.e. only aggregate shocks matter) by justifying different optimal (country specific) stock portfolios to hedge the deviation from the world average growth of labour income in addition to the hedging component designed to cope with the deviation from the world average rate of inflation. Here we consider the possibility of characterizing individuals resident in the same country, and so facing the same inflation risk, by taking into account the heterogeneity in labor income processes[10], induced by being emplyed in different industries [11].

Our results may provide useful insights for occupational pension funds, since their membership eligibility is often defined on employment industry basis and therefore participants plausibly face the same industrial shocks. In particular, we think that these results may be directly referred to Defined Contribution (DC) pension plans[12]. In DC plans contributions are fixed proportions of participants' salary, while benefits depends on returns on the plan's portfolio without guarantees on the performance, so the financial risks is borne by the participant.

This paper is structured as follows. In section 2 we describe the theoretical setting. In section 3 we report details on the dataset used. In section 4 we consider the empirical implementation by specifying the econometric setting and results are discussed. Section 5 concludes.

[10] How optimal portfolio choice is affected by income heterogeneity at sectoral level has been already investigated in financial literature in a standard closed economy framework (see for example Campbell and Viceira, 2002). In particular, the issue has been addressed by solving a multi-asset class portfolio choice problem, where the (efficient) composition of each broad asset class (stocks, bonds and cash) is the same for all investors. Here, instead, we concentrate on the efficient composition of the equity part.

[11] Economic literature on real business cycles has widely emphasized the comovent in output and total hours worked in different industries but also the fact that, though aggregate wages tend to be cyclical, wages at industry level are acyclical (Blanchard and Fischer,1989, Chirinko,1980, Bils,1985, Shin, 1994, and Solon, Barsky, and Parker,1994.

[12] In Defined Benefit (DB) plans, benefits are fixed in advance by the sponsor, while contributions are set and adjusted in order to achieve that level of benefits maintaining the fund balance. DB plans have to meet explicit fund requirements and usually the financial risks are beard by the plan sponsor. Here, we do not maintain that the background risk is unimportant for DB plans, in fact their liabilities are linked to the salaries of their participants. The point is that optimal asset allocation process for DB plans cannot abstract from the consideration of the liability side of their balance and should be analysed in an asset/liability framework, while, here, we adopt rely on the asset-only side of the optimal financial decisions.

2 The model

We derive optimal equity portfolios in a continuous time setting following Cooper and Kaplanis (1994) and Coën (2000). The violation of the Purchasing Power Parity and the presence of human wealth play a central role in the international portfolio diversification prescribing investor specific portfolio allocations.

We consider a representative investor living in home country l and working in industry s who chooses among N country stock indexes and 1 risk-free asset.[13]

The instantaneous rate of return on the equity index $j (j = 1, ..., N)$, expressed in the measurement currency[14], follows the stationary Ito process (Brownian motion)

$$dY_j/Y_j = \mu_j dt + \sigma_j dz_j$$

where we denote by Y_j the market value of equity index j in terms of the measurement currency; μ_j represents the instantaneous expected nominal rate of return on the equity index j, σ_j is the instantaneous standard deviation of the nominal rate of return on the equity index j, z_j is a standard Wiener process and dz_j is the associated white noise process.

In each home country l the investor faces the price index P_l, expressed in the measurement currency, which follows the stationary Ito process

$$dP_l/P_l = \pi_l dt + \sigma_{l,\pi} dz_{l,\pi}$$

where P_l is the price index faced by investor in country l in terms of the measurement currency, π_l is the instantaneous expected of rate of inflation faced by investor in country l, $\sigma_{l,\pi}$ is the instantaneous standard deviation of rate of inflation faced by investor in country l, $z_{l,\pi}$ is a standard Wiener process and $dz_{l,\pi}$ is the associated white noise process.

The return on human capital for investor belonging to industry s in country l ("investor s, l"), expressed in the measurement currency, follows the stationary Ito process

$$dH_{s,l}/H_{s,l} = h_{s,l} dt + \sigma^h_{s,l} dz^h_{s,l}$$

[13] We ignore the presence of foreign bonds and other assets (real estate).

[14] Consistently with related papers in the literature (Adler and Dumas, 1983, Cooper and Kaplanis, 1994) we assume the currency position to be fully hedged.

where $H_{s,l}$ is the value of labor income (wage) of investor s, l in terms of the measurement currency, $h_{s,l}$ is the instantaneous expected nominal rate of change of wage of investor s, l, $\sigma_{s,l,h}$ is the instantaneous standard deviation of the nominal rate of change of wage of investor s, l, $z_{s,l,h}$ is a standard Wiener process and $dz_{s,l,h}$ is the associated white noise process.

Each investor maximizes a time-additive von Neumann-Morgensten expected utility over life-time consumption, where homothetic direct utility function is assumed.

The investor's objective function is expressed as:

$$\underset{C}{Max}\ E\int_t^T V(C, P, \tau)d\tau \tag{1}$$

where C is the nominal rate of consumption expenditures, P is the price level index and $V(.)$ is the instantaneous rate of indirect utility characterized as function with homogeneity of degree zero in C and P.

Each investor is assumed to receive $(1-\eta)$ of his total income from financial income and η from income related to human capital[15], then the wealth dynamics are:

$$dW = (1-\eta)\left[\sum_{j=1}^{N} w_j(\mu_j - r) + r\right] Wdt + \eta h_{s,l}Wdt - Cdt + (1-\eta)\sum_{j=1}^{N} w_j\sigma_j W dz_j + \eta\sigma_{s,l}^h W dz_{s,l}^h \tag{2}$$

where W denotes the investor's nominal wealth w_j denotes the $N \times 1$ vector containing the investor's portfolio weights on the available equity indexes.

We denote by $J(W, P, t)$ the maximum value of the instantaneous expected utility subject to the wealth accumulation constraint, obtained by solving the problem with the Bellman principle, and by λ

$$\lambda = -\frac{J_{WW}}{J_W}W$$

the investor's relative risk aversion coefficient (J_W and J_{WW} are, respectively, the first and second partial derivative of $J(.)$ with respect to W).

[15] The hypothesis of constant η can be also found in Campbell (1996) where he approximates the actual time dependent labor share with the average long term one.

From the solution of the problem, the nominal yield on security j is:

$$\mu_j = \left[r + \sigma_{s,l}^{j,\pi}(1-\lambda)\right] + \lambda\left[(1-\eta)\sum_{k=1}^{N} w_k\sigma^{j,k} + \eta\sigma_{s,l}^{j,h}\right] \tag{3}$$

and the following portfolio allocation for investor s,l:

$$\mathbf{w}_{s,l} = \frac{\frac{1}{\lambda}}{(1-\eta)}\underbrace{\begin{pmatrix}\mathbf{\Omega}^{-1}(\boldsymbol{\mu}-r\mathbf{i})\\ 1-\mathbf{i}'\mathbf{\Omega}^{-1}(\boldsymbol{\mu}-r\mathbf{i})\end{pmatrix}}_{\text{logarithmic portfolio}} + \frac{(1-\frac{1}{\lambda})}{(1-\eta)}\underbrace{\begin{pmatrix}\mathbf{\Omega}^{-1}\boldsymbol{\varpi}_l\\ 1-\mathbf{i}'\mathbf{\Omega}^{-1}\boldsymbol{\varpi}_l\end{pmatrix}}_{\pi-\text{ hedging portfolio}} - \frac{\eta}{(1-\eta)}\underbrace{\begin{pmatrix}\mathbf{\Omega}^{-1}\boldsymbol{\kappa}_{s,l}\\ 1-\mathbf{i}'\mathbf{\Omega}^{-1}\boldsymbol{\kappa}_{s,l}\end{pmatrix}}_{h-\text{ hedging portfolio}} \tag{4}$$

where $\mathbf{i}$ is a $N-$vector of ones, $\mathbf{\Omega}$ is a (NxN) matrix of instantaneous variances-covariances $\sigma_{j,k}$ of nominal rates of returns, $\boldsymbol{\varpi}_l$ is a $N-$vector of covariances $\sigma_{l,\pi}^{j}$ between nominal equity return in country j and country l's rate of inflation and $\boldsymbol{\kappa}_{s,l}$ is a $N-$vector of covariances $\sigma_{s,l,h}^{j}$ between nominal equity return j and investor s,l's labor income growth.

The equity portfolio of investor $\{s,l\}$ is, therefore[16]:

$$\mathbf{w}_{s,l} = \mathbf{\Omega}^{-1}\left\{\frac{\frac{1}{\lambda}}{(1-\eta)}\left[\boldsymbol{\mu}-r\mathbf{i}\right] + \frac{(1-\frac{1}{\lambda})}{(1-\eta)}\boldsymbol{\varpi}_l - \frac{\eta}{(1-\eta)}\boldsymbol{\kappa}_{s,l}\right\} \tag{5}$$

The optimal portfolio may ideally be decomposed into three parts: the first is the universal logarithmic portfolio, which is common to all investors since it only depends upon stocks' excess return; the second is the country specific hedge portfolio built to hedge the inflation risk while the third is the industry-country specific hedge portfolio built to hedge labor income risk.

We apply the market clearing condition:

$$\underbrace{\mathbf{MS}}_{\text{supply}} = \underbrace{\sum_{s,l} v_{s,l}\mathbf{w}_{s,l}}_{\text{demand}} \tag{6}$$

[16] Here we rewrite the above expression for portfolio weights focusing on the first N elements of the vector representing the risky portfolio and ignoring the last element represented by the risk-free asset. Similarly to Baxter and Jermann (1997), since we are interested in looking at the within composition of the stock portfolio, we normalize to 1 the sum of stock weights.

where $v_{s,l}$ represents the wealth of industry s in country l as a fraction of total world wealth.

The equilibrium condition is therefore

$$\underbrace{\mathbf{MS}}_{\text{asset supply}} = \underbrace{\boldsymbol{\Omega}^{-1}\left[\frac{\frac{1}{\lambda}}{(1-\eta)}(\boldsymbol{\mu} - r\mathbf{i}) + \frac{(1-\frac{1}{\lambda})}{(1-\eta)}\sum_l v_l\varpi_l - \frac{\eta}{(1-\eta)}\sum_{s,l} v_{s,l}\kappa_{s,l}\right]}_{\text{asset demand}} \tag{7}$$

By substituting the market clearing condition into the equity portfolio we can rewrite the final equilibrium portfolio as:

$$\mathbf{w}_{s,l} = \mathbf{MS} + \frac{(1-\frac{1}{\lambda})}{(1-\eta)}\boldsymbol{\Omega}^{-1}\left[\left(\varpi_l - \sum_l v_l\varpi_l\right)\right] - \frac{\eta}{(1-\eta)}\boldsymbol{\Omega}^{-1}\left[\left(\boldsymbol{\kappa}_{s,l} - \sum_{s,l} v_{s,l}\boldsymbol{\kappa}_{s,l}\right)\right] \tag{8}$$

where the first term is the market share of the destination stock market which is common to all investors, the second is the inflation hedging portfolio which is common within each country and is the portfolio hedging the deviation of country l's inflation rate from the average world's inflation and the third addend is the labor income hedging portfolio which is specific to each industry within each country and is the portfolio hedging the deviation of investor s, l wage growth from the average world's wage growth.

3 Data

We consider three investing countries -US, Canada and Italy- for which monthly data on wages at industry level are available for a sufficient span of time[17]: for each country, data on wages at national level and industrial level are used. We rely on a seven investing industry level of disaggregation: Financials, Leisure, Manufacturing, Trade, Transports and Communications, Utilities, Other Services. This industry classification does not coincide with occupational pension funds industry classification, however our analysis may provide some useful results which might be easily extended to actual pension funds' industries.

[17] US: *Current Employment Statistics*; Canada: *Survey of Employment, Payrolls and Hours*; Italy: *Retribuzioni e Lavoro, ISTAT*

The optimal equity portfolios are computed at end-2004 using a monthly dataset on equity returns with span ranging from January 1996 to December 2004; they are constructed over ten destination countries -Canada, France, Germany, Italy, Japan, Netherlands, Sweden, United Kingdom, United States, Rest of the World- whose stock market capitalization and monthly observations of annual total stock returns -in US dollars- are computed on Datastream Equity Indexes.

The inflation rate is computed on CPI indices from International Financial Statistics (*IMF*).

Descriptive statistics for the variables considered are reported in Appendix A.

4 Methodology

4.1 Hedging coefficients

We can rewrite the optimal above portfolios in (8) as

$$w_{sl} = MS + \frac{(1-\frac{1}{\lambda})}{(1-\eta)} b_l - \frac{\eta}{(1-\eta)} q_{s,l} \tag{9}$$

or in terms of individual asset

$$w_{sl}^j = MS^j + \frac{(1-\frac{1}{\lambda})}{(1-\eta)} b_l^j - \frac{\eta}{(1-\eta)} q_{s,l}^j \tag{10}$$

where (Cooper and Kaplanis (1994))

$$\mathbf{\Omega}^{-1}\left(\varpi_l - \sum_l v_l \varpi_l\right) = \mathbf{b}_l \equiv \begin{pmatrix} b_{l1} \\ \vdots \\ b_{lj} \\ \vdots \\ b_{lN} \end{pmatrix} \tag{11}$$

and (Coen (2001))

$$\boldsymbol{\Omega}^{-1}\left(\kappa_l - \sum_{s,l} v_{sl}\boldsymbol{\kappa}_{sl}\right) = \mathbf{q}_{sl} \equiv \begin{pmatrix} q_{sl1} \\ \vdots \\ q_{slj} \\ \vdots \\ q_{slN} \end{pmatrix} \tag{12}$$

In order to compute the optimal portfolios we need just to estimate the b_l and $q_{s,l}$ coefficients since λ and η are just parameters ($\lambda = 5$, reflecting a medium risk aversion and $\eta = 0.63$, which is the world average labor share)[18] while MS is directly observable from the data.

We first give an interpretation of the hedging coefficients to be estimated and then enter more in details on the estimation procedure.

Defining as p_l the inflation rate of country l, b_l represents the vector of coefficients of the multiple regression of the variable $(p_l - \sum_l v_l p_l)$ on the vector of realized nominal returns R: in fact, we have the inverse of the returns' covariance matrix ($\boldsymbol{\Omega}^{-1}$) multiplied by the vector of covariances between the deviation of investor l's inflation rate from the average world's inflation and the stock returns $(\varpi_l - \sum_l v_l \varpi_l)$ which is then the $\mathbf{b}_l$ regression coefficient defined above. The variation of the inflation rate constitutes a factor of risk the investor wants to hedge and so, given the returns' covariance matrix, the *higher* the covariance between return j and inflation rate l's deviation the *higher* the share of country j's equity in investor l's portfolio: when the domestic inflation l (relative to world average) increases the returns on asset j increases too so compensating the loss of wealth caused by inflation.

Similarly, for the labor income hedging portfolio, defining as x_{sl} the rate of change of labor income in industry s-country l, q_{sl} represents the vector of coefficients of the multiple regression of the variable $(x_{sl} - \sum_{s,l}^{S,L} v_{sl} x_{sl})$ on the vector of realized nominal returns R : in fact, we have the inverse of the returns' covariance matrix ($\boldsymbol{\Omega}^{-1}$) multiplied by the vector of covariances between the deviation of investor s, l's income growth rate from the average world's growth and the stock returns $(\kappa_l - \sum_{s,l} v_{sl}\boldsymbol{\kappa}_{sl})$ which is then the $\mathbf{q}_{sl}$ regression coefficient defined above.

The variation of labor income represents a factor of risk the investor wants to hedge and so, given the returns' covariance matrix, the *lower* the covariance between return j and income s, l's growth deviation rate the *higher* the

[18] We have also considered alternative values (in the range 1 to 10 as commonly proposed by the literature) for the coefficient of relative risk aversion λ obtaining very similar results.

share of country j's equity in investor s, l's portfolio: when sector s, l deviation (relative to world average) increases the return on asset j decreases so that the returns on two sources of wealth, financial and human, compensate each other.

In order to estimate the hedging coefficients we run one regression for each country l to obtain the inflation hedging coefficient b_l (13)[19] and one regression for each industry s, l to obtain the industry specific labor income hedging coefficient $q_{s,l}$ (14)[20]

$$(p_l - \sum_{l} MS_l p_l)_t = b_{l0} + \sum_{j=1}^{J} b_l^j R_{l,t}^j + \varepsilon_{lt} \tag{13}$$

$$(x_{sl} - \sum_{s,l} MS_{s,l} x_{s,l})_t = q_{l0} + \sum_{j=1}^{J} q_{s,l}^j R_{l,t}^j + \upsilon_{slt} \tag{14}$$

To implement the above regressions we proxy the wealth shares (v_l) by the market shares (MS_l) as common practice in the literature (Cooper and Kaplanis (1994), Adler and Dumas (1983)) and instrument the contemporaneous returns with lagged returns through a GMM estimation. A further point is worth noticing: since we consider annual rates for our dependent and independent variables computed on monthly observations, we use overlapping observations: we consider Newey-West consistent standard errors to correct for the induced serial correlations in the errors.

4.2 Optimal equity portfolios

In this section we present the optimal equity portfolios represented as in (9) by estimating, as specified above, the hedging coefficients b_l and $q_{s,l}$ in

[19] In regression (13) the dependent variable is the deviation of domestic inflation rate from the average world inflation, while county-based stock indices returns are taken as regressors.

[20] In regression (14) the dependent variable is the deviation of domestic wage rate from the average world wage rates, when we want to evaluate how country based stock index returns are suitable to hedge labor income risks faced by the domestic average investor. The dependent variable in (14) is, instead, the deviation of domestic industry-specific wage rate from the average world wage rates, when we want to evaluate optimal investment strategies suitable to hedge labor income risks faced by resident in a given country and working in the specified industry.

regressions (13) and (14). The resulting optimal portfolio compositions at national and industry level are reported in Panel a) of Tables 1 to 3.

We then test the statistical significance of the hedging coefficients b_l^j and $q_{s,l}^j$ and compute again optimal portfolios considering only significant coefficients (at ten percent confidence level), setting equal to zero the non significant ones. We are therefore imposing that if the stock considered has no significant role in hedging labor income risk (or inflation risk), then the corresponding labor hedging portfolio (or the inflation hedging portfolio) has zero weight[21]. We show these results in panel b) of tables 1-3.

Optimal equity portfolios for the average investor resident in US are reported in the eighth column of table 1 in panels a) and b), while the corresponding results for Canada and Italy are in the eighth column of tables 2 and 3. The first seven columns in panels a) and b) of table 1 report optimal portfolios specifically designed to hedge labour income risk for the average investors resident in US and working in the different industries. The last column reports, for reference, the market shares of the destination countries considered[22]: if either the inflation hedging nor the labor income hedging are unimportant then the optimal portfolio will be equal to the market share of the considered destination countries. Tables 2 and 3 report the corresponding results for Canada and Italy.

[21] This imples that when the optimal weight in panel a) is equal to the corresponding optimal weight in panel b), then both coefficients relative to the considered destination country are significant. If, instead, they are different it implies that at least one of the two coefficients is significantly different from zero.

[22] That is, the value weighted portfolios that would universally efficient when investors' specific risks are disregarded.

Table 1. Optimal equity portfolios.

a) USA (all coeffs.)

	trade	util	transp	other	manufact	fin	leisure	nation	market share
Ca	0,26	0,32	0,20	0,07	0,07	0,11	0,25	0,16	0,03
Fr	0,17	0,36	0,05	0,10	0,42	0,28	0,22	0,13	0,05
It	-0,06	-0,23	0,06	0,02	-0,11	0,00	0,03	0,01	0,02
Jp	0,14	0,14	0,20	0,14	0,09	0,11	0,13	0,15	0,11
Nl	0,11	0,10	0,30	0,22	-0,12	0,11	0,16	0,19	0,02
Sw	-0,14	-0,29	-0,03	-0,01	0,05	-0,05	-0,12	-0,05	0,01
UK	0,07	0,01	-0,05	0,04	0,25	0,07	-0,06	0,02	0,09
US	0,28	0,40	0,31	0,33	0,42	0,32	0,27	0,30	0,42
Ge	0,05	0,16	-0,03	-0,11	-0,21	-0,18	-0,06	-0,08	0,04
Rest	0,12	0,02	0,01	0,19	0,13	0,23	0,18	0,15	0,22

b) USA (sign. coeffs)

	trade	util	transp	other	manufact	fin	leisure	nation	market share
Ca	0,16	0,28	0,15	0,14	0,07	0,18	0,14	0,14	0,03
Fr	0,15	0,45	0,05	0,07	0,56	0,28	0,17	0,10	0,05
It	-0,06	-0,22	0,05	0,02	-0,10	0,00	0,02	0,01	0,02
Jp	0,18	0,17	0,17	0,16	0,08	0,11	0,16	0,16	0,11
Nl	0,09	0,09	0,26	0,17	-0,11	0,11	0,12	0,15	0,02
Sw	-0,12	-0,24	0,01	0,01	0,01	0,01	-0,09	0,01	0,01
UK	0,07	0,07	0,07	0,06	0,38	0,08	0,06	0,06	0,09
US	0,36	0,34	0,34	0,31	0,41	0,41	0,32	0,31	0,42
Ge	0,04	0,14	-0,03	-0,08	-0,43	-0,43	-0,05	-0,06	0,04
Rest	0,11	-0,07	-0,07	0,14	0,12	0,23	0,14	0,11	0,22

Table 2. Optimal equity portfolios.

a) Canada (all coeffs.)

	trade	util	transp	other	manufact	fin	leisure	nation	market share
Ca	0,03	0,12	0,10	-0,03	0,06	-0,08	0,00	0,00	0,03
Fr	-0,23	-0,24	-0,16	-0,20	-0,02	-0,31	-0,64	-0,19	0,05
It	-0,12	-0,12	-0,09	-0,01	-0,20	-0,16	0,68	-0,09	0,02
Jp	0,04	0,04	0,06	0,06	0,00	0,01	0,26	0,04	0,11
Nl	0,76	0,64	0,36	0,39	0,53	0,60	-0,06	0,54	0,02
Sw	0,15	0,10	0,12	0,15	0,14	0,32	-0,01	0,17	0,01
UK	-0,24	-0,12	0,03	-0,23	-0,05	0,07	-0,41	-0,11	0,09
US	0,45	0,25	0,39	0,66	0,48	0,52	0,61	0,52	0,42
Ge	-0,18	0,01	-0,07	-0,12	-0,21	-0,22	0,10	-0,16	0,04
Rest	0,34	0,32	0,27	0,31	0,28	0,27	0,47	0,29	0,22

b) Canada (sign. coeffs)

	trade	util	transp	other	manufact	fin	leisure	nation	market share
Ca	0,02	0,03	0,02	-0,38	-0,18	-0,32	-0,40	-0,32	0,03
Fr	-0,20	-0,23	-0,12	-0,26	-0,02	-0,28	-0,92	-0,23	0,05
It	0,02	0,02	0,02	0,03	-0,30	0,02	0,79	0,03	0,02
Jp	0,08	0,09	0,07	0,13	0,09	0,09	0,51	0,12	0,11
Nl	0,82	0,79	0,39	0,75	0,64	0,70	0,03	0,85	0,02
Sw	0,01	0,01	0,01	0,01	0,01	0,01	0,01	0,01	0,01
UK	-0,46	-0,40	0,05	-0,68	0,07	0,07	-1,02	-0,48	0,09
US	0,57	0,37	0,43	1,15	0,63	0,67	1,19	0,87	0,42
Ge	-0,16	0,01	-0,05	-0,16	-0,20	-0,20	0,14	-0,20	0,04
Rest	0,29	0,31	0,20	0,41	0,26	0,24	0,68	0,35	0,22

Table 3. Optimal equity portfolios.

a) Italy (all coeffs.)

	trade	util	transp	other	manufact	fin	leisure	nation	market share
Ca	-0,25	-0,12	-0,18	-0,29	-0,21	-0,28	-0,17	-0,25	0,03
Fr	0,03	0,04	0,05	0,10	0,08	0,18	-0,02	0,09	0,05
It	0,07	0,00	-0,02	0,05	0,05	0,01	0,10	0,07	0,02
Jp	0,03	0,02	-0,05	0,01	0,01	-0,01	-0,05	-0,01	0,11
Nl	0,97	1,10	1,15	1,00	0,98	0,90	1,15	0,97	0,02
Sw	-0,08	-0,09	0,05	-0,04	-0,03	-0,04	0,02	-0,03	0,01
UK	-0,58	-0,96	-0,93	-0,62	-0,69	-0,62	-1,13	-0,76	0,09
US	0,45	0,48	0,47	0,46	0,44	0,49	0,50	0,47	0,42
Ge	-0,33	-0,06	-0,25	-0,40	-0,27	-0,29	-0,17	-0,26	0,04
Rest	0,71	0,60	0,72	0,73	0,66	0,66	0,77	0,72	0,22

b) Italy (sign. coeffs.)

	trade	util	transp	other	manufact	fin	leisure	nation	market share
Ca	-0,32	-0,12	-0,14	-0,39	-0,24	-0,36	-0,10	-0,26	0,03
Fr	0,04	0,04	0,03	0,05	0,05	0,05	0,03	0,04	0,05
It	0,08	0,00	-0,02	0,07	0,05	0,01	0,07	0,08	0,02
Jp	0,04	0,02	-0,04	0,01	0,01	-0,01	-0,03	-0,01	0,11
Nl	1,55	1,35	1,17	1,75	1,61	1,75	0,98	1,48	0,02
Sw	-0,43	-0,37	0,01	-0,43	-0,38	-0,42	0,01	-0,35	0,01
UK	-1,00	-0,87	-0,76	-1,12	-1,04	-1,13	-0,63	-0,96	0,09
US	0,56	0,45	0,36	0,62	0,50	0,64	0,31	0,50	0,42
Ge	-0,42	-0,06	-0,19	-0,54	-0,31	-0,37	-0,11	-0,28	0,04
Rest	0,89	0,57	0,56	0,98	0,75	0,85	0,48	0,76	0,22

From the comparison between the optimal portfolio composition suitable to hedge background risks (both labor income and inflation risks) faced by the average investor in US (column 8 in table 1) with the universally efficient portfolio (column 9 in table 1), we can immediately notice that there is a potentially relevant role for the background risks (to be tested more formally later on) in shaping optimal international risky portfolios. This is true also for Canada and Italy (see table 2 and 3 respectively).

In order to evaluate the importance of hedging income risks at industry level (i.e. risks faced by all workers employed in different industries), we report the portfolios computed in order to hedge the labour income for each investing industry: if labour income risks are homogeneous across the different industries in the same country then these risks are hedged by the same combination of risky assets, (i.e. the combination which is optimal for the worker earning the average national labour income); if, instead, labor income risks are different across investing industries then the optimal combinations will be consistently different.

When considering the industry specific allocations, Tables 1-3 (columns from 1 to 7) show that, for all industries in each country considered, optimal portfolio compositions are quite different from the national optimal portfolio; they also differ from the value weigthed portfolio suggesting that there is scope for optimal hedging labor income risk even at industry level). The same consideration holds even when looking at the corresponding "significant" portfolios (panel b). Whenever the coefficients tend to be equal across sector it implies that the industry specific hedging factor is not significant.

In the following sections we proceed at examining the relevance of the inflation and the labor income hedging component (section 4.3) and the heterogeneity of the optimal portfolio composition across different industries (section 4.4).

4.3 Economic relevance

After having tested the statistical significance of the difference in the weights across industries, we also try to capture somehow the economic importance of the hedging factors. We consider the relative weight of the inflation hedging portfolio and of the labor income hedging portfolio over the market share of the destination stock index, i.e. the relative importance of the investor specific components over the value weighted portfolio (common to all investors).

In Table 4 we report the relative weight of the total hedging component (inflation hedging portfolio plus labor income hedging portfolio) with respect to the market shares for all three countries, as well as the relative weight of each single hedging portfolio separately: Table 4 clearly shows that the hedging component is large and relevant and it is true even when restricting our analysis only to the "significant" portfolios.

It is worth noticing how the relative weight for the hedging portfolios are of course decreasing with the market share of the destination stock market, while there is no evident dominance of one component of the hedging portfolio on the other[23].

As far as the importance of investors' hedging behavior is concerned it is worth opening a parenthesis: in our work, as in Cooper and Kaplanis (1994) and Coën (2001), the hedging behavior does not explain the "home bias puzzle"[24]. However, due to the imperfect correlation of returns on hu-

[23] The inflation hedging component computed at national level is common to all industries in a country.

[24] According to the original IAPM prescriptions, people fail to profit from international diversification gains and prefer domestic assets. In particular, the weight of domestic assets in residents' portfolios is much higher than the market share of the country.

man capital and financial capital within a country, the Baxter and Jermann (1997)'s prescription of going short in domestic assets, does not necessarily hold. In particular we find contrasting evidence for the investing countries considered: in the case of Canada, the correlation between returns on financial assets and on labor income is so high within the country that Canadian investors should optimally go short in domestic stock market, for US there is a positive correlation inducing an optimal share below the market share, for Italy the correlation is sufficiently low or even negative to induce a higher investment in domestic assets than the Italian market share.

We then consider the variability of the relative importance of the labor hedging component across industries and compute the significant distances between industry portfolio weights and national portfolio weights.

Tables 5-6 show the relative weight of the labor income hedging portfolio with respect to the market share at industry level revealing a substantial heterogeneity across industries in each country considered even when looking only at the "significant" portfolios.

Table 4. Relative importance of hedging portfolio

a) USA National Portfolio

	HEDGE/MS		(LABOR HEDGE)/MS		(INFL HEDGE)/MS		
	all coeffs	sign. coeffs	all coeffs	sign. coeffs	all coeffs	sign. coeffs	market share
Ca	4,50	5,32	-0,82	0,00	5,32	5,32	0,03
Fr	1,98	1,98	-9,48	-9,48	11,46	11,46	0,05
It	-0,56	-0,56	11,85	11,85	-12,41	-12,41	0,02
Jp	0,44	0,98	-0,54	0,00	0,98	0,98	0,11
Nl	9,21	9,21	-28,99	-28,99	38,20	38,20	0,02
Sw	-5,28	0,00	-4,84	0,00	-0,44	0,00	0,01
UK	-0,78	0,00	0,95	0,00	-1,74	0,00	0,09
US	-0,28	0,00	0,06	0,00	-0,34	0,00	0,42
Ge	-3,15	-3,15	10,17	10,17	-13,32	-13,32	0,04
Rest	-0,30	-0,30	1,10	1,10	-1,40	-1,40	0,22

b) Canada National Portfolio

	HEDGE/MS		(LABOR HEDGE)/MS		(INFL HEDGE)/MS		
	all coeffs	sign. coeffs	all coeffs	sign. coeffs	all coeffs	sign. coeffs	market share
Ca	-1,09	-10,88	-10,88	-10,88	9,79	0,00	0,03
Fr	-5,74	-5,74	-18,32	-18,32	12,58	12,58	0,05
It	-5,22	0,00	-11,10	0,00	5,88	0,00	0,02
Jp	-0,62	0,00	0,34	0,00	-0,96	0,00	0,11
Nl	29,79	39,83	39,83	39,83	-10,04	0,00	0,02
Sw	16,77	0,00	11,67	0,00	5,10	0,00	0,01
UK	-2,38	-6,14	-6,14	-6,14	3,76	0,00	0,09
US	0,36	0,92	0,92	0,92	-0,55	0,00	0,42
Ge	-6,14	-6,14	20,02	20,02	-26,16	-26,16	0,04
Rest	0,51	0,51	-2,40	-2,40	2,91	2,91	0,22

b) Italy National Portfolio

	HEDGE/MS		(LABOR HEDGE)/MS		(INFL HEDGE)/MS		
	all coeffs	sign. coeffs	all coeffs	sign. coeffs	all coeffs	sign. coeffs	market share
Ca	-10,61	-10,61	36,49	36,49	-47,10	-47,10	0,03
Fr	1,23	0,00	-7,19	0,00	8,42	0,00	0,05
It	2,37	2,37	-38,82	-38,82	41,20	41,20	0,02
Jp	-1,12	-1,12	2,98	2,98	-4,10	-4,10	0,11
Nl	56,92	82,85	-25,93	0,00	82,85	82,85	0,02
Sw	-4,17	-35,88	-35,88	-35,88	31,71	0,00	0,01
UK	-11,22	-13,12	1,91	0,00	-13,12	-13,12	0,09
US	0,29	0,29	1,98	1,98	-1,69	-1,69	0,42
Ge	-9,61	-9,61	30,66	30,66	-40,27	-40,27	0,04
Rest	2,84	2,84	-6,88	-6,88	9,72	9,72	0,22

Table 5. Relative importance of hedging portfolio (LABOR HEDGE/MS)

a) USA (all coeffs)

	trade	util	transp	other	manufact	fin	leisure	nation	market share
Ca	2,50	**5,24**	0,85	**-3,91**	-3,90	-2,53	2,29	-0,82	0,03
Fr	-8,56	-3,84	**-11,23**	-10,34	**-3,59**	-6,17	-7,55	-9,48	0,05
It	8,76	**1,29**	**13,83**	12,28	7,13	11,47	12,66	11,85	0,02
Jp	-0,70	-0,63	**-0,06**	-0,68	**-1,19**	-0,91	-0,73	-0,54	0,11
Nl	-33,46	-33,41	**-22,71**	-27,55	**-45,20**	-33,35	-30,86	-28,99	0,02
Sw	-13,77	**-28,81**	-3,78	-1,17	**4,23**	-4,90	-11,65	-4,84	0,01
UK	1,57	0,92	0,07	1,26	**3,54**	1,52	**0,04**	0,95	0,09
US	0,02	**0,35**	0,11	0,13	0,30	0,13	**-0,01**	0,06	0,42
Ge	13,75	**17,24**	11,33	9,11	**6,72**	7,00	10,60	10,17	0,04
Rest	0,99	0,48	**0,45**	1,29	0,99	**1,50**	1,25	1,10	0,22

b) Canada (all coeffs)

	trade	util	transp	other	manufact	fin	leisure	nation	market share
Ca	-9,51	**-6,25**	-6,75	-11,76	-8,62	**-13,64**	-10,91	-10,88	0,03
Fr	-19,12	-19,47	-17,78	-18,43	**-14,07**	-20,98	**-28,73**	-18,32	0,05
It	-12,36	-12,30	-11,03	-7,26	**-16,17**	-13,93	**22,92**	-11,10	0,02
Jp	0,35	0,33	0,56	0,61	**-0,06**	0,01	**2,50**	0,34	0,11
Nl	**53,16**	46,15	31,32	31,86	40,39	42,06	**5,86**	39,83	0,02
Sw	9,23	4,27	6,80	9,39	8,54	**25,12**	**-6,79**	11,67	0,01
UK	-7,89	-6,29	-4,34	-7,70	-5,48	**-3,84**	**-9,85**	-6,14	0,09
US	0,73	**0,23**	0,64	**1,31**	0,87	0,88	1,10	0,92	0,42
Ge	19,43	25,42	22,67	21,26	**18,27**	18,41	**28,06**	20,02	0,04
Rest	-2,16	-2,26	-2,44	-2,29	-2,43	**-2,59**	**-1,55**	-2,40	0,22

c) Italy (all coeffs)

	trade	util	transp	other	manufact	fin	leisure	nation	market share
Ca	34,99	**41,44**	39,66	**33,89**	38,09	35,03	40,33	36,49	0,03
Fr	-8,63	-8,37	-8,34	-6,71	-7,45	**-4,73**	**-9,93**	-7,19	0,05
It	-38,70	-42,40	**-43,21**	-39,53	-39,98	-41,94	**-37,80**	-38,82	0,02
Jp	**3,45**	3,28	2,65	3,19	3,17	3,03	**2,58**	2,98	0,11
Nl	**-18,30**	-19,77	-19,82	-18,86	-25,66	**-28,20**	-22,45	-25,93	0,02
Sw	**-42,56**	-41,79	**-27,98**	-37,56	-36,22	-36,73	-30,49	-35,88	0,01
UK	3,26	-0,47	0,44	3,11	2,93	**3,49**	**-1,44**	1,91	0,09
US	2,07	1,97	1,88	2,06	**1,88**	**2,08**	1,92	1,98	0,42
Ge	27,01	**37,24**	31,70	**25,21**	30,33	29,45	34,23	30,66	0,04
Rest	**-6,40**	**-7,55**	-7,11	-6,49	-7,21	-7,08	-7,03	-6,88	0,22

Table 6. Relative importance of hedging portfolio (LABOR HEDGE/MS)

a) USA (sign.coeffs)

	trade	util	transp	other	manufact	fin	leisure	nation	market share
Ca	0,00	5,24	0,00	0,00	-3,90	0,00	0,00	0,00	0,03
Fr	-8,56	0,00	-11,23	-10,34	0,00	-6,17	-7,55	-9,48	0,05
It	8,76	0,00	13,83	12,28	7,13	11,47	12,66	11,85	0,02
Jp	0,00	0,00	0,00	0,00	-1,19	-0,91	0,00	0,00	0,11
Nl	-33,46	-33,41	-22,71	-27,55	-45,20	-33,35	-30,86	-28,99	0,02
Sw	-13,77	-28,81	0,00	0,00	0,00	0,00	-11,65	0,00	0,01
UK	0,00	0,00	0,00	0,00	3,54	0,00	0,00	0,00	0,09
US	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,42
Ge	13,75	17,24	11,33	9,11	0,00	0,00	10,60	10,17	0,04
Rest	0,99	0,00	0,00	1,29	0,99	1,50	1,25	1,10	0,22

b) Canada (sign.coeffs)

	trade	util	transp	other	manufact	fin	leisure	nation	market share
Ca	0,00	0,00	0,00	-11,76	-8,62	-13,64	-10,91	-10,88	0,03
Fr	-19,12	-19,47	-17,78	-18,43	-14,07	-20,98	-28,73	-18,32	0,05
It	0,00	0,00	0,00	0,00	-16,17	0,00	22,92	0,00	0,02
Jp	0,00	0,00	0,00	0,00	0,00	0,00	2,50	0,00	0,11
Nl	53,16	46,15	31,32	31,86	40,39	42,06	0,00	39,83	0,02
Sw	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,01
UK	-7,89	-6,29	0,00	-7,70	0,00	0,00	-9,85	-6,14	0,09
US	0,73	0,00	0,64	1,31	0,87	0,88	1,10	0,92	0,42
Ge	19,43	25,42	22,67	21,26	18,27	18,41	28,06	20,02	0,04
Rest	-2,16	-2,26	-2,44	-2,29	-2,43	-2,59	-1,55	-2,40	0,22

c) Italy (sign.coeffs)

	trade	util	transp	other	manufact	fin	leisure	nation	market share
Ca	34,99	41,44	39,66	33,89	38,09	35,03	40,33	36,49	0,03
Fr	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,05
It	-38,70	-42,40	-43,21	-39,53	-39,98	-41,94	-37,80	-38,82	0,02
Jp	3,45	3,28	2,65	3,19	3,17	3,03	2,58	2,98	0,11
Nl	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,02
Sw	-42,56	-41,79	0,00	-37,56	-36,22	-36,73	0,00	-35,88	0,01
UK	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,09
US	2,07	1,97	1,88	2,06	1,88	2,08	1,92	1,98	0,42
Ge	27,01	37,24	31,70	25,21	30,33	29,45	34,23	30,66	0,04
Rest	-6,40	-7,55	-7,11	-6,49	-7,21	-7,08	-7,03	-6,88	0,22

4.4 Industry heterogeneity

We test the difference among labor income hedging coefficients across investing industries ($q^j_{s,l}$) by estimating the regressions for the seven industries considered (within the same country) in a system. The null hypothesis of the Wald test we perform is the following

$$Ho : \underset{k\in S}{q^j_{k,l}} = \underset{s\in S, s\neq k}{q^j_{s,l}}$$

$$H_A : \underset{k\in S}{q^j_{k,l}} \neq \underset{s\in S, s\neq k}{q^j_{s,l}}$$

where S is the space containing the seven investing industries.

We report in Table 7, the absolute significant distance between industry and national optimal portfolio weights to capture the impact of the heterogeneity of labor income stochastic processes across industries. We find that the absolute significant distances of industry weights from the national portfolio's ones are large (relative to the national's). In particular it seems quite evident that the distances for Canada are larger than for Italy and US: the significant absolute distances range from a minimum of 0.04 to 0.78 for Canada, from 0.02 to 0.31 for US and from 0.01 to 0.37 for Italy.

This quantitative difference between Canada and the other countries emerges also when considering, in Table 8, the synthetic portfolio dispersion measure[25] capturing the deviation of industry portfolios from the national one: the indicators of the degree of dispersion are always quite large. Panel A shows the standard deviation of industry portfolios from the national portfolio and the standard deviation of individual weights from the corresponding national weights. For portfolios' dispersion we find 69 percentage points (pp) for Canada, 37 pp for US and 10 pp for Italy, when only significant (at ten percent level) weighted[26] differences are considered. When looking at the standard deviation of industry individual weights from the corresponding national weights the standard deviation is 22 pp for Canada, 12 pp for US and 3 pp for Italy. In panel B we report the average distance of individual portfolio weights from the corresponding national weights: it amounts to 8 pp in Canada, 8 pp in US and 3 pp in Italy.

[25] The degree of dispersion is computed as the standard deviation of differences between industrial and national optimal portfolios.

[26] We consider each industry entering the dispersion measure according to its relative weight in terms of aggregate labor compensation (i.e. industry s in country l is weighted according to the ratio $\frac{labor \quad compensation_{s,l}}{\sum_s labor \quad compensation_l}$)

Table 7. Absolute distance sector-national (only sign. diff.)

a) USA

	trade	util	transp	other	manufact	fin	leisure	national portfolio
Ca	***0,09***	***0,16***	0,00	***0,09***	***0,05***	***0,09***	***0,10***	0,16
Fr	0,00	***0,23***	0,00	***0,08***	***0,14***	***0,28***	0,00	0,13
It	0,00	***0,24***	0,00	0,00	0,00	***0,12***	***0,07***	0,01
Jp	0,00	0,00	***0,04***	***0,02***	***0,04***	***0,06***	0,00	0,15
Nl	0,00	0,00	0,00	0,00	0,00	***0,31***	0,00	0,19
Sw	***0,04***	***0,24***	0,00	***0,07***	0,00	***0,10***	***0,10***	-0,05
UK	0,00	0,00	0,00	***0,08***	0,00	***0,23***	0,00	0,02
US	0,00	***0,10***	0,00	0,00	0,00	***0,12***	0,00	0,30
Ge	0,00	***0,24***	0,00	0,00	***0,11***	***0,13***	***0,12***	-0,08
Rest	***0,04***	***0,13***	***0,14***	***0,03***	***0,08***	0,00	0,00	0,15

b) Canada

	trade	util	transp	other	manufact	fin	leisure	national portfolio
Ca	0,00	***0,12***	***0,10***	0,00	***0,08***	***0,06***	0,00	0,00
Fr	0,00	0,00	0,00	***0,45***	0,00	***0,17***	0,00	-0,19
It	***0,09***	0,00	0,00	***0,78***	0,00	***0,11***	0,00	-0,09
Jp	***0,03***	0,00	0,00	***0,22***	0,00	0,00	0,00	0,04
Nl	***0,14***	0,00	0,00	***0,60***	0,00	0,00	***0,23***	0,54
Sw	0,00	0,00	0,00	***0,18***	***0,14***	0,00	0,00	0,17
UK	***0,12***	0,00	***0,14***	0,00	***0,18***	0,00	***0,13***	-0,11
US	***0,14***	***0,27***	***0,13***	0,00	0,00	0,00	***0,07***	0,52
Ge	0,00	***0,17***	0,00	0,00	0,00	0,00	0,00	-0,16
Rest	0,00	0,00	0,00	***0,18***	0,00	0,00	0,00	0,29

c) Italy

	trade	util	transp	other	manufact	fin	leisure	national portfolio
Ca	0,00	0,00	***0,07***	***0,08***	***0,03***	***0,04***	0,00	-0,25
Fr	0,00	***0,05***	0,00	***0,11***	***0,09***	0,00	0,00	0,09
It	0,00	0,00	***0,09***	0,00	***0,07***	***0,02***	0,00	0,07
Jp	0,00	0,00	***0,03***	***0,04***	0,00	***0,02***	***0,04***	-0,01
Nl	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,97
Sw	0,00	0,00	0,08	***0,05***	0,00	0,00	0,00	-0,03
UK	0,00	0,00	***0,17***	***0,37***	***0,14***	***0,07***	0,00	-0,76
US	0,00	***0,01***	0,00	0,00	***0,02***	***0,03***	0,00	0,47
Ge	***0,13***	0,00	***0,02***	***0,09***	0,00	0,00	0,00	-0,26
Rest	***0,01***	0,00	0,00	0,00	***0,06***	***0,06***	0,00	0,72

Table 8. Synthetic measures of dispersion

A: standard deviation around national

	United States		Canada		Italy	
	all coeffs	sign. dist.	all coeffs	sign. dist.	all coeffs	sign. dist.
-portfolios						
weighted	0.29	0.37	0.38	0.69	0.22	0.10
unweighted	0.34	0.32	0.53	0.48	0.28	0.19
-weights						
weighted	0.09	0.12	0.12	0.22	0.07	0.03
unweighted	0.11	0.10	0.17	0.15	0.09	0.06

B: average absolute distance from national

	United States		Canada		Italy	
	all coeffs	sign. dist.	all coeffs	sign. dist.	all coeffs	sign. dist.
-weights						
weighted	0.07	0.08	0.08	0.08	0.05	0.03
unweighted	0.08	0.06	0.10	0.07	0.09	0.03

Finally we provide a graphical evidence of the degree of the distance among portfolios by considering the number of significantly different coefficients for each pair of industries considered. We conduct the Wald test on the significance of the differences among coefficients of regressions 13) and 14) estimated for all industries in all countries and show in Figure 1-3 the distribution of industry-pairs according to the number of significantly different coefficients: since we have seven industries, to compare all investing industries one another, we consider 21 possible couples[27]. For each of these couples we count the number of significantly different coefficients and then plot the number of couples corresponding to each number of different coefficients. We also report, as a subtitle of each graph, the total number of significant coefficients as a percentage out of 210 (21 couples times 10 coefficients, one for each destination country). We can immediately observe that all industry-pairs differ significantly for at least one weight in the optimal portfolio with the mode ranging from 3 to 5 in the three countries.

[27] Of course, we do not allow for repetitions.

Figure 1. USA. Differences across industry-pairs

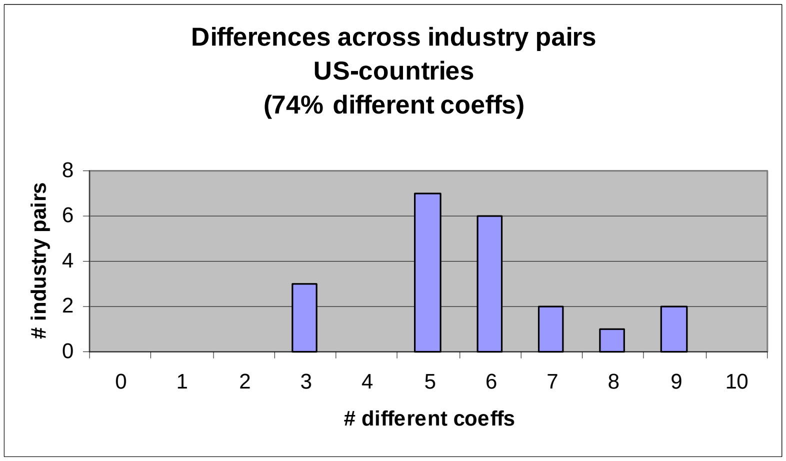


Figure 2. Canada. Differences across industry-pairs

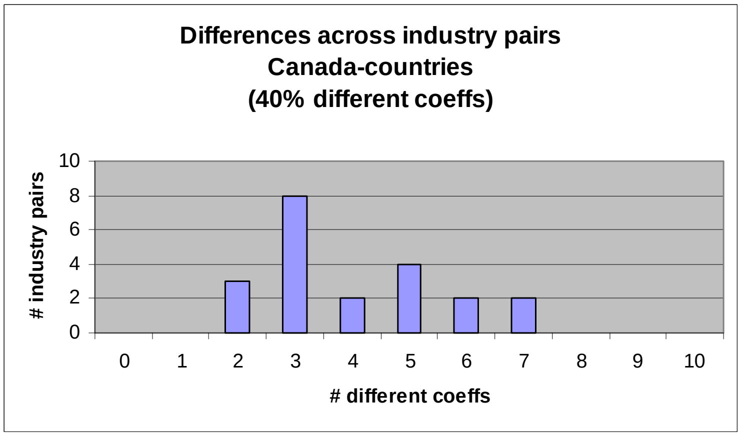
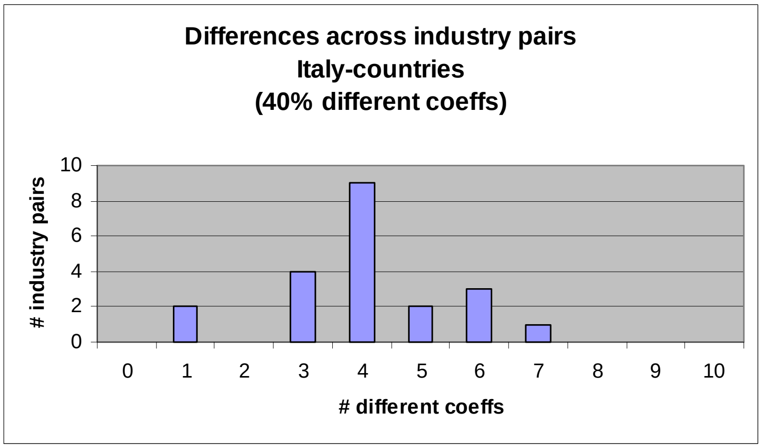


Figure 3. Italy. Differences across industry-pairs



5 Conclusions

Our paper aims at evaluating through a normative analysis whether occupational pension funds – whose membership eligibility is often defined on an employment industry basis- are, among financial institutions, the natural candidate to exploit the possibility of hedging risk at industry level. We rely on the extended versions (Cooper and Kaplanis (1994), and Coen (2001)) of the international asset pricing model of Adler and Dumas (1983) to obtain investors' efficient strategies suitable to hedge the labour income risk at both national and industry level. We compute optimal portfolios for seven industries in three countries (Canada, US and Italy) and we find that both the inflation and the labour income hedging components are relevant, at national and at industry level. Moreover, heterogeneity across optimal investment strategies at industry level suggests that occupational pension funds might play a peculiar role in allowing adherents to hedge the common industry labour income risk.

More specifically, it reveals two main points: the importance of the labor income hedging portfolio and the notable heterogeneity in labor income growth across industries. The first result is important and differs from the results of the existing literature (Baxter and Jermann, 1997) adopting income profiles. The second result gives interesting insights about the relevance of building optimal strategies not only country specific but also industry specific. These two crucial points have two immediate implications: first, ignoring human capital may produce remarkable distortion in investment decisions, second that the investment strategies should be tailored to diversify away specific risks.

References

[1] Adler, M. and B. Dumas (1983), "International Portfolio Choice and Corporation Finance: A Synthesis", Journal of Finance, 38, 925-984.

[2] Baxter, M. and U. J. Jermann (1997). "The International Diversification Puzzle Is Worse Than You Think," American Economic Review, American Economic Association, vol. 87(1), pages 170-80.

[3] Baxter, M., U.J. Jermann and R.G. King, (1998), « Nontraded Goods, Nontraded Factors, and International Non-Diversification », Journal of International Economics.

[4] Bodie, Z., R. C. Merton and W. Samuelson, (1992), "Labor supply flexibility and portfolio choice in a life cycle model", Journal of Economic Dynamics and Control, 16, 427–449.

[5] Bodie, Z., (2002), "Life-Cycle Finance in Theory and in Practice", Boston University School of Management Working Paper No. 2002-02.

[6] Bottazzi, L, P. Pesenti and E. van Wincoop, (1996), « Wages, Profits, and the International PortfolioPuzzle », European Economic Review, 40 (6), 219-254.

[7] Brainard, W. C., J. B., Shoven and L. Weiss, (1980), "The Financial Valuation of the Return to Capital", Brookings Papers on Economic Activity 2, 453-511.

[8] Campbell, J.Y., (1996), « Understanding Risk and Return », Journal of Political Economy 104 (2), 298-345.

[9] Campbell, J. Y. and L. M. Viceira, (2002), Strategic Asset Allocation, Oxford University Press, New York.

[10] Campbell, J. Y. (2006), "Household Finance", Journal of Finance, 61, 1553-1604.

[11] Campbell, J. Y. and R. J. Shiller, (1988), "Stock Prices, Earnings and Expected Dividends", Journal of Finance, 3, 661-76.

[12] Cocco, J. F., F. J. Gomes and P. J. Maenhout (2005) “Consumption and Portfolio Choice over the Life Cycle”, Review of Financial Studies, 2005 18, 491-533.

[13] Coën, A. (2001), “Home bias and International Capital Asset Pricing Model with Human Capital”, Journal of Multinational Financial Management, 11, 497-513.

[14] Cooper, I. A. and E. Kaplanis (1994), " Hom Bias in Equity Portfolios. Inflation Hedging and International Capital Market Equilibrium", Review of Financial Studies, 7, 45-60.

[15] Dickens, W. T. and Katz, L. F. (1987a). ‘Inter-Industry Wage Differences and Industry Characteristics’,in Lang K. and Leonard J. (eds), Unemployment and the Structure of Labor

[16] Markets, Basil Blackwell, Oxford.

[17] Fama, E.F. and G.W. Schwert, (1977), « Human Capital and Capital Market Equilibrium », Journal of Financial Economics 4, 95-125.

[18] French, K. and J. Porterba, (1991), "Investor Diversification and International Equity Markets",American Economic Review, 81, 222-226.

[19] Griffin, J. and G. Karolyi, (19989, “Another look at the role of industrial structure of markets for international diversification strategies”, Journal of Financial Economics, 50, 351-373.

[20] Heaton, J. and D. Lucas , (1997)," Savings Behavior and Portfolio Choice : What Risks Matter ?", working paper, Kellogg, Northwestern University.

[21] Heaton, J. and D. Lucas, (2000), “Portfolio choice and asset prices: The importance entrepreneurial risk”, Journal of Finance 55, 1163–1198.

[22] Jagannathan, R. and Z., Wang, (1996), "The Conditional CAPM and the Cross-Section of Expected Returns", Journal of Finance, 51, 3-53.

[23] Katz, L. F. and Summers, L. H. (1989). ‘Industry rents: evidence and implications’, Brookings Papers on Economic Activity: Microeconomics, Vol. 1989, pp. 209–275.

[24] Krueger, A. B. and Summers, L. H. (1987). 'Reflection on the inter-industry wage structure', in Lang K. and Leonard J. (eds), Unemployment and the Structure of Labor Markets, Basil Blackwell, Oxford.

[25] Krueger, A. B. and Summers, L. H. (1988). 'Efficiency wages and the inter-industry wage structure', Econometrica, 56, pp. 259–293.

[26] Mayers, D., (1972), "Non-Marketable Assets and the Capital Market Equilibrium Under Uncertainty", in Jensen, ed, Studies in the Theory of Capital Markets, Praeger, New York, 1972, 223-248.

[27] Merton, R.C., (1971),"Optimum Consumption and Portfolio Rules in a Continuous-Time Model", Econometrica, 41, 867-87.

[28] Palacios-Huerta, I., (2001),"The Human Capital of Stockholders and the International Diversification Puzzle", Journal of International Economics, 54, 309-31.

[29] Sercu, P., (1980), "A Generalization of the International Asset Pricing Model," Revue de l'Association Française de Finance,1, 91-135.

[30] Solnik, B. H., (1974), "an Equilibrium Model of the International Capital Market ," Journal of Economic Theory, 8, 500-524.

[31] Viceira, L. M., (2001), "Optimal portfolio choice for long-horizon investors with nontradable labor Income", Journal of Finance 56, 433–470.

[32] Weinberg, B. A., (2001), "Long-Term Wage Fluctuations with Industry-Specific Human Capital", Journal of Labor Economics, 1. 231-264.

Appendix

A Descriptive statistics

Table A1. Nominal wages (Annual Rate of Growth)

Investing industries	USA Mean	USA Std. Dev.	Canada Mean	Canada Std. Dev.	Italy Mean	Italy Std. Dev.
National	0,03	0,01	0,02	0,01	0,02	0,01
Financial	0,04	0,01	0,02	0,01	0,02	0,01
Leisure	0,03	0,02	0,01	0,04	0,02	0,02
Manufact	0,03	0,01	0,02	0,02	0,03	0,01
Other svs	0,04	0,01	0,02	0,01	0,02	0,02
Trade	0,03	0,02	0,02	0,01	0,03	0,02
Transport	0,02	0,02	0,01	0,02	0,02	0,02
Utilities	0,03	0,02	0,02	0,02	0,02	0,02

Table A2. Nominal Wages (Annual Rate of Growth). Correlations

a) US (1996-2004)

	Nation	Fin	Leis	Manufact	Other	Trade	Transp	Util
National	1	0,78	0,87	0,31	0,65	0,80	0,14	0,27
Financial		1	0,70	0,20	0,62	0,66	-0,13	0,29
Leisure			1	0,25	0,44	0,75	0,14	0,25
Manufact				1	0,13	0,22	-0,05	0,10
Other					1	0,42	-0,20	0,10
Trade						1	-0,04	0,51
Transport							1	-0,10
Utilities								1

b) Canada (1997-2004)

	Nation	Fin	Leis	Manufact	Other	Trade	Transp	Util
National	1	0,38	0,55	0,73	0,50	-0,15	0,01	-0,42
Financial		1	0,25	0,07	-0,26	-0,13	-0,25	-0,32
Leisure			1	0,59	0,00	-0,40	0,13	-0,47
Manufact				1	0,20	-0,47	-0,02	-0,63
Other					1	0,21	0,27	0,06
Trade						1	-0,06	0,32
Transport							1	0,41
Utilities								1

a) Italy (1997-2004)

	Nation	Fin	Leis	Manufact	Other	Trade	Transp	Util
National	1	0,54	0,40	0,80	0,28	0,19	0,20	0,50
Financial		1	-0,25	0,46	0,54	0,44	-0,39	0,17
Leisure			1	0,31	-0,54	-0,54	0,75	0,65
Manufact				1	0,30	0,20	0,24	0,48
Other					1	0,96	-0,38	-0,28
Trade						1	-0,39	-0,28
Transport							1	0,55
Utilities								1

Table A3. Employment (Annual Rate of Growth)

	USA (1996-2004)		Canada (1997-2004)		Italy (1997-2004)	
Investing industries	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.
National	0,01	0,02	0,02	0,01	-0,03	0,03
Financial	0,02	0,03	0,03	0,03	-0,01	0,01
Leisure	0,02	0,01	0,02	0,03	0,06	0,04
Manufact	-0,02	0,03	0,02	0,01	-0,02	0,01
Other svs	0,02	0,01	0,01	0,03	0,03	0,02
Trade	0,01	0,02	0,02	0,02	0,04	0,03
Transport	0,01	0,03	0,01	0,02	-0,03	0,01
Utilities	-0,02	0,01	0,02	0,02	-0,06	0,03

Table A4. Employment (Annual Rate of Growth). Correlations

a) US (1996-2004)

	Nation	Fin	Leis	Manufact	Other	Trade	Transp	Util
National	1	0,98	0,79	0,50	0,68	0,92	0,93	-0,20
Financial		1	0,71	0,53	0,69	0,92	0,89	-0,26
Leisure			1	0,43	0,36	0,67	0,82	-0,27
Manufact				1	-0,05	0,73	0,41	-0,48
Other					1	0,48	0,55	0,23
Trade						1	0,83	-0,32
Transport							1	-0,12
Utilities								1

b) Canada (1997-2004)

	Nation	Fin	Leis	Manufact	Other	Trade	Transp	Util
National	1	0,88	0,80	0,45	0,75	0,80	0,28	-0,29
Financial		1	0,84	0,13	0,79	0,57	0,42	-0,24
Leisure			1	0,23	0,56	0,50	0,34	-0,17
Manufact				1	-0,01	0,52	-0,23	-0,20
Other					1	0,37	0,41	-0,43
Trade						1	-0,01	-0,10
Transport							1	-0,01
Utilities								1

a) Italy (1997-2004)

	Nation	Fin	Leis	Manufact	Other	Trade	Transp	Util
National	1,0	0,64	-0,54	0,54	0,36	0,08	0,47	-0,57
Financial		1,0	-0,03	0,27	-0,03	0,64	-0,02	-0,48
Leisure			1,0	-0,15	-0,18	0,38	-0,40	0,25
Manufact				1,0	0,13	-0,03	0,22	-0,01
Other					1,0	-0,16	0,39	-0,55
Trade						1,0	-0,49	-0,38
Transport							1,0	-0,05
Utilities								1,0

Table A6. Nominal Stock Returns (annual). Correlations (1996-2004)

a) Country Indexes

	Can	Fr	Ge	It	Jp	Nl	Sw	Uk	Us	Rest
Canada	1	0,75	0,74	0,53	0,60	0,74	0,92	0,70	0,69	0,77
France		1	0,95	0,84	0,54	0,86	0,87	0,83	0,82	0,59
Germany			1	0,82	0,46	0,89	0,86	0,89	0,81	0,61
Italy				1	0,17	0,77	0,64	0,77	0,73	0,24
Japan					1	0,33	0,64	0,37	0,39	0,81
Netherlands						1	0,80	0,95	0,92	0,52
Sweden							1	0,77	0,76	0,75
Uk								1	0,90	0,57
Us									1	0,47
Rest										1

b) Global Industry Indexes

	Basic	Cons gds	Health	Cons svs	Fin	Ind	Techno	Oil_gas	Telecom	Util
Basic	1	0,84	0,27	0,70	0,76	0,73	0,38	0,81	0,42	0,57
Cons gds		1	0,55	0,86	0,85	0,84	0,61	0,80	0,62	0,59
Healthcare			1	0,59	0,76	0,44	0,36	0,48	0,38	0,70
Cons svs				1	0,82	0,88	0,81	0,64	0,87	0,62
Financials					1	0,77	0,52	0,80	0,55	0,84
Industrials						1	0,86	0,78	0,79	0,56
Techno							1	0,43	0,93	0,33
Oil and gas								1	0,38	0,60
Telecom									1	0,43
Utilities										1

Table A5. Nominal stock returns (annual)

Country Market	Mean	Std. Dev.	Global industries	Mean	Std. Dev.
Canada	0,16	0,23	**Basic**	0,06	0,18
France	0,14	0,23	**Consumer gds**	0,07	0,17
De	0,09	0,24	**Healthcare**	0,11	0,14
Italy	0,14	0,26	**Consumer svs**	0,08	0,17
Japan	0,03	0,33	**Financials**	0,09	0,16
Netherlands	0,10	0,21	**Industrials**	0,11	0,22
Sweden	0,17	0,34	**Techno**	0,19	0,45
Uk	0,11	0,19	**Oil and gas**	0,14	0,16
Us	0,13	0,21	**Telecom**	0,10	0,32
Rest	0,05	0,22	**Utilities**	0,08	0,15

B Role of employment risk

In this section, we compute optimal international equity portfolio allocations suitable to hedge both wage risk and employment risk at industry level, through country index-based optimal investment strategies. We follow the same approach used in the main text with a difference due to the fact that now uncertainty on labor income is proxied by the rate of growth of aggregate (industry or national) income. When considering only the average wage growth (at national or industry level) we are implicitly looking only at the variation in the wage rate of those who are employed, so we do not take into account the fact that the nation or industry is facing another source of variation which is the number of working individuals.

From the individual point of view this method may be seen as a way of introducing the possibility of hedging not only the wage risk but also the unemployment risk: we maintain that she is aware not only about shocks on her wage (captured by the random variations around the mean growth rate of wage) but also about shocks to employment (captured by the random variations around the mean growth rate of employment, which proxies the variation in the probability of being occupied). According to this view, we compute optimal portfolio strategies suitable to hedge labor income risks unconditional to the probability of being employed (an ex-ante hedging taking into account the variation in the probability of loosing the job proxied by the variation in employment in the country or industry)[28]. Therefore, risky asset are valuable when their returns are negatively correlated with economic conditions in broad sense: the demand of a risky asset is positive if it provides high returns when the labor income growth is low or when the employment growth is low, as in this second case the probability of being unemployed is high.

As in the main text we are interested on how heterogeneity affects optimal investment strategies, therefore we compute both optimal allocations suitable to hedge the variability in the rate of growth of national income and the set of portfolios suitable to hedge the variability of labor income by the different industries in the same country (proxied by the variation in the rate of growth of workers compensation paid at industry level).

In this section the analysis is performed for one investing country (US)

[28] Here we are assuming the Labor force constant so that the employment rate variation equals the rmployment variation.

and seven investing US industries considered in the paper. Data on labor income and on employment in US and in the different industries are taken from the Current Employment Statistics survey[29]

Table B1. Optimal equity portfolios.

a) USA (all coeffs.)

	trade	util	transp	other	manufact	fin	leisure	nation	market share
Ca	0,56	0,27	0,49	0,12	0,57	0,45	0,40	0,38	0,03
Fr	0,19	0,28	0,06	0,05	0,62	0,33	0,25	0,42	0,05
It	-0,13	-0,17	0,02	0,07	-0,47	-0,07	-0,04	-0,21	0,02
Jp	0,24	0,14	0,29	0,16	0,27	0,20	0,18	0,26	0,11
Nl	0,11	0,26	0,55	0,22	-0,61	0,03	0,26	0,70	0,02
Sw	-0,27	-0,24	-0,23	-0,03	-0,03	-0,27	-0,18	-0,17	0,01
UK	0,00	-0,11	-0,18	0,07	0,43	0,05	-0,02	-0,12	0,09
US	0,20	0,39	0,11	0,24	0,63	0,20	0,18	0,10	0,42
Ge	0,21	0,11	0,05	-0,08	0,07	0,04	-0,03	-0,22	0,04
Rest	-0,12	0,07	-0,17	0,19	-0,48	0,05	0,01	-0,13	0,22

b) USA (sign. coeffs)

	trade	util	transp	other	manufact	fin	leisure	nation	market share
Ca	0,41	0,15	0,28	0,14	0,36	0,34	0,30	0,28	0,03
Fr	0,14	0,45	0,03	0,03	0,43	0,25	0,19	0,31	0,05
It	-0,09	-0,22	0,01	0,05	-0,21	-0,05	-0,03	-0,15	0,02
Jp	0,17	0,17	0,17	0,16	0,16	0,17	0,17	0,19	0,11
Nl	0,08	0,23	0,45	0,16	-0,38	0,03	0,20	0,53	0,02
Sw	-0,20	-0,21	-0,13	0,01	0,01	-0,20	-0,13	-0,12	0,01
UK	0,07	0,07	0,05	0,06	0,38	0,07	0,07	0,06	0,09
US	0,33	0,34	0,15	0,31	0,51	0,34	0,33	0,17	0,42
Ge	0,15	0,10	0,03	-0,06	0,04	0,03	-0,02	-0,16	0,04
Rest	-0,07	-0,07	-0,05	0,14	-0,30	0,04	-0,07	-0,10	0,22

[29] This dataset include series for total employment, number of production or nonsupervisory workers, average hourly earnings, average weekly hours, average weekly earnings, and average weekly overtime hours in manufacturing industries.

Table B2. Relative importance of hedging portfolio

Panel a: USA National Portfolio

	HEDGE/MS		(LABOR HEDGE)/MS		(INFL HEDGE)/MS		
	all coeffs	sign. coeffs	all coeffs	sign. coeffs	all coeffs	sign. coeffs	market share
Ca	12,38	12,38	7,06	7,06	5,32	5,32	0,03
Fr	8,83	8,83	-2,63	-2,63	11,46	11,46	0,05
It	-10,05	-10,05	2,36	2,36	-12,41	-12,41	0,02
Jp	1,54	1,54	0,55	0,55	0,98	0,98	0,11
Nl	37,24	38,20	-0,96	0,00	38,20	38,20	0,02
Sw	-17,15	-16,72	-16,72	-16,72	-0,44	0,00	0,01
UK	-2,53	0,00	-0,79	0,00	-1,74	0,00	0,09
US	-0,76	-0,42	-0,42	-0,42	-0,34	0,00	0,42
Ge	-7,63	-7,63	5,70	5,70	-13,32	-13,32	0,04
Rest	-1,64	-1,64	-0,24	-0,24	-1,40	-1,40	0,22

Table B3. Relative importance of hedging portfolio (LABOR HEDGE/MS)

a) USA (all coeffs)

	trade	util	transp	other	manufact	fin	leisure	nation	market share
Ca	**11,26**	3,58	9,55	**-2,18**	9,29	8,11	6,74	7,06	0,03
Fr	-8,55	-5,78	-11,22	**-11,46**	**-1,30**	-5,54	-7,04	-2,63	0,05
It	6,65	4,02	12,40	**14,43**	**-4,43**	8,69	9,72	2,36	0,02
Jp	0,07	**-0,61**	**0,65**	-0,53	0,05	-0,24	-0,38	0,55	0,11
Nl	-33,69	-24,54	-11,35	-27,89	**-65,09**	-37,55	-26,04	**-0,96**	0,02
Sw	-24,04	**-24,83**	-21,38	-2,95	**-2,53**	-24,61	-16,78	-16,72	0,01
UK	0,73	-0,67	**-1,28**	1,49	**4,82**	1,32	0,51	-0,79	0,09
US	-0,22	0,37	-0,40	-0,10	**0,57**	-0,20	-0,24	**-0,42**	0,42
Ge	**17,91**	15,75	13,68	10,06	13,97	13,29	11,59	**5,70**	0,04
Rest	-0,11	0,78	-0,36	**1,27**	**-1,41**	0,62	0,46	-0,24	0,22

b) USA (sign.coeffs)

	trade	util	transp	other	manufact	fin	leisure	nation	market share
Ca	11,26	0,00	9,55	0,00	9,29	8,11	6,74	7,06	0,03
Fr	-8,55	0,00	-11,22	-11,46	0,00	-5,54	-7,04	-2,63	0,05
It	6,65	0,00	12,40	14,43	0,00	8,69	9,72	2,36	0,02
Jp	0,00	0,00	0,65	0,00	0,00	0,00	0,00	0,55	0,11
Nl	-33,69	-24,54	0,00	-27,89	-65,09	-37,55	-26,04	0,00	0,02
Sw	-24,04	-24,83	-21,38	0,00	0,00	-24,61	-16,78	-16,72	0,01
UK	0,00	0,00	0,00	0,00	4,82	0,00	0,00	0,00	0,09
US	0,00	0,00	-0,40	0,00	0,57	0,00	0,00	-0,42	0,42
Ge	17,91	15,75	13,68	10,06	13,97	13,29	11,59	5,70	0,04
Rest	0,00	0,00	0,00	1,27	-1,41	0,62	0,00	-0,24	0,22

Notes: we report in (a) the ratio of *total hedging portfolio weights* including both wage and employment risk (HEDGE_we) over *total hedging portfolio weights* including only wage risk (HEDGE_w). In (b) we report the ratio of *labor hedging portfolio weights* including both wage and employment risk (LABOR HEDGE_we) over *labor hedging portfolio weights* including only wage risk (LABOR HEDGE_w). "-" denotes a ratio where the numerator is different from zero and the denominator is equal to zero; "na" denotes a ratio where both the numerator and the denominator are equal to zero.

We find that accounting for the possibility of hedging employment risk significantly increases the relative weight of the hedging portfolio on the market share: in fact, as reported in Table B4 (a), the ratio between the hedge portfolio with employment risk and the hedge portfolio without employment risk, is always larger than 1. However, when looking at the relative labor income hedging portfolios is not necessary larger for the case with employ-

Table B4. Relative hedging portfolios*

	HEDGE_we / HEDGE_w (a)		LABOR HEDGE_we / LABOR HEDGE_w (b)	
	all coeffs	sign. coeffs	all coeffs	sign. coeffs
Ca	2,75	2,33	-8,58	-
Fr	4,46	4,46	0,28	0,28
It	18,03	18,03	0,20	0,20
Jp	3,47	1,56	-1,03	-
Nl	4,05	4,15	0,03	0,00
Sw	3,25	-	3,45	-
UK	3,22	na	-0,83	na
US	2,75	-	-6,78	-
Ge	2,42	2,42	0,56	0,56
Rest	5,39	5,39	-0,22	-0,22

ment[30]: the reason is that, although the inflation hedging portfolio is the same, if the signs of the two components (labor and inflation) are opposite they cancel out each other resulting in a lower total hedging weight. Accordingly, even when the labor hedging weight without employment is relatively larger than the corresponding weight with employment we end up with a higher weight of the total hedging portfolio.

Here we have just started looking at the effect of taking into account employment risk in equity portfolio diversification strategies: we find that the optimal portfolios significantly differ from the value weighted portfolios and that there is heterogeneity across investing industries. We find that employment risk hedging component has the effect of magnifying the weight of the total hedging portfolio on the market share and so emphasizing the economic relevance of hedging background risk in optimal portfolio decisions. Further investigation is needed to assess the role of employment risk hedging in the degree of heterogeneity in industry optimal equity portfolios: if the differences in the comovement of employment across investing industries is lower (higher) than for wages than we should observe an higher (lower) heterogeneity in portfolio allocations.

[30]Notice that the "-" symbol indicates that the labor hedging portfolio weight with employment is different from zero while the labor hedging portfolio weight is equal to 0.

C Industry vs Country diversification strategies

C.1 Introduction

Many contributions in financial literature focused on the correlation structure of international stock market indexes finding a conflicting evidence on the importance of country and sector factors in the cross sectional variation of stock returns. Heston and Rouwenhorst (1994), Griffin and Karolyi (1998) and Rouwenhorst (1999) show that the industrial factors play a minor role in the variation of stock market returns while more recently Baca, Garve and Weiss(2000), Cavaglia, Brightman and Aked (2000) and L'Her, Ouman and Tnani (2002), Carrieri, Errunza and Sarkissian (2003) underline the increasing relative importance of the industry on the country effect.

The ambiguity on the relative importance of industry versus country factors is reflected directly in efficient portfolio strategies derived in a mean-variance framework where the correlation structure among financial assets crucially determines the optimal solution.

Our objective is evaluating the diversification benefits of strategies based on country and on industry stock market indices, when background risks (labour income and inflation) are explicitly taken into account (while existing literature on whether the source of gains from international diversification arise from industrial or country effects looks implicitly at mean variance efficient portfolios)

In order to attain this objective we repeat the analysis conducted in the paper for the case in which the investor sectors in the same country (US) optimally diversifies across different destination world industries.

We derive optimal equity portfolios suitable to hedge risk at both aggregate and industrial level for the same country. Then we compare the degree of dispersion of optimal portfolios across industries in different countries to have a first insight about the way the conclusion on the relative benefits from country and industry diversification may change when heterogeneity in investor's specific risks is taken into account.

C.2 Data

In this section to derive the three components of the optimal equity portfolios we need for each country the stock market capitalization, stock returns and information on the country inflation, labour earnings.

We derive results for one investing country (US) for which monthly data on wages are those used in the paper and ten destination world industries (Basic, Consumer Goods, Consumer Services, Financial, Health, Industrial, Oil, Technologies, Telecommunications, Utilities)[31]. Portfolios are computed at end-2004 using a monthly dataset on equity returns with span ranging from January 1996 to December 2004. Monthly observations of annual total returns[32] on equities are computed on the Datastream Indices for the ten industries considered.

C.3 Optimal portfolio weights

[31] As pointed out by Griffin and Karolyi (1998), grouping industries in broad classes may provide little cross sectional variation in returns and consequently induce biased results against the finding of any industry effects. Then, by keeping this broad classification we provide a lower bound for the impact of the industry effect on the optimality of portfolio strategies and at the same time we keep the computational burden within reasonable limits.

[32] All returns are computed in US dollars.

Table C1. USA Optimal equity portfolios

a) USA (all coeffs)

	trade	util	transp	other	manufact	fin	leisure	nation	market share
basic	0,02	0,08	-0,28	-0,01	-0,02	-0,04	-0,18	-0,05	0,06
cgds	-0,14	-0,24	-0,02	0,04	-0,14	0,00	0,08	-0,03	0,04
csvs	0,14	0,38	0,08	0,13	0,40	0,24	0,11	0,09	0,13
fin	0,38	0,27	0,34	0,19	0,05	0,15	0,38	0,29	0,25
health	0,07	0,17	0,08	0,15	0,06	0,04	-0,10	0,10	0,15
ind	0,37	0,21	0,48	0,16	0,07	0,25	0,45	0,36	0,08
oil	0,03	-0,06	0,15	0,16	0,28	0,12	0,01	0,09	0,09
tec	0,05	0,20	-0,06	0,07	0,17	0,05	0,03	0,03	0,09
tel	-0,01	-0,23	0,15	0,06	-0,05	0,02	0,01	0,07	0,06
util	0,10	0,21	0,08	0,05	0,20	0,17	0,22	0,07	0,04

b) USA (sign. Coeffs)

	trade	util	transp	other	manufact	fin	leisure	nation	market share
basic	0,07	0,16	-0,22	0,06	0,58	0,07	0,07	0,07	0,06
cgds	-0,16	-0,64	-0,02	0,04	-1,31	0,00	0,08	-0,03	0,04
csvs	0,16	0,35	0,10	0,13	1,23	0,14	0,15	0,14	0,13
fin	0,45	0,73	0,28	0,18	-3,41	0,16	0,40	0,31	0,25
health	0,09	0,46	0,07	0,15	0,54	0,04	-0,11	0,10	0,15
ind	0,44	0,58	0,57	0,16	0,62	0,27	0,47	0,39	0,08
oil	-0,28	-0,87	0,07	0,09	0,84	0,10	-0,30	-0,19	0,09
tec	0,11	0,80	0,07	0,09	0,88	0,10	0,11	0,10	0,09
tel	0,08	-0,68	0,05	0,06	0,61	0,07	0,08	0,07	0,06
util	0,05	0,12	0,03	0,04	0,41	0,05	0,05	0,05	0,04

Table C1 reports optimal portfolios at national and industry level when the strategy is industry-based. We find that, focusing on panel b), where only significant coefficients are considered, the national portfolio is different with respect to the value weighted portfolio although the difference is less remarkable than in the case of country-based diversification strategy. However, when comparing the industry portfolios we find a large heterogeneity comparable to the country-diversification case.

Table C2.Relative importance of hedging portfolio

US National Portfolio							
	HEDGE/MS		(LABOR HEDGE)/MS		(INFL HEDGE)/MS		
	all coeffs	sign. coeffs	all coeffs	sign. coeffs	all coeffs	sign. coeffs	market share
basic	-3,54	0,00	*-2,99*	*0,00*	-0,55	0,00	0,06
cgds	-1,48	-1,48	*8,84*	*8,84*	-10,32	-10,32	0,04
csvs	-1,69	0,00	*-2,17*	*0,00*	0,48	0,00	0,13
fin	0,18	0,18	*5,78*	*5,78*	-5,59	-5,59	0,25
health	-2,74	-2,74	*-32,97*	*-32,97*	30,22	30,22	0,15
ind	24,60	24,60	*-35,41*	*-35,41*	60,01	60,01	0,08
oil	-0,01	-3,02	*-3,02*	*-3,02*	3,01	0,00	0,09
tec	-0,16	0,00	*0,06*	*0,00*	-0,21	0,00	0,09
tel	-0,02	0,00	*-0,64*	*0,00*	0,62	0,00	0,06
util	0,10	0,00	*0,08*	*0,00*	0,02	0,00	0,04

In Table C2 we report the relative importance of the hedging portfolio for the national US optimal allocation in global industries: we observe a larger number of zeros than in the country-based approach but the weight seems larger when different from zero.

Table C3. Relative importance of labor hedging portfolio (LABOR HEDGE/MS)

USA (all. coeffs)

	trade	**util**	**transp**	**other**	**manufact**	**fin**	**leisure**	**nation**	**market share**
basic	-0,97	**1,33**	**-11,35**	-1,68	-2,14	-2,87	-6,76	*-2,99*	0,06
cgds	6,55	**4,32**	9,03	10,42	6,48	9,44	**11,00**	*8,84*	0,04
csvs	-0,42	9,76	**-2,20**	-0,62	**10,18**	4,11	-1,59	*-2,17*	0,13
fin	**6,58**	5,69	6,54	4,97	**3,69**	4,62	6,39	*5,78*	0,25
health	-34,16	**-29,19**	-33,37	-30,09	-34,90	-35,70	**-42,53**	*-32,97*	0,15
ind	-34,57	-47,63	**-20,83**	-52,27	**-61,14**	-44,15	-30,88	*-35,41*	0,08
oil	-3,64	**-4,69**	-2,17	-2,21	**-0,89**	-2,61	-3,96	*-3,02*	0,09
tec	0,10	0,48	-0,16	0,16	0,38	0,11	0,07	*0,06*	0,09
tel	-2,81	**-8,82**	**2,17**	-0,80	-3,85	-1,91	-2,28	*-0,64*	0,06
util	0,20	**0,73**	0,19	**0,01**	0,66	0,57	0,67	*0,08*	0,04

USA (sign. coeffs)

	trade	**util**	**transp**	**other**	**manufact**	**fin**	**leisure**	**nation**	**market share**
basic	0,00	0,00	-11,35	0,00	0,00	0,00	0,00	*0,00*	0,06
cgds	6,55	4,32	9,03	10,42	6,48	9,44	11,00	*8,84*	0,04
csvs	0,00	0,00	0,00	0,00	0,00	0,00	0,00	*0,00*	0,13
fin	6,58	5,69	6,54	4,97	0,00	4,62	6,39	*5,78*	0,25
health	-34,16	-29,19	-33,37	-30,09	-34,90	-35,70	-42,53	*-32,97*	0,15
ind	-34,57	-47,63	0,00	-52,27	-61,14	-44,15	-30,88	*-35,41*	0,08
oil	-3,64	-4,69	0,00	0,00	0,00	0,00	-3,96	*-3,02*	0,09
tec	0,00	0,48	0,00	0,00	0,00	0,00	0,00	*0,00*	0,09
tel	0,00	-8,82	0,00	0,00	0,00	0,00	0,00	*0,00*	0,06
util	0,00	0,00	0,00	0,00	0,00	0,00	0,00	*0,00*	0,04

When looking at the heterogeneity in the relative importance of the labor hedging portfolio on the market share for different industries (Table C3) we observe a large heterogeneity comparable to the country diversification case.

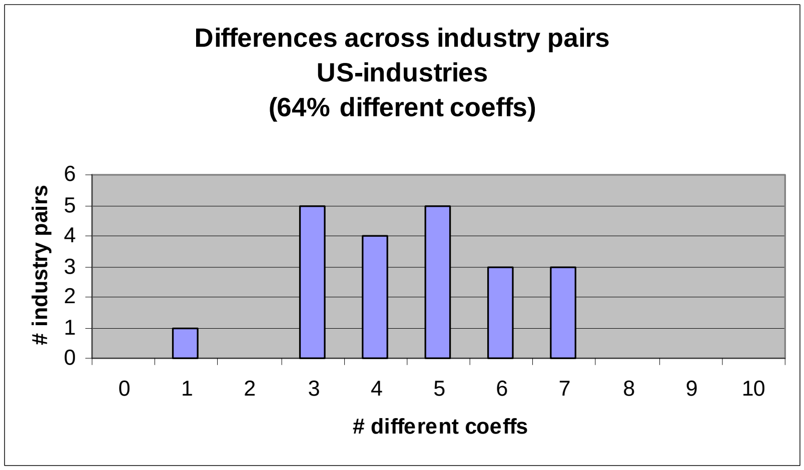
Table C4. Distance industry-national (only sign. diff.).

	trade	util	transp	other	manufact	fin	leisure	national portfolio
basic	0,00	***0,13***	***0,23***	***0,13***	0,00	0,00	***0,06***	-0,05
cgds	***0,07***	***0,21***	0,00	***0,11***	0,00	***0,11***	***0,11***	-0,03
csvs	0,00	***0,29***	0,00	0,00	***0,15***	***0,31***	0,00	0,09
fin	***0,10***	***0,02***	0,00	0,00	***0,13***	***0,24***	***0,10***	0,29
health	0,00	0,00	0,00	***0,20***	0,00	0,00	0,00	0,10
ind	***0,20***	***0,15***	0,00	0,00	***0,11***	***0,29***	0,00	0,36
oil	***0,07***	***0,15***	0,00	***0,08***	0,00	***0,19***	***0,05***	0,09
tec	***0,04***	***0,18***	***0,09***	0,00	0,00	***0,14***	0,00	0,03
tel	0,00	***0,29***	0,00	***0,06***	0,00	***0,12***	***0,08***	0,07
util	0,00	***0,14***	0,00	***0,15***	***0,10***	***0,13***	0,00	0,07

Table C5. Synthetic measures of dispersion (USA)

	all coeffs	sign. dist.
A: standard deviation around national		
-portfolios		
weighted	0,34	0,43
unweighted	0,33	0,38
-weights		
weighted	0,11	0,13
unweighted	0,10	0,12
B: average distance from national		
-weights		
weighted	0,08	0,10
unweighted	0,10	0,08

Figure C1. USA. Differences across industry-pairs



Also the distances (Table C4), the dispersion measures (Table C5) and Figure C1 support the conclusion of a similar degree of heterogeneity across investing industries regardless the diversification strategy adopted.

This result could induce thinking that the two diversification strategies are actually the same strategy seen under different perspectives (investing in the world stock market divided into countries or into global industries) and that this is the reason of the similar heterogeneity degree that we find. Actually, if background risk is not taken into account, the two investment strategies must be the same: when considering, instead, the possibility of hedging background risk then it is not the case. In order to address this issue, in the following two tables (Table C6 and Table C7), we try to make the two investing strategies somehow comparable.

In table C6 we label "direct" country investment the optimal allocations in different country stock markets when the country-based approach is adopted We label, instead, "indirect" country investment the optimal allocations in different stock markets when the industry-based approach is adopted: we derive the optimal investment in a given industry and then, looking at the share of each country within a given industry, we derive the indirect investment in each country. We repeat the same procedure for both the national portfolio and for each industry portfolio: we then consider the aggregation of all investing industries[33]. What we can immediately notice is

[33] The aggregation is made up weighting each investing industry by its relative weight within the country in terms of labor compensation.

that the "direct" portfolio differs remarkably from the "indirect" portfolio even when restricting our attention exclusively to the significant portfolio. The same holds when looking at the industry aggregation: as mentioned before, the presence of background risk is responsible of this discrepancy and the larger the discrepancy the stronger the support for the relative importance of background risk.

Tables C6. Direct-Indirect Country Investment

a) USA (all coeffs)

	National		Industry aggregation		
	Direct	Indirect	Direct	Indirect	market share
Ca	0,16	0,03	0,12	0,03	0,03
Fr	0,13	0,04	0,23	0,04	0,05
Ge	-0,08	0,03	-0,13	0,03	0,04
Jp	0,15	0,11	0,12	0,09	0,11
Us	0,30	0,44	0,33	0,47	0,42
Uk	0,02	0,08	0,08	0,09	0,09
It	0,01	0,03	-0,02	0,03	0,02
Sw	-0,05	0,02	-0,04	0,01	0,01
Nl	0,19	0,02	0,11	0,02	0,02
Rest	0,15	0,21	0,18	0,19	0,22

b) USA (sign. coeffs)

	National		Industry aggregation		
	Direct	Indirect	Direct	Indirect	market share
Ca	0,14	0,01	0,15	0,02	0,03
Fr	0,10	0,04	0,25	0,01	0,05
Ge	-0,06	0,04	-0,25	0,00	0,04
Jp	0,16	0,14	0,13	0,01	0,11
Us	0,31	0,47	0,38	0,65	0,42
Uk	0,06	0,05	0,13	0,08	0,09
It	0,01	0,02	-0,02	0,00	0,02
Sw	0,01	0,02	-0,01	0,01	0,01
Nl	0,15	0,01	0,09	0,01	0,02
Rest	0,11	0,20	0,16	0,20	0,22

Table C7. Direct-Indirect Industry Investment

a) USA (all coeffs)

	National		Industry aggregation		
	Direct	Indirect	Direct	Indirect	market share
basic	-0,05	0,10	-0,03	0,09	0,06
cgds	-0,03	0,06	-0,03	0,13	0,04
csvs	0,07	0,01	0,22	-0,04	0,13
fin	0,29	0,44	0,19	0,33	0,25
health	0,03	0,21	0,07	0,06	0,15
ind	0,09	-0,04	0,23	-0,02	0,08
oil	0,09	0,02	0,14	0,11	0,09
tec	0,36	0,20	0,07	0,23	0,09
tel	0,10	-0,05	0,01	-0,10	0,06
util	0,07	0,07	0,13	0,08	0,04

b) USA (sign. coeffs)

	National		Industry aggregation		
	Direct	Indirect	Direct	Indirect	market share
basic	0,07	0,09	0,14	0,08	0,06
cgds	-0,03	0,05	-0,23	0,15	0,04
csvs	0,07	0,01	0,31	-0,04	0,13
fin	0,31	0,46	-0,35	0,36	0,25
health	0,10	0,16	0,15	0,04	0,15
ind	-0,19	0,01	0,34	-0,02	0,08
oil	0,14	0,07	0,14	0,21	0,09
tec	0,39	0,21	0,23	0,24	0,09
tel	0,10	-0,04	0,15	-0,18	0,06
util	0,05	0,05	0,11	0,07	0,04

In Table C7 we repeat the same analysis when the "direct" investment is industry-based while the indirect is obtained from the country-based strategy by looking at how each country stock market is articulated into its domestic industries. We find again a remarkable difference between the "direct" and the "indirect" approach.

The results looking at the industry-based diversification strategy confirm what we previously found relatively to a country-based diversification strategy, i.e. the importance of background risk and the notable heterogeneity across investing industries. This conclusion is further corroborated by the evidence of discrepancy between the "direct" investment in countries (or industries) and the "indirect" investment in industries (or countries). This suggests that it is not irrelevant the strategy adopted and that the optimal strategy has to be chosen on a utility based approach: the result is therefore investor specific and it is not possible asserting the general dominance of one strategy on the other like in the case where only financial risk is considered. Our future research will be therefore devoted to investigating the comparison between country versus industry diversification benefits from hedging background risk.