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# CAN PENSION FUNDS HEDGE WAGE RISK?

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*Human capital is the present value of future wages, so it can be a large component of the total wealth of active workers. This raises the question of whether labour income risk can be hedged by how the retirement savings of workers are invested. The answer is that it cannot if correlations between labour income and financial return fluctuations are zero, or close to it. Previous research suggests this is generally the case at the total economy level, when domestic investments are used. This article presents the results of a study addressing the above question at the industry level, using a menu of foreign investment indexes. Specifically, we examine the situations of American and Canadian workers in seven different industries whose pension funds can invest in the equity markets of 10 countries, including their own. We find largely positive and negative correlations between wage and return fluctuations, which point to opportunities to hedge labour income risk at the individual industry level through the investment of industry pension funds.*

## **Previous Research on this Topic**

The idea that human capital should influence optimal portfolio composition has been around for a while (e.g., see Mayers, 1972). Empirical evidence as to whether this link exists is mixed. On one hand, some empirical studies on households' actual portfolio holdings suggest that households do hedge human capital risk (Guiso et al., 1996; Angerer and Lam, 2008). On the other hand, Cocco et al. (2005) look at how permanent and transitory shocks to individual labour income affect optimal portfolio composition in a life-cycle setting. They cannot reject that the hypothesis of zero correlation between permanent labour income shocks and stock returns. Similarly, Campbell et al. (2001) find that the correlation cannot be precisely measured in many industries. Finally, Davis and Willen (2000) confirm that the correlation between the occupation-level component of individual income fluctuations and aggregate equity returns is close to zero.<sup>1</sup>

Our assessment of hedging opportunities also relies on the correlation structure between financial asset returns and labour income when labour supply is inelastic<sup>2</sup>. Unlike previous studies, we look at human capital at the industry-level and focus on international diversification. The importance of industry-related factors in human capital is apparent from the different cyclicity of wages at aggregate and industry level (Barsky and Solon, 1991). Recent work by Eiling (2008) supports this view by confirming that human capital returns vary considerably across industries and that industry-specific human capital impacts portfolio choice and expected stock returns. By including industry-specific human capital, the risk-reward attributes of asset portfolios are substantially improved. Furthermore, the benefits of international diversification of equity portfolios have been well documented for some time (Levy and Sarnat, 1970) and persist despite increased stock market integration (De Santis and Gerard, 1997).

### How We Build Optimal Portfolios

Consider a worker in industry  $s$  in country  $l$ , who derives a fraction  $\eta$  of her wealth from human capital and  $1-\eta$  from financial wealth that she invests in  $N$  stock markets. Her optimal portfolio contains a first component called the mean-variance optimal portfolio that depends positively on stock excess return and negatively on return variance. The second component is the hedge portfolio that hedges labour income risk. This component depends on the relative share of human wealth in financial wealth and the covariance between financial returns and wage growth.

In Equation (1), the equity portfolio of investor  $sl$  is<sup>3</sup>

$$\mathbf{w}^{sl} = \mathbf{\Omega}^{-1} \left[ \frac{1/\lambda}{(1-\eta)} (\boldsymbol{\mu} - r\mathbf{i}) - \frac{\eta}{(1-\eta)} \boldsymbol{\kappa}^{sl} \right] \quad (1)$$

where  $\boldsymbol{\mu} - r\mathbf{i}$  is a  $N$ -vector of real expected excess returns,  $\mathbf{\Omega}$  is a  $(N \times N)$  matrix of variances-covariances  $\sigma_{jk}$  of real rates of return on equity indexes, and  $\boldsymbol{\kappa}^{sl}$  is a  $N$ -vector of co-variances  $\sigma_{jk}^{sl}$  between real equity return  $j$  and  $sl$  real labour income growth. The mean-variance portfolio only depends upon the joint distribution of equity returns. The weighting invested in the  $j$ -th stock index increases in  $j$ -th excess return and falls in its contribution to overall risk. The second term is industry-country specific. We assume that investors working in the same industry and country receive the same labour income.

Consequently, they share the same hedging portfolio against this type of risk. The hedging demand in the  $j$ -th stock index is positive if the correlation between wage risk in industry  $s$  in country  $l$  and the  $j$ -th nominal return is negative.

The implication here is that as the negative correlation between financial returns and labour income growth increases, so does the appeal of the asset, since a negative co-movement implies that low human capital returns are compensated with high financial returns. The optimal portfolio coincides with the mean-variance portfolio when investors' specific background risks are neglected. In the equilibrium case, this portfolio will also be equal to the market share of each equity market.

### **Two Countries, Seven Industries and Ten Equity Markets**

We examine two investing countries, the US and Canada, for which monthly data on industry level wages are available. The Current Employment Statistics (US) and the Survey of Employment, Payrolls and Hours (Canada) allow us to consider seven industries: Financials, Leisure, Manufacturing, Trade, Transports and Communications, Utilities and Other Services. We use the real rate of growth per capita labour income to measure real returns to human capital following Jagannathan and Wang (1996)<sup>4</sup>. We then focus on the part of labour income risk that is mirrored in the wage volatility of the employed, overlooking the risk of becoming unemployed. Our sample runs from 1997 to 2004<sup>5</sup>. From this, we derive 84 overlapping annual observations for the corresponding growth rates prevailing from 1998 to 2004. We then have enough information to estimate the relationship of wage growth with financial returns in a consistent manner<sup>6</sup>.

Datastream provides annual stock market capitalization and total returns on Equity Indexes for ten stock markets: Canada, France, Germany, Italy, Japan, Netherlands, Sweden, UK, US and the Rest of the World. Our research assumes that investors hedge exchange rate risk (e.g., all variables are expressed in local currency). Table 1 displays the correlation between industry and national wage growth for both countries. Hedging labour income at the industry level is worthwhile if growth differs across industries. If wages in various industries were driven exclusively by country-specific factors, then these would all move together perfectly, making any industry-specific diversification redundant. Table 1 reveals considerable differences across industries<sup>7</sup>. In Canada, the range of correlation goes from 0.3 for the Utilities sector to 0.8 for Manufacturing. In the US, the correlation ranges from 0.3 in Manufacturing to 0.9 in the Leisure industry<sup>8</sup>.

## Estimating Hedging Demand

Hedging demand is calculated by estimating the following relationship:

$$x_t^{sl} = q_0^{sl} + \sum_{j=1}^J q_j^{sl} R_j^t + v_t^{sl} \quad (2)$$

In Equation (2)  $x_t^{sl}$  is the growth rate of wages in industry  $s$ -country  $l$ , and  $R_j$  is the return on asset  $j$ <sup>9</sup>. The regression coefficient  $q_j^{sl}$  captures the ability of asset  $j$  in hedging human capital risk in industry  $s$ -country  $l$ . We will test the null hypothesis of zero hedging coefficient as in Cooper and Kaplanis (1994) and, if rejected, we will multiply  $q_j^{sl}$  by  $-\eta/(1-\eta)$  to obtain the labour income hedging demand. We are then able to derive hedging demands for each destination stock market by a worker in each industry of both countries. We similarly compute the national restricted hedging demand, considering the covariance of asset returns with the average country wage growth (e.g., by using  $x_t^l$  as dependent variable in Equation (2)). Finally, the national unrestricted demand is obtained as the weighted average of industry-specific demands. The weight attached to each industry in the aggregation corresponds to the relative labour compensation (e.g., the fraction of labour income accruing to workers in each industry).

To check if there is scope for tailoring portfolio strategies at the industry level, we assess the statistical significance of the distances between the hedging demands across diverse industries. To this end, we implement a Wald test on the differences between industry hedging demands and the national restricted hedging demand. The absence of statistically significant differences would imply equal hedging demands for all industries, rejecting the theory that occupational pension funds play a role in hedging industry-specific sources of risk.

## Hedging Demand Estimates for Canada

Table 2 illustrates the hedging demands for Canadian workers when the opportunity set comprises ten national stock indexes. To understand the results, focus on the hedging demands for the representative Canadian worker (e.g., the national restricted weightings column). These hedging demands are non-zero for five equity indexes out of ten. Similarly at the individual industry level, half

of the equity indexes are not required for hedging purposes in each case. It is interesting to note how the demands differ among industries. For example, Canadian trade industry workers invest in six stock indexes for hedging purposes, while leisure industry workers invest in five. Two of these markets are different from those required by the trade industry workers.

The national unrestricted weightings represent the aggregation of all these industry portfolio tilts. It reveals that all ten equity indexes, not just five, help in diversifying away labour income risk at the industry level. Some national restricted hedging demands are zero because wage shocks in certain industries are offset by shocks in other industries. The national unrestricted column indicates negative hedging demands by Canadian workers for five international equity indexes and positive hedging demand for the other five including Canadian equities<sup>10</sup>. For example, Italian stocks play a major role in smoothing wage-growth shocks in Canadian industries, resulting in a substantial overweighting of 16 per cent for this equity index relative to its mean-variance portfolio weight in the last column (2.5 per cent). On the contrary, Swedish (-11 per cent) and Dutch shares (-16 per cent) are underweighted by Canadian industries given their relatively high covariance with industry wage growth.

The size of the hedging demands by some industries for some equity markets is large compared with the mean variance portfolio shares in the last columns. For example, Table 2 indicates that the representative Canadian utilities worker should have a 20 per cent weighting in German equities, which is approximately six times the mean-variance optimal weight of 3.5 per cent. We speculate that these very large positions would be scaled down if we computed equilibrium-consistent portfolio allocations, such as those obtained through the Black and Litterman (1992) methodology. These results suggest that these workers may improve the risk return trade-off of their total wealth by tailoring international portfolios to their labour income risk.

### **Hedging Demand Estimates for the US**

Table 3 displays the findings for US workers. Once again, the national unrestricted column reveals that industry workers need nine stock indexes out of ten for hedging purposes, where the representative US worker would use only five of these. This indicates again that support for portfolio strategies that hedge labour income risk is stronger when industry shocks are taken into account. Optimal equity weightings display some similarities across different industries. For example, workers in each industry have negative hedging demands for US stocks. As a result, the aggregation of industry demands is negative

(-16 per cent), in line with Baxter and Jermann (1997) findings and close to the national restricted one (-18 per cent). Similarly, all industries are neutral vis-à-vis UK stocks for hedging purposes due to the very low correlation of UK stock returns with US wage growth. Finally, Canadian shares have positive hedging demands by five US industry workers and zero in the remaining two. As a result, Canadian stocks, together with Italian and French stocks, provide the best hedges against US industries' labour income shocks while Swedish and US equities should be underweighted.

As a final observation in this section, we note that implementing these hedging strategies will require several robustness checks. For example, we would like to assess the stability of the correlation estimates over time. This is not possible in the current two-country multi-industry analysis due to the limited length of our series, but would be manageable in a one-country setting<sup>11</sup>. This more acute focus would also ease the tracing of economic connections between country structure and hedging demands, since the economic interpretation of the correlation between stock returns and industry wage growth rests on the industrial and institutional structure of an economy<sup>12</sup>.

### **A Benchmark: Hedging Labour Income Risk with Domestic Equities Only**

We have previously noted that Campbell et al. (2001) and Davis and Willen (2000) have focused on the correlation between individual labour income risk and domestic equity returns, finding that it is nearly zero. In a similar vein, this final section of the article asks if and how a representative industry worker would hedge industry-specific income risk using the domestic equity index only. Table 4 displays the industry hedging demands when the investment opportunity set is restricted to the Canadian and US domestic markets. As in previous examples, we only report demands derived from statistically significant coefficients and set the others equal to zero. Two industries in Canada and five in the US display non-zero hedging demands.

The national restricted column of Table 4 reveals that the representative Canadian worker does not use domestic equities for hedging wage risk, while the representative US worker has a negative demand for US equities. The correlation between domestic wage growth and domestic financial assets is the reason that US investors cut their position in domestic assets by four percentage points (i.e., from a 42 per cent weighting to a 38 per cent weighting). At the industry level, the two Canadian non-zero tilts are in the financial (-3.5 per cent) and the transportation industries (seven per cent). Note that the weighting of Canada in the mean-variance optimal portfolio is three per cent. In the US, the number of



non-zero hedging tilts is higher, ranging from -8 per cent in the Trade industry to six per cent in the Transportation industry. These tilts are relatively small compared to the 42 per cent weighting of US equities in the mean-variance portfolio.

Workers in the transportation industries of both countries have a positive hedging demand for domestic assets. This may be surprising, as transport services are not tradable and wages are likely to be influenced by domestic economic conditions. The transportation industries contribute marginally to fluctuations in domestic equity markets because of their relatively small size. This is reflected in the low correlations of transport industry wage growth with the national wage growth displayed in Table 1. Transportation workers buy more domestic equities for diversification purposes than workers in larger industries, who are more exposed to fluctuations in aggregate economic activity.

Comparing the national unrestricted with the restricted hedging demands in Table 4 reveals that the differences are modest. This confirms that considering industry-specific wage risk does not change the fact that hedging wage risk with the domestic equity index has little importance because total demand is close to that suggested by the mean variance portfolio. Similarly, by comparing Table 4 to Tables 2 and 3, we observe that hedging demands in domestic assets differ more frequently from zero when the opportunity set is open to international equities. This implies a more precise estimation of the correlation between domestic returns and wage growth. It then suggests that limiting the opportunity set to domestic assets reduces the hedging role of domestic assets as well and supports the notion that international diversification is crucial in diversifying away human capital risk.

### **Labor income insurance mechanisms**

Through this article, we have examined the consideration of human capital in an international equity diversification context at the industry level. We found that correlations between labour income growth and financial returns are generally non-zero, indicating that hedging human capital risk through portfolio choice is feasible. In contrast, we have confirmed that restricting the asset menu to domestic equities only blocks considerable diversification opportunities. We have also showed that experiences can vary substantially at the industry level, pointing to the indisputable role of occupational pension funds in hedging labour income risk at industry level.

We caution that these findings may not apply to other countries with different labour market institutions, where these institutions affect wage co-movements across industries by functioning as wage-insurance mechanisms. Fugazza et al. (2008) suggest that industry-tailored portfolios are less valuable in Italy where centralized wage-setting processes are present. Such processes dampen industry-level differences in wage fluctuations. That said, international equity diversification appears to be an alternative industry-wage insurance mechanism in the decentralized wage-setting environments of the US and Canada.<sup>13</sup>

## End Notes

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<sup>1</sup> They also discover non-zero correlations between occupational-level income fluctuations and selected industry-level equity portfolios, suggesting that different components of aggregate equities may be better hedges of labour income risk.

<sup>2</sup> Fugazza et al. (2008) consider the problem in a general equilibrium setting, while here we focus on a partial equilibrium setting.

<sup>3</sup> See Fugazza et al. (2008) for details. Their model builds on the Coen (2001) extension of the Adler and Dumas (1983) model for international asset pricing, which considers investors hedging both inflation and labor income risk. Here we allow for heterogeneity in real wage growth across industries not dealing explicitly with the inflation risk component common to all industries within the same country.

<sup>4</sup> Jagannathan and Wang (1996) provide support for the conditional CAPM with human capital by approximating its returns with the growth rate in per capita income.

<sup>5</sup> In Canada these labour statistics are available since 1997 only.

<sup>6</sup> We correct for the induced serial correlations in the errors with the Newey-West method to obtain consistent standard errors.

<sup>7</sup> Fugazza et al. (2008) report correlations of nominal industry wage growth with the corresponding national wage growth. The heterogeneity across industries is much stronger for nominal wages than for real wages; it reveals that industry nominal wages incorporate inflation in different proportions, thus amplifying the heterogeneity of real wages.

<sup>8</sup> The low correlation of the Manufacturing industry wage growth with respect to the national should not be so surprising since only 16% of total labour compensation goes to Manufacturing while most is absorbed by Financial Services and Other Services.

<sup>9</sup> Contemporaneous returns are instrumented with lagged returns and estimation is performed through Generalized Method of Moments so as to address possible endogeneity of explanatory variables.

<sup>10</sup> Baxter and Jermann (1997) argue that the high correlation between returns on human capital and financial capital within a country implies a negative hedging demand in domestic assets. Bottazzi et al. (1996), on the contrary, find that accounting for human capital reduces the bias towards domestic assets. Our results of positive domestic hedging demands for Canada are in line with Bottazzi et al. (1996).

<sup>11</sup> We inserted a dummy for the 'bubble burst' years 2000-2004 in the regressions explaining wage growth, which was significantly negative. However, the correlations and heterogeneity were only marginally affected.

<sup>12</sup> The short labour income series prevented us from decomposing labour income growth into predictable and unpredictable components. This decomposition is possible when the focus is on one-industry-one country labour income growth.

<sup>13</sup> We thank Dirk Broeders and Tomas Franzén for insightful comments, without implicating them for any remaining errors. We thank the Rotman International Centre for Pension Management for funding the research on which this article is based.

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**Table 1. National and Industry Real Wages (Annual Rate of Growth)- Correlations**

The table reports, for each country, contemporaneous correlations between national and industry-specific annual rates of growth of real wages. The sample period is Jan 1998: Dec 2004. Source: for US data *Current Employment Statistics*, for Canadian data *Survey of Employment, Payrolls and Hours*. Inflation rates are drawn from IFS (*IMF*)

	trade	util	transp	other	manufact	fin	leisure
Can	0.635	0.275	0.467	0.652	0.811	0.501	0.501
US	0.816	0.384	0.384	0.731	0.318	0.855	0.897

**Table 2. International hedging demands: Canada**

This table reports the labour hedging demands in 10 equity indexes (by rows) - Canada, France, Germany, Italy, Japan, Netherlands, Sweden, United Kingdom, United States and Rest of the World - by an investor living in Canada and working in one of the seven industries (by columns). Columns 1 – 7 report the labour hedging demand at industry level. Column 8 and 9 show the labour hedging demand in the unrestricted and restricted national portfolio, respectively. The last column reports, for comparison, the mean variance portfolio, i.e. the optimal portfolio when human capital risk is disregarded. Only statistically significant coefficients (at 10% confidence level) are considered.

	trade	util	transp	other	manufact	fin	leisure	national unrestricted	national restricted	mean variance ptf
Ca	0.108	0.197	0.188	-	0.128	-	-	0.059	0.060	0.030
Fr	-	-	-	-	0.240	-	-	0.050	-	0.045
Ge	-	0.199	-	-	-	-0.127	-	-0.016	-	0.035
It	0.098	-	0.153	0.233	-	-	1.002	0.160	0.135	0.025
Jp	0.070	-	0.091	0.093	-	-	0.298	0.066	0.061	0.109
Nl	-	-	-	-0.306	-	-	-0.956	-0.156	-	0.019
Sw	-0.108	-0.154	-0.156	-0.126	-0.123	0.068	-0.330	-0.106	-0.091	0.011
UK	-0.205	-	-	-	-	0.132	-	-0.015	-	0.086
Us	-0.157	-0.358	-0.215	-	-0.106	-0.084	-	-0.079	-0.087	0.423
RW	-	-	-	-	-	-	0.207	0.011	-	0.216

**Table 3. International hedging demands: United States**

This table reports the labour hedging demands in 10 equity indexes (by rows) by an investor living in the United States and working in one of the seven industries (by columns). Otherwise the table is the same as Table 2.

	trade	util	transp	other	manufact	fin	leisure	national unrestricted	national restricted	mean variance ptf
Ca	0.200	0.261	0.122	-	-	0.101	0.220	0.078	0.118	0.030
Fr	-	-	0.307	-	0.293	-	-	0.058	-	0.045
Ge	-	0.235	-0.355	-	-0.192	-	-	-0.042	-	0.035
It	-	-	-	0.178	-0.083	0.117	0.129	0.080	0.104	0.025
Jp	-	-	-	0.071	-0.059	-	-	0.008	0.051	0.109
Nl	-	-	0.321	-	-0.132	-	-	-0.010	-	0.019
Sw	-0.154	-0.374	-	-0.105	-	-0.132	-0.181	-0.105	-0.104	0.011
UK	-	-	-	-	-	-	-	-	-	0.086
Us	-0.199	-	-0.174	-0.176	-	-0.197	-0.222	-0.159	-0.184	0.423
RW	-	-0.090	-0.101	0.047	-	0.082	-	0.039	-	0.216

**Table 4. Domestic hedging demands**

The table reports the hedging demands in domestic assets for Canadian and US investors working in seven industries (Financials, Leisure, Manufacturing, Trade, Transports and Communications, Utilities, Other Services). The asset menu is restricted to domestic assets.

	<b>trade</b>	<b>util</b>	<b>transp</b>	<b>other</b>	<b>manufact</b>	<b>fin</b>	<b>leisure</b>	<b>national unrestricted</b>	<b>national restricted</b>	<b>mean variance ptf</b>
<b>Can</b>	-	-	0.070	-	-	-0.035	-	-0.001	-	0.030
<b>US</b>	-0.081	-	0.062	-0.053	-	-0.049	-0.062	-0.042	-0.044	0.423