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Industry-Specific Human Capital, Idiosyncratic Risk and the Cross-Section of Expected Stock Returns

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Human capital and stock returns

- A large fraction of investors' wealth is due to nontradable human capital
  - Heaton and Lucas (00): 48% versus 6.8% for financial assets
  - Lustig, Van Nieuwerburgh, Verdelhan (10): 90% versus 2% for stocks

- Shocks in labor income are correlated with equity returns

  e.g., Shiller (95), Campbell (96), Lustig and Van Nieuwerburgh (08)

- Human capital affects asset pricing
  - Human capital may induce a hedging demand for stocks: e.g., Mayers (72)
  - Stock market return is not a good proxy for total market return: Roll (77), Jagannathan and Wang (96)

Industry-specific human capital

- Challenge: measuring human capital returns
  - Typical approach: growth rate in *aggregate* labor income (Jagannathan and Wang, 96, Campbell, 96)

- Human capital is essentially investor-specific
  - It may depend on age, education, experience, occupation, industry, …
    e.g., Davis and Willen (00)
  - This heterogeneity may affect hedging demands for stocks and measures for aggregate human capital returns

Industry-specific human capital (ctd)

- I focus on industry-specific human capital
  - Labor economics literature: inter-industry wage differentials (e.g., Katz and Summers, 89, Neal, 95, Weinberg, 01)

- I find that hedging portfolio weights are often significantly different across industries of employment

Research question 1

How does industry-specific human capital impact the cross-section of stock returns?

- Linear asset pricing model with equity market returns and HC returns from 5 industries
  - Motivated by Mayers (72) and the literature on heterogeneous agent models with incomplete risk sharing

- Main finding:
  - Industry-specific labor income growth substantially improves the asset pricing model
    - For 25 size-BM, 100 size-beta and 100 size-idiosyncratic risk portfolios

Human capital and idiosyncratic risk

- Empirical evidence for a "premium" for Idiosyncratic Risk (IR)
  - E.g. Spiegel and Wang (05), Ang, Hodrick, Xing and Zhang (06, 09), Fu (09)

- However, true idiosyncratic risk should not be priced
  - IR measured w.r.t. market model or Fama and French (93) model
  - Not all systematic risk is captured

Research question 2

Can human capital explain the apparent premium for idiosyncratic risk?

- Main findings:
  - Stocks with higher IR tend to have higher Human Capital (HC) exposures
  - The cross-section of 100 size-IR sorted portfolios can be best explained by a model with industry-specific HC
  - The "premium" for IR depends on hedging demand due to HC
    - Can be shown in the model
    - Empirical results confirm this: industry-specific HC explains 10% to 36% of the premium for IR

Outline

1) A simple model with nontradable assets
2) Analysis of hedging portfolio weights
3) Industry-specific HC and cross-section of expected returns
4) Human capital and the premium for idiosyncratic risk

Model setup

- Standard one-period mean variance framework
- 1 risk free asset
- N + K risky assets
  - N tradable assets, excess returns $r_{tr} = R_{tr} - R_f$
  - K nontradable assets, returns R_{nt}
- Investor i has total initial wealth $W_{0,i}$ and positions in tradable assets (x_i) and in nontradable assets (q_i)
- Her portfolio optimization problem is as follows:

$$\max_{x_i} E[W_{1,i}] - \frac{1}{2}\gamma_i Var(W_{1,i})$$

$$\text{s.t.}\, W_{1,i} = W_{0,i}\left[(1+R_f) + x'_i\, r_{tr} + q_i'\, R_{nt}\right]$$

The nontradable assets model

- Investor i's optimal portfolio weights are:

$$x_i = \underbrace{\gamma_i^{-1}\Sigma_{tr}^{-1}\mu_{tr}}_{\text{Speculative demand}} - \underbrace{\Sigma_{tr}^{-1}\Sigma_{tr,nt}q_i}_{\textbf{hedging demand}}$$

- Pricing equation:

$$\mu_{tr} = \bar{\gamma}\,\Sigma_{tr,mkt} + \bar{\gamma}\,\Sigma_{tr,nt}q_{nt}$$

where

– the market portfolio (mkt) consists of tradable assets only

– q_{nt} is the aggregate value of nontradable assets divided by the total value of all tradable assets

A multi-beta specification

- The pricing equation can be written as:

$$E(r_{tr,i}) = \beta_{mkt,i}\left(E(r_{mkt}) - \bar{\gamma}\sum_{k=1}^{K} Cov(r_{mkt}, R_{nt,k})q_{nt,k}\right) + \sum_{k=1}^{K} \beta_{nt,k,i}\bar{\gamma}\, Var(R_{nt,k})q_{nt,k}$$

where $\beta_{mkt,i} \equiv \dfrac{Cov(r_{tr,i}, r_{mkt})}{Var(r_{mkt})}$ and $\beta_{nt,k,i} \equiv \dfrac{Cov(r_{tr,i}, R_{nt,k})}{Var(R_{nt,k})}$

- I will estimate this using the following cross-sectional regression:

$$E(r_{i,tr}) = c_0 + c_{mkt}\beta_{mkt,i} + \sum_{k=1}^{K} c_k \beta_{nt,k,i}$$

where I consider K = 5: human capital from 5 different industries

A typical measure of returns on human capital

- Common approach (e.g., Jagannathan and Wang, 96):
  - Assume that $L_t = (1+g)L_{t-1} + \varepsilon_t$ and a constant discount rate *r*
  - This implies: $\text{Wealth}_{HC,t} = \dfrac{\text{L}_t}{r-g}$ where L is *aggregate* labor income
  - The return on human capital are estimated as: $R_{HC,t} = \dfrac{L_{t-1} + L_{t-2}}{L_{t-2} + L_{t-3}} - 1$
- Implicit assumption: *r* and *g* are equal across industries
- Based on a one-month lag to account for the publication delay in labor data

Measuring industry-specific human capital returns

- Allow for heterogeneity in *r* and *g* across industries

- Contemporaneous rather than lagged labor income growth rates
  - Investors can observe their own labor income at the same time they observe stock returns

- Human capital returns for industry *k* are measured as:

$$R_{k,t}^{HC} = \frac{L_{k,t} + L_{k,t-1}}{L_{k,t-1} + L_{k,t-2}} - 1$$

Labor income data and summary statistics

- Monthly per worker wages from NIPA tables, Apr 59 – Dec 09
  - 5 US industries: goods producing, manufacturing, distribution, services, and government
  - Wald tests: $\overline{R}_{HC}$ and Var(R_{HC}) vary significantly across industries

- Correlations:

	r_{mkt}	$R_{HC,US}$	$R_{HC,gds}$	$R_{HC,man}$	$R_{HC,dist}$	$R_{HC,serv}$
$R_{HC,US}$	0.032					
$R_{HC,gds}$	0.025	0.394				
$R_{HC,man}$	0.053	0.826	0.305			
$R_{HC,dist}$	0.009	0.842	0.346	0.702		
$R_{HC,serv}$	0.041	0.885	0.251	0.676	0.713	
$R_{HC,gov}$	-0.027	0.266	0.074	0.057	0.082	0.038

Industry-specific HC affects portfolio choice

- Portfolio adjustments due to HC depend on *q* and corr(R_{HC} , R_{EQ})
- Hedging portfolio weights (up to *q*) for a selection of matched industry equity portfolios (in %)

	HC Constr.	HC Manuf.	HC Wholes.	HC Serv.
Construction	0.60	-0.27	0.58	0.42
Manufacturing	4.32*	-3.00	-1.73	0.21
Wholesale	0.02	-0.41	0.23	0.53
Retail	-0.58	3.83**	2.76*	1.97
.....				
Services	-1.67	-1.74*	-1.61*	-2.55**
H_0 : all weights = 0	(0.360)	(0.417)	(0.349)	(0.366)

Impact on cross-section of stock returns

- Test of the nontradable assets model with industry-specific HC:

$$E[r_i] = c_0 + c_{mkt}\beta_{mkt,i} + \sum_{k=1}^{5} c_k^{HC}\beta_{k,i}^{HC}$$

- Test assets: 25 size-BM and 100 size-beta equity portfolios
- Benchmark models:
  - Human capital CAPM with aggregate labor income growth
  - Static CAPM
  - Conditional CAPM (Jagannathan and Wang, 96) incl. yieldspread
  - Fama and French (93) three-factor model, extended with momentum (Carhart, 97) and liquidity (Pastor and Stambaugh, 03) factors

Fama-MacBeth regressions for 25 size-BM portfolios:

- Industry-specific HC is significantly priced, while aggregate labor income growth is not

Coeff.	c_o	c_{mkt}	$c_{HC,aggr}$	$c_{HC,gds}$	$c_{HC,man}$	$c_{HC,distr}$	$c_{HC,serv}$	$c_{HC,gov}$
c ($\cdot 10^2$)	1.53	-0.92	0.17					
t-value$_{FM}$	**(4.34)**	**(-2.36)**	(1.37)					
t-value$_{JW}$	**(3.38)**	**(-1.99)**	(1.18)					
$R^2_{OLS\ (GLS)}$	9.35%	12.53%						
c ($\cdot 10^2$)	1.20	-0.94		0.44	0.61	-0.68	-0.23	-0.04
t-value$_{FM}$	**(4.33)**	**(-2.50)**		**(2.66)**	**(2.79)**	**(-3.77)**	(-0.83)	(-0.42)
t-value$_{JW}$	**(2.31)**	(-1.40)		(1.55)	(1.46)	**(-1.86)**	(-0.49)	(-0.24)
$R^2_{OLS\ (GLS)}$	60.92%	24.88%						

Timing of HC returns

- The results for the HC CAPM seem to contrast Jagannathan and Wang (96)
  - They use 1-month lagged labor income growth
  - With a lag, I find that aggregate HC is significant, but the model with (lagged) industry-specific HC returns still outperforms

- Contemporaneous growth rates are the most relevant measure (e.g., Heaton and Lucas, 00)
  - Investors observe their own labor income in real time
  - Lagged growth rates may capture announcement effects of labor income data

Economic interpretation of CSR coefficients

- Focus on 100 size-beta portfolios for which [ι B] has full column rank

Coeff.	c_0	c_{mkt}	$c_{HC,gds}$	$c_{HC,man}$	$c_{HC,distr}$	$c_{HC,serv}$	$c_{HC,gov}$
c $(\cdot 10^2)$	0.73	-0.10	0.32	0.03	0.09	-0.35	0.19
t-value$_{FM}$	**(4.81)**	(-0.44)	**(4.16)**	(0.19)	(0.87)	**(-2.55)**	**(2.63)**
t-value$_{JW}$	**(3.51)**	(-0.33)	**(2.99)**	(0.14)	(0.60)	(-1.49)	**(2.09)**
$R^2_{OLS\ (GLS)}$	60.99%	11.82%					

- According to the nontradable assets model: $\hat{c}_k^{HC} = \bar{\gamma}\, Var(R_k^{HC}) q_k^{HC}$
- A risk aversion of 5 implies $q_{gds}^{HC} = 26.9$ and $q_{gov}^{HC} = 23.1$
  - Assuming insignificant coefficients are zero, aggregate *q* equals 50
  - In line with Lustig and Verdelhan (10) who estimate that 90% of total wealth is due to HC and 2% due to equity

Aggregate and orthogonalized ind. HC returns

- Separate common component from industry-specific components in HC returns
  - Orthogonalize industry-level HC returns w.r.t. aggregate HC returns

- Results for 100 size-beta portfolios:

Coeff.	c_0	c_{mkt}	$c_{HC,aggr}$	$c_{HC,gds}$	$c_{HC,man}$	$c_{HC,distr}$	$c_{HC,serv}$	$c_{HC,gov}$
c ($\cdot 10^2$)	0.71	-0.11	0.03	0.21	-0.04	0.00	-0.14	0.06
t-value$_{FM}$	**(4.78)**	(-0.48)	(0.45)	**(3.63)**	(-0.80)	(0.08)	**(-2.47)**	(0.90)
t-value$_{JW}$	**(3.59)**	(-0.37)	(0.37)	**(2.74)**	(-0.58)	(0.06)	**(-1.94)**	(0.65)
$R^2_{OLS\ (GLS)}$	61.89%	12.04%						

  - $c_{HC,aggr}$ insignificant: industry-specific components matter most
  - Results similar for 25 size-BM portfolios

Benchmark models for 100 size-beta portfolios

Coeff.	c_0	c_{mkt}	c_{prem}	c_{SMB}	c_{HML}	$R^2_{OLS(GLS)}$
Static CAPM						
c $(\cdot 10^2)$	0.67	0.01				-1.02%
t-value$_{FM}$	**(3.81)**	(0.02)				0.00%
t-value$_{JW}$	**(3.81)**	(0.02)				
Conditional CAPM						
c $(\cdot 10^2)$	0.70	-0.49	0.50			37.25%
t-value$_{FM}$	**(4.01)**	**(-1.97)**	**(3.52)**			0.19%
t-value$_{JW}$	**(2.66)**	(-1.40)	**(2.58)**			
Fama and French (93) model						
c $(\cdot 10^2)$	0.65	-0.24		0.45	0.37	63.36%
t-value$_{FM}$	**(3.77)**	(-0.72)		**(2.81)**	(1.64)	5.23%
t-value$_{JW}$	**(3.87)**	(-0.71)		**(2.75)**	**(1.73)**	

Benchmark models for 100 size-beta portfolios

Coeff.	c_0	c_{mkt}	c_{SMB}	c_{HML}	c_{MOM}	c_{LIQ}	$R^2_{OLS(GLS)}$
Fama and French (93) model + momentum							
c ($\cdot 10^2$)	0.58	0.03	0.47	0.41	0.74		64.63%
t-value$_{FM}$	**(3.12)**	(0.07)	**(3.02)**	**(1.74)**	**(1.94)**		12.16%
t-value$_{JW}$	**(2.88)**	(0.06)	**(2.83)**	(1.55)	**(1.78)**		
Fama and French (93) model + momentum + liquidity							
c ($\cdot 10^2$)	0.58	-0.07	0.46	0.37	0.98	0.40	64.76%
t-value$_{FM}$	**(3.18)**	(-0.15)	**(2.80)**	(1.59)	**(2.70)**	(0.60)	12.85%
t-value$_{JW}$	**(2.82)**	(-0.12)	**(2.40)**	(1.30)	**(2.28)**	(0.53)	

- The model with industry-specific HC compares well to these models
  - Easily outperforms static and conditional CAPM
  - Similar R^2s and pricing errors to 3-, 4- and 5-factor models
  - For 25 size-BM portfolios the latter 3 models have slightly higher R^2s

Robustness check

- The results are robust when:
  - Using quarterly returns
  - Including HC from one industry at a time
    - Hence, the outperformance is not simply due to the larger number of factors
  - Adding the yieldspread, SMB and HML, momentum and liquidity
  - Including portfolio characteristics (size, B/M ratio)
    - While the characteristics are significant, industry-specific HC remains significant as well

The idiosyncratic risk puzzle

- Various empirical papers show that expected returns are affected by stocks' idiosyncratic volatilities $\rightarrow$ a puzzle?
  - Negative premium for IR: Ang, Hodrick, Xing and Zhang (06, 09)
  - Positive premium for IR: e.g. King et al. (94), Malkiel and Xu (04), Spiegel and Wang (05), Fu (09)

- IR is measured as the residual volatility of the market model or Fama and French model
  - Can be interpreted as a test of model misspecification
  - These models do not include human capital

Idiosyncr. risk in the nontradable assets model

- Consider CAPM residual volatility:

$$\Sigma_{\varepsilon} = \Sigma_{tr} - \beta_{mkt} \sigma^2_{mkt} \beta'_{mkt}$$

- In the presence of nontradable assets, expected returns are affected by CAPM residual risk:

$$\mu_{tr} = \beta_{mkt} \mu_{mkt} + \bar{\gamma} \, \Sigma_{\varepsilon} \underbrace{\Sigma_{tr}^{-1} \Sigma_{tr,nt} q_{nt}}$$

Aggregate hedging demand

- Or, equivalently:

$$E(r_{tr,i}) = \beta_{mkt,i} E(r_{mkt}) + \bar{\gamma} \sum_{k=1}^{K} Cov(e_i, R_{nt,k}) q_{nt,k}$$

Idiosyncratic risk and expected returns

- 10 IR-sorted portfolios: averaged over size deciles, based on all CRSP stocks, idiosyncratic risk w.r.t. the market model (using EGARCH)
- Estimated alphas (%):

	CAPM alphas	FF3 alphas
Low IR	0.00	-0.16***
2	0.09	-0.11*
..		
9	0.12	-0.07
High IR	0.56**	0.50***
H-L	0.56**	0.66***

- This suggests a “premium” for IR

Idiosyncratic risk and human capital

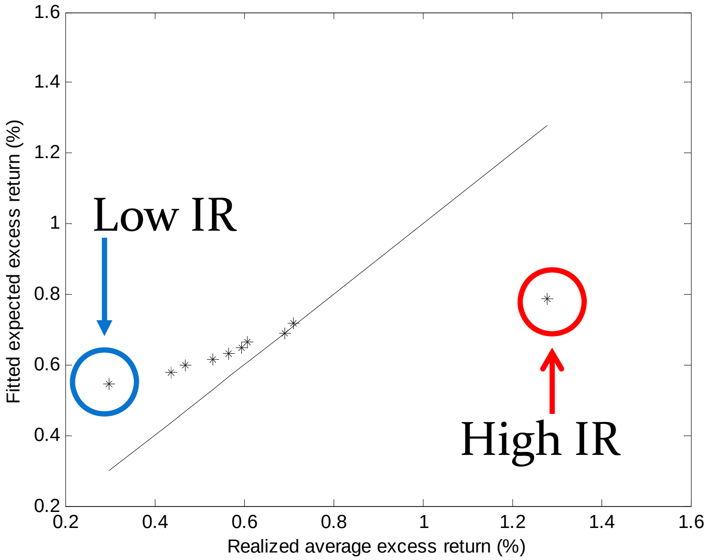
- Estimated HC betas:

	$\beta_{HC,gds}$	$\beta_{HC,man}$	$\beta_{HC,distr}$	$\beta_{HC,serv}$	$\beta_{HC,gov}$
Low IR	0.18	0.04	-0.30	0.04	-0.50
2	0.25	0.11	-0.18	0.09	-0.42
..					
9	0.60	0.62*	-0.07	0.43	0.12
High IR	0.81	1.39*	0.28	0.88	0.45
H-L	0.63	1.36**	0.58	0.85*	0.95

- High IR stocks typically have higher exposures to HC returns
- Next: explain cross-section of expected returns on IR-sorted portfolios

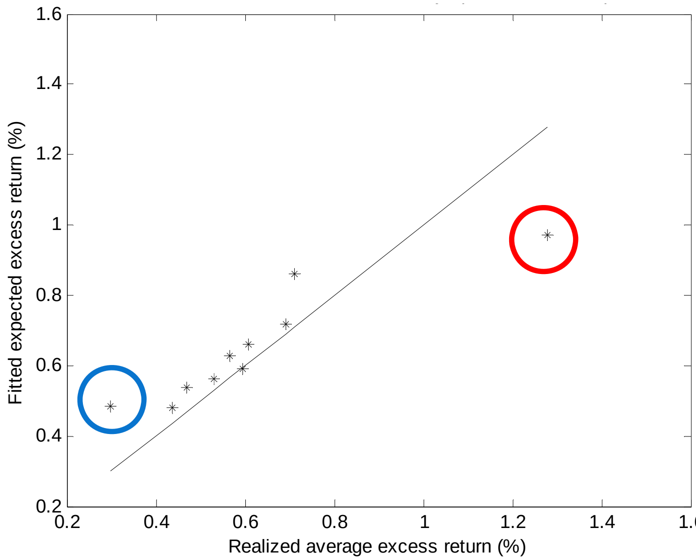
Pricing errors for 10 IR portfolios*

Static CAPM:



H-L = 0.74%

Model with industry-specific HC:



H-L = 0.50%

Industry-specific HC captures 32% of the IR premium

* CSR are run for the combined set of 10 IR and 25 size-BM portfolios

The link between HC, IR and expected returns

- For 100 size-IR portfolios, estimate:

$$E(r_i) = \delta_0 + \delta_{mkt}\beta_{mkt,i} + \sum_{k=1}^{5} \delta_{HC,k} Cov(e_i, R_{HC,k})$$

Coeff.	δ_o	δ_{mkt}	$\delta_{HC,aggr}$	$\delta_{HC,gds}$	$\delta_{HC,man}$	$\delta_{HC,distr}$	$\delta_{HC,serv}$	$\delta_{HC,gov}$
δ	-0.00	0.01	108.92					
t-value	(-1.07)	**(2.91)**	(1.34)					
$R^2_{OLS\ (GLS)}$	36.43%	6.93%						
δ	-0.00	0.01		171.46	92.05	-464.03	-103.81	90.32
t-value	**(-2.32)**	**(2.90)**		**(3.12)**	**(2.09)**	**(-5.08)**	**(-2.50)**	(1.58)
$R^2_{OLS\ (GLS)}$	59.91%	14.65%						

- The covariance between CAPM idiosyncratic returns and industry HC returns is significantly priced

Conclusion

1. Heterogeneity in human capital at the industry level affects the cross-section of expected stock returns

2. The "premium" for idiosyncratic risk is related to human capital

Thanks!

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