Industry Affiliation and the Value of Portfolio Choice

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Overview

- In the presence of persistent inter-industry wage differentials (see, e.g., Dickens and Katz (1987), Krueger and Summers (1987, 1988), Katz and Summers (1989)), the value of portfolio choice varies across otherwise identical households employed in different industries.
- If human capital is nontradable, hedging demands for stocks vary with industry affiliation because the joint distribution of labor income growth and aggregate stock returns varies across industries.
- I solve a dynamic portfolio choice model with industry-specific labor income for 72 industries at the 3-digit classification level and investigate the impact of industry affiliation on the value of portfolio choice.

- I use certainty equivalent consumption to measure this value.
- From solving the model for all industries, I obtain the cross-sectional distribution of certainty equivalent consumption across industries.
- I analyze this distribution to answer three main research questions, which have not been addressed in existing literature:
    1. Do households in higher paid industries, i.e. those with a higher level of initial average earnings, benefit more from optimal portfolio choice than households in lower paid industries?
    2. Which moments of earnings growth and comoments of earnings growth and stock returns determine the value of portfolio choice?
    3. Does cyclical variation in the risk of industry-specific earnings growth matter for the value of portfolio choice?

Motivation: Literature on industry-specific hedging demands

- Campbell, Cocco, Gomes, and Maenhout (2001) report differences in the variance of labor income shocks across 12 industries. For 3 of these industries, Cocco, Gomes, and Maenhout (2005) derive life-cycle portfolio choice implications.
- Eiling (2013) documents variation in hedging demands across households working in 5 industries, which differ in the covariance structure between earnings growth and stock returns.
- Eiling (2013) shows that the cross-section of expected stock returns is mostly affected by industry-level rather than aggregate earnings risk.

Q1: Does consumption inequality mirror earnings inequality?

- A literature in economics reviewed by Attanasio and Pistaferri (2016) investigates whether consumption inequality mirrors income inequality.
- Whether or not consumption tracks income depends on the tools available to move resources across time and states of the world.
- Dynamic portfolio choice is such a tool. Its effectiveness is limited by borrowing and short-sale constraints.
- Fagereng, Guiso, Malacrino, and Pistaferri (2016) show that the returns on wealth increase in the level of wealth.
- Unlike this literature, I investigate whether certainty equivalent consumption inequality across industries mirrors initial earnings inequality.

Q2: Which moments of earnings growth matter?

- A large empirical literature in finance estimates the impact of earnings-related risks and background risks, i.e. covariances with stocks, on observed portfolio choice at household level (with varying results):
  - Guiso, Jappelli, Terlizzese (1996), Heaton, Lucas (2000), Vissing-Jorgensen (2002), Hochguertel (2003), Massa, Simonov (2006), Angerer, Lam (2009), Betermier, Jansson, Parlour, Walden (2012), Palia, Qi, Wu (2014), Bonaparte, Korniotis, Kumar (2014), Fagereng, Guiso, Pistaferri (2018), Bagliano, Corvino, Fugazza, Nicodano (2019), Brugler, Inkmann, Rizzo (2020)
- Unlike this literature, I investigate which moments and comoments of earnings growth affect the value of portfolio choice across industries.

Q3: Does cyclical variation at industry level matter?

- Influential literature on cyclical variation in idiosyncratic earnings risk:
  - o Storesletten, Telmer, and Yaron (2004) find countercyclical variation in idiosyncratic labor income volatility. Lynch and Tan (2011) explore the portfolio choice implications.
  - o Guvenen, Ozkan, and Song (2014) document cyclical skewness in the distribution of idiosyncratic earnings shocks. Catherine (2020) and Shen (2018) analyze the portfolio choice implications.
- Unlike this literature, I investigate whether cyclical variation in earnings growth risk at the industry level (which may contribute to idiosyncratic earnings risk if not controlled for) affects the value of portfolio choice.

Main Findings

- Inequality in certainty equivalent consumption mirrors inequality in initial earnings across industries. Benhabib, Bisin, and Luo (2019): models that “focus on precautionary savings as an optimal response to stochastic earnings […] tend to produce tail indices of wealth close to the distribution of labor earnings which has been fed into the model."
- The covariance structure of earnings growth and stock returns affects the value of portfolio choice across industries. However, the impact of correlation disappears once kurtosis of earnings growth is controlled for.
- Cyclical variation in earnings growth risk at the industry level does not affect the value of portfolio choice. Kurtosis describes relevant tail risks.

Dynamic portfolio choice with consumption and labor income

- Households maximize time-0 conditionally expected power utility

$$\mathbb{E}_0\left[\sum_{t=0}^{T}\delta^t\frac{C_t^{1-\gamma}}{1-\gamma}\right]$$

- subject to intertemporal budget constraint (where $G_{t+1} = L_{t+1}/L_t$)

$$X_{t+1} = (X_t - C_t)\,R_{t+1}^p + L_{t+1}$$

$$\Leftrightarrow \frac{X_{t+1}}{L_{t+1}} = G_{t+1}^{-1}\left(\frac{X_t}{L_t} - \frac{C_t}{L_t}\right)R_{t+1}^p + 1$$

$$\Leftrightarrow x_{t+1} = G_{t+1}^{-1}\,(x_t - c_t)\,R_{t+1}^p + 1$$

$$\Leftrightarrow x_{t+1} = G_{t+1}^{-1}x_t\,(1 - q_t)\,R_{t+1}^p + 1,$$

- Bellman equation (z_t: predictor of earnings growth and asset returns)

$$V_t\left(x_t, z_t\right) = \max_{c_t, w_t}\left\{\frac{c_t^{1-\gamma}}{1-\gamma} + \delta \mathbb{E}_t\left[G_{t+1}^{1-\gamma} V_{t+1}\left(x_{t+1}, z_{t+1}\right)\right]\right\}$$

- Euler equations for consumption and portfolio choice

$$\mathbb{E}_t\left[\delta\left(G_{t+1}\frac{x_{t+1}q_{t+1}}{x_t q_t}\right)^{-\gamma} R_{t+1}^p - 1\right] = 0$$

$$\mathbb{E}_t\left[\delta\left(G_{t+1}x_{t+1}q_{t+1}\right)^{-\gamma} R_{t+1}^e\right] = 0.$$

- Set of conditional moments restrictions (for given x_t; $\beta_t = (q_t, w_t)'$)

$$\mathbb{E}_t\left[\rho\left(y_{t+1}, \beta_t^0\right)\right] = \mathbb{E}\left[\rho\left(y_{t+1}, \beta_t^0\right) \mid z_t\right] = 0$$

Estimating parameterized policy functions by GMM

- Parameterize optimal control variables, β_t^0, as a function of polynomial terms, z_t^p, in the predictive variable z_t (papers by Brandt and coauthors)

$$\begin{aligned}
\beta_t^0 &= \Lambda\left(\Theta_t^0\left(x_t\right) z_t^p\right) \\
&= \Lambda\left(\operatorname{vec}\left(\Theta_t^0\left(x_t\right) z_t^p\right)\right) \\
&= \Lambda\left(\left(z_t^p \otimes I_2\right)' \operatorname{vec}\left(\Theta_t^0\left(x_t\right)\right)\right) \\
&= \Lambda\left(\left(z_t^p \otimes I_2\right)' \theta_t^0\right),
\end{aligned}$$

- Note that we get different parameterizations for different candidate x_t.
- I propose to use cdf of the Logistic distribution, Λ, to enforce borrowing and short-sale constraints of typical households such that $0 \leq \beta_t^0 \leq 1$.

- Vector of unconditional moment functions implied by Euler equations

$$\psi\left(y_{t+1}, z_t, \theta_t\right) = \begin{pmatrix} \left(I_2 \otimes z_t^p\right) \rho\left(y_{t+1}, \beta_t\right) \\ \beta_t - \Lambda\left(\left(z_t^p \otimes I_2\right)' \theta_t\right) \end{pmatrix}$$

- This system is overidentified because the Euler equations are not necessarily zero if borrowing and short-sale constraints are binding.
- Use GMM with identity weight matrix to estimate parameters θ_t of policy functions at rebalancing time t from a sample of S observations of y_s, z_s

$$\hat{\theta}_t = \underset{\theta_t}{\operatorname{argmin}} \left(\frac{1}{S-T} \sum_{s=t+1}^{S-(T-t)} \psi\left(y_{s+1}, z_s, \theta_t\right)\right)' \left(\frac{1}{S-T} \sum_{s=t+1}^{S-(T-t)} \psi\left(y_{s+1}, z_s, \theta_t\right)\right)$$

Estimated policy functions

- Repeat for every x_t in a given grid of cash-on-hand and obtain $\Theta_t(x_t)$.
- Make this relationship explicit by regressing $\Theta_t(x_t)$ on a polynomial in x_t

$$\theta_t = \text{vec}\left(\Theta_t\left(x_t\right)\right) = \Gamma_t x_t^p + \varepsilon_t.$$

- The policy functions are now functions of all polynomial terms in cash-on-hand and the predictor variable and all possible interactions of these terms

$$\hat{\beta}_t = \Lambda\left(\left(z_t^p \otimes I_2\right)' \hat{\Gamma}_t x_t^p\right)$$

- This extends parameterization approach by Brandt and coauthors to a dynamic portfolio choice problem that is not homogeneous in wealth.

Certainty equivalent consumption

- Estimate the average value function at time 0

$$\widehat{V}_0 = \frac{1}{S-T} \sum_{s=1}^{S-T} \sum_{t=0}^{T} \delta^t \frac{\widehat{C}_{st}^{1-\gamma}}{1-\gamma}$$

- Certainty equivalent consumption (CEC) follows from solving

$$\sum_{t=0}^{T} \delta^t \frac{CEC^{1-\gamma}}{1-\gamma} = \widehat{V}_0$$

- Household is indifferent between receiving risk-free CEC or implementing the optimal choices of consumption and portfolio choice.

Data sources

- Calculate industry-specific earnings growth from Current Employment Statistics (CES) data provided by the Bureau of Labor Statistics (BLS).
- Use “average weekly earnings of production and nonsupervisory employees” in 1982-84 dollars from January 1990 – December 2019.
- Available for 72 industries at 3-digit NAICS level (84% coverage).
- Monthly return on broad value-weighted stock market index from CRSP.
- Monthly return on 30-day T-bill from CRSP. Monthly inflation from CRSP.
- Use log dividend-price ratio as predictor variable (as in Campbell and Shiller (1988), Lynch and Tan (2011), Michaelides and Zhang (2017)).
- Sample includes three NBER recessions (important for cyclical variation).

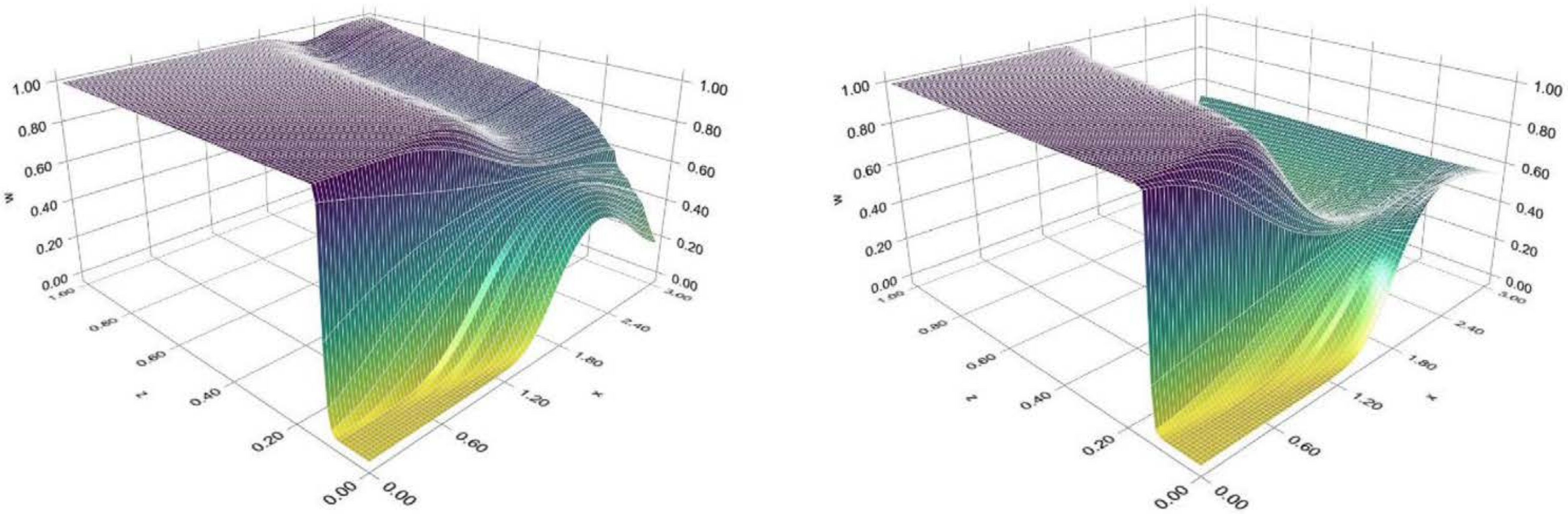
Baseline parameter choice

- Sample: $S = 360$ months. Use investment horizon of $T = 180$ months.
- Rebalancing occurs every 18 months (to save on computation time).
- Initial ratio of cash-on-hand to annual earnings: $x_0 = 1$.
- Comparative statics results for $T = 90$ and $x_0 = 2$ in the paper.
- Coefficients of risk aversion: $\gamma = 10$ or $\gamma = 5$.
- Subjective discount factor: $\delta = 0.97$.
- Third-order polynomial in cash-on-hand.
- Unconditional model ($m = 1$) and conditional models with linear ($m = 2$) and quadratic ($m = 3$) functions in the log dividend-price ratio are solved (Campbell, Chan, and Viceira (2003): policy functions are quadratic in z_t).

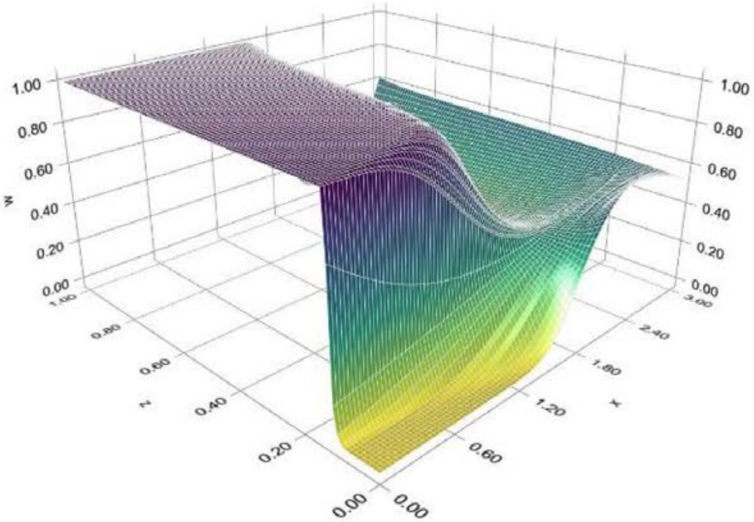
Estimated policy functions (for $m = 2$)

Figure 1: Policy functions for allocation to stocks for two selected industries and $\gamma = 10$

A. Petroleum and coal products $t = 1$ B. Securities and investments



$t = 5$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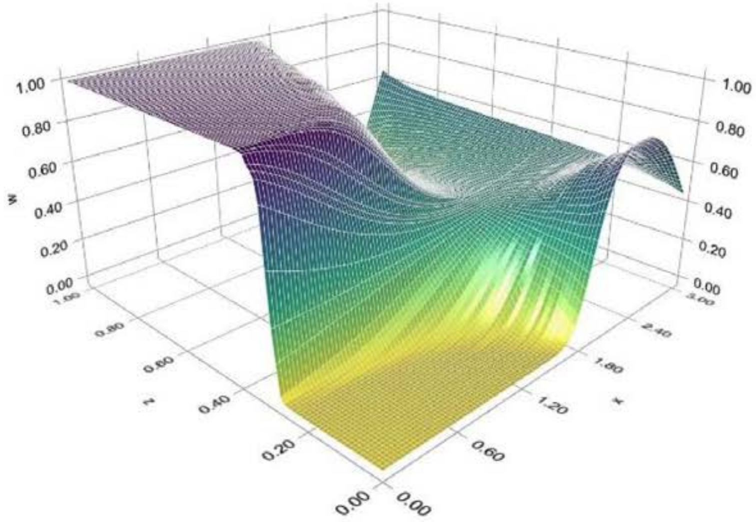
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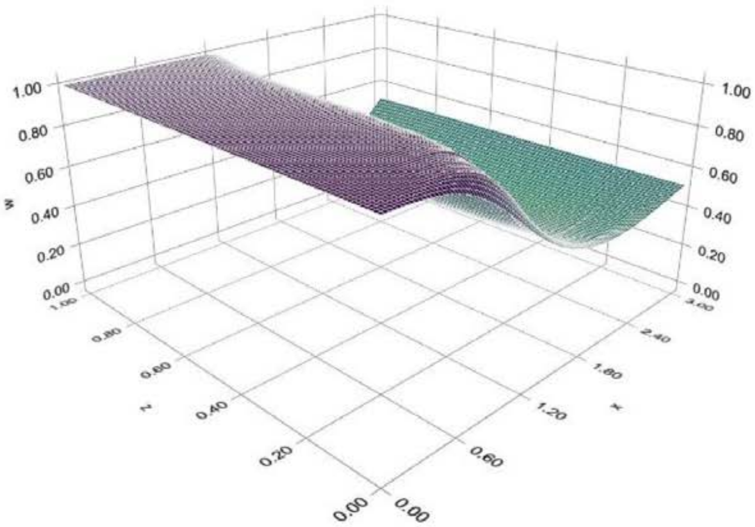
$t = 9$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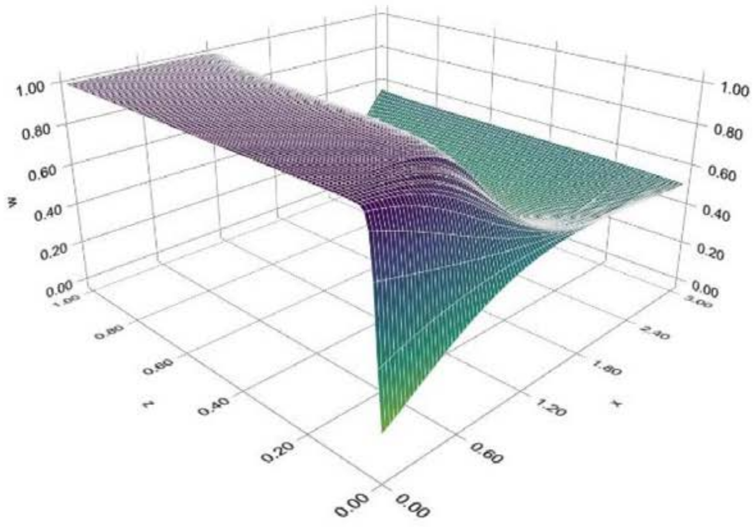
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Certainty equivalent consumption mirrors initial earnings

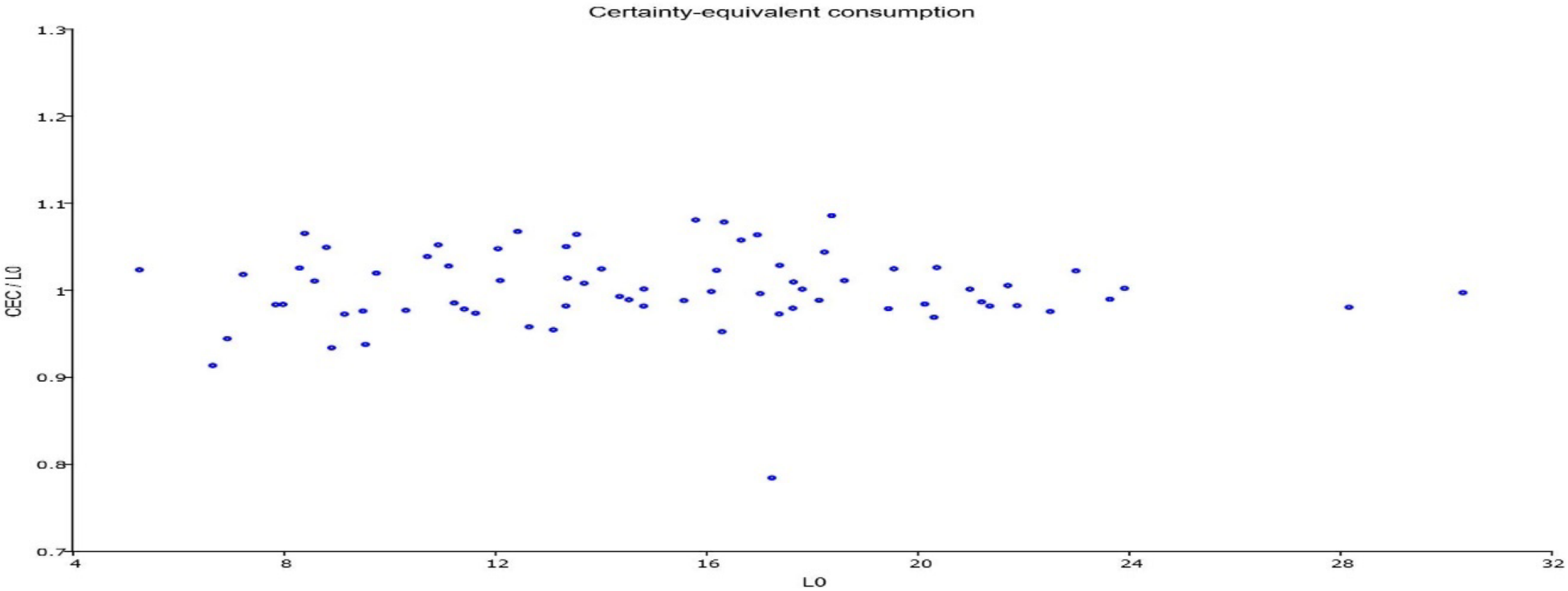
Table 4: Distribution of certainty-equivalent consumption (CEC) by risk aversion: $T = 180$ & $x_0 = 1$

		$\gamma = 10$			$\gamma = 5$		
		$m = 1$	$m = 2$	$m = 3$	$m = 1$	$m = 2$	$m = 3$
	L_0	CEC	CEC	CEC	CEC	CEC	CEC
Mean	15.08	15.08	15.10	15.10	15.37	15.41	15.40
Std. dev.	5.29	5.28	5.31	5.29	5.38	5.40	5.39
Max	30.32	30.14	30.24	30.24	30.65	30.75	30.74
Q90	21.67	21.39	21.44	21.42	21.88	21.94	21.92
Q50	14.81	14.44	14.47	14.47	14.81	14.85	14.84
Q10	8.40	8.51	8.52	8.55	8.74	8.76	8.76
Min	5.26	5.38	5.38	5.38	5.45	5.46	5.45
Q90/Q10	2.58	2.51	2.52	2.51	2.50	2.50	2.50
Q90/Q50	1.46	1.48	1.48	1.48	1.48	1.48	1.48
Q50/Q10	1.76	1.70	1.70	1.69	1.70	1.70	1.69
Gini	0.20	0.20	0.20	0.20	0.20	0.20	0.20
Mean($1[CEC(m) > CEC(m-1)]$)			0.88	0.19		0.99	0.14

Certainty equivalent consumption divided by initial earnings

Figure 5: Scaled certainty-equivalent consumption (CEC/L_0) by initial earnings (L_0) for $\gamma = 10$

A. Investment horizon $T = 180$ months and initial cash-on-hand $x_0 = X_0/L_0 = 1$



Winners and losers

- As evidenced by the Gini coefficients, inequality in certainty equivalent consumption tracks inequality in initial earnings. The industry with highest average earnings (*Petroleum and coal products*) also obtains highest CEC.
- There remains substantial variation in CEC that is unrelated to the level of initial earnings. Households in higher paid industries do not benefit more from portfolio choice than those in lower paid industries (and vice versa).
- Per unit of initial earnings, households in the *Securities and investments* industry (Wall Street) benefit most from portfolio choice. Households in the *Motion picture and sound recording* industry (Hollywood) benefit least.
- What explains this variation in scaled certainty equivalent consumption?

Table 7: Cross-sectional regressions of scaled certainty-equivalent consumption (CEC/L_0) on moments of real earnings growth for $T = 180$ and $x_0 = 1$

A. Relative risk aversion: $\gamma = 10$

	(1)		(2)		(3)	
	$N = 72$	$N = 71$	$N = 72$	$N = 71$	$N = 72$	$N = 71$
Intercept	1.0014	1.0033	1.0014	1.0033	1.0014	1.0033
	(341.5)	(433.3)	(352.0)	(455.6)	(348.2)	(451.0)
Mean	0.0416	0.0360	0.0441	0.0377	0.0442	0.0377
	(11.37)	(12.03)	(11.55)	(12.26)	(11.44)	(12.12)
Variance	-0.0402	-0.0336	-0.0395	-0.0330	-0.0400	-0.0337
	(-11.04)	(-11.11)	(-11.16)	(-11.44)	(-10.66)	(-11.11)
Skewness			-0.0043	-0.0024	-0.0042	-0.0028
			(-1.35)	(-0.96)	(-1.21)	(-1.07)
Kurtosis			-0.0077	-0.0075	-0.0081	-0.0072
			(-2.37)	(-3.01)	(-2.31)	(-2.71)
Correlation	-0.0013	-0.0043	0.0019	-0.0012	0.0010	-0.0029
	(-0.43)	(-1.80)	(0.60)	(-0.47)	(0.23)	(-0.87)
Coskewness					0.0020	0.0000
					(0.56)	(0.01)
Cokurtosis					0.0010	0.0026
					(0.22)	(0.75)
Adjusted R^2	0.690	0.718	0.709	0.745	0.702	0.740

All X variables are standardized.

B. Relative risk aversion: $\gamma = 5$

	(1)		(2)		(3)	
	$N = 72$	$N = 71$	$N = 72$	$N = 71$	$N = 72$	$N = 71$
Intercept	1.0219	1.0230	1.0219	1.0230	1.0219	1.0230
	(381.0)	(403.5)	(388.0)	(414.0)	(387.6)	(413.5)
Mean	0.0442	0.0412	0.0449	0.0414	0.0451	0.0415
	(13.22)	(12.60)	(12.71)	(12.00)	(12.72)	(12.00)
Variance	-0.0290	-0.0255	-0.0285	-0.0249	-0.0296	-0.0261
	(-8.72)	(-7.72)	(-8.69)	(-7.70)	(-8.59)	(-7.75)
Skewness			-0.0002	0.0008	-0.0002	0.0005
			(-0.08)	(0.30)	(-0.08)	(0.17)
Kurtosis			-0.0063	-0.0062	-0.0066	-0.0062
			(-2.08)	(-2.20)	(-2.07)	(-2.07)
Correlation	-0.0048	-0.0063	-0.0022	-0.0039	-0.0043	-0.0063
	(-1.75)	(-2.44)	(-0.74)	(-1.39)	(-1.10)	(-1.73)
Coskewness					0.0027	0.0016
					(0.83)	(0.54)
Cokurtosis					0.0026	0.0034
					(0.62)	(0.89)
Adjusted R^2	0.722	0.716	0.732`	0.730	0.731	0.730

All X variables are standardized.

Proposed measures of cyclical variation in earnings growth

- An industry with a (low) negative value of coskewness between earnings growth, G, and stock returns, R, is likely to exhibit high earnings growth volatility during recessions.

$$Coskewness = \frac{E[(G - E[G])^2(R - E[R])]}{\sigma^2(G)\sigma(R)}$$

- An industry with a (high) positive value of cokurtosis is likely to exhibit negative skewness in earnings growth during recessions.

$$Cokurtosis = \frac{E[(G - E[G])^3(R - E[R])]}{\sigma^3(G)\sigma(R)}$$

Conclusions

- Inequality in certainty equivalent consumption tracks earnings inequality.
- Accounting for the trivial effect that CEC increases with the level of initial earnings, there remains lots of cross-sectional heterogeneity in certainty equivalent consumption across households in different industries.
- First and second moments of industry-specific earnings growth explain much of this heterogeneity. Correlation between average earnings growth at industry level and stock returns ($\epsilon[-9\%, +9\%]$) hardly matters.
- Households in industries with an earnings growth distribution exhibiting fat tails (regardless of the business cycle), benefit less from portfolio choice.
- Implications for pension asset allocation in industry-level pension funds.