



**JACOBS LEVY EQUITY
MANAGEMENT CENTER**
FOR QUANTITATIVE FINANCIAL RESEARCH

The Common Factor in Idiosyncratic Volatility: Quantitative Asset Pricing Implications

Bryan Kelly

University of Chicago Booth School of Business

(with Bernard Herskovic, Hanno Lustig, and Stijn Van Nieuwerburgh)

Outline

1. **Common idiosyncratic volatility (CIV) facts**
2. Firm risk and household risk
3. CIV and stock returns
4. Heterogeneous agent model with common idiosyncratic volatility
5. Firm volatility in dynamic networks

Volatility Factor Structure

Facts:

1. Firm-level volatility obeys a strong factor structure
 - ▶ Both in returns and in cash-flow growth rates
 - ▶ Both total volatility and residual volatility
2. Not due to omitted factors in return/growth rate model
 - ▶ Among uncorrelated residuals (e.g. from 10 PCs), strong factor structure in *volatilities* remains intact
3. A **common idiosyncratic volatility factor (CIV)** captures much of the covariation [not market volatility]

$$\begin{aligned}r_{i,t} \text{ (or } g_{i,t}) &= \gamma_{0,i} + \gamma_i' \mathbf{F}_t + \varepsilon_{i,t} \\ \sigma^2(\varepsilon_{i,t}) &= \sigma_i^2 + \delta_t \text{CIV}_t + \nu_{i,t}\end{aligned}$$

* Return to discussion of potential mechanisms at the end

Calculations

Return volatility (year-firm panel, CRSP 1926-2010)

- ▶ “Total” volatility: Std dev of daily stock returns within calendar year
- ▶ “Idiosyncratic” volatility: Daily factor model in each calendar year

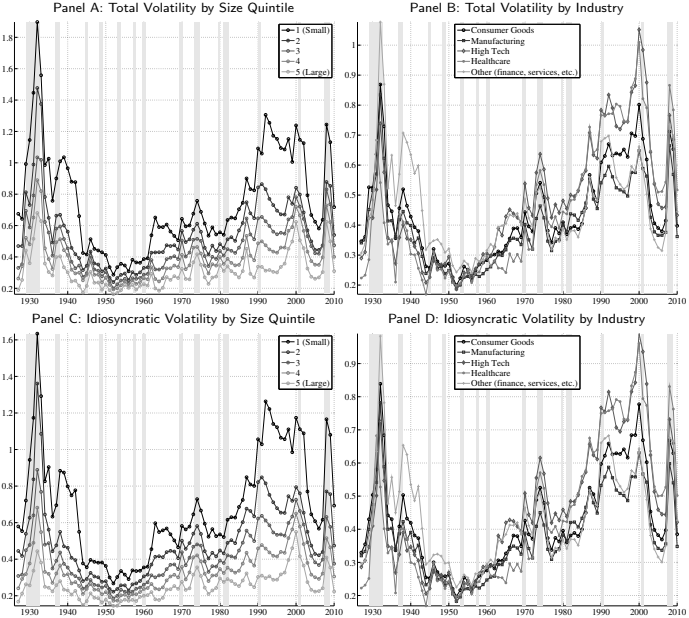
$$r_{i,t} = \gamma_{0,i} + \gamma_i' \mathbf{F}_t + \varepsilon_{i,t}$$

- ▶ \mathbf{F}_t can be mkt, FF3, 5PCs, 10PCs
- ▶ Extensions: Monthly panel, monthly returns, portfolios, etc.

Fundamental volatility (year-firm panel, CRSP/Compustat 1975-2010)

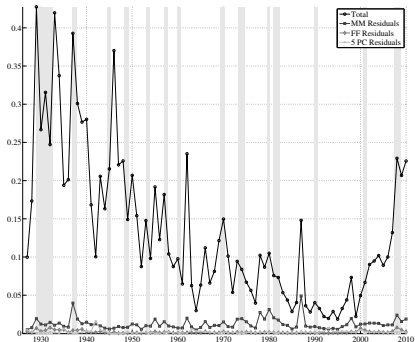
- ▶ “Total” volatility: Std dev of 20 qtrly yoy sales growth observations for calendar years $\tau - 4$ to τ
- ▶ “Idiosyncratic” volatility: Qtrly factor model in 5-year window (PCs)
- ▶ Extensions: Cash flows, estimation window, etc.

Common Factor in Total and Residual Volatility



Correlation and Volatility

Average Pairwise Correlation

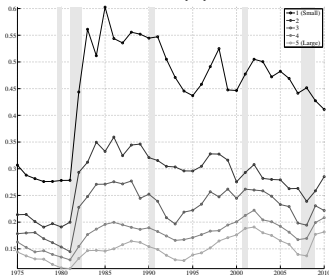


Average Volatility

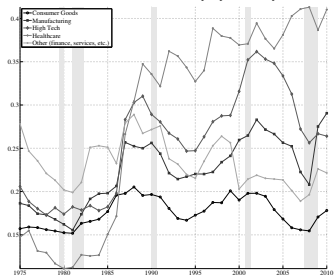


Comovement in Fundamental Volatilities

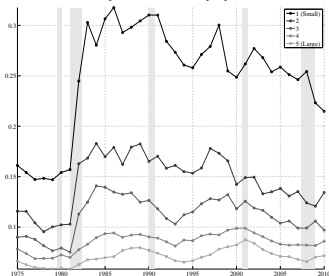
Panel A: Total Volatility by Size Quintile



Panel B: Total Volatility by Industry



Panel C: Idiosyncratic Volatility by Size Quintile



Panel D: Idiosyncratic Volatility by Industry



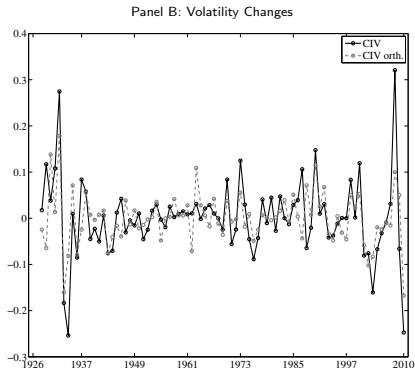
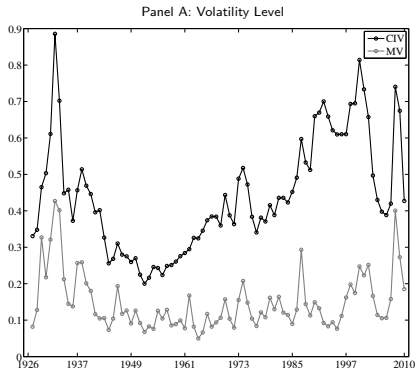
Quantifying the Factor Structure

- ▶ Panel regression of firm vol on equally-weighted average vol across firms

	Panel A: Returns			
	Total	MM	FF	5 PCs
Loading (average)	1.012	1.024	1.032	1.031
Intercept (average)	0.006	0.005	0.004	0.004
R^2 (average univariate)	0.362	0.347	0.346	0.348
R^2 (pooled)	0.345	0.337	0.339	0.347

	Panel B: Sales Growth			
	Total (5yr)	1 PC (5yr)	5 PCs (5yr)	Total (1yr)
Loading (average)	0.885	1.149	1.249	0.884
Intercept (average)	0.044	-0.018	-0.024	0.030
R2 (average univariate)	0.293	0.299	0.299	0.178
R2 (pooled)	0.303	0.315	0.304	0.168

CIV, MV, and CIV Innovations



- ▶ Common idios. volatility (CIV) and market volatility (MV) correlated
- ▶ Nonetheless, shocks to CIV and shocks to MV are distinct: 67% correlation between CIV changes and CIV changes orthogonalized to MV changes

Outline

1. Common idiosyncratic volatility (CIV) facts
2. **Firm risk and household risk**
3. CIV and stock returns
4. Heterogeneous agent model with common idiosyncratic volatility
5. Firm volatility in dynamic networks

CIV and Individual Income Risk

- ▶ Many of persistent, idiosyncratic income shocks experienced by households begin with firm/employer from which income is derived
 - ▶ Job displacement: “a plant closing, an employer going out of business, a layoff from which he/she was not recalled” (Kletzer 1989,1990)
 - ▶ Firm-specific human capital “... cost of and the return to the investment will be shared by the worker and the employer” (Becker 1962)
 - ▶ Direct exposure to equity risk of employer for incentive reasons... (Jensen and Meckling 1976, Murphy 1985, Morck, Shleifer, and Vishny 1988, Kole 1995, etc.)
 - ▶ ...and for non-incentive reasons (Benartzi 2001, Cohen 2009, Van Nieuwerburgh and Veldkamp 2006)

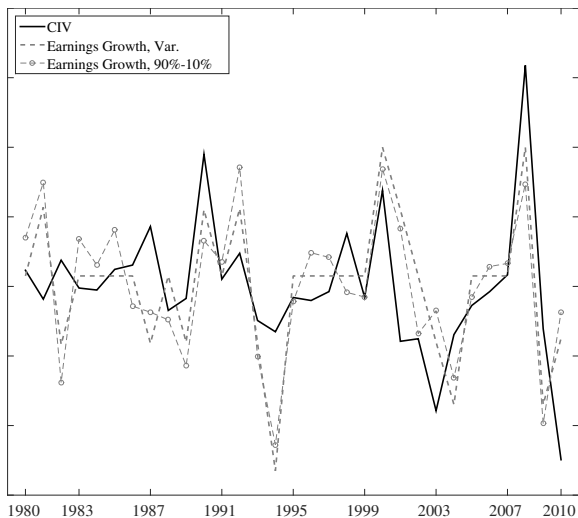
CIV and Individual Income Risk

- ▶ Consensus view in the literature: Households can't fully insulate their consumption from persistent shocks to labor income. $> 40\%$ of permanent labor income shocks are passed to consumption (Cochrane 1991, Attanasio and Davis 1996, Blundell, Pistaferri, and Preston 2008, Heathcote, Storesletten, and Violante 2013)
- ▶ Firms provide employees with some temporary insurance against idiosyncratic shocks, little protection against persistent shocks which ultimately affect compensation through wages or layoffs (Berk, Stanton, and Zechner 2010, Lustig, Syverson, and Nieuwerburgh 2011)

Data: Proxies for Household Income Risk

1. Dispersion in income growth from (US Social Security Admin)
2. Dispersion in employment growth growth at U.S. public firms (Compustat)
3. Dispersion in employment growth for U.S. industries (Fed)
4. Dispersion in regional wage growth and house price growth (BEA)

CIV and Individual Income Risk



- ▶ Individual income growth from SSA, annual cross section stdev 1980-2010 from Guvenen et al. (2014)
- ▶ 53% correlation ($t=3.4$) between annual CIV and this measure (in changes)

CIV and Individual Income Risk

- ▶ CIV associated with employment risk (public firms)
 - ▶ IQR of firm-level employment growth rates growth for U.S. publicly-listed firms from 1975-2010
 - ▶ CIV has 33.5% correlation ($t = 2.7$) with employment growth dispersion (in changes)
- ▶ Similar employment risk result for public+private universe
 - ▶ Federal Reserve reports monthly total employment for over 100 sectors beginning in 1991
 - ▶ We calculate dispersion of sector-level employment growth
 - ▶ CIV has 44.2% correlation ($t = 2.0$) with employment growth dispersion (in changes)
- ▶ CIV associated with regional house price and wage risk
 - ▶ Quarterly house price data from Federal Housing Financing Agency and wage data from BEA
 - ▶ Dispersion in house price and wage growth across MSAs, 1969-2009, 386 regions
 - ▶ Correlation with quarterly changes in CIV of 23.2% ($t = 2.6$) for HP and 16.6% ($t = 1.9$) for wage growth

Summary: CIV and Household Risk

- ▶ CIV shocks correlated with shocks to dispersion of household income growth, firm employment growth, regional house price growth
- ▶ Interpretation: Households' income growth directly exposed to shocks to employers
- ▶ Fact: Households cannot insure away all income risk, esp. not the permanent shocks; consumption growth is affected
- ▶ Implication: With incomplete markets, CIV shocks affect consumption growth distribution and should be priced

Outline

1. Common idiosyncratic volatility (CIV) facts
2. Firm risk and household risk
3. **CIV and stock returns**
4. Heterogeneous agent model with common idiosyncratic volatility
5. Firm volatility in dynamic networks

β_{CIV} Portfolios

- ▶ Shocks to CIV are priced: High $\beta_{i,CIV} \Leftrightarrow$ low $E[R_i]$
- ▶ Factor: Shocks to CIV, orthogonalized w.r.t. MV shocks
- ▶ Betas from past 60 months, returns are first post-formation month (annualized)

	CIV beta						t(5-1)
	1 (Low)	2	3	4	5 (High)	5-1	
$E[R]$	15.23	12.39	11.71	10.55	8.80	-6.44	-3.42
α_{CAPM}	3.38	1.47	1.14	0.27	-1.95	-5.33	-2.91
α_{FF}	2.32	0.84	0.94	0.22	-1.97	-4.28	-2.33

- ▶ Results hold in subsamples
- ▶ Results hold for various double sorts (next slides)

β_{CIV} Portfolios

CIV vs. MV Exposure

	1 (Low)	2	3	4	5 (High)	5-1	t(5-1)
Panel A: Two-way sorts on CIV beta and MV beta							
MV beta							
1 (Low)	16.05	14.50	11.72	11.60	9.37	-6.69	-2.55
2	14.47	13.42	11.55	11.49	10.25	-4.22	-1.91
3	16.67	12.98	13.51	11.27	10.91	-5.76	-2.48
4	17.17	11.26	10.81	9.26	9.12	-8.05	-2.95
5 (High)	14.48	12.88	10.84	10.86	8.72	-5.76	-1.96
5-1	-1.57	-1.63	-0.87	-0.73	-0.64		
t(5-1)	-0.54	-0.52	-0.29	-0.25	-0.22		
Panel B: One-way sorts on CIV beta, no orthogonalization							
$E[R]$	14.81	12.75	11.60	10.32	9.70	-5.11	-2.53
α_{CAPM}	2.66	1.43	0.97	0.13	-0.68	-3.34	-1.77
α_{FF}	1.97	0.97	0.68	0.00	-0.98	-2.96	-1.63
Panel C: One-way sorts on MV beta							
$E[R]$	11.06	11.76	12.15	9.86	10.64	-0.42	-0.17
α_{CAPM}	-1.51	0.41	1.46	-0.30	0.84	2.34	1.09
α_{FF}	-1.20	0.29	1.10	-0.85	-0.13	1.06	0.58

CIV Pricing of Anomaly Portfolios

Fama MacBeth Analysis

	Panel A: 10 BM			Panel B: 10 ME		
Constant	0.009	0.014	0.012	-0.008	-0.004	0.004
t-stat	0.971	5.048	3.774	-4.816	-2.348	1.130
Rm-Rf	-0.003	-0.009	-0.007	0.013	0.009	0.001
t-stat	-0.280	-3.292	-2.190	8.955	5.568	0.366
CIV	-	-0.069	-0.069	-	-0.020	-0.033
t-stat	-	-9.934	-8.855	-	-7.265	-6.777
MV	-	-	-0.005	-	-	-0.025
t-stat	-	-	-0.621	-	-	-4.286
R^2	0.013	0.796	0.837	0.839	0.919	0.955
RMSE	1.886	0.857	0.768	0.543	0.386	0.287

- ▶ CIV “prices” a number of other anomaly portfolios
- ▶ Notable exceptions: Momentum and idiosyncratic vol
- ▶ Corroborative results for income distribution “mimicking” portfolio

Outline

1. Common idiosyncratic volatility (CIV) facts
2. Firm risk and household risk
3. CIV and stock returns
4. **Heterogeneous agent model with common idiosyncratic volatility**
5. Firm volatility in dynamic networks

Heterogeneous agent model

- ▶ Goal: Coherent framework to understand three sets of facts
- ▶ Follow Constantinides and Duffie (1996), Constantinides and Ghosh (2014), and others
 - ▶ Key state variable: Dispersion in household consumption growth rates
- ▶ New feature: Household consumption growth has common idiosyncratic volatility with the same factor structure as that in firms' cash flow growth
- ▶ Positive shocks to CIV increases cross-sectional dispersion of equilibrium consumption growth; CIV shocks carry negative price of risk
- ▶ Stocks with positive return exposure to CIV innovations are hedges and should carry low average returns, magnitudes rationalized with firm volatility level/comovement data

Idiosyncratic Vol Comovement: Potential Mechanisms

- ▶ Dynamic models (especially with learning), e.g. Pastor and Veronesi (05,06), Menzly, Santos, and Veronesi (04): Idiosyncratic vol driven by common state variables
 - ▶ Idios vol not focus in these models, quantification TBD
 - ▶ Cash flow vs. return vol
 - ▶ CIV vs. market vol

- ▶ Granular networks

“Firm Volatility in Granular Networks”

Kelly, Lustig, Van Nieuwerburgh

- ▶ Factors vs. networks: Network dynamics govern firm vols, “aggregate” shocks provide poor description of firm-level shocks
- ▶ Focus on cash flow vol
- ▶ We are agnostic in this paper
 - ▶ Firm vols comove → household inheritance of common risks (limited hedgibility) → pricing in asset markets

More work to be done...

Conclusion

- ▶ Strong factor structure in firm volatility \Rightarrow “Common Idiosyncratic Volatility” factor (CIV)
(returns, cash flows, stocks, portfolios, various frequencies, etc.)
- ▶ Empirical link between dispersion in income growth across households and CIV
- ▶ Stocks whose returns covary more negatively with CIV innovations carry higher average returns
- ▶ Heterog. agent asset pricing model with CIV quantitatively matches CIV risk premium and volatility facts