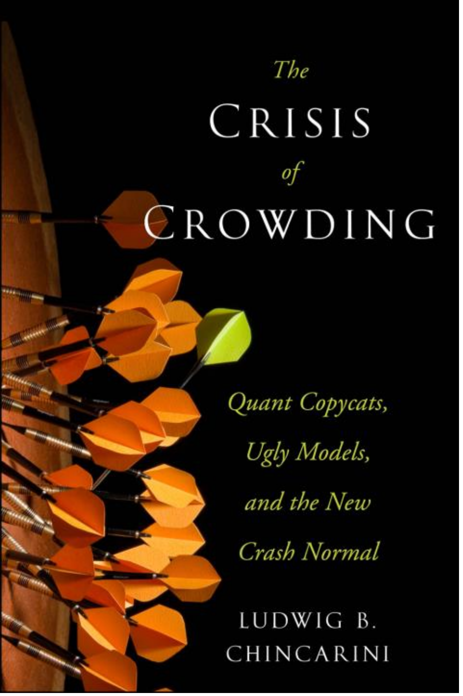
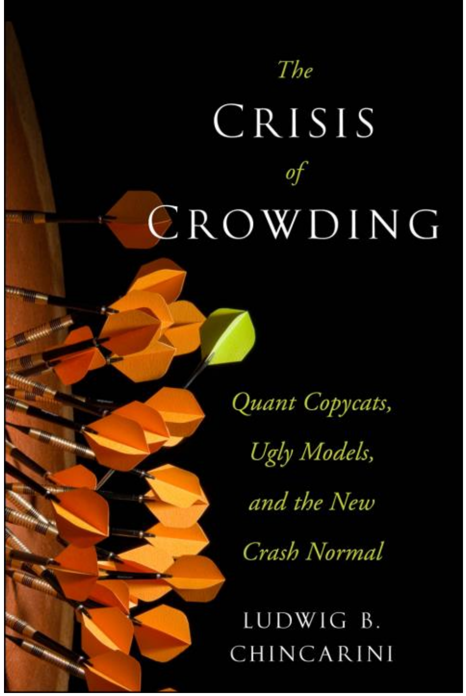


Beta and Firm Age



November 20, 2020

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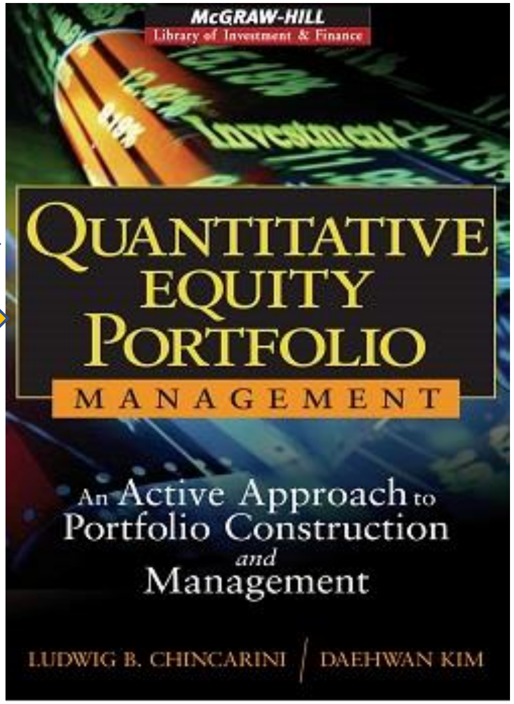
- Thank you Honghui Chen and all of the participants of this session.

New Edition of QEPM will be released in 2021. Please look out for it. ;)



Summary

- Despite the criticisms, the Capital Asset Pricing Model (CAPM) is used extensively in finance.
  - Graham and Harvey (2001) report that 73% of their firms use the CAPM to estimate the cost of equity capital.
- We find the beta of a company declines as the company ages
- Standard beta determinants (e.g., firm characteristics, liquidity, information variables) cannot explain this pattern
- Familiarity is important to explain the pattern
  - We provide a theoretical model to support this
- Accounting for the age of a company may be important when using beta to compute cost of equity
- Controlling for age is important for long-run asset pricing tests

Model

- Based on model of Clarkson and Thomson (1990) and Boyle, Garlappi, Uppal, and Wang (2012)
- Two firms and risk-free asset
  - The mean excess return parameter of one firm (e.g., the young firm) is unknown and agent makes inference from the information generated by analysts
- The agent adopts a bayesian approach and optimizes the mean-variance-familiarity criterion described by Boyle et al. using the predictive distribution
- Estimation risk is determined by the amount of information (the # of analysts)
- Familiarity is obtained by holding the information longer
- Beta of young firm is higher and as firm gets older lower beta because less estimation risk and reduction in unfamiliarity premium

Data

1. CRSP Data – obtain US traded total stock returns.
2. IBES Data – obtain number of analysts following a stock, consensus earnings and realized earnings for each stock.
3. Compustat – obtain fundamental stock data (e.g. size, price-to-book, and leverage)
4. Incorporation and founding dates collected by Jovanovic and Rousseau (2001) updated using the Jay Ritter's dataset

Time Period: We study companies from 1966 to 2016.

Methodology: The Basics

- To measure the "age" of a company, we consider its birth year as the year of incorporation or founding, whichever is earlier.
- We group stocks into age cohorts.
- We create 100 age-cohort portfolios (Age 1 to Age 100) in any given year. We then compute the subsequent 1-year return for each cohort using equal-weighted and value-weighted portfolios.

Methodology: Computing Beta

- For each company in each age-cohort, we compute the beta of each individual company with the following regression (Dimson approach):

$$r_t = \alpha + \beta_1(\tilde{r}_{M,t}) + \beta_2(\tilde{r}_{M,t-1}) + \beta_3(\tilde{r}_{M,t-2} + \tilde{r}_{M,t-3} + \tilde{r}_{M,t-4})/3 + \varepsilon_t$$

The returns are computed weekly from July 1 of year t-1 to June 30 of year t. Our beta is beta1+beta2+beta3.

We follow Han and Lesmond (2011) and use the midpoint of the bid-ask spread to measure prices and consequently returns.

- The age-cohort portfolio beta is the equal-weighted or value weighted average of all stocks in the portfolio as of July 1st.

Regressions

- We run several types of regressions to analyze the relationship between age a

$$\beta_{t,a} = \gamma_0 + \gamma_1 a_t + \epsilon_{t,a}$$

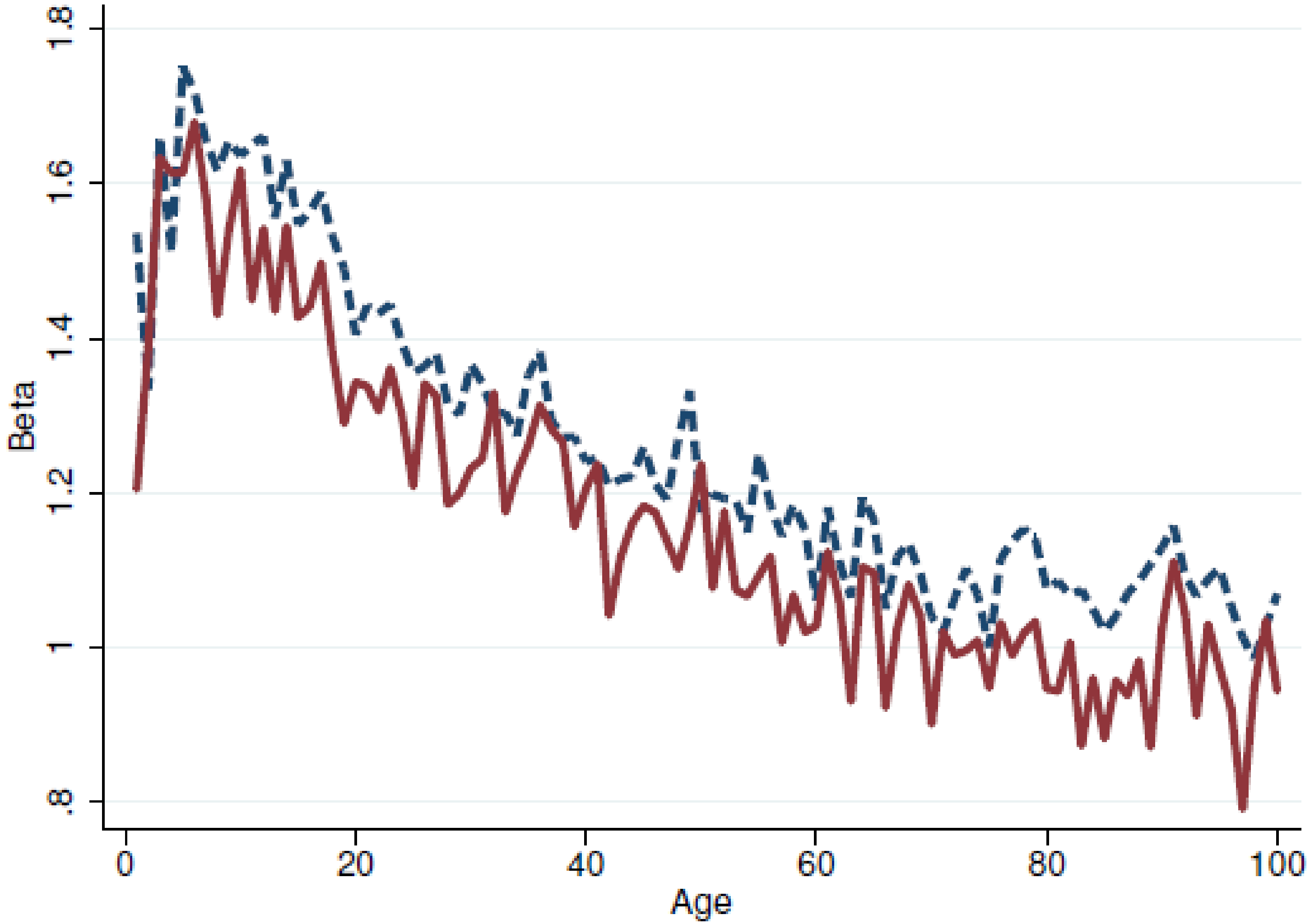
- Gamma(1) represents the relationship between the age of a portfolio of companies and it's average beta.
- We estimate this relationship in different ways:

1. Pooled. All of the year returns for all age portfolios for the entire period are used to estimate the regression

2. Fama-MacBeth. Each year the cross-sectional regression is run, parameters estimated, and then the average of parameters averaged over all years.

- Also stock-level analysis

Beta Declines with Age



The solid line represents value-weighted beta, and the dotted line equal-weighted beta

Explaining the Decline

- The fundamentals of a company are changing over time (Beaver, Kettler, and Scholes, 1970).
  - Size, book-to-market ratio, payout ratio, earning variability, earning covariability
- Liquidity of the shares
  - Bid-ask spread and liquidity beta
- Life-cycle proxies (Dickinson, 2011)
- As the quantity and quality information about a company increases the uncertainty and estimation risk declines
  - Number of analysts following a stock, dispersion of analyst forecasts of earnings, public and private information measures suggested by Botosan, Plumlee, and Xie (2004)

	(1)	(2)	(3)
Age	-0.007	-0.006	-0.004
	[-37.45]	[-35.34]	[-19.93]
	{-6.16	{-5.70	{-4.97
	***	***	***
Size		-0.012	-0.002
		[-5.10]	[-0.55]
		{-0.88	{-0.12
B/M			-0.008
			[-1.04]
			{-0.24
Leverage			0.002
			[0.73]
			{0.29
Payout ratio			-0.190
			[-15.18]
			{-9.27
			***
Earnings variability			1.643
			[14.97]
			{5.14
			***
Earnings covariability			0.003
			[4.10]
			{1.65
Liquidity beta			-0.082
			[-3.14]
			{-0.75
Bid-ask spread			-2.241
			[-10.11]
			{-1.46

Stock level regressions including fundamentals and liquidity measures

Stock level regression including information measures

	(1)	(2)	(3)	(4)	(5)
Age	-0.007	-0.007	-0.005	-0.004	-0.004
	[-32.44]	[-33.06]	[-19.89]	[-17.68]	[-17.77]
	{-5.96}	{-6.49}	{-5.86}	{-5.48}	{-5.51}
	***	***	***	***	***
Size		0.019	0.028	-0.005	-0.008
		[6.70]	[7.11]	[-0.97]	[-1.57]
		{1.51}	{1.70}	{-0.26}	{-0.43}
			*		
B/M			-0.019	-0.038	-0.037
			[-1.93]	[-3.82]	[-3.75]
			{-0.54}	{-1.17}	{-1.15}
Leverage			-0.003	-0.003	-0.003
			[-1.13]	[-1.31]	[-1.31]
			{-0.48}	{-0.58}	{-0.58}
Payout ratio			-0.165	-0.162	-0.159
			[-11.38]	[-11.13]	[-10.98]
			{-10.57}	{-10.34}	{-10.34}
			***	***	***
Earnings variability			2.087	1.924	1.945
			[16.56]	[15.25]	[15.41]
			{6.57}	{5.94}	{6.00}
			***	***	***
Earnings covariability			0.002	0.002	0.002
			[2.20]	[1.79]	[1.82]
			{0.92}	{0.76}	{0.77}
Liquidity beta			-0.092	-0.089	-0.087
			[-3.30]	[-3.19]	[-3.14]
			{-0.83}	{-0.79}	{-0.78}
Bid-ask spread			-3.407	-2.849	-2.954
			[-12.16]	[-9.96]	[-10.34]
			{-1.56}	{-1.32}	{-1.37}
Number of analysts				0.011	0.011
				[6.06]	[6.11]
				{2.07}	{2.09}
				**	**
Dispersion				2.704	2.737
				[12.17]	[12.32]
				{5.02}	{5.07}
				***	***
Public info				-3.775	
				[-4.50]	
				{-4.28}	
				***	
Private info				-0.842	
				[-1.41]	
				{-3.07}	
				***	
Public info share					-0.024
					[-0.54]
					{-0.44}

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Age	-0.001	-0.001	-0.004	-0.003	-0.004	-0.003	-0.004	-0.002
	[-6.01]	[-5.45]	[-23.58]	[-16.04]	[-31.13]	[-19.27]	[-21.14]	[-10.54]
	{-2.81}	{-2.58}	{-5.66}	{-4.90}	{-5.44}	{-4.47}	{-3.88}	{-2.66}
	***	***	***	***	***	***	***	***
Constant	1.755	1.479	1.424	1.169				
	[66.06]	[36.01]	[38.39]	[20.04]				
	{9.08}	{6.97}	{5.97}	{3.72}				
	***	***	***	***				
MLDA2	-0.274	-0.117						
	[-22.51]	[-8.78]						
	{-3.53}	{-1.94}						
	***	*						
MLDA3	-0.422	-0.229						
	[-22.38]	[-11.56]						
	{-4.44}	{-3.08}						
	***	***						
MLDA4	-0.032	-0.071						
	[-0.83]	[-1.83]						
	{-0.38}	{-0.82}						
DCS2			-0.293	-0.106				
			[-16.01]	[-5.48]				
			{-3.79}	{-1.77}				
			***	*				
DCS3			-0.427	-0.209				
			[-23.37]	[-10.70]				
			{-4.70}	{-3.00}				
			***	***				
DCS4			-0.086	-0.034				
			[-4.09]	[-1.60]				
			{-1.35}	{-0.58}				
RETA					-0.074	-0.047		
					[-36.89]	[-16.52]		
					{-3.90}	{-2.92}		
					***	***		
Adjusted age							-0.002	-0.001
							[-5.95]	[-5.04]
							{-2.33}	{-2.07}
							**	**

Stock level regression including life cycle proxies

Robustness

- Use unlevered beta
- Value vs equally-weighted portfolios
- Include a squared age term to capture non linearity
- Subsample analysis: stronger effects on younger firms
- Survivorship bias concern: exclude non-surviving firms

Additional recent analyses

- Use as a proxy for familiarity a variable that cumulate the past total information (public + private information variable)
- Include more determinants of beta (operating leverage, momentum)
- Include industry dummies
- Use daily returns instead of weekly and with and without Dimson's adjustment

Asset pricing implications

- The decline in beta with age leads to a decline in the cost of equity capital: The issue is the validity of CAPM
- Test whether controlling for age is important for asset pricing tests of the CAPM
- Follow Cohen, Polk, and Vuolteenaho (2009) and take a long-horizon perspective to test the CAPM
- Calculate the 'price level' of portfolio *k* at time *t* as the cumulative *N*-period discounted portfolio return

$$P_{k,t}^{N} = \sum_{j=1}^{N} \rho^{j} R_{k,t,t+j}$$

where ρ= 0.975 and N = 15

- Compute the price level measure for 100 portfolios sorted using beta, B/M-size (10 B/M sorted portfolios are sorted again according to the size), age, and age-beta (20 on age and then beta)

Expected returns vs beta

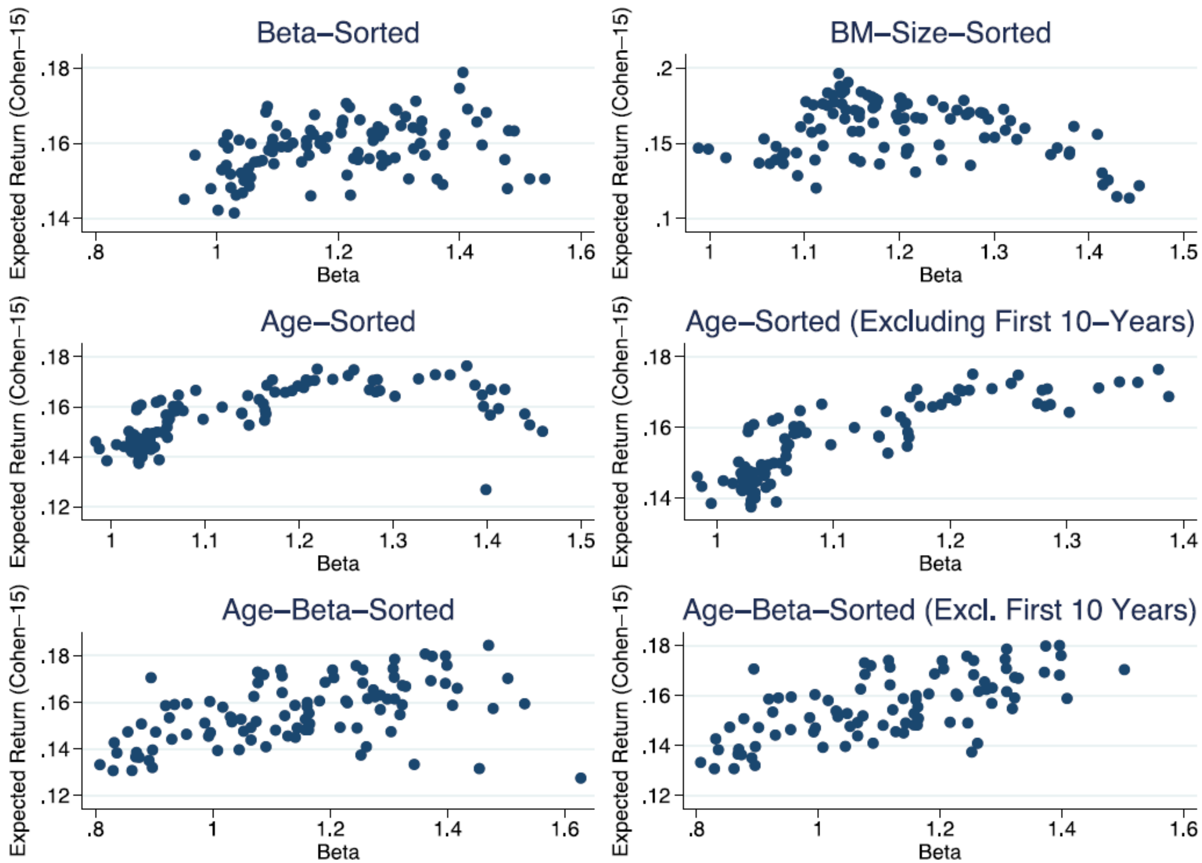


Fig. 4. Expected returns versus beta. *Note*: The plots show the holding-period expected return (the Cohen-15 price level measure) vs. beta of beta, B/M-size, and age sorted portfolios. The initial sample includes stock-years of non-financial common stocks in the CRSP-Compustat universe, of the period between 1966 and 2016, and of ages between 1 and 100. We have determined the age as the number of years (as of the end of June of year t) since incorporation or founding, whichever is earlier. We create different portfolios for each year t. Once portfolio (k,t) is created, we calculate returns of the portfolio for the next 15 years, from which we compute the price level measure $P^{15}_{k,t}$. See the text for exact formula. We also calculate post-ranking portfolio betas using the next 15 years portfolio returns. Ranking betas are instead estimated from weekly returns between July of year $t-1$ and June of year t. We then take the average of $P^{15}_{k,t}$ and post-ranking portfolio betas over years to obtain P^{15}_{k} and average beta. The price level measure is annualized by dividing by the annualization factor $\sum_{j=1}^{15} \rho^j$. The plots show P^{15}_{k} against average betas of different k's. For the first plot, 100 beta-sorted portfolios are created. For the second plot, 100 portfolios are created by sorting on B/M first and then on size. For the third plot, 100 portfolios are created based on age. For the fourth plot, 100 portfolios are created based on age and then we remove the portfolios from age 1 to 10. For the fifth plot, 100 portfolios are created by sorting on age first (20 portfolios) and then on beta (5 portfolios). From the sixth plot, we remove the first 2 age portfolios (with age less than and equal to 10 years) from the portfolios in the fifth plot.

Fama-MacBeth regressions

	(1)	(2)	(3)	(4)	(5)	(6)
Slope	0.0187	0.0217	0.0369	0.0430	0.0332	0.0420
	[1.07]	[1.27]	[2.11]	[3.17]	[2.27]	[3.06]
			**	***	**	***
Intercept	0.1383	0.1332	0.1169	0.1106	0.1191	0.1106
	[11.61]	[8.23]	[6.83]	[6.47]	[9.28]	[9.03]
	***	***	***	***	***	***

The slope estimate is 0.0369, which is 3.69% per year.

The intercept is 0.1169, which is 11.69% per year.

$\Rightarrow$ high intercept and low slope—suggest that the relationship between expected return and beta is weaker than the CAPM predicts

CAPM is still an incomplete measure of risk. However, when we control for age, there is a positive risk-return tradeoff as implied by the theory.

Conclusion

- Age matters for beta.
- Age serves as a proxy for firm risk that captures familiarity and uncertainty not captured by established accounting and fundamental factors
- Controlling for age is important for long-run asset pricing tests:
  - Provide support for the main empirical prediction of the CAPM and for using the CAPM in long-term investment decisions

Thank you

- Dr. Ludwig Chincarini Ph.D, CFA
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QEPM is a great book for teaching portfolio management. Please check it out!