Betting against beta

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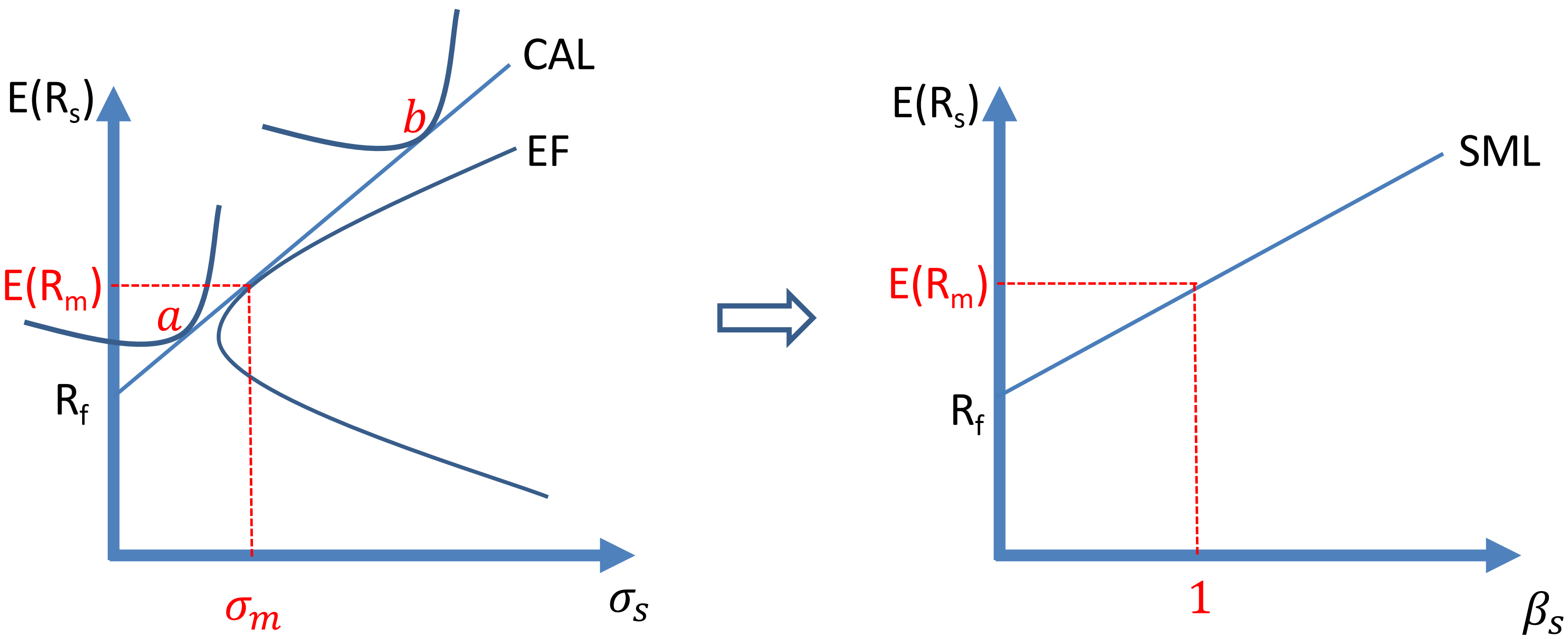
Agenda

- Motivation
- OLG Model
- Results
- Discussion

Motivation

Motivation

The CAPM Model

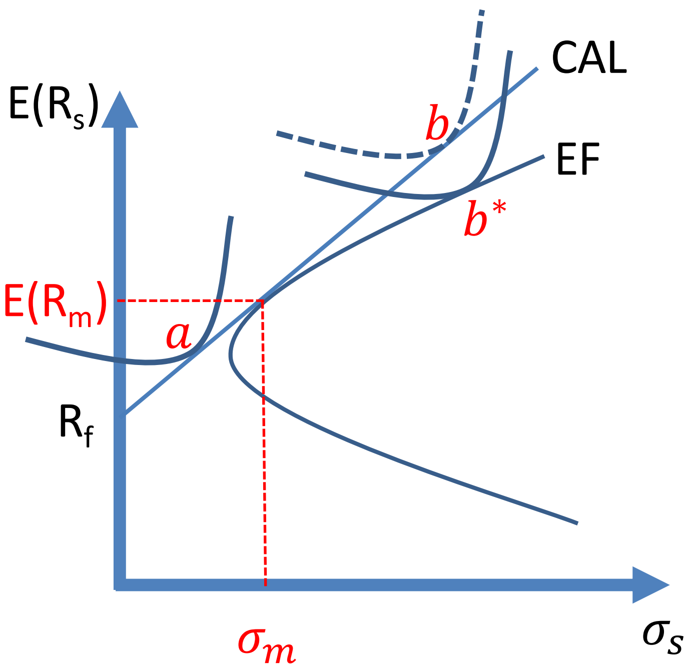


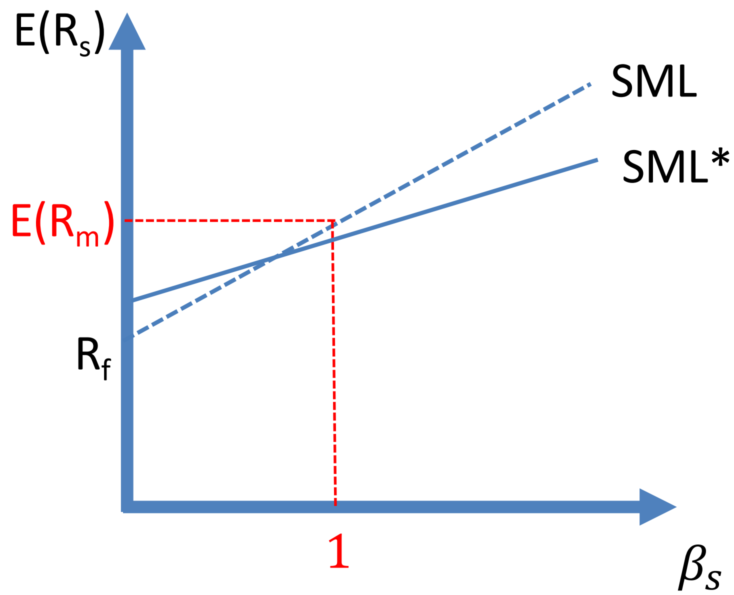
Where: $E_t(r_{t+1}^s) = r^f + \beta_t^s \lambda_t$

$\lambda_t = E_t(r_{t+1}^m) - r^f$

Motivation

What about borrowing constraints?





"This behavior of tilting toward high-beta assets suggests that risky high-beta assets require lower risk adjusted returns than low-beta assets, which require leverage."

"Unconstrained agents underweight (or short-sell) high-beta assets and buy low-beta assets that they lever up."

Where: $E_t(r_{t+1}^s) = r^f + \psi_t + \beta_t^s \lambda_t$

$\lambda_t = E_t(r_{t+1}^m) - r^f - \psi_t$

ψ_t is a tightness measure of funding constraints

Motivation

Empirical evidence from SML (Cohen, Polk, and Vuolteenaho (2005))

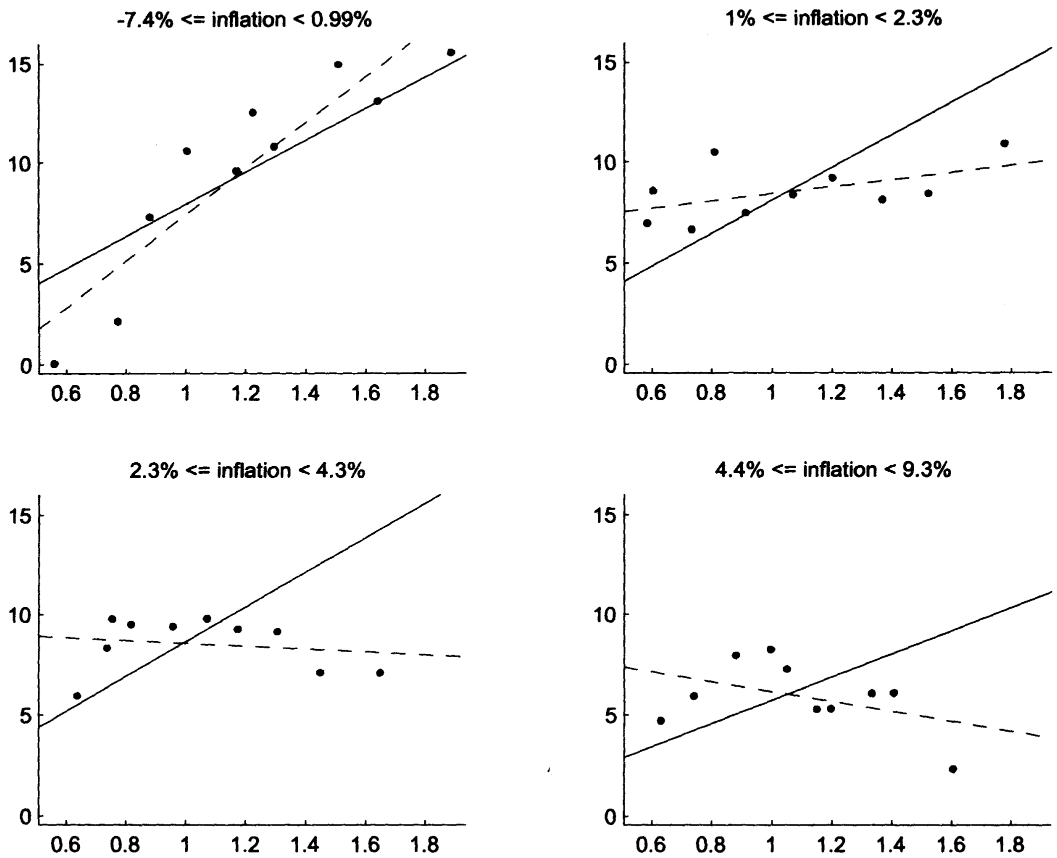


FIGURE I

Average Excess Returns and Beta in Different Inflation Environments

We first create ten portfolios by sorting stocks on their past estimated betas. We then record the excess returns on these portfolios. Next, we sort months in our 1927:06–2001:12 sample into four groups based on lagged inflation (defined as the smoothed change in the producer price index). For each group, we then estimate the postformation betas and average excess returns. The average annualized excess returns (y-axis) and betas (x-axis) of these portfolios form the graphs. The solid line (drawn from the [0,0] to [1, average market's excess return in this subsample]) is the relation predicted by the Sharpe-Lintner CAPM. The dashed line is the fitted line computed by regressing the average returns on betas in each subsample.

Motivation

Related Literature

Low return of high-beta stocks in the U.S., borrowing constraints

- Black (1972, 1993), Black, Jensen, and Scholes (1972), Gibbons (1982), Kandel (1984), Shanken (1985), Polk, Thompson, and Vuolteenaho (2006)

Margin requirements and funding constraints:

- Deviations from the Law of One Price: Garleanu and Pedersen (2009)
- The impact of central banks' lending facilities: Ashcraft, Garleanu, and Pedersen (2010)
- Variation in market liquidity and liquidity crises: Brunnermeier and Pedersen (2009)

Background:

- Flat Security Market Line for U.S. stocks
- Borrowing constraints
- Surprisingly little research on factors based on the flatness of the SML

Motivation

- Research questions:

1. Is the SML flat in other markets? (Rather than stocks)
2. Betting-Against-Beta (BAB):
   - How to capture this effect with a factor?
   - BAB returns relative to size/ value/ momentum effects?

- What the papers does?
  - Predictions of a OLG model with constrained investors
  - Building the BAB Factor
  - Empirical evidence
    - US Stocks
    - Global Stocks
    - Equity Index
    - Country bonds
    - Foreign exchanges
    - US Treasury bonds
    - Credit Index
    - Corporate bonds
    - Commodities

OLG Model

The OLG Model

The OLG Model: $\exists i\ agents,\ i = 1, \dots, I\ and\ \exists s\ securities,\ s = 1, \dots, S$

$$max_{\{x\}} \left\{ x^T \left[E_t(P_{t+1} + \delta_{t+1}) - \left(1 + r^f\right) P_t \right] - \frac{1}{2} \gamma^i x^T \Omega_t x \right\}$$

s.t. $m_t^i \sum_{s=1}^{S} x^s P_t^s \leq W_t^i$

which can capture:

- No leverage: $m^i = 1$
- No leverage and cash constraint: $m^i > 1$
- Margin constraints: $m^i < 1$

Competitive equilibrium + some algebra:

$$E_t(r_{t+1}^s) = r^f + \psi_t + \beta_t^s \left[E_t(r_{t+1}^m) - r^f - \psi_t \right]$$

where: $\psi_t = \sum_{i=1}^{I} \left({}^{\gamma}/_{\gamma^i} \right) \psi_t^i$

$${}^{1}/_{\gamma} = \sum_{i=1}^{I} \left({}^{1}/_{\gamma^i} \right)$$

agent FOC: $0 = E_t(P_{t+1} + \delta_{t+1}) - \left(1 + r^f\right) P_t - \gamma^i \Omega_t x - \psi_t^i P_t$

ψ_t^i is the Lagrange multiplier of the portfolio constraint

Define: $r_{t+1}^{BAB} = \frac{1}{\beta_t^L}\left(r_{t+1}^L - r^f\right) - \frac{1}{\beta_t^H}\left(r_{t+1}^H - r^f\right)$

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The OLG Model: Propositions

Proposition 1: High beta is low alpha

$$E_t(r_{t+1}^s) = r^f + \psi_t + \beta_t^s\left[E_t(r_{t+1}^m) - r^f - \psi_t\right] \Rightarrow \alpha_t^s = \psi_t(1-\beta_t^s)$$

Proposition 2: Expected excess return BAB factor is positive and increasing in the ex ante beta spread and funding tightness

$$E_t\left(r_{t+1}^{BAB}\right) = \frac{\beta_t^H - \beta_t^L}{\beta_t^L \beta_t^H}\psi_t \geq 0$$

Proposition 3: A tighter portfolio constraint leads to a contemporaneous loss for the BAB factor and an increase in its future required return

$$\frac{\partial r_t^{BAB}}{\partial m_t^i} \leq 0 \; and \; \frac{\partial E\left(r_{t+1}^{BAB}\right)}{\partial m_t^i} \geq 0 \; for \; \forall i$$

The OLG Model: Propositions

Proposition 4: if "the conditional variance of the discount factor rises (falls) due to new information about m_t and/or W_t, then:

The conditional return betas β_{t-1}^{i} of all securities are compressed toward one (more dispersed), and

The conditional beta of the BAB portfolio becomes positive (negative), even though it is market neutral relative to the information set used for portfolio formation"

Proposition 5: "Unconstrained agents hold risk free securities and a portfolio of risky securities that has a beta less than 1; constrained agents hold portfolios of securities with higher betas"

Building the BAB Factor

Ex ante Betas:

$$\hat{\beta}_t^{ts} = \hat{\rho}_{s,m} \frac{\hat{\sigma}_s}{\hat{\sigma}_m} \; with\ one\ and\ five\ years\ rolling\ for\ \hat{\sigma}_s\ and\ \hat{\rho}_{s,m}\ respectively$$

$$\hat{\beta}_t^{s} = w_i \hat{\beta}_t^{ts} + (1 - w_i)\hat{\beta}_t^{xs} \; with\ w = 0.6\ and\ \hat{\beta}_t^{xs} = 1$$

BAB Factor Recipe:

$$z_s = rank\left(\hat{\beta}_t^{s}\right)$$

$$\bar{z} = 1^T z/S$$

$$w_H = k(z - \bar{z})^+ \text{ and } w_L = k(z - \bar{z})^-$$

$$k = 2/1^T|z - \bar{z}|$$

$$r_{t+1}^H = r_{t+1}^T w_H \; and\ r_{t+1}^L = r_{t+1}^T w_L$$

$$\beta_t^H = \beta_t^T w_H \; and\ \beta_t^L = \beta_t^T w_L$$

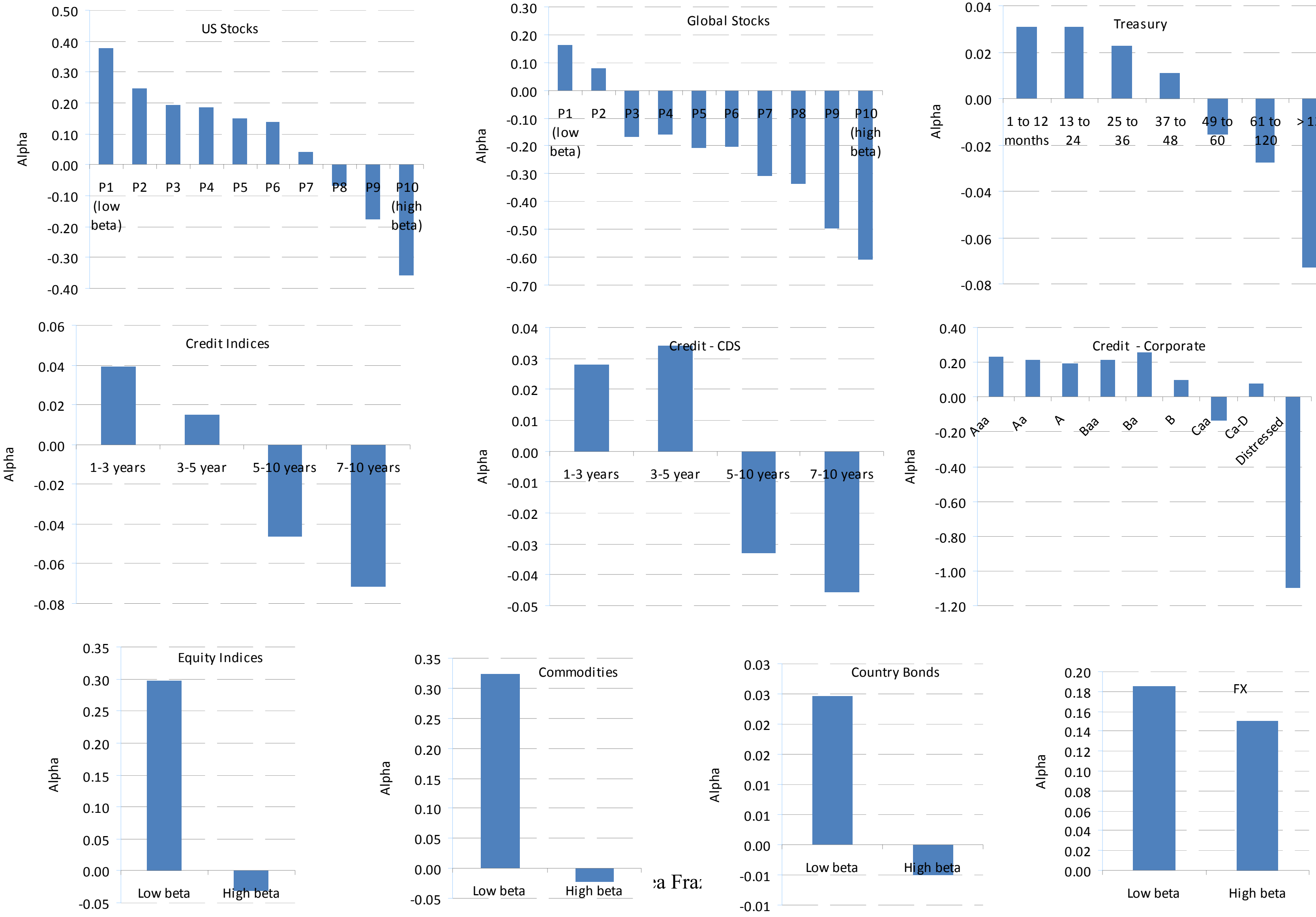
$$r_{t+1}^{BAB} = \frac{1}{\beta_t^L}\left(r_{t+1}^L - r^f\right) - \frac{1}{\beta_t^H}\left(r_{t+1}^H - r^f\right)$$

BAB is a self-financing zero-beta portfolio

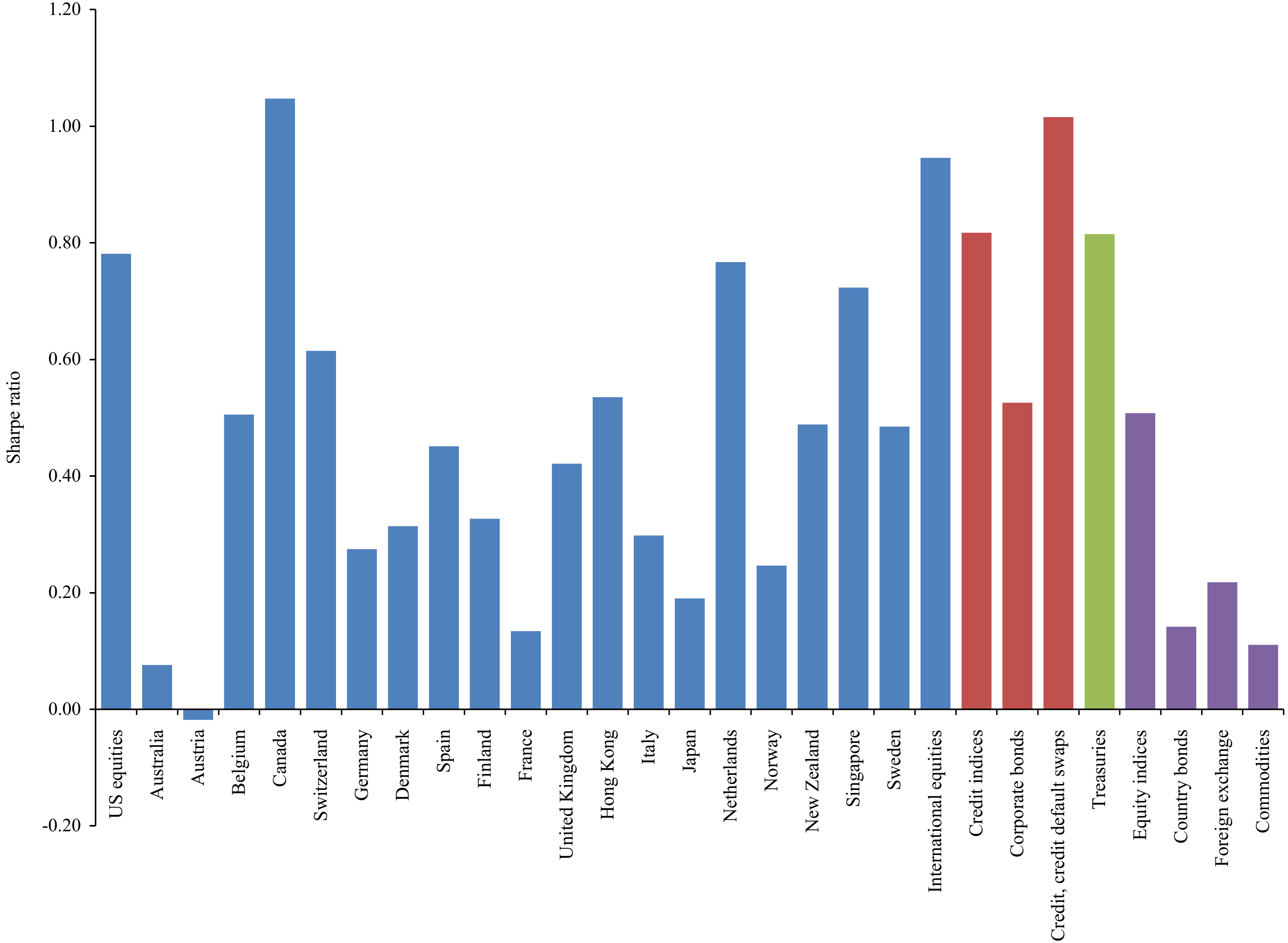
Results: P1 and P2

Results – P1: $\alpha_t^s = \psi_t(1 - \beta_t^s)$

All Asset Classes, 1964 – 2009



Results – P2: $E_t\left(r_{t+1}^{BAB}\right) \geq 0$ (annualized S.R.)



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Results – Stocks

US equities

Flat SML

Abnormal returns

Portfolio	P1 (low beta)	P2	P3	P4	P5	P6	P7	P8	P9	P10 (high beta)	BAB
Excess return	**0.91**	**0.98**	**1.00**	**1.03**	**1.05**	**1.10**	**1.05**	**1.08**	**1.06**	**0.97**	**0.70**
	(6.37)	(5.73)	(5.16)	(4.88)	(4.49)	(4.37)	(3.84)	(3.74)	(3.27)	(2.55)	(7.12)
CAPM alpha	**0.52**	**0.48**	**0.42**	**0.39**	**0.34**	**0.34**	0.22	0.21	0.10	−0.10	**0.73**
	(6.30)	(5.99)	(4.91)	(4.43)	(3.51)	(3.20)	(1.94)	(1.72)	(0.67)	(−0.48)	(7.44)
Three-factor alpha	**0.40**	**0.35**	**0.26**	**0.21**	**0.13**	0.11	−0.03	−0.06	**−0.22**	**−0.49**	**0.73**
	(6.25)	(5.95)	(4.76)	(4.13)	(2.49)	(1.94)	(−0.59)	(−1.02)	(−2.81)	(−3.68)	(7.39)
Four-factor alpha	**0.40**	**0.37**	**0.30**	**0.25**	**0.18**	**0.20**	0.09	0.11	0.01	−0.13	**0.55**
	(6.05)	(6.13)	(5.36)	(4.92)	(3.27)	(3.63)	(1.63)	(1.94)	(0.12)	(−1.01)	(5.59)
Five-factor alpha	**0.37**	**0.37**	**0.33**	**0.30**	**0.17**	**0.20**	0.11	0.14	0.02	0.00	**0.55**
	(4.54)	(4.66)	(4.50)	(4.40)	(2.44)	(2.71)	(1.40)	(1.65)	(0.21)	(−0.01)	(4.09)
Beta (ex ante)	0.64	0.79	0.88	0.97	1.05	1.12	1.21	1.31	1.44	1.70	0.00
Beta (realized)	0.67	0.87	1.00	1.10	1.22	1.32	1.42	1.51	1.66	1.85	−0.06
Volatility	15.70	18.70	21.11	23.10	25.56	27.58	29.81	31.58	35.52	41.68	10.75
Sharpe ratio	0.70	0.63	0.57	0.54	0.49	0.48	0.42	0.41	0.36	0.28	0.78

Sharpe ratio monotonically declines

Alpha monotonically declines

Results – Treasury Bonds

Increasing SML: credit risk?

Abnormal returns

Table 6
US Treasury bonds: returns, 1952–2012.

This table shows calendar-time portfolio returns. The test assets are the Center for Research in Security Prices Treasury Fama bond portfolios. Only non callable, non flower notes and bonds are included in the portfolios. The portfolio returns are an equal-weighted average of the unadjusted holding period return for each bond in the portfolios in excess of the risk-free rate. To construct the zero-beta betting against beta (BAB) factor, all bonds are assigned to one of two portfolios: low beta and high beta. Bonds are weighted by the ranked betas (lower beta bonds have larger weight in the low-beta portfolio and higher beta bonds have larger weights in the high-beta portfolio) and the portfolios are rebalanced every calendar month. Both portfolios are rescaled to have a beta of one at portfolio formation. The BAB factor is a self-financing portfolio that is long the low-beta portfolio and shorts the high-beta portfolio. Alpha is the intercept in a regression of monthly excess return. The explanatory variable is the monthly return of an equally weighted bond market portfolio. The sample period runs from January 1952 to March 2012. Returns and alphas are in monthly percent, *t*-statistics are shown below the coefficient estimates, and 5% statistical significance is indicated in bold. Volatilities and Sharpe ratios are annualized. For P7 returns are missing from August 1962 to December 1971.

Portfolio	P1 (low beta)	P2	P3	P4	P5	P6	P7 (high beta)	BAB
Maturity (months)	one to 12	13–24	25–36	37–48	49–60	61–120	> 120	
Excess return	**0.05**	**0.09**	**0.11**	**0.13**	**0.13**	**0.16**	**0.24**	**0.17**
	(5.66)	(3.91)	(3.37)	(3.09)	(2.62)	(2.52)	(2.20)	(6.26)
Alpha	**0.03**	**0.03**	0.02	0.01	−0.01	−**0.02**	−0.07	**0.16**
	(5.50)	(3.00)	(1.87)	(0.99)	(−1.35)	(−2.28)	(−1.85)	(6.18)
Beta (ex ante)	0.14	0.45	0.74	0.98	1.21	1.44	2.24	0.00
Beta (realized)	0.16	0.48	0.76	0.98	1.17	1.44	2.10	0.01
Volatility	0.81	2.07	3.18	3.99	4.72	5.80	9.26	2.43
Sharpe ratio	0.73	0.50	0.43	0.40	0.34	0.32	0.31	0.81

Alpha and S.R. monotonically declines

- Ranking on betas is equivalent to rank on maturities
- Abnormal returns:
  - One Factor model: Market Factor
  - Market factor = equally weighted Treasury bond excess market return

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Results – Corporate Credit

Flat SML

Abnormal returns

Alpha and S.R. monotonically declines

Panel A: Credit indices, 1976–2012

	Unhedged					Hedged				
Portfolios	One to three years	Three to five years	Five to ten years	Seven to ten years	BAB	One to three years	Three to five years	Five to ten years	Seven to ten years	BAB
Excess return	**0.18**	**0.22**	**0.36**	**0.36**	**0.10**	**0.11**	**0.10**	0.11	0.10	**0.16**
	(4.97)	(4.35)	(3.35)	(3.51)	(4.85)	(3.39)	(2.56)	(1.55)	(1.34)	(4.35)
Alpha	**0.03**	0.01	−**0.04**	−**0.07**	**0.11**	**0.05**	**0.03**	−**0.03**	−**0.05**	**0.17**
	(2.49)	(0.69)	(−3.80)	(−4.28)	(5.14)	(3.89)	(2.43)	(−3.22)	(−3.20)	(4.44)
Beta (ex ante)	0.71	1.02	1.59	1.75	0.00	0.54	0.76	1.48	1.57	0.00
Beta (realized)	0.61	0.85	1.38	1.49	−0.03	0.53	0.70	1.35	1.42	−0.02
Volatility	2.67	3.59	5.82	6.06	1.45	1.68	2.11	3.90	4.15	1.87
Sharpe ratio	0.83	0.72	0.74	0.72	0.82	0.77	0.58	0.35	0.30	1.02

Panel B: Corporate bonds, 1973–2012

Portfolios	Aaa	Aa	A	Baa	Ba	B	Caa	Ca-D	Distressed	BAB
Excess return	**0.28**	**0.31**	**0.32**	**0.37**	**0.47**	**0.38**	0.35	0.77	−0.41	**0.44**
	(3.85)	(3.87)	(3.47)	(3.93)	(4.20)	(2.56)	(1.47)	(1.42)	(−1.06)	(2.64)
Alpha	**0.23**	**0.23**	**0.20**	**0.23**	**0.27**	0.10	−0.06	−0.04	−**1.11**	**0.57**
	(3.31)	(3.20)	(2.70)	(3.37)	(4.39)	(1.39)	(−0.40)	(−0.15)	(−5.47)	(3.72)
Beta (ex ante)	0.67	0.72	0.79	0.88	0.99	1.11	1.57	2.22	2.24	0.00
Beta (realized)	0.17	0.29	0.41	0.48	0.67	0.91	1.34	2.69	2.32	−0.47
Volatility	4.50	4.99	5.63	5.78	6.84	9.04	14.48	28.58	23.50	9.98
Sharpe ratio	0.75	0.75	0.68	0.77	0.82	0.50	0.29	0.32	−0.21	0.53

- Hedged = attempt to isolate the credit component by hedging away the interest rate risk
- Abnormal returns:
  - Two Factor model: Market Factor + Treasury BAB
  - Market factor = equally weighted average pseudo-CDS excess return

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Results – Futures

Table 8
Equity indices, country bonds, foreign exchange and commodities: returns, 1965–2012.

This table shows calendar-time portfolio returns. The test assets are futures, forwards or swap returns in excess of the relevant financing rate. To construct the betting against beta (BAB) factor, all securities are assigned to one of two portfolios: low beta and high beta. Securities are weighted by the ranked betas (lower beta security have larger weight in the low-beta portfolio and higher beta securities have larger weights in the high-beta portfolio), and the portfolios are rebalanced every calendar month. Both portfolios are rescaled to have a beta of one at portfolio formation. The BAB factor is a self-financing portfolio that is long the low-beta portfolio and short the high-beta portfolio. Alpha is the intercept in a regression of monthly excess return. The explanatory variable is the monthly return of the relevant market portfolio. Panel A reports results for equity indices, country bonds, foreign exchange and commodities. All futures and Country selection are combo portfolios with equal risk in each individual BAB and 10% ex ante volatility. To construct combo portfolios, at the beginning of each calendar month, we rescale each return series to 10% annualized volatility using rolling three-year estimate up to moth $t-1$ and then equally weight the return series and their respective market benchmark. Panel B reports results for all the assets listed in Tables 1 and 2. All bonds and credit includes US Treasury bonds, US corporate bonds, US credit indices (hedged and unhedged) and country bonds indices. All equities includes US equities, all individual BAB country portfolios, the international stock BAB, and the equity index BAB. All assets includes all the assets listed in Tables 1 and 2. All portfolios in Panel B have equal risk in each individual BAB and 10% ex ante volatility. Returns and alphas are in monthly percent, *t*-statistics are shown below the coefficient estimates, and 5% statistical significance is indicated in bold. $Short (Long) is the average dollar value of the short (long) position. Volatilities and Sharpe ratios are annualized. *Denotes equal risk, 10% ex ante volatility.

BAB portfolios	Excess return	*t*-Statistics excess return	Alpha	*t*-Statistics alpha	$Short	$Long	Volatility	Sharpe ratio
Panel A: Equity indices, country bonds, foreign exchange and commodities								
Equity indices (EI)	**0.55**	2.93	**0.48**	2.58	0.86	1.29	13.08	0.51
Country bonds (CB)	0.03	0.67	0.05	0.95	0.88	1.48	2.93	0.14
Foreign exchange (FX)	0.17	1.23	0.19	1.42	0.89	1.59	9.59	0.22
Commodities (COM)	0.18	0.72	0.21	0.83	0.71	1.48	19.67	0.11
All futures (EI+CB+FX+COM)*	**0.26**	2.62	**0.25**	2.52			7.73	0.40
Country selection (EI+CB+FX)*	**0.26**	2.38	**0.26**	2.42			7.47	0.41
Panel B: All assets								
All bonds and credit*	**0.74**	6.94	**0.71**	6.74			9.78	0.90
All equities*	**0.63**	6.68	**0.64**	6.73			10.36	0.73
All assets*	**0.53**	6.89	**0.54**	6.98			8.39	0.76

Abnormal returns only in equities or combined portfolios (diversification)

Controls?

Results: P3

Results – P3: $\frac{\partial r_t^{BAB}}{\partial m_t^i} \leq 0 \; and \; \frac{\partial E(r_{t+1}^{BAB})}{\partial m_t^i} \geq 0 \; for \; \forall i$

- m_t^i = TED spread
- TED spread = difference between the three-month Eurodollar LIBOR and the three-month US Treasuries rate
- TED spread as a proxy for time periods when credit constraints are more likely to be binding (Garleanu and Pedersen (2011))
- Regresses the BAB factor on the lagged level of the TED spread and the contemporaneous change in the TED spread

Results – P3: $\frac{\partial r_t^{BAB}}{\partial m_t^i} \leq 0 \; and \; \frac{\partial E(r_{t+1}^{BAB})}{\partial m_t^i} \geq 0 \; for \; \forall i$

Table 9
Regression results.

This table shows results from (pooled) time series regressions. The left-hand side is the month t return of the betting against beta (BAB) factors. To construct the BAB portfolios, all securities are assigned to one of two portfolios: low beta and high beta. Securities are weighted by the ranked betas (lower beta security have larger weight in the low-beta portfolio and higher beta securities have larger weights in the high-beta portfolio), and the portfolios are rebalanced every calendar month. Both portfolios are rescaled to have a beta of one at portfolio formation. The BAB factor is a self-financing portfolio that is long the low-beta portfolio and short the high-beta portfolio. The explanatory variables include the TED spread and a series of controls. Lagged TED spread is the TED spread at the end of month $t-1$. Change in TED spread is equal to TED spread at the end of month t minus Ted spread at the end of month $t-1$. Short volatility return is the month t return on a portfolio that shorts at-the-money straddles on the S&P 500 index. To construct the short volatility portfolio, on index options expiration dates we write the next-to-expire closest-to-maturity straddle on the S&P 500 index and hold it to maturity. Beta spread is defined as (HBeta – LBeta)/(HBeta* LBeta) where HBeta (LBeta) are the betas of the short (long) leg of the BAB portfolio at portfolio formation. Market return is the monthly return of the relevant market portfolio. Lagged inflation is equal to the one-year US Consumer Price Index inflation rate, lagged one month. The data run from December 1984 (first available date for the TED spread) to March 2012. Columns 1 and 2 report results for US equities. Columns 3 and 4 report results for international equities. In these regressions we use each individual country BAB factors as well as an international equity BAB factor. Columns 5 and 6 report results for all assets in our data. Asset fixed effects are included where indicated, t-statistics are shown below the coefficient estimates and all standard errors are adjusted for heteroskedasticity (White, 1980). When multiple assets are included in the regression, standard errors are clustered by date and 5% statistical significance is indicated in bold.

as not
expected

as expected

	US equities		International equities, pooled		All assets, pooled	
Left-hand side: BAB return	(1)	(2)	(3)	(4)	(5)	(6)
Lagged TED spread	**−0.025**	**−0.038**	**−0.009**	**−0.015**	**−0.013**	**−0.018**
	(−5.24)	(−4.78)	(−3.87)	(−4.07)	(−4.87)	(−4.65)
Change in TED spread	**−0.019**	**−0.035**	**−0.006**	**−0.010**	**−0.007**	**−0.011**
	(−2.58)	(−4.28)	(−2.24)	(−2.73)	(−2.42)	(−2.64)
Beta spread		0.011		0.001		0.001
		(0.76)		(0.40)		(0.69)
Lagged BAB return		0.011		0.035		0.044
		(0.13)		(1.10)		(1.40)
Lagged inflation		−0.177		0.003		−0.062
		(−0.87)		(0.03)		(−0.58)
Short volatility return		**−0.238**		0.021		0.027
		(−2.27)		(0.44)		(0.48)
Market return		**−0.372**		**−0.104**		**−0.097**
		(−4.40)		(−2.27)		(−2.18)
Asset fixed effects	No	No	Yes	Yes	Yes	Yes
Number of observations	328	328	5,725	5,725	8,120	8,120
Adjusted R^2	0.070	0.214	0.007	0.027	0.014	0.036

Results: P4

Results – P4: betas are compressed toward one when funding liquidity risk is high

- Liquidity risk = Volatility of the TED spread
- Cross-sectional dispersion in betas in different time periods sorted by the TED volatility
- The cross-sectional dispersion in betas is lower when credit constraints are more volatile

Results – P4: betas are compressed toward one when funding liquidity risk is high

as expected

Cross-sectional dispersion	Standard deviation	Mean absolute deviation	Interquintile range
Panel A: US equities			
All	0.32	0.25	0.43
P1 (low TED volatility)	0.34	0.27	0.45
P2	0.33	0.26	0.44
P3 (high TED volatility)	0.29	0.23	0.40
P3 minus P1	− **0.05**	− **0.04**	− 0.05
t-Statistics	(− 2.71)	(− 2.43)	(− 1.66)
Panel B: International equities			
All	0.22	0.17	0.29
P1 (low TED volatility)	0.23	0.18	0.30
P2	0.22	0.17	0.29
P3 (high TED volatility)	0.20	0.16	0.27
P3 minus P1	− **0.04**	− **0.03**	− 0.03
t-Statistics	(− 2.50)	(− 2.10)	(− 1.46)
Panel C: All assets			
All	0.45	0.35	0.61
P1 (low TED volatility)	0.47	0.37	0.63
P2	0.45	0.36	0.62
P3 (high TED volatility)	0.43	0.33	0.58
P3 minus P1	− **0.04**	− **0.03**	− **0.06**
t-Statistics	(− 3.18)	(− 3.77)	(− 2.66)

Results – P4: conditional beta of the BAB portfolio becomes positive when funding liquidity risk is high

- Reminding: BAB factor is market neutral conditional on the information set used in the estimation of ex ante betas (historical information)
- Dummies for TED volatility regimes (low, neutral, and high)
- Controls: 3 and 4 factor model
- Results: conditional market betas of the BAB portfolio returns based on the volatility of the credit environment

Results – P4: conditional beta of the BAB portfolio becomes positive when funding liquidity risk is high

as expected

	Alpha	Conditional market beta			
		P1 (low TED volatility)	P2	P3 (high TED volatility)	P3 – P1
Panel D: US equities					
CAPM	**1.06**	– **0.46**	– 0.19	– 0.01	**0.45**
	(3.61)	(– 2.65)	(– 1.29)	(– 0.11)	(3.01)
Control for three factors	**0.86**	– **0.40**	– 0.02	0.08	**0.49**
	(4.13)	(– 3.95)	(– 0.19)	(0.69)	(3.06)
Control for four factors	**0.66**	– **0.28**	0.00	0.13	**0.40**
	(3.14)	(– 5.95)	(0.02)	(1.46)	(4.56)
Panel E: International equities					
CAPM	**0.60**	– 0.09	0.02	0.06	0.16
	(2.84)	(– 1.30)	(0.64)	(1.28)	(1.87)
Control for three factors	**0.59**	– 0.09	0.02	0.05	0.14
	(3.23)	(– 1.22)	(0.74)	(1.09)	(1.70)
Control for four factors	**0.35**	– 0.04	0.05	**0.07**	**0.11**
	(2.16)	(– 1.16)	(1.51)	(2.03)	(2.24)
Panel F: All assets					
CAPM	**0.54**	– **0.13**	– 0.07	0.01	**0.14**
	(4.96)	(– 2.64)	(– 1.82)	(0.21)	(2.34)

Beta BAB Factor increases as the liquidity risk is higher

Results: P5

Results – P5: more-constrained investors hold higher-beta securities

- Binding constraints difficult to observe (leverage constrain vs risk aversion)

- Identification strategy: pre-select groups of investors that are plausibly constrained and unconstrained

- Assumes that unconstrained investors could be allowed to use leverage and are operating below their leverage cap so that their leverage constraints are not binding

- Aggregate the stocks for each investor groups

- Realized beta: time series regression of these excess returns on the excess returns of the CRSP value-weighted index

Results – P5: more-constrained investors hold higher-beta securities

Table 11
Testing the model's portfolio predictions, 1963–2012.

This table shows average ex ante and realized portfolio betas for different groups of investors. Panel A reports results for our sample of open-end actively-managed domestic equity mutual funds as well as results a sample of individual retail investors. Panel B reports results for a sample of leveraged buyouts (private equity) and for Berkshire Hathaway. We compute both the ex ante beta of their holdings and the realized beta of the time series of their returns. To compute the ex-ante beta, we aggregate all quarterly (monthly) holdings in the mutual fund (individual investor) sample and compute their ex-ante betas (equally weighted and value weighted based on the value of their holdings). We report the time series averages of the portfolio betas. To compute the realized betas, we compute monthly returns of an aggregate portfolio mimicking the holdings, under the assumption of constant weight between reporting dates (quarterly for mutual funds, monthly for individual investors). We compute equally weighted and value-weighted returns based on the value of their holdings. The realized betas are the regression coefficients in a time series regression of these excess returns on the excess returns of the Center for Research in Security Prices value-weighted index. In Panel B we compute ex ante betas as of the month-end prior to the initial takeover announcements date. *t*-Statistics are shown to right of the betas estimates and test the null hypothesis of beta = 1. All standard errors are adjusted for heteroskedasticity and autocorrelation using a Bartlett kernel (Newey and West, 1987) with a lag length of 60 months. A 5% statistical significance is indicated in bold.

Investor, method	Sample period	Ex ante beta of positions: Beta	Ex ante beta of positions: *t*-Statistics (H0: beta = 1)	Realized beta of positions: Beta	Realized beta of positions: *t*-Statistics (H0: beta = 1)
Panel A: Investors likely to be constrained					
Mutual funds, value weighted	1980–2012	**1.08**	2.16	**1.08**	6.44
Mutual funds, equal weighted	1980–2012	1.06	1.84	**1.12**	3.29
Individual investors, value weighted	1991–1996	**1.25**	8.16	**1.09**	3.70
Individual investors, equal weighted	1991–1996	**1.25**	7.22	**1.08**	2.13
Panel B: Investors who use leverage					
Private equity (all)	1963–2012	0.96	−1.50		
Private equity (all), equal weighted	1963–2012	**0.94**	−2.30		
Private equity (LBO, MBO), value weighted	1963–2012	**0.83**	−3.15		
Private equity (LBO, MBO), equal weighted	1963–2012	**0.82**	−3.47		
Berkshire Hathaway, value weighted	1980–2012	**0.91**	−2.42	**0.77**	−3.65
Berkshire Hathaway, equal weighted	1980–2012	**0.90**	−3.81	**0.83**	−2.44

as expected

Discussion

Discussion:

- **Paper provides:**
  - Empirical evidence for borrowing constraints
  - Lower beta = higher Sharpe Ratio
  - BAB Factor strategy
- **Discussion:**
  - High beta is correlated with Volatility? YES
  - If so, low risk assets present better expected returns?
  - Is Beta and/or Volatility a good measure of risk?

Discussion:

- **Ideas for future research:**
    - BAB vs other factors and/or characteristics
    - BAB in the Emerging Markets
    - Betas and volatility are good measures for risk?
    - More-constrained investors hold higher-beta securities?