Risk and Return Characteristics of Venture Capital-Backed Entrepreneurial Companies

Arthur Korteweg
Stanford GSB

Morten Sorensen
Columbia GSB

Introduction

- Goal: to estimate the risk and return characteristics of VC-backed private firms.

- BUT: Valuations only observed when companies have funding or exit events.
  - Returns observed over irregular intervals.
  - Well-performing firms are more likely to have funding and exit events, creating a

    "Dynamic sample selection problem"

- Develop an empirical methodology to deal with both issues.

Results: A preview

- After controlling for sample selection:
  - Alphas decrease from 5.2% to 3.3%/month.
  - Betas increase marginally.
  - Idiosyncratic risk increases from 36% to 41%/month.
- Alphas vary substantially over time and by stage of investment.
- Entrepreneurial firms behave like small, growth firms.
- Evidence of a VC-specific risk factor.

Why is this interesting?

- Important for understanding the returns to entrepreneurial investments (and portfolio decisions).

- Dynamic selection issue arises in any setting where the

  probability of observing a return

  is related to the return itself.

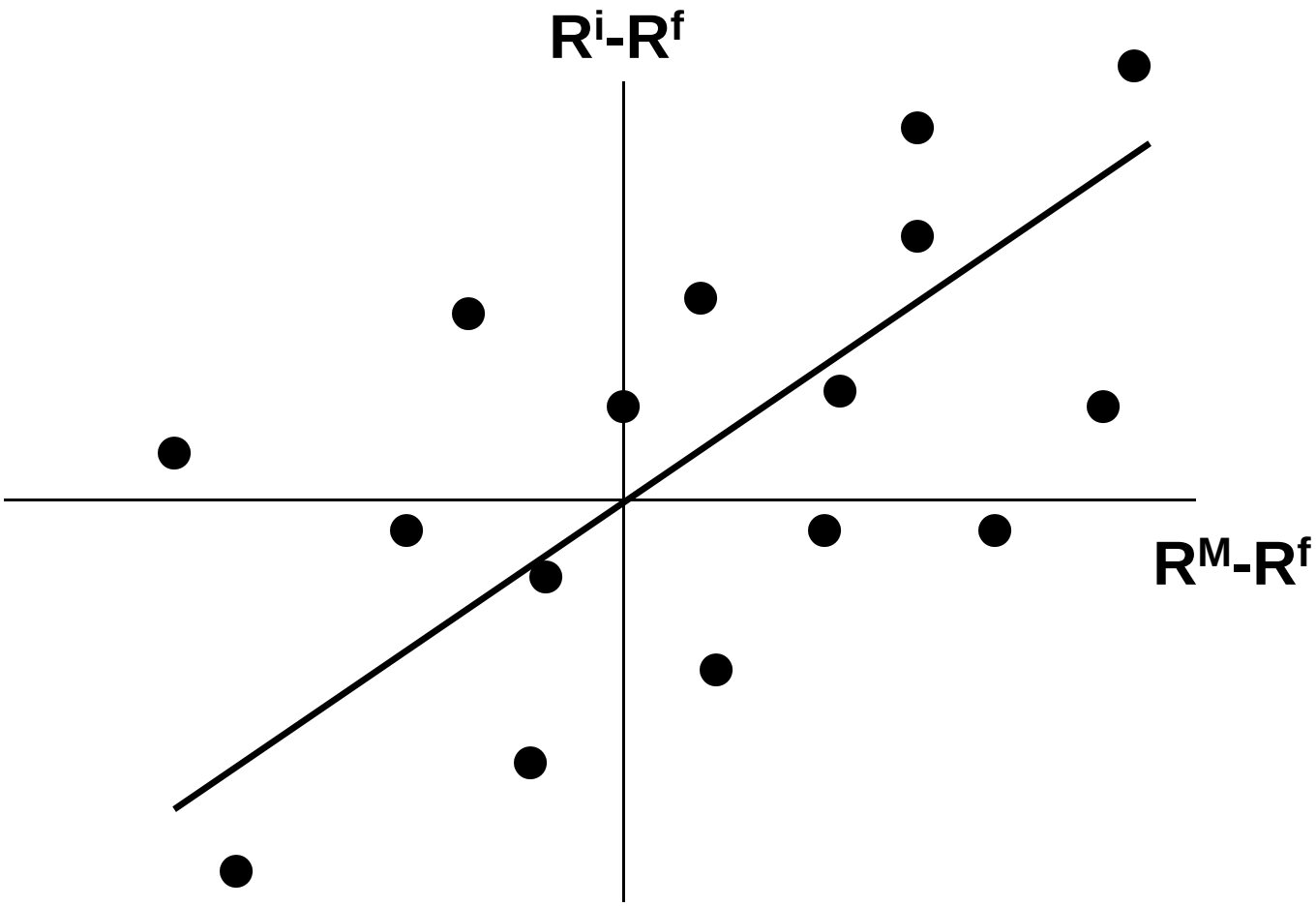
Dynamic Selection: Applications

- Hedge fund performance measurement.
  - Voluntary performance reporting.
- Real estate price index
  - Traditional repeat-sales index (Case-Shiller-Weiss) is a special case of our model that does not account for sample selection.
- Pricing illiquid securities: corporate bonds, MBS, CDO, VC investments.

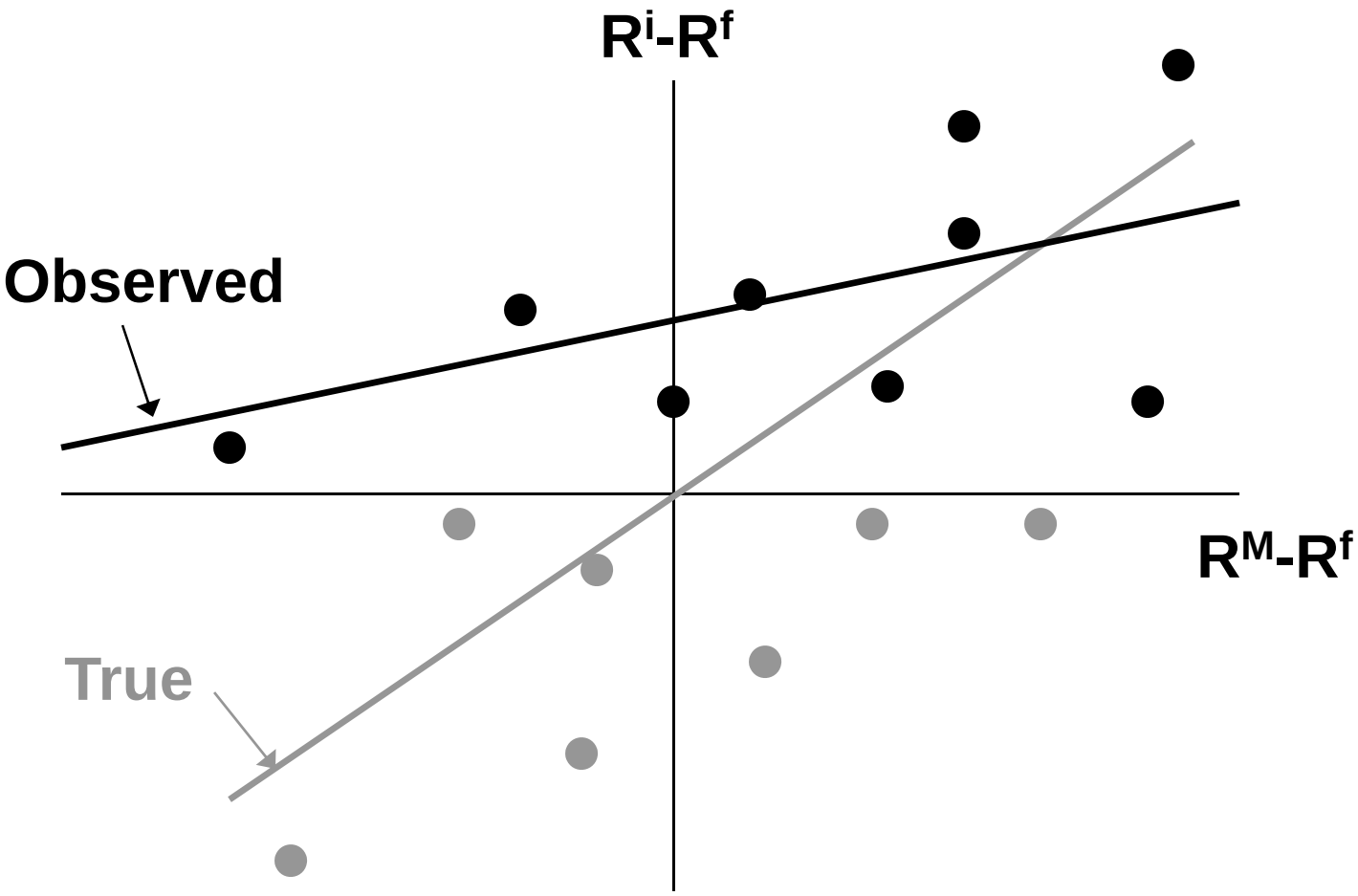
What we do

- We focus on entrepreneurial companies financed by VC investors.
  - Dataset with 5,501 VC investments in 1,934 portfolio companies between 1987 and 2005.
  - Source: Sand Hill Econometrics.
- Staged financing.
  - Companies typically receive financing over a number of financing rounds.
- Eventually, companies go public (10.3%), or are acquired (23.3%), or are liquidated (23.0%).
- BUT: 43.4% are “zombies”.

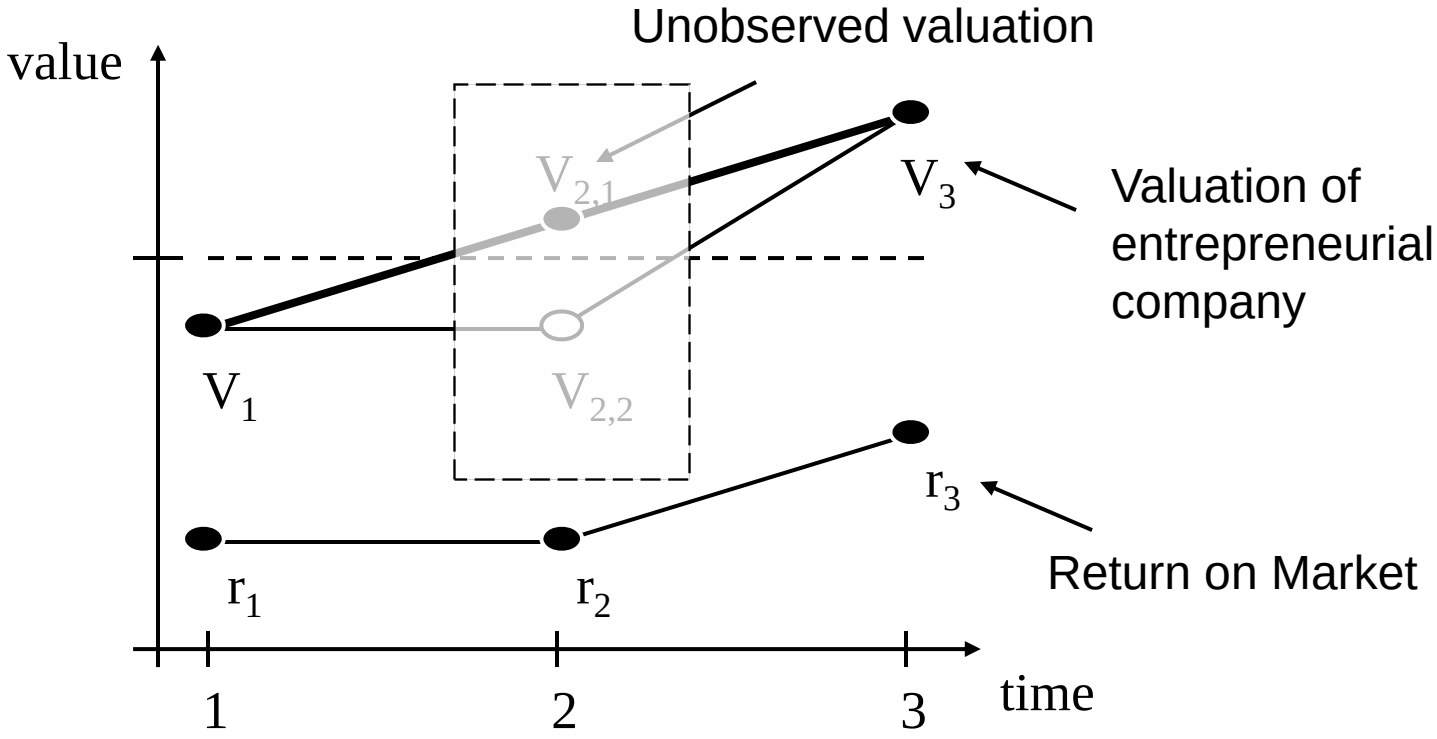
Motivating sample selection



Static (Heckman) sample selection



Dynamic sample selection



- Knowing that V_2 is unobserved contains information about V_2.
  - A standard Heckman selection correction will ignore this information.

Overview of model

- Start with a standard factor-model of market values (one-factor or three-factor, in logs).
  - Unobserved valuations are treated as latent variables.
- Add selection equation to this model.
  - Determines when valuations are observed.
  - Extends standard Heckman model to capture dynamic sample selection.
- The large number of latent valuation and selection variables create numerical problems.
  - To evaluate likelihood function, all latent variables must be integrated out, but this is infeasible.
  - We overcome this problem with Bayesian methods using Kalman filtering and Gibbs sampling.

Estimation: MCMC/Gibbs sampling

- We divide variables into three “blocks”:
  - Parameters in the two model equations.
  - Latent selection variables.
  - Latent valuation variables.
- Draw from posterior distribution of each block, conditional on the other blocks:
  - Standard Bayesian regression.
  - Truncated Normal distribution.
  - Kalman Filtering problem (using FFBS).

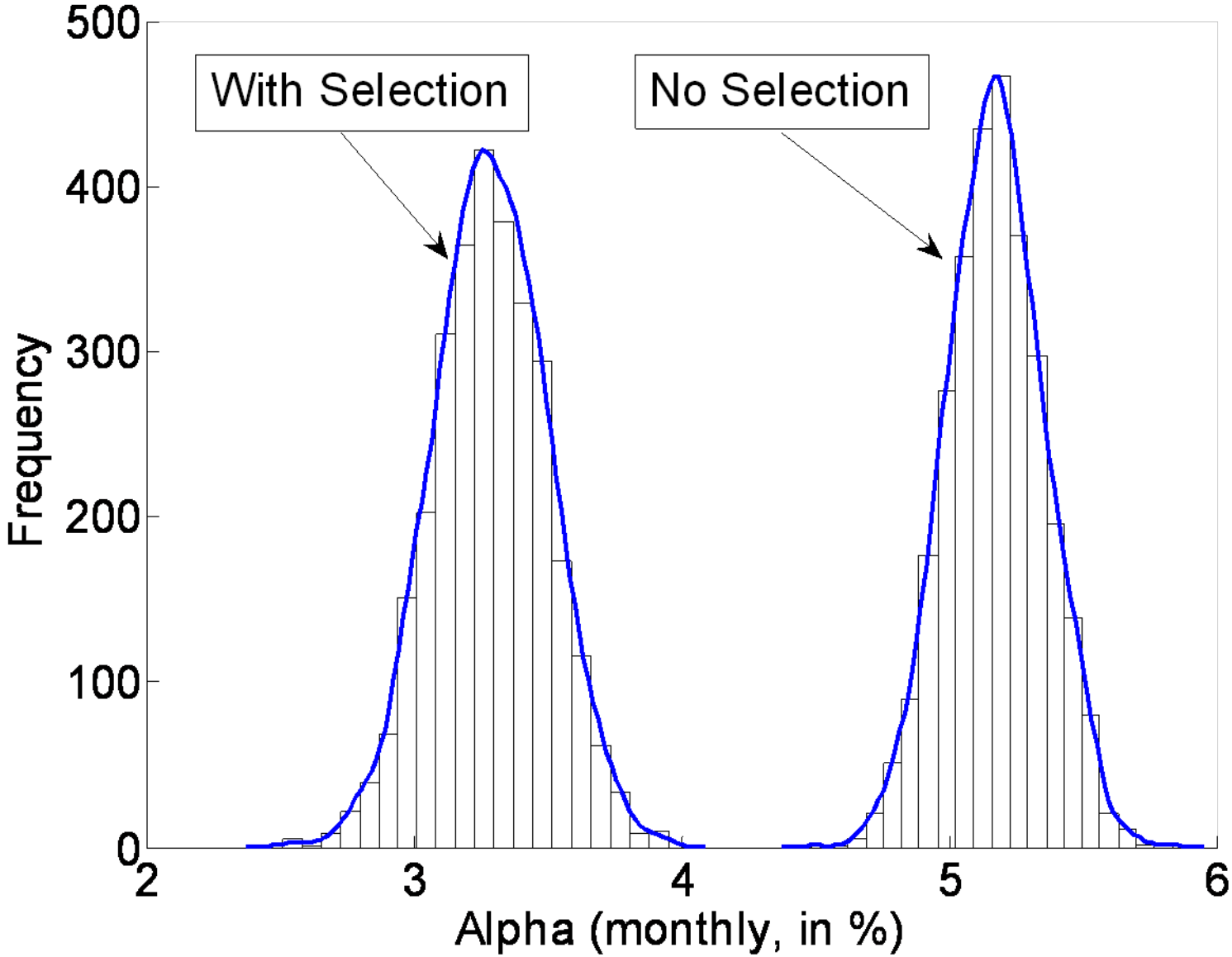
Risk and return estimates

- CAPM in monthly log-returns:

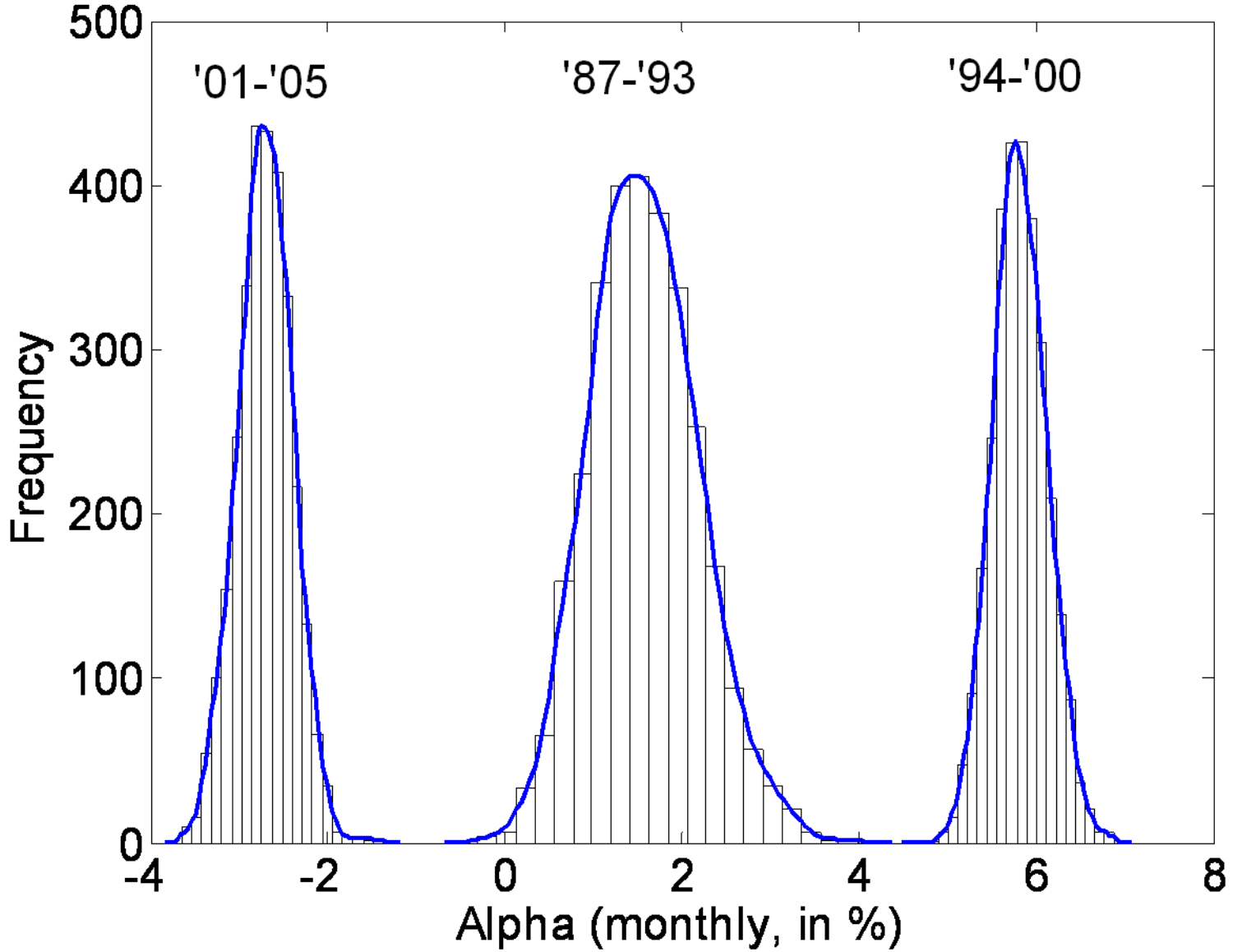
	No Selection	With Selection
Intercept	-1.6%	-5.6%
Beta	2.7	2.8
Idiosyncratic volatility	35.6%	41.1%

- Robust across specifications of selection equation.
- Arithmetic vs. log-returns.
  - To calculate alpha, adjust for Jensen's Inequality term.

Posterior distribution of Alpha



Alpha by period



Probability of a financing event

- The probability of a financing event depends on:

Variable	Effect on prob of observing a financing event
Return since last financing round	**(+)**
Time since last financing round	(+) when low (-) when high
Aggregate # acquisitions of VC-backed firms	(+)
Agg. # IPOs of VC-backed firms	(0)/(-)
Agg. # financing rounds	(+)
Market return	(+)

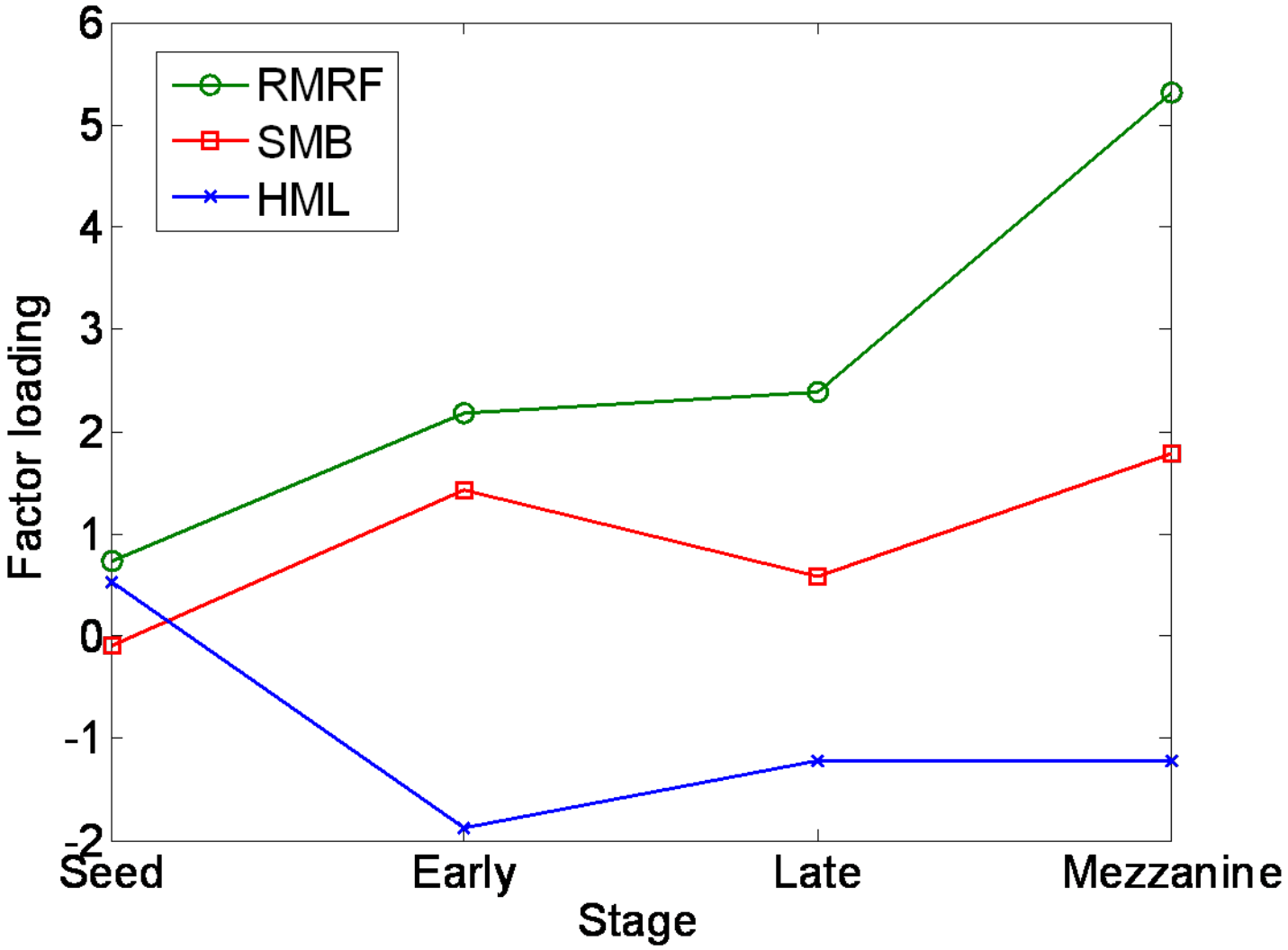
Fama-French model

- In monthly log-returns:

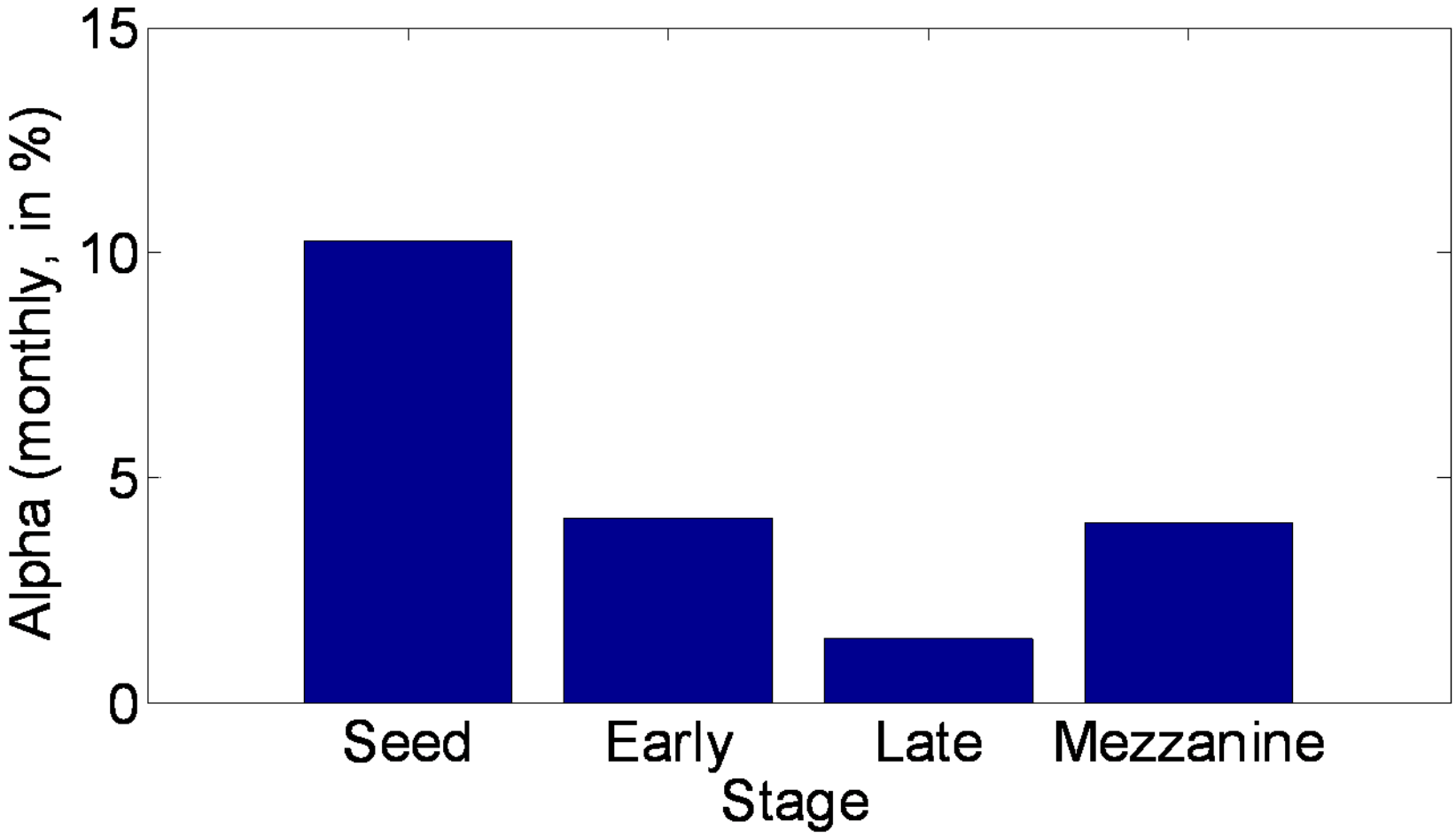
	No Selection	With Selection
Intercept	-1.2%	-5.4%
RMRF	2.3	2.3
SMB	1.1	1.1
HML	-1.2	-1.6
Idiosyncratic volatility	35.6%	40.3%

- VC-backed private firms behave like small growth firms.
- Alphas of same magnitude as CAPM.

Factor loadings by company stage



Alphas by company stage



VC-specific factor

- Gompers and Lerner (2000) and Kaplan and Schoar (2005) suggest the existence of a VC-specific risk factor.
- Define VC factor as change in log(dollars invested by VCs).
  - VC investments load highly positively on this factor.
  - Loadings on CAPM and Fama-French betas lower when including VC factor.
- BUT: can we construct a factor-mimicking portfolio?

Caveats

- Model does not incorporate cross-sectional covariance.
- “Instruments” in selection equation may be correlated with VC specific shocks.
  - Time since last financing is probably a better instrument than market-wide activity.
- Caution required when interpreting coefficients.
  - Alphas reflect compensation for investors’ skill, illiquidity, lack of rebalancing, and zero-payout risk.
  - Are the alphas attainable?
  - Dollar-weighted alpha by stage = 2.5%/month.

Summary

- Estimators of risk-return of infrequently traded assets face a sample selection problem.
- We develop and estimate a dynamic model to account for this problem.
  - Provide most comprehensive risk-return estimates of entrepreneurial companies to date.
  - Estimates show reasonable patterns both in return and selection equations.
- Methodology generally applicable.
  - Hedge fund performance, real-estate, corporate bonds, and CLOs / CDOs.