The link between investor holding period and liquidity

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Motivation

- Empirical evidence suggests that liquidity matters for asset pricing
- Why?
  - Information and information risk
    - O'Hara (2003)
  - Cost compensation
    - Amihud/Mendelson (1986) ("AM model")
- The AM model is widely accepted

Article	Where	When	No of citations
Amihud/Mendelson	JFE	1986	972
Glosten/Milgrom	JFE	1985	1268
Kyle	Econometrica	1985	1965

Source: Google Scholar

The AM model

- Simple model; simple intuition
  - Investors have different expected holding periods and assets have different spreads
  - Investors demand a compensation for spread costs, i.e.
    - total return = net return + $\frac{\%\ \text{spread}}{\text{holding period}}$
    - $\Rightarrow$ Positive and concave relationship between spreads and returns
- Too simple?
  - What is the source of the spread differences?
  - Should not all stocks be priced by the marginal short term investor?

Literature

Three hypotheses from the AM model

1. **The return-spread relationship**: observed asset returns should be an increasing and concave function of the relative spread
   - Supported by Amihud and Mendelson (1986)
2. **The spread-holding period relationship:** assets with higher spreads should be allocated to portfolios with the same or longer expected holding periods
   - Supported by Atkins and Dyl (1997)
3. **The return-holding period relationship**: observed asset returns should be an increasing and concave function of the expected holding period
   - Supported by Datar et al (1998) and Hu (1997)

Problems

- A relationship between spread and returns has several potential explanations (information risk)
  - Tests of the AM model should include holding period
    - Do we see signs of investor clienteles?
    - Does holding period explain returns
- All existing tests use turnover as a proxy for holding period
  - Turnover is a characteristic of a stock while holding period is a decision made by individual investors
  - Turnover may be linked to spread and returns for other reasons than through its correlation with holding period

Contribution

Access to the complete holdings of all investors in a stock market over an 11 year period

- Test the spread-holding period relationship using duration analysis of actual holding periods of individual investors
- Test the return-holding period relationship using a holding period index constructed from actual holding periods
- Is turnover a good proxy for holding period?
  - compare to estimates from the duration analysis
  - compare to the constructed holding period index

Market and Data

All firms listed at the Oslo Stock Exchange (OSE) in the period 1992-2003

Data Sources

- Norwegian Securities Registry (VPS)
  - equity holdings of the complete stock market
  - can distinguish between investor types
- Oslo Stock Exchange Data Service (OBI)
  - stock prices and accounting data
- Central Bank of Norway
  - interest rates

Individual Decisions on Holding Period

- Describe the holding periods of all equity investors in the Norwegian stock market using duration analysis
- Study what variables might affect holding period decisions
  - Direct test of the spread-holding period relationship in Amihud and Mendelson (1986)
- Compare with results from existing literature using turnover as a proxy for holding period

Duration Analysis

- The main tool for analyzing length of time spent in a particular state (economic, social, health)
- The probability distribution of duration can be specified by a distribution function
  - $F(t) = Pr(T < t)$

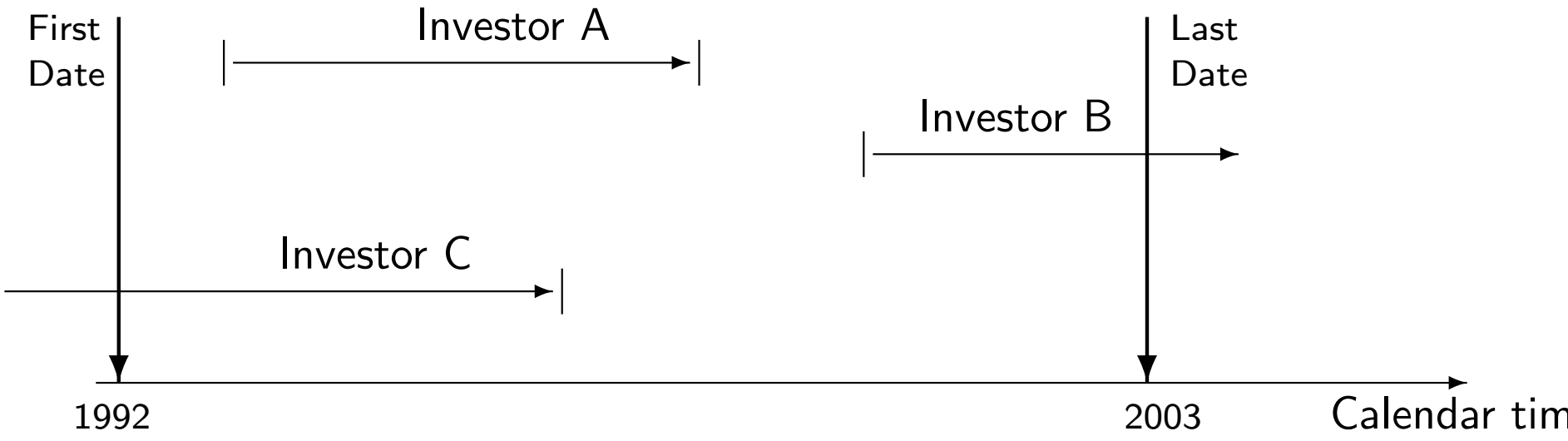
  which specify that a random variable T is less than some value t

- Models the decision to terminate a relationship
  - Here, the decision to liquidate the equity holding in a firm

Duration Analysis (2)

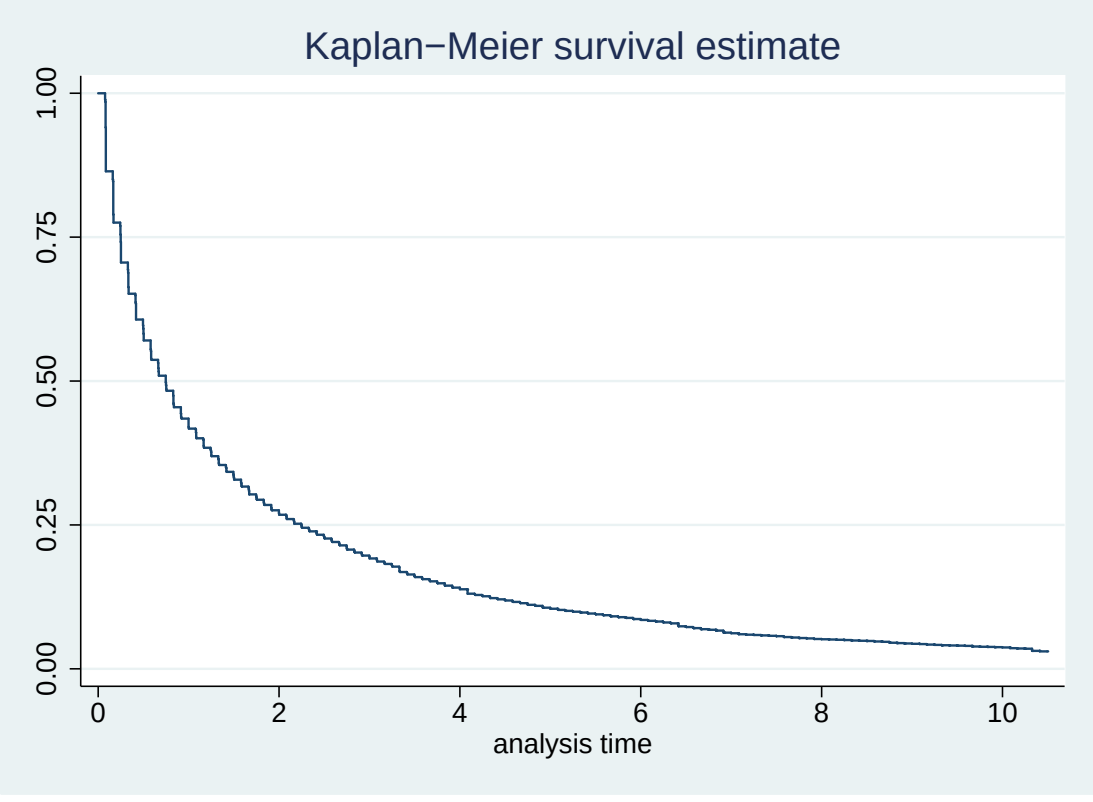
- Several ways to characterize the probability distribution of the termination decision:
  - **The survival function**; the unconditional probability of surviving beyond a given date
    - $S(t) = 1 - F(t) = Pr(T \geq t)$
  - **The hazard function**; the probability of termination, conditional of having survived so far
    - $\lambda(t) = \frac{f(t)}{S(t)}, f(t) = dF(t)/dt$

The Truncation Problem

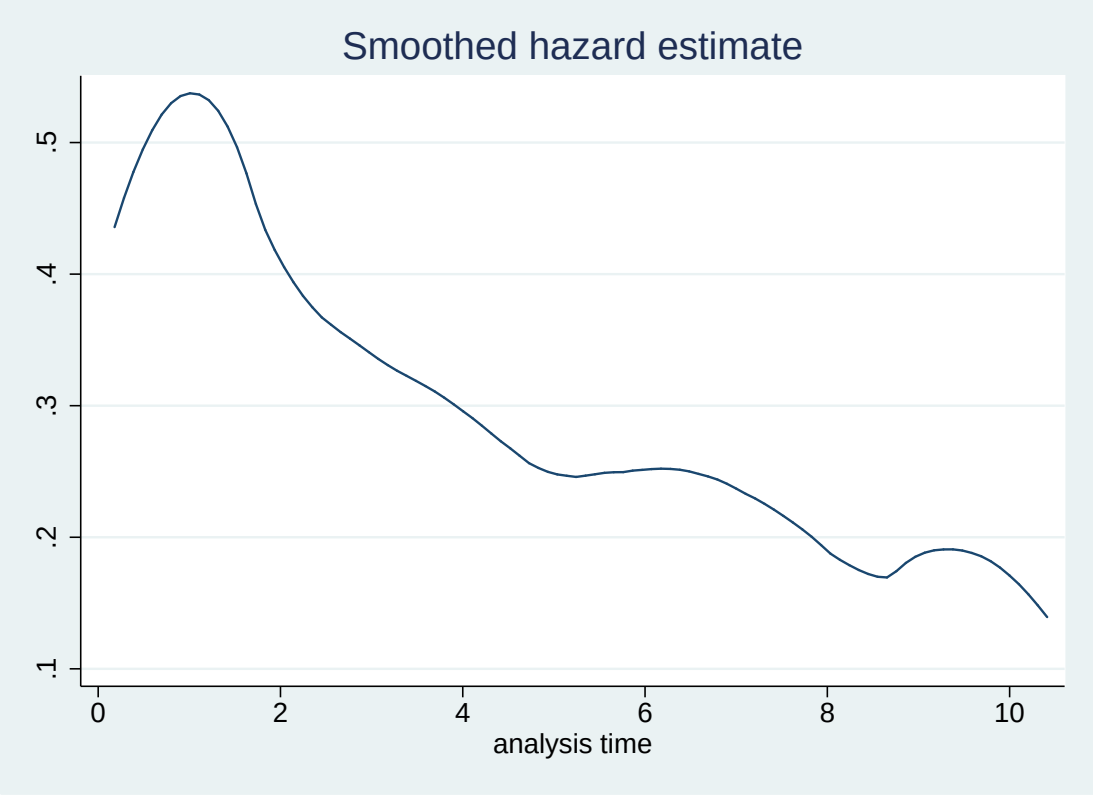


- Investor A: correctly estimated
- Investor B: right truncated
- Investor C: left truncated

Unconditional Probability Distribution



Conditional Probability Distribution



Determinants of the Hazard Function

- Hazard $= f$(observables at entry)
- Variables
  - spread (test of the AM-model)
  - firm characteristics (size, volatility)
  - investor types (financial, foreign, ..)
  - size of investment
- Ideally, we should have a theoretical model

Determinants of the Hazard Function (2)

Variable	Hazard ratio	pvalue	Prob of exit
Spread	0.0034	(0.00)	$\downarrow$
Ln(Firm size)	1.0097	(0.00)	$\uparrow$
Ln(Volatility)	1.4317	(0.00)	$\uparrow$
Financial	1.1916	(0.00)	$\uparrow$
Foreign	0.9932	(0.61)	
Non-financial	1.1157	(0.00)	$\uparrow$
Individual	0.7551	(0.00)	$\downarrow$
Ln(Investment)	0.9829	(0.00)	$\downarrow$
n	1038170		

Contribution to the hazard function:

- coefficient $= 1$, no contribution
- coefficient > 1, higher conditional probability
- coefficient < 1, lower conditional probability

Estimating Holding Period Using Turnover

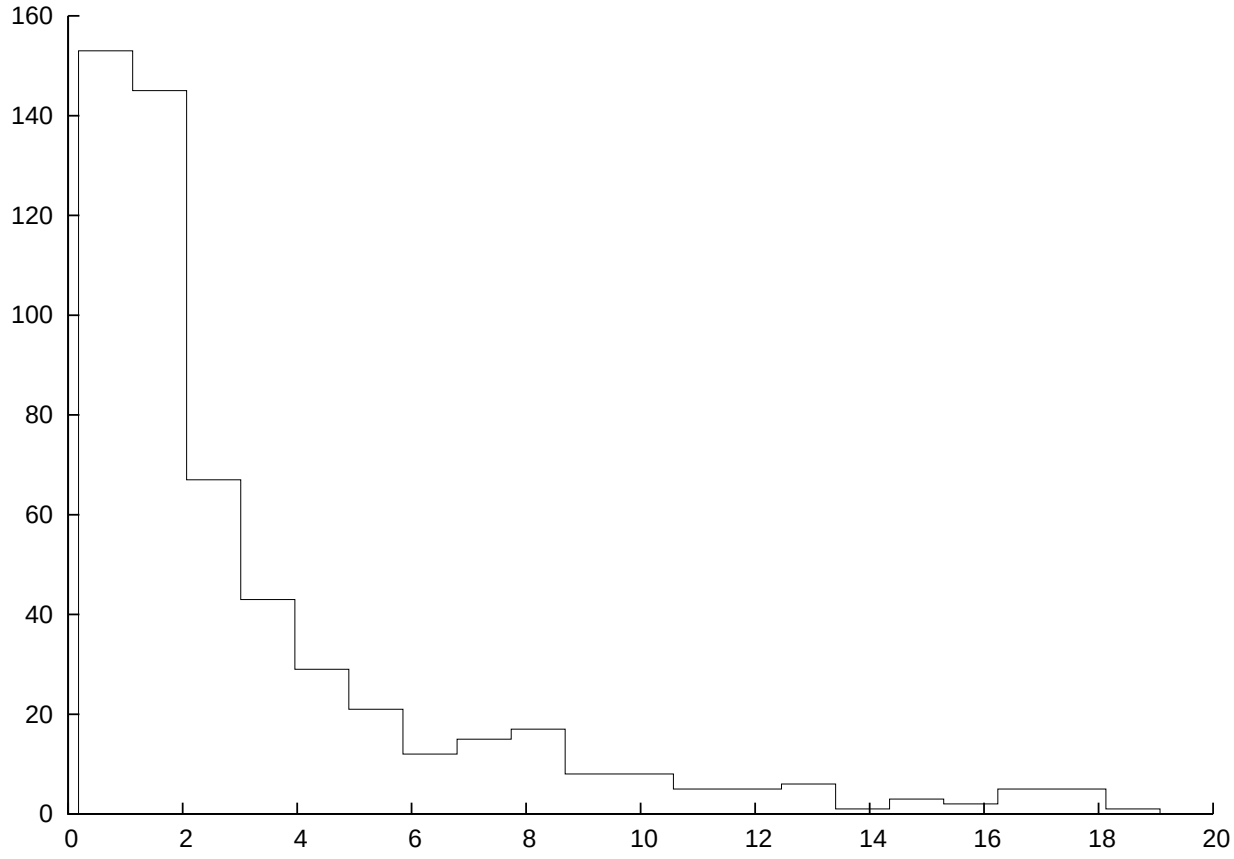
- Existing literature, e.g. Atkins and Dyl (1997)
  - Average holding period $= \frac{1}{\text{Turnover}}$
  - Turnover $= \frac{\text{no of stocks outstanding}}{\text{no of stocks traded}}$
  -

	NYSE	Nasdaq	OSE
	1975-1989	1983-1991	1992-2003
Average	6.99	4.01	3.33
Median	3.38	2.43	1.96

- Considerably longer average holding period than suggested by duration analysis

Estimating Holding Period from Turnover (2)

The distribution of average holding periods estimated as in Atkins and Dyl (1997)



Individual Decisions on Holding Period - Summary

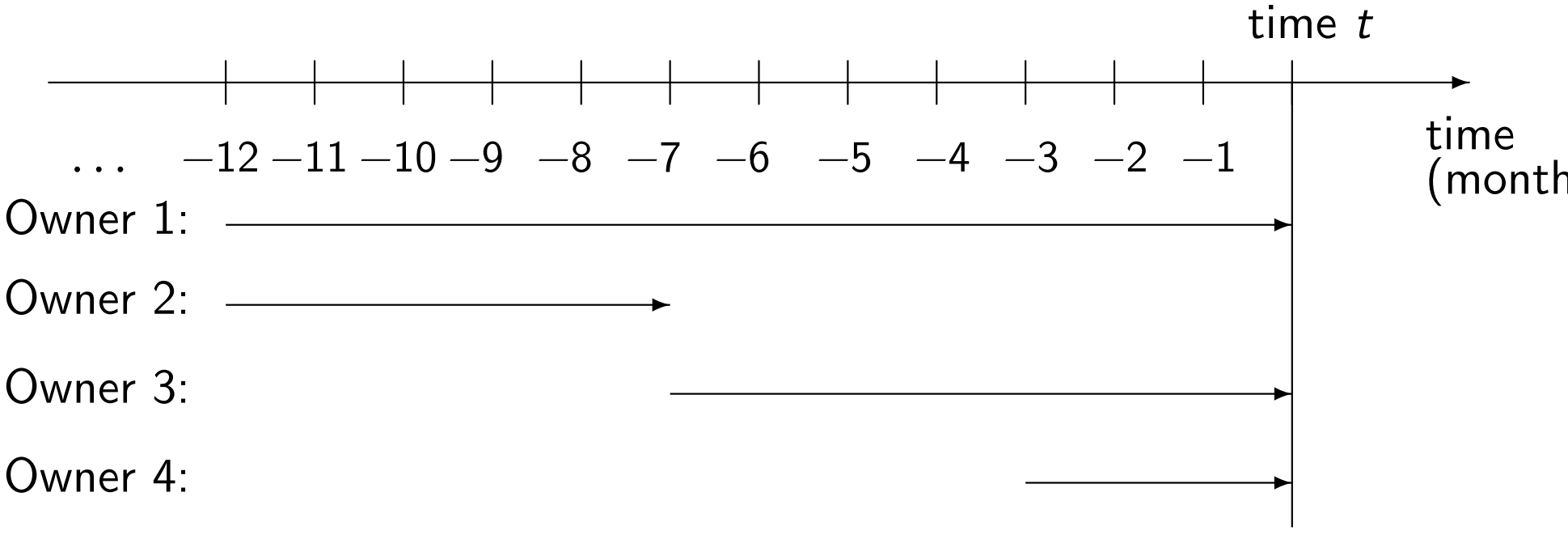
- The average holding period is around 1 year
- Considerable time variation in the conditional probability of exit
- Liquidity is important for the holding period decision
- Estimating holding period from turnover seriously overstates average holding period

Stock Level Analysis

How is a stock's liquidity related to the holding periods of its owners?

- Aggregate individual holding periods into a single measure at the stock level (holding period index)
  - What are the determinants of the holding period index?
  - How is the holding period index related to other liquidity measures
  - Does the holding period index explain the cross section of stock returns better than alternative liquidity proxies

Holding Period Index (hpi)



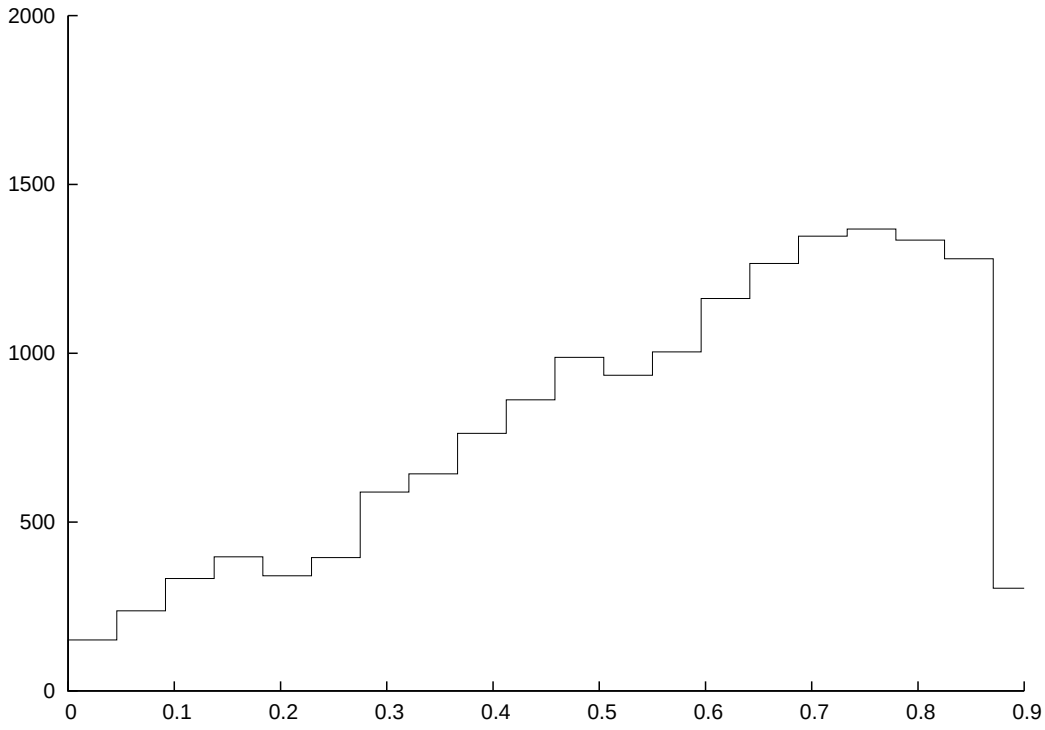
Let w_i = weight for owner $i \Rightarrow$

$$hpi = w_1 1 + w_3 \frac{7}{12} + w_4 \frac{3}{12}$$

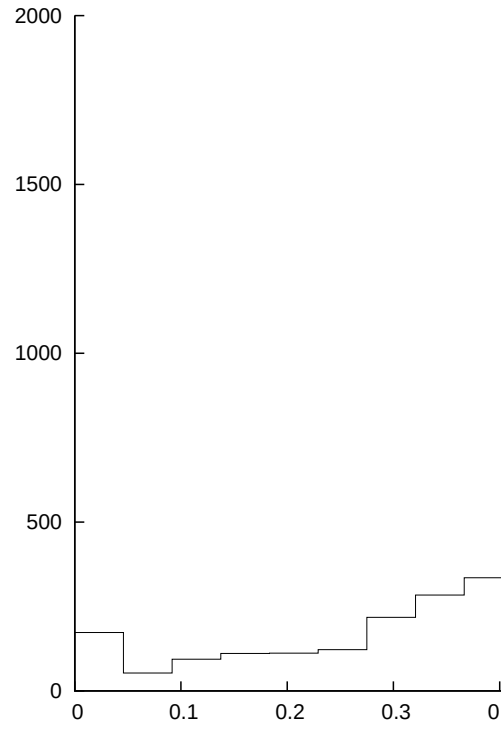
The Distribution of Holding Period Indices

The distribution of holding period indices

`hpi(ew)`



`hpi(vw)`



- Tendency that large owners have longer holding periods than small owners

The Determinants of Holding Period Indices

	hpi(ew)		hpi(vw)	
Variable	coeff	pvalue	coeff	pvalue
Constant	0.767	(0.00)	0.548	(0.00)
Ln(Firm size)	-0.023	(0.00)	-0.000	(0.98)
Stock volatility	0.579	(0.07)	0.414	(0.14)
BM ratio	0.059	(0.00)	0.036	(0.00)
Ln(Firm listing age)	0.102	(0.00)	0.038	(0.00)
Primary insider fraction	-0.122	(0.07)	0.056	(0.36)
Largest owner	0.112	(0.00)	0.130	(0.00)
n	1118		1118	
R^2	0.30		0.11	

- hpi $\uparrow \Rightarrow$ smaller firm (ew), value firm, older firm, large owner larger
- Variables related to information have no effects

The Determinants of hpi - Including Liquidity

	hpi(ew)		hpi(ew)		hpi(vw
Variable	coeff	pvalue	coeff	pvalue	
Constant	0.719	(0.00)	-0.128	(0.20)	
Ln(Firm size)	-0.013	(0.00)	0.021	(0.00)	
Stock volatility	0.695	(0.01)	-2.765	(0.00)	
BM ratio	0.036	(0.00)	0.063	(0.00)	
Ln(Firm listing age)	0.097	(0.00)	0.079	(0.00)	
Primary insider fraction	-0.099	(0.09)	-0.124	(0.04)	
Largest owner	-0.043	(0.13)	-0.012	(0.69)	
Annual turnover	-0.153	(0.00)			
Annual relative spread			4.776	(0.00)	2.622 (0
n	1118		1118		
R^2	0.50		0.46		

- Turnover end spreads affects hpi in expected ways
- Volatility turns significant, and with different signs?

The Link between hpi and Liquidity - Quartile Table

		Annual turnover	Annual relative spread
hpi(ew)			
	All	0.58	0.58
	1	0.72	0.52
	2	0.64	0.55
	3	0.55	0.57
	4	0.43	0.69
hpi(vw)			
	All	0.67	0.67
	1	0.79	0.64
	2	0.74	0.65
	3	0.67	0.67
	4	0.52	0.74

Larger hpi $\Rightarrow$ lower turnover and larger spread

The Link between hpi and Liquidity

	Correlation		Rank correlation	
	hpi(vw)	hpi(ew)	hpi(vw)	hpi(ew)
Annual turnover	-0.51	-0.51	-0.48	-0.43
Annual relative spread	0.17	0.32	0.15	0.23

- Correlations have expected signs
- Turnover is an imperfect measure of holding period

Holding Period and Returns

- What is the relationship between holding period indices and returns?
- Simple portfolio sorting on excess returns
  - Excess return = Portfolio return − Risk free return
- Standard Fama Macbeth asset pricing tests
  - one-factor model
  - three-factor specification

Excess Returns on Sorted Portfolios

10 portfolios sorted on hpi and liquidity measures

	hpi(ew)	hpi(vw)	Turnover	Spread
1	1.11	1.26	2.04	0.51
2	1.36	1.44	1.20	1.48
3	1.16	1.04	1.37	0.95
4	1.44	0.91	1.41	1.86
5	1.15	1.01	1.94	1.85
6	0.80	1.28	1.86	1.62
7	0.58	1.03	1.61	1.60
8	1.18	0.95	1.78	1.75
9	1.15	0.57	1.39	2.06
10	0.68	1.16	1.63	2.35

Fama Macbeth Analysis

Adding `hpi` and liquidity measures to a one-factor model

Example

hpi(ew)

- For each time-series observation, estimate over all firms i
  - $Return^i = \text{Constant}^i + b_1^i \hat{\beta}^i + b_2^i hpi(ew)^i$
- Take time-series averages of the coefficients
  - Constant, b_1 (Stock beta), and b_2 (hpi(ew))

	`hpi(ew)`		`hpi(vw)`		Turnover	
Constant	-0.0016	(0.89)	-0.0110	(0.28)	**0.0088**	**(0.0**
Stock beta	-0.0025	(0.45)	-0.0018	(0.61)	-0.0007	(0.8
`hpi(ew)`	0.0148	(0.27)				
`hpi(vw)`			**0.0249**	**(0.02)**		
Annual turnover					-0.0027	(0.2
Annual relative spread						
n	114		114		115	

Fama Macbeth Analysis (2)

Adding `hpi` and liquidity measures to a three-factor specification

	`hpi(ew)`		`hpi(vw)`		Tu
Constant	**0.0867**	**(0.02)**	**0.0843**	**(0.01)**	**0.086**
Stock beta	0.0027	(0.47)	0.0033	(0.36)	0.0025
ln(Firm size)	**-0.0045**	**(0.00)**	**-0.0047**	**(0.00)**	**-0.004**
BM ratio	0.0004	(0.93)	0.0007	(0.87)	0.0013
`hpi(ew)`	0.0083	(0.55)			
`hpi(vw)`			0.0163	(0.13)	
Annual turnover					-0.000
Annual relative spread					
n	114		114		115

Conclusions

Summary of Results

- Liquidity affects holding period decisions
  - low liquidity when a stock is entered into tend to result in longer holding periods
- Turnover is an imperfect measure of holding period
- Holding period is only weakly related to asset returns

Potential Explanations

- `hpi` does not measure the salient features of holding period
- Investors do react to spreads but the link between returns and microstructure variables is linked to the cause of spread differences