The Efficiency of Market Reaction to Earnings News

Bin Miao
National University of Singapore

Gillian Yeo
Nanyang Technological University

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Market Efficiency

- Is the Market Efficient?

  No consensus conclusion yet (Lo 2007)

  - The *Joint Hypothesis* problem
  - The Impossibility of efficiency markets
  - *"…perfect efficiency is an unrealistic benchmark that is unlikely to hold in practice*."

    -- Campbell, Lo, and Mackinlay 1997

Market Efficiency

"…*the notion of relative efficiency—the efficiency of one market measured against another…may be a more useful concept than the all-or-nothing view taken by much of the traditional market-efficiency literature*."

-- Campbell, Lo, and Mackinlay (1997)

"…I don't think it is a yes or no question…think about it as a continuum, where a score of 100 means prices are exactly right and a score of zero means prices are exactly wrong…"

-- Kenneth French (2001)

Research Question

This paper aims to:

1. Propose a continuous measure of market efficiency, using the event of earnings announcement

2. Examine the cross-sectional determinants of market efficiency

Literature

- Post-Earnings Announcement Drift (PEAD)

  After the announcement of quarterly earnings, equity prices continue to move in the same direction of earnings surprise for a prolonged period. (Ball and Brown 1968, Foster, Olson, and Shevlin 1984, Bernard and Thomas 1989)

Literature

- Why PEAD occurs?

Hypothesis 1 (Risk Mismeasurement): Expected return models are mis-specified, and thus “abnormal” returns are mis-calculated.

Evidence: Ball 1978, Foster, Olson, and Shevlin 1984

Risk mismeasurement is unlikely to explain the drift because the drift is observed in almost every quarter and because it is concentrated in a few days around earnings announcements. (Kothari 2001)

Hypothesis 2 (Underreaction): PEAD results from investors’ delayed reaction to earnings news.

Evidence: Bernard and Thomas 1989

Literature

- Why investors underreact?

  Hypothesis 2a: Market Imperfections

  - Transaction Costs
    - Bhushan (1994), Ng, Rusticus, and Verdi (2007), Chordia, Goyal, Sadka, Sadka, and Shivakumar (2007)
  - Limits of Arbitrage:
    - Mendenhall (2004)

Literature

- Why investors under-react?

  Hypothesis 2b: Bounded Rationality

  - Conservatism
    - Barberis, Shleifer, and Vishny (1998)
  - Overconfidence and self-attrition bias
    - Daniel, Hirshleifer, and Subrahmanyam (1998)
  - Moderated confidence
    - Bloomfield, Libby, and Nelson (2000)
  - Disposition Effect (Prospect Theory + Mental Accounting)
    - Frazzini (2005)

Literature

Earnings announcement provides an ideal setting for investigating market (in)efficiency

- PEAD is (strong) evidence that inefficiency likely exists in market reaction to earnings news
- For earnings announcements inefficiency is one-direction: underreaction more likely than overreaction

Methodology

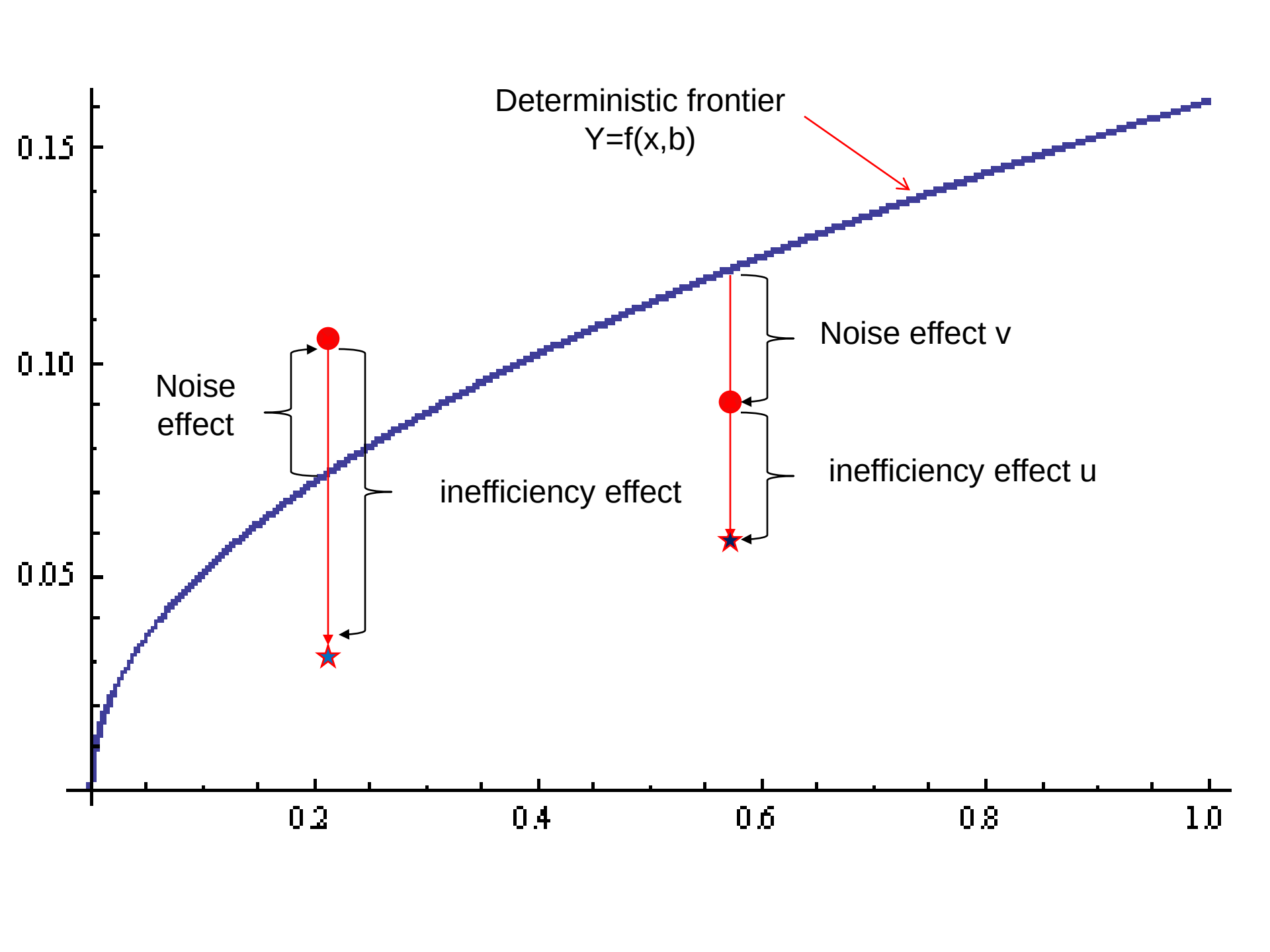
- Stochastic Frontier Analysis (SFA)

  (Aigner, Lovell, and Schmidt 1977, Meeusen and van den Broeck 1977)

$$y_i = f(x_i, \beta) + v_i - u_i$$

$$v_{i,t} \sim N(0, \sigma_v^2)$$

$$u_{i,t} \sim N^+(0, \sigma_u^2)$$


Deterministic frontier
Y=f(x,b)
Noise effect v
Noise
effect
inefficiency effect
inefficiency effect u
0.15
0.10
0.05
0.2
0.4
0.6
0.8
1.0

Applications of SFA in Capital Market Research

- IPO under-pricing

  (Hunt-McCool, Koh, and Francis 1997, *Review of Financial Studies*)

- Mutual Fund Under-performance

  (Annaert, van den Broeck, and Vennet 2003, *European Journal of Operational Research*)

- Tobin's Q and Agency Costs

  (Habib and Ljungqvist 2005, *Journal of Business*)

Application of SFA in this study:

Earnings-Return Relation Model

$$CAR_{i,t} = \alpha \cdot SUE_{i,t}^{\ \beta} \cdot ME_{i,t} \cdot \Omega_{i,t}$$

Output (Price Change)

Input (Earnings News)

Market Efficiency

Random Shock

In Logarithmic Form

$$car_{i,t} = a + \beta \cdot sue_{i,t} - u_{i,t} + v_{i,t}$$

Where

$$\ln CAR_{i,t} = car_{i,t}$$

$$\ln \alpha = a$$

$$\ln SUE_{i,t} = sue_{i,t}$$

$$\ln ME_{i,t} = -u_{i,t}$$

$$\ln \Omega_{i,t} = v_{i,t}$$

And

$$v_{i,t} \sim N(0, \sigma_v^2)$$

$$u_{i,t} \sim N^{+}(0, \sigma_u^2)$$

(Nonnegative half-normal)

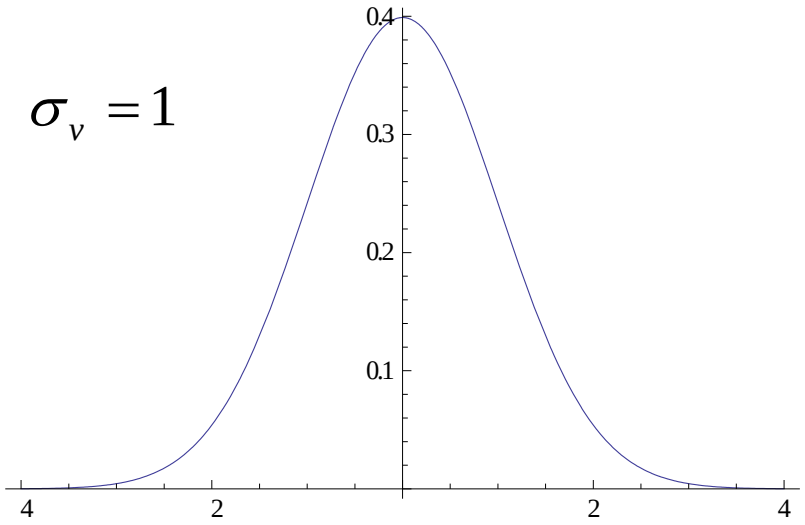
v and *u* are distributed independently of each other, and of the *sue*

Normal and Half-Normal Distribution

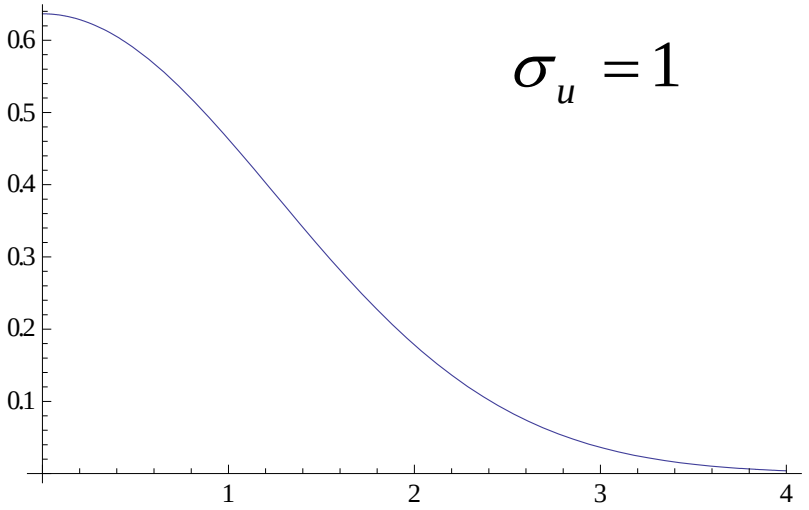
$$f(v) = \frac{1}{\sqrt{2\pi}\sigma_v} \exp\left(-\frac{v^2}{2\sigma_v^2}\right)$$

$$f(u) = \frac{2}{\sqrt{2\pi}\sigma_u} \exp\left(-\frac{u^2}{2\sigma_u^2}\right)$$

$\sigma_v = 1$



$\sigma_u = 1$



The model in a more familiar form:

$$car_{i,t} = a + b \cdot sue_{i,t} + \varepsilon_{i,t}$$

And the distribution function of ε is

$$f(\varepsilon) = \frac{2}{\sigma} \cdot \phi(\frac{\varepsilon}{\sigma}) \cdot \Phi(-\frac{\varepsilon\lambda}{\sigma})$$

where $\varepsilon_{i,t} = v_{i,t} - u_{i,t}$

$$\sigma = \sqrt{\sigma_u^2 + \sigma_v^2}$$

$$\lambda = \frac{\sigma_u}{\sigma_v}$$

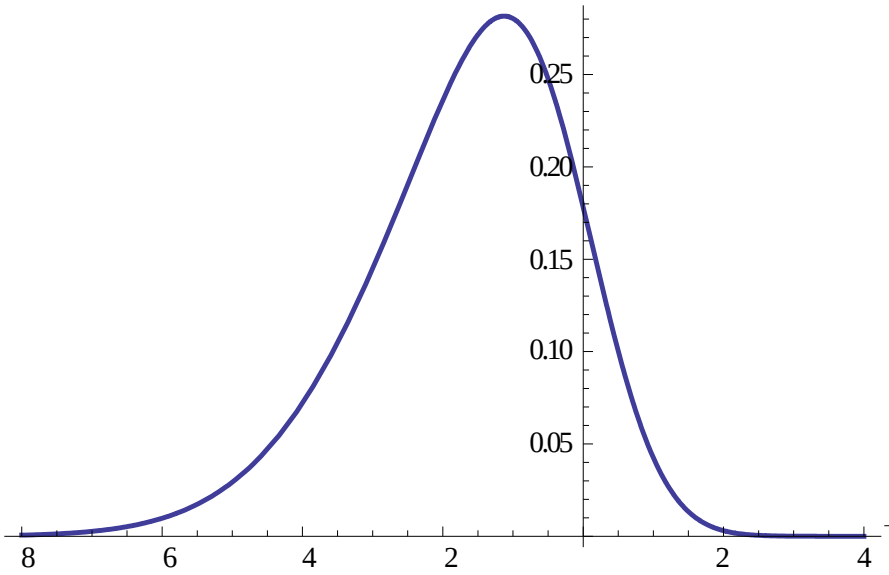
$\Phi(\cdot)$ and $\phi(\cdot)$ are the standard normal cumulative distribution and density functions

Distribution of Composed Error

$$f(\varepsilon) = \frac{2}{\sigma} \cdot \phi\left(\frac{\varepsilon}{\sigma}\right) \cdot \Phi\left(-\frac{\varepsilon\lambda}{\sigma}\right)$$

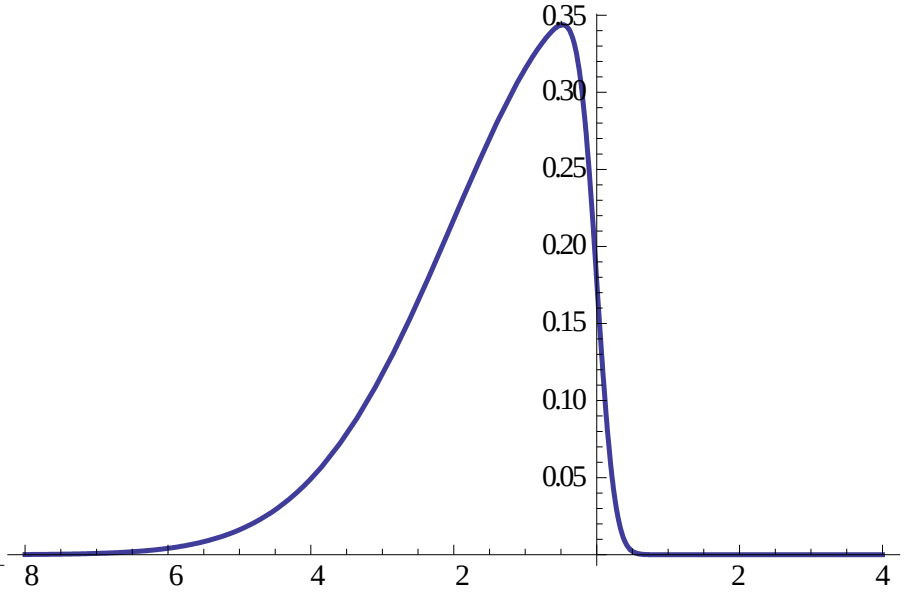
$\sigma_u = 2$

$\sigma_v = 1$



$\sigma_u = 2$

$\sigma_v = 0.2$



The log-likelihood function is

$$\ln L = const - N \ln \sigma + \sum_{i,t} \ln \Phi(-\frac{\varepsilon_i \lambda}{\sigma}) - \frac{1}{2\sigma^2} \sum_{i,t} \varepsilon_{i,t}^2$$

By maximizing the log-likelihood function, we can estimate parameters α, β, σ, and λ

Estimate for Overall Efficiency

Lee and Tyler (1978) show that the unconditional expectation of $ME = \exp(-u)$ is

$$E[\exp(-u)] = 2[1-\Phi(\sigma_u)]\cdot\exp\{\frac{\sigma_u^2}{2}\}$$

Estimate for Firm-Specific Efficiency

Battese and Coelli (1988) show that the conditional expectation of $ME_{i,t} = \exp(-u_{i,t})$ is

$$E[ME_{i,t} \mid \varepsilon_{i,t}] = \{\frac{1-\Phi[\sigma_* - (\mu^*_{i,t}/\sigma_*)]}{1-\Phi(-\mu^*_{i,t}/\sigma_*)}\} \cdot \exp(-\mu^*_{i,t} + \frac{1}{2}\sigma^2_*)$$

Where

$$\mu^*_{i,t} = -\frac{\varepsilon_{i,t} \cdot \sigma^2_u}{\sigma^2} \qquad \sigma^2_* = \frac{\sigma^2_u \cdot \sigma^2_v}{\sigma^2}$$

Finally, market's under-reaction to earnings news can be calculated as

$$UR_{i,t} = (\frac{1}{ME_{i,t}} - 1) \cdot CAR_{i,t}$$

Data and Variables

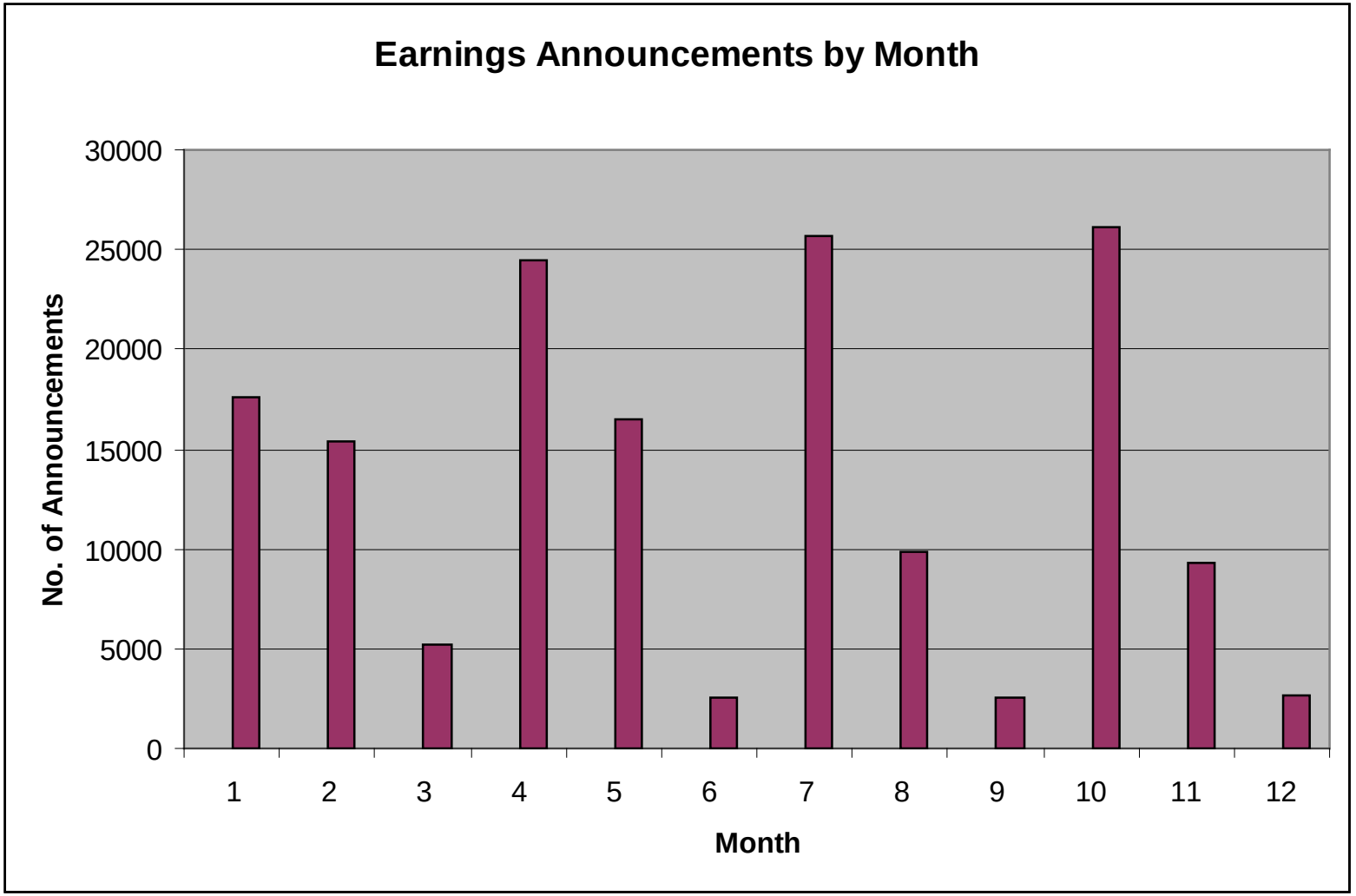
- Main Variables:
  - Earnings Surprises (*SUE*): actual EPS minus mean EPS forecasts (both from I/B/E/S summary file), scaled by share price one day before the earnings announcement window.
  - Cumulative Abnormal Return (*CAR*): size-adjusted cumulative return over a three-day window (-1,0,1) (day 0 is the quarterly earnings announcement date on COMPUSTAT)

Data Cleaning Procedures

- Common stock only
- Earnings announcement date from COMPUSTAT and IBES must match
- At least two forecasts for calculating consensus
- *SUE* truncated to between -1 and 1
- Portfolios of earnings announcement firms
  - 10 *SUE* decile portfolios each calendar month
  - At least 30 stocks in each portfolio
  - Average *SUE* and *CAR* of all firms within each portfolio used as portfolio *SUE* and *CAR*
  - Portfolio SUE × CAR > 0

Sample Earnings Announcements

1,251 portfolios, consisting of 110,881 quarterly earnings announcements from 1985 to 2005



Sample and OLS Results

Panel A: Summary Statistics of Key Variables

	Good News (SUE>0; N=689)			Bad News (SUE<0; N=562)		
Variable	Mean	Median	Std Dev	Mean	Median	Std Dev
SUE	0.005	0.002	0.009	-0.013	-0.003	0.022
AR	0.021	0.018	0.014	-0.018	-0.015	0.014
LOG(|SUE|)	-6.232	-6.397	1.429	-5.850	-5.932	1.994
LOG(|AR|)	-4.197	-3.990	0.970	-4.342	-4.197	0.956

Panel B. OLS Regression Results

News	Sample Size	Intercept	Log(|SUE|)	Adj-R^2	F-stat
Good (SUE>0)	689	-1.933 (-13.8)	0.363 (16.6)	0.286	275.6
Bad (SUE<0)	562	-3.137 (-27.7)	0.206 (11.3)	0.183	126.8

MLE Estimates of Stochastic Frontier Model

Parameters	Good News (SUE>0 N=689)	Bad News (SUE<0 N=562)
Alpha	-1.825	-2.393
Beta	0.232	0.159
Sigma	1.252	1.339
Lamda	4.419	4.270
Sigma_V	0.276	0.305
Sigma_U	1.221	1.303
ME_LT	0.468	0.450
Alpha_OLS	-1.933	-3.137
Beta_OLS	0.363	0.206

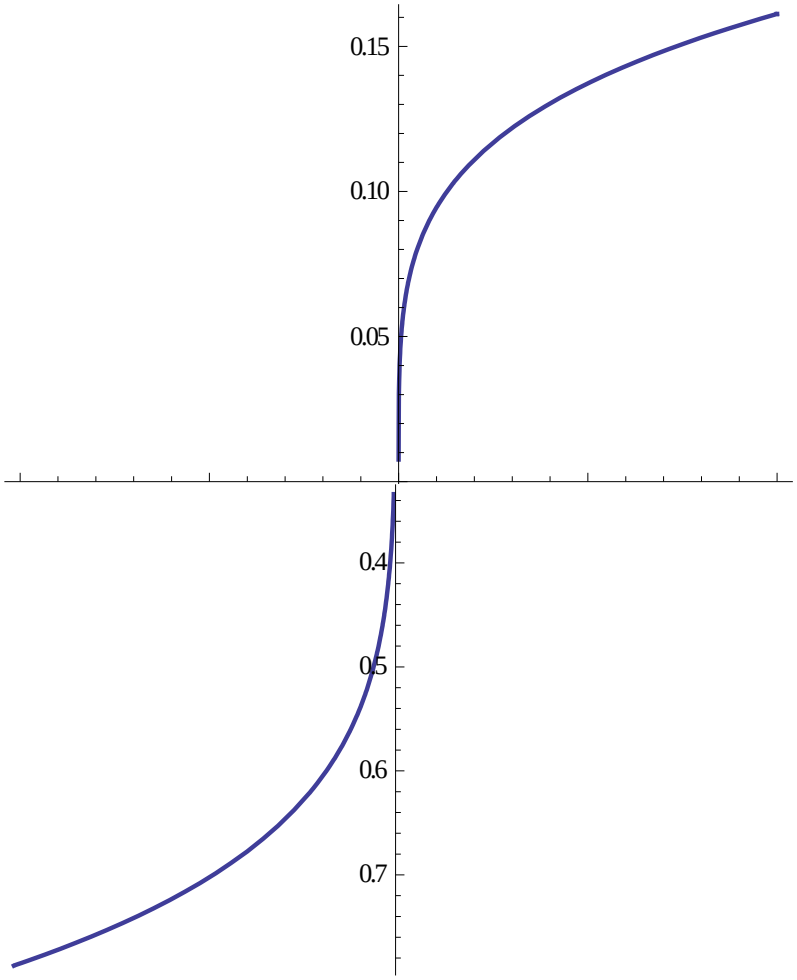
Deterministic Frontier Defined by Estimated Earnings-Return Relation

Good News

$$CAR = 0.16 \cdot SUE^{0.232}$$

Bad News

$$CAR = 0.09 \cdot SUE^{0.159}$$



Portfolio-Specific Estimates

Panel A. Summary statistics of portfolio-specific market efficiency estimates

News	Mean	Median	Std Dev	Q1	Q3	Max	Min
Good News (SUE>0; N=689)	0.505	0.502	0.256	0.310	0.691	0.988	0.007
Bad News (SUE<0; N=562)	0.474	0.453	0.266	0.255	0.680	0.986	0.006

Panel B. Summary statistics of portfolio-specific under-reaction estimates

News	Mean	Median	Std Dev	Q1	Q3	Max	Min
Good News (SUE>0; N=689)	-0.018	-0.018	0.010	-0.024	-0.011	0.000	-0.049
Bad News (SUE<0; N=562)	-0.018	-0.018	0.010	-0.024	-0.011	0.000	-0.049

Determinants of Market Efficiency

- Arbitrage Risk (*ABRISK*): residual return volatility (*negative*) $R_{i,t} = \alpha_i + \beta_i \cdot R_{m,t} + \varepsilon_{i,t}$
- Illiquidity (*ILLIQ*): price change divided by trading volume $ILLIQ = \frac{1}{D_{i,t}} \sum_{d=1}^{D_{i,t}} \frac{|R_{itd}|}{DVOL_{itd}} \times 10^6$ (*negative*)
- Analyst Following (NUMEST): number of analyst forecasts (*positive*)

Determinants of Market Efficiency

- Transaction Costs (*PRC*, *DVOL*): average price and dollar trading volume (*positive*)
- Information Uncertainty (*STDEV*): standard deviation of earnings forecasts (*negative*)
- Institutional Ownership (INST): shares owned by institutional investors (*positive*)
- Firm Size (*MV*): market value of equity (*positive*)

Determinants of Market Efficiency

Partial Correlation between market efficiency and its determinants conditional on the absolute value of abnormal return |*CAR*|

	Good News (SUE>0) N=689	Bad News (SUE<0) N=562
MV	0.454	0.632
DVOL	0.347	0.586
PRC	0.459	0.504
STDEV	-0.745	-0.804
NUMEST	0.450	0.634
INST	0.419	0.619
ARBRISK	-0.062 [c]	-0.155
ILLIQ	-0.335	-0.516

Does Under-reaction explain PEAD?

Model (1)

$$CAR(n) = \alpha + \beta \cdot SUE + \varepsilon$$

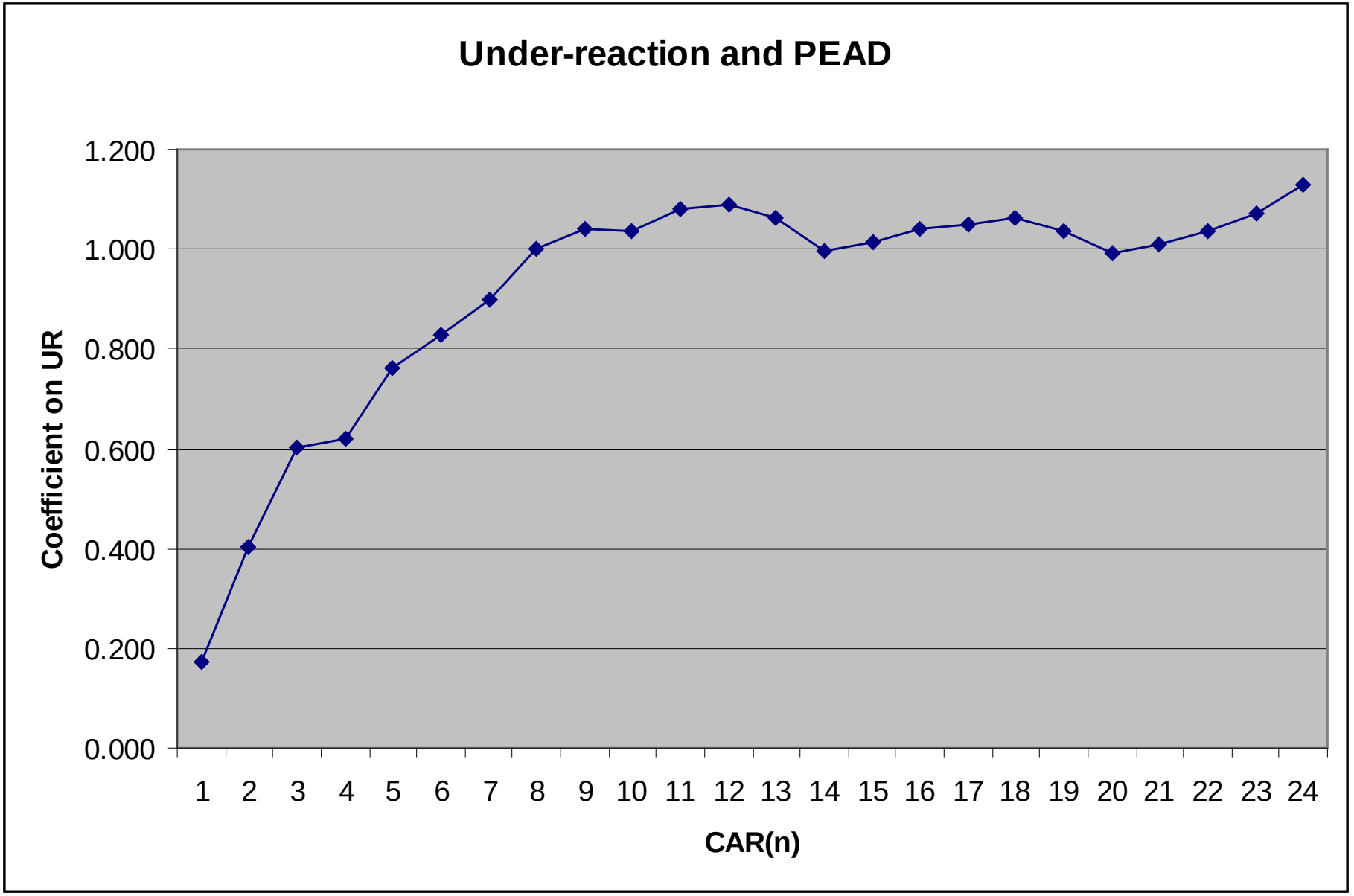
Model (2)

$$CAR(n) = \alpha + \beta \cdot SUE + \gamma \cdot UR + \varepsilon$$

Model (3)

$$CAR(n) = \alpha + \beta \cdot UR + \varepsilon$$

	MODEL1		MODEL2	MODEL3
CAR (n)	SUE	UR	SUE	UR
1	0.293***	0.031	0.274***	0.171***
2	0.324***	0.351***	0.102	0.403***
3	0.437***	0.560***	0.081	0.602***
4	0.522***	0.521***	0.191*	0.619***
5	0.566***	0.697***	0.124	0.760***
6	0.636***	0.747***	0.162	0.830***
7	0.827***	0.706***	0.379***	0.900***
8	0.880***	0.817***	0.362**	1.002***
9	0.938***	0.828***	0.413**	1.039***
10	0.888***	0.860***	0.342*	1.035***
11	0.931***	0.896***	0.363*	1.081***
12	0.913***	0.920***	0.329*	1.088***
13	1.010***	0.811***	0.495**	1.065***
14	0.893***	0.801***	0.385*	0.998***
15	0.839***	0.868***	0.288	1.016***
16	0.910***	0.852***	0.369*	1.041***
17	0.840***	0.916***	0.259	1.049***
18	0.820***	0.954***	0.214	1.064***
19	0.863***	0.880***	0.305	1.036***
20	0.734***	0.911***	0.156	0.991***
21	0.773***	0.911***	0.195	1.010***
22	0.738***	0.972***	0.121	1.034***
23	0.784***	0.993***	0.154	1.072***
24	0.840***	1.035***	0.183	1.129***


Under-reaction and PEAD
Coefficient on UR
1.200
1.000
0.800
0.600
0.400
0.200
0.000
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24
CAR(n)

Summary of Findings

- On average, the efficiency of market reaction to earnings news is about 50% for the past two decades (1985-2005)

- Market efficiency varies significantly across firms, and is higher for firms with larger market capitalization, more analyst following, lower transaction cost, less information uncertainty, higher institutional ownership, higher liquidity, and lower arbitrage risk.

- The market's under-reaction to earnings news predicts hedged return of as much as 11.2% in the post-announcement period.

Future Research

- Is the efficiency estimate sensitive to alternative earnings-return models?
- Better technologies to address the potential omitted variable problem?
- Other settings to apply the SFA model?
  - o Discretionary accrual model
  - o Book-to-market ratio and conservatism