Imperfect Competition, Information Asymmetry, and Cost of Capital

Judson Caskey, UT Austin

John Hughes, UCLA

Jun Liu, UCSD

Institute of Financial Studies

Southwestern University of Economics and Finance

July 3, 2012

Outline

- An Empirical Regularity on Cost of Capital
- APT and Some Clarification
- A Model of Imperfect Competition
- Information Asymmetry and Cost of Capital: Perfect Competition
- Information Asymmetry and Cost of capital: Imperfect Competition
- Conclusion

P/E Ratio of an Opaque Firm

Samsung and Sony are similar but Samsung has a lower P/E ratio

$$P = \frac{D}{r - g}$$

There are potentially two contributing factors

1. Samsung has a lower expected cash flow (lemon problem): numerator effect
2. Does Samsung also has higher discount rate? denominator effect

Empirical Findings

Firms with higher information asymmetry have higher cost of capital, after controlling for beta

Modern Asset Pricing

- Theory: risk premium is determined by beta: CAPM and APT
- This is at odds with previously-mentioned empirical regularity: risk premium is not determined just by beta (information asymmetry etc.)

Empirical Tests of Asset Pricing Models

- Most cross-sectional tests of asset pricing models assumes that the Arbitrage Pricing Theory (APT) holds
- Deviations from APT are called anomaly

Terminology

- Factor models are models of risk (shocks)
- Arbitrage Pricing Theory (APT) is a asset pricing theory that specifies the risk premium for factor models

APT Is Not a Result of No Arbitrage

- The risk premium depends on preferences towards risk
- Arbitrage Pricing Theory (APT) is stronger than equilibrium (not to mention no arbitrage)
- Diversification alone is not enough
- The degree of risk aversion needs to be specified

Example

- One period, N assets with ID payoffs

$$\pi_i = \beta F + \sigma \epsilon_i$$

- CARA/normal: risk premium $= A(N\beta^2\sigma_F^2 + \sigma^2)$
- CRRA/log-normal: qualitatively same; idiosyncratic risk premium will not be zero as long as N is finite

A Model of Imperfect Competition

- Imperfect Competition: trades affect price
- Symmetric (same strategy) Nash equilibrium: optimal strategy given other agents' strategy
- Price impact of agent m: $p(x_m) = p_U + \lambda x_m$

  profit: $(v - p)x_m = (v - p_U - \lambda x_m)x_m$

  Utility equivalent: $(\bar{v} - p_U)x_m - \frac{A}{2}\sigma_v^2 x_m^2 - \lambda x_m^2$

  Optimal trade: $x_m = \frac{\bar{v} - p}{A\sigma_v^2 + \lambda}$

  Price impact acts as an extra risk aversion: $\lambda = \frac{A\sigma_v^2}{M-2}$

  Equilibrium risk premium: $\bar{v} - \bar{p} = \frac{\bar{z}}{M} A\sigma_v^2 \frac{M-1}{M-2}$

Literature

- Information asymmetry seems to lead higher cost of capital
- Grossman and Stiglitz (AER, 1980) and Admati (Econometrica, 1985)

  Easley and O'Hara (JF, 2004)
- Information asymmetry is idiosyncratic, why should it affect cost of capital?
- Hughes, Liu, and Liu (AR, 2007) and Lambert, Leuta, and Verrecchia (JAR, 2007): perfect competition; same conclusion
- Caskey, Hughes, and Liu (2011) and Lambert and Verrecchia (2011): imperfect competition; different conclusion

Questions

- Informed may affect market prices
- If uninformed is a price taker, APT still holds, even if the insider's trades affect the price
- Kyle (ReStud, 1989) and Vayanos and Wang (2011): single asset

The Contribution of This Paper

1. We solve a noisy rational expectations equilibrium model with
   - a monopolist informed trader and price-taking uninformed traders
   - multiple assets with payoffs following a factor model
2. We show that controlling for beta, there are no asymmetric information effects on cost of capital, in the large economy limit

This result complements results of previous studies with perfectly competitive informed traders; raises issues regarding what may be driving empirical findings of an association between cost of capital with information asymmetries.

Theory: First Thought

- Firms with higher information asymmetry have higher volatility
- Thus, they should have a higher cost of capital
- Easley and OHara (JF, 2004)

Theory: Further Consideration

- Cost of capital is determined by exposure to systematic risk, not by total volatility
- Information asymmetry, if pertaining to idiosyncratic risk, should not affect the systematic risk exposure
- Thus, information asymmetry should not affect cost of capital, after controlling for beta
  - Hughes, Liu, and Liu (AR, 2007)
  - Lambert, Leuz, and Verrecchia (JAR, 2007)

Theory: Recent Development

What happens if informed agent is a monopolist

- Lambert and Verrecchia (2007) shows there is effect on cost of capital
- Our work shows that the effect goes away in the large economy limit

Other Related Literature

- Kyle (ReStud, 1989) studies relation between imperfect competition and liquidity: both informed and unformed have price impact
- Vayanos and Wang (2011) study interaction between liquidity and information asymmetry
- Their set up is similar except that they have a single asset

Setup: Agents

- Risk-neutral informed agent with price impact (monopolist) as in Kyle (1985)

  $$\max \mathrm{E}_I[y'(v - p(y))]$$

  I is the informed information set; y is the amount invested; $v - p(y)$ is the profit; y affects p directly (thus price impact)

- CARA price-taking uninformed agents as in standard noisy rational expectation equilibrium (NREE) models

  $$\max \mathrm{E}_U[\exp(-A(d'(v - p))]$$

  A is the CARA coefficient; d is the amount invested

Setup: Assets

N assets with payoff

$$\bar{v} + \beta f + \Sigma^{1/2}\epsilon$$

$\bar{v}$ and β are constant N-vectors, Σ is a diagonal N-matrix

f is a normal random variable, while ϵ is an N-vector of normal random variables

The asset supply x is a N-vector of normal random variables with a mean of $\bar{x}$ and covariance matrix Σ_x

Setup: A Hybrid of Kyle and NREE

- Relative to Kyle (1985)

  Multiple assests

  Risk-averse uninformed agents

- Relative to NREE

  Informed agent is a monopolist (non price-taking) and risk neutral

Solution: Price Impact

The price impact is assumed to have the form

$$p = \mu + \Lambda(y - (x - \bar{x}))$$

μ is a constant N-vector and Λ is a constant $N \times N$ matrix

As in Kyle (1985), Λ measures price impact/liquidity

Extension to Kyle: off-diagonal elements of Λ measure price impact between assets

Solution: Informed Trade and Noisy Signal

The informed observes ϵ. The optimal informed trade has the form

$$y = (\Lambda + \Lambda')^{-1}(\bar{v} + \Sigma^{1/2}\epsilon - \mu)$$

The price has the form

$$p = \bar{v} - \Lambda(\Lambda + \Lambda')^{-1}(\bar{v} - \mu) + \Lambda(\Lambda + \Lambda')^{-1}(\Sigma^{1/2}\epsilon - (\Lambda + \Lambda')(x - \bar{x}))$$

The uninformed agent observes the price thus learns signal
$s = \Sigma^{1/2}\epsilon - (\Lambda + \Lambda')(x - \bar{x})$ but not ϵ itself

Solution: Uninformed Trade

The uninformed trade is given by the mean-variance theory

$$d = \frac{1}{A}\Sigma_{v|s}(\mathrm{E}[v|s] - p)$$

with $\mathrm{E}[v|s]$ being the mean and $\Sigma_{v|s}$ being variance conditioning on the price p/signal s

When $N = 1$ and $A \to 0$, the solution reduces to Kyle (1985)

Solution: The Equilibrium

The market clearing condition is

$$x = y + D$$

This leads to an equation that is affine function of signal s. Equating the coefficients, we obtain an equation for the matrix Λ

$$(\Lambda + \Lambda')\Sigma_x(\Lambda + \Lambda')\Sigma^{-1}(\Lambda - A\beta\Sigma_F\beta' - A\Sigma) - \Lambda' - A\beta\Sigma_F\beta' = 0$$

This is a cubic equation for an $N \times N$ matrix Λ; it should have multiple solutions. Rely on economics to choose the unique one.

For example, if $N = 1$, the unique positive root; two more examples later

Solution: The Equilibrium Price

The equilibrium price is

$$p = \bar{v} - A\Sigma_{v|s}(A\Sigma_{v|s} + \Lambda')^{-1}\Lambda'\bar{x} + \Lambda(\Lambda + \Lambda')^{-1}(\Sigma^{1/2}\epsilon - (\Lambda + \Lambda')(x - \bar{x}))$$

$\Sigma_{v|s}$ and $A\Sigma_{v|s}$ are expressed in terms of parameters of model and Λ. Thus, given Λ, the price is determined

Solution: Special Case 1

When $\Sigma_x \to 0$, Λ is given by

$$\Lambda \to \frac{1}{2}\Sigma^{1/2}\Sigma_x^{-1/2}$$

The price is given by

$$\begin{aligned} p &= \bar{v} - A(\frac{1}{2}\Sigma + \beta\Sigma_F\beta')\bar{x} + \frac{1}{2}(\Sigma^{1/2}\epsilon - \Sigma^{1/2}\Sigma_x^{-1/2}(x - \bar{x})) \\ &= \bar{v} - A(\frac{1}{2}\Sigma + \beta\Sigma_F\beta')\bar{x} + \frac{1}{2}(\Sigma^{1/2}\epsilon - \Sigma^{1/2}\Sigma_x^{1/2}\epsilon_x) \end{aligned}$$

The price almost reveals ϵ and has maximal information content

Λ is diagonal and its diagonal elements are same as Kyle's lambda

The demand of assets by and the profit to the informed are zero

The idiosyncratic variance is reduced by a half

The risk premium is completely determined by uninformed agents

Solution: Special Case 2

When $\Sigma_x \to \infty$, the (non-diagonal) Λ matrix is given by

$$\Lambda \to A(\beta \Sigma_F \beta' + \Sigma)$$

The equilibrium price is given by

$$\begin{aligned} p &= \bar{v} - \frac{A}{2}(\Sigma + \beta\Sigma_F\beta')\bar{x} + \frac{1}{2}(\Sigma^{1/2}\epsilon - 2A(\Sigma + \beta\Sigma_F\beta')(x - \bar{x})) \\ &= \bar{v} - \frac{A}{2}(\Sigma + \beta\Sigma_F\beta')\bar{x} + \frac{1}{2}(\Sigma^{1/2}\epsilon - 2A(\Sigma + \beta\Sigma_F\beta')\Sigma_x^{1/2}\epsilon_x) \end{aligned}$$

The price has minimal information content

The demand of assets by and the profit to the informed are determined by price impact concern, not information

Neither idiosyncratic nor systematic variance is affected; uninformed agents act as if there is no information asymmetry

The Large Economy Limit

The expected return dictated by Arbitrage Pricing Theory is only obtained in the limit when $N \to \infty$ and $A \to 0$ such that $NA \to$ constant

This is case when there is no information asymmetry. Also the case when informed agent is price taking (Hughes, Liu, and Liu (AR, 2007))

Lambert and Verrecchia (2010) does not take this limit and reaches opposite conclusion

Cost of Capital In The Large Economy Limit

In the APT limit, the cost of capital is determined by beta as required by APT,

$$\mathrm{E}[\bar{v} - p] = \beta A \Sigma_F \beta' \left(I + \Lambda'^{-1} A \Sigma_{v|s} \right)^{-1} \bar{x}$$

This is the form dictated by APT: the risk premium is determined by β alone

The information asymmetry only affects the factor risk premium which is given by

$$A \Sigma_F \beta' \left(I + \Lambda'^{-1} A \Sigma_{v|s} \right)^{-1} \bar{x}$$

Controlling for beta, there is no effect of information asymmetry on cost of capital

Cost of Capital: Special Cases

1. When $\Sigma_x \to 0$,

$$\mathrm{E}[\bar{v} - p] \to A(\frac{1}{2}\Sigma + \beta\Sigma_F\beta')\bar{x}$$

   In the large economy limit,

$$\mathrm{E}[\bar{v} - p] \to A\beta\Sigma_F\beta'\bar{x}$$

2. When $\Sigma_x \to \infty$

$$\mathrm{E}[\bar{v} - p] \to \frac{A}{2}(\Sigma + \beta\Sigma_F\beta')\bar{x}$$

   In the large economy limit,

$$\mathrm{E}[\bar{v} - p] \to \frac{A}{2}\beta\Sigma_F\beta'\bar{x}$$

   The monopoly demand reduces supply by a half

Discussion

What happens in other settings: multiple periods? limited liability?

Conjecture: APT holds with information asymmetry, as long as it holds without information asymmetry. Thus, after controlling for beta, there is no cost of capital effect

This is at odds with empirical findings

Reinterpretation? Market frictions? Time variation? Given up on APT (small number of assets; can of worms)?

Information asymmetry on the distribution (Armstrong, Banerjee, and Corona (2010)) instead of on the realization

Noise?

Suppose that the market price and the fundamental value differ by a random noise

There is no difference in cost of capital between firms with different degree of information asymmetry using fundamental value

The Jensen effect will lead to a higher cost of capital for firms with a higher information asymmetry because these firms have higher volatility

Conclusion

We solve a model with a strategic informed traders and price-taking uninformed traders. We show that, in the large economy limit,

- Information asymmetry only affects factor risk premium
- There is no cost of capital effects after controlling for beta

This complements earlier results with price-taking informed traders.

It raises the issue on how to interpret empirical findings that associate higher cost of capital with higher information asymmetry