Moral Hazard and Excess Returns

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Consider a Manager with two Roles

Executive

- can raise the company's value by working hard (costly effort)
- known identity

Trading Investor

- holds shares of the company and can trade them on the market
- trades anonymously

Let us call someone with these two properties a "Distinguished Player"

Asset Pricing vs. Game Theory?

⟶ at which price is a company with DP traded?

asset pricing intuition

→ distinguished player is "priced in": stock price anticipates increased value in expectation

game theory intuition

→ if stock price fully anticipates value increasing effort, distinguished player should sell instead and save on effort cost: moral hazard problem

?

We formalize and solve this puzzle:

consider two periods

1. anonymous market for shares of a firm with outside investors and distinguished player, standard asset pricing model

2. effort decision of distinguished player, standard corporate finance moral hazard problem

→ study two classes of equilibria

Equilibria

1. **true value equilibria**: trade at the anticipated equilibrium value

2. **excess returns equilibria**: trade strictly below anticipated equilibrium value yields higher payoffs for buyers

Our Main Results

1. true value equilibria do not exist in realistic settings: call auction markets with continuous effort, this formalizes the paradox

2. excess returns equilibria exist in the same context and are robust w.r.t. (i) trading costs (ii) noise traders and price taking behavior (iii) discrete vs continuous effort (iv) specification of the market mechanism

…Main Results

3. …excess returns equilibria do not exist without a distinguished player

→ together:

Distinguished Player-Hypothesis: Excess returns for companies with a publicly perceived distinguished player — relative to the whole market — are consistent with this model.

→ More on empirical valididy: v.Lilienfeld & Rünzi (2010)

Consequences for No-Arbitrage, Strategic Players

- generalize no-arbitrage towards a game theoretic understanding, no player can strictly improve by deviating, however:

- in excess returns equilibria buyers strictly gain and sellers strictly loose by trading below the correctly anticipated price, clearly at odds with efficient markets hypothesis: Public and private information is “priced in”

- **strategic players**: in an excess returns equilibrium there are traders – besides the distinguished player – who understand that buying more can bid up the market price → DP sells → low effort → low firm value → everyone worse off. We show in a continuum trader model with noise: This reasoning is consistent with price taking behavior

Further Consequences of our Results
(among many others)

- Equity Premium “Puzzle”: If DP-companies on average outperform stock-market we expect that the stock market as a whole containing DP-companies outperforms a benchmark portfolio without DP assets — such as government bonds — on average even when we correct appropriately for risk

- excess returns equilibria are also consistent with price drop at expiration of IPO-lock-up agreements (v.Lilienfeld 2005), another known “anomaly” inconsisent with efficient markets

What is this?

- Finance…
  - Asset pricing anomalies
  - No-arbitrage and efficient markets hypothesis
  - Corporate finance

- Games and Price Mechanisms
  - “Killer” Application of a Large Game
  - Characterization of Equilibria for General Price Mechanisms
  - Details depend on Price Mechanism

Literature (1): Market Games with Large Shareholders

True value equilibria following asset pricing intuition: among others

- Shleifer and Vishny (1986)
- Admati, Pfleiderer and Zechner (1994)
- Maug (1998)
- Kahn and Whinton (1998)
- Magill and Quinzii (2002)
- DeMarzo and Urosevic (2006)
- Admati & Pfleiderer (2005)

→ analyze consequences of large shareholders; more general than our paper in other respects as incomplete information, dynamics, however:

→ by assumption focus almost exclusively on what we call true value equilibria, market mechanism is specific

Literature (2) Excess Returns, Pivotalness

- Bolton and von Thadden (1998)
  → excess returns equilibria may exist but implications are not discussed, relationship to asset pricing is not an issue

- Bagnoli and Lipman (1985), Holmstrom and Nalebuff (1992);
  → related concept of pivotalness. There: pivotalness solution to free rider problem in takeover games (Grossman and Hart, 1980)

- Gorton and He (2006)

- von Lilienfeld-Toal and Ruenzi (2010) → testing DP-hypothesis

Empirical Evidence: v.Lilienfeld-Toal and Ruenzi (2010)

confirm our prediction and show that

value-weighted portfolio consisting of all S&P 500 firms (1994-2005) in which the CEO holds more than 10% of the company's stocks

significantly outperforms the total market portfolio by 13% p.a.

asset pricing theorists call this sort of observation an "asset pricing anomaly"

Simple example

- consider four players $i \in I = \{0, 1, 2, 3\}$
  0 is poor but a genius!
  1,2,3 are rich
- ownership $(\alpha_0, \alpha_1, \alpha_2, \alpha_3) = (1, 1, 1, 1)$
- value $\underline{v} = 0$ $\bar{v} = 40$
- costly effort $e \in \{0, 1\}$ $c(e) = 4e$
- payoffs without market $(u_0, u_1, u_2, u_3) = (6, 10, 10, 10)$

introduce market game

- strategies: can buy or sell 1 unit at price

$$p_i^b \in \{0, 1, \ldots, 10\}$$
$$p_i^s \in \{0, 1, \ldots, 10\}$$

- player 0 can only sell (too poor to buy)
- players 1, 2 are rational
- player 3 is a noise trader

The noise trader $i = 3$ is assumed to do nothing with probability $1 - \lambda$, to submit a sell market order $p_3^s = 0$ with probability $\frac{\lambda}{2} \geq 0$ and to submit a buy market order $p_3^b = 10$ with probability $\frac{\lambda}{2}$ (negative and positive liquidity shocks).

market mechanism

- Trade if and only if there is at least one buy and one sell order with $p_j^s \leq p_i^b$.
- Trade volume maximization…
- Price priority…
- Realized price: Executed selling price

- No equilibrium at price $p^* = 10$ exists! Why? Player 0 could sell at $p_0^s = 9$

Excess returns equilibrium

- However, there exists a trade equilibrium at price 6. Why?
- Suppose 0 submits $p_0^s = 7$
- Player 1: The only way to make sure that 0 does not sell is to submit $p_1^s = 6$
- Player 2: Yep! I am happy to buy something at price 6 that is worth 10.
- Excess returns on market price!

General Model Roadmap

asset pricing perspective

$t = 1$ trade of shares, market game

outcome of the market game induces

$t = 2$ effort decision of the *Distinguished Player*

which determines

$t = 3$ payoffs are realized (firm is liquidated)

corporate finance perspective

Notation

Players

$i = 0$	distinguished player
$i = 1, ..., N$	outside investors or later
$i \in [0, 1]$	continuum of investors

Project Ownership

$\alpha = (\alpha_0, \alpha_1, ..., \alpha_N) \in \Delta$	initial ownership
$\omega = (\omega_0, \omega_1, ..., \omega_N) \in \Delta$	final ownership, after trade

Notation…

DP's Effort

$e \in [0, \infty)$	continuous or
$e \in \{0, 1\}$	discrete effort decision
$c(e) = c \cdot e^2$	effort cost

Firm Value

$v = \underline{v} + e(\bar{v} - \underline{v})$	firm value
$\Delta v = \bar{v} - \underline{v}$	degree of firm value
	endogeneity

Corporate Finance Part

DP picks e to maximize	$\omega_0 \left[f(e)\bar{v} - (1 - f(e))\,\underline{v}\right] - c(e)$
FOC	$\omega_0 f'(e)(\bar{v} - \underline{v}) = 1$

yields incentive problem

privately optimal effort choice	$e\,(\omega_0)$
first best effort level	$e\,(1) > e\,(\omega_0)$ for $\omega_0 < 1$

Market Game Notation

Prices

$p \in P \subset \mathbb{R}$	continuous or discrete

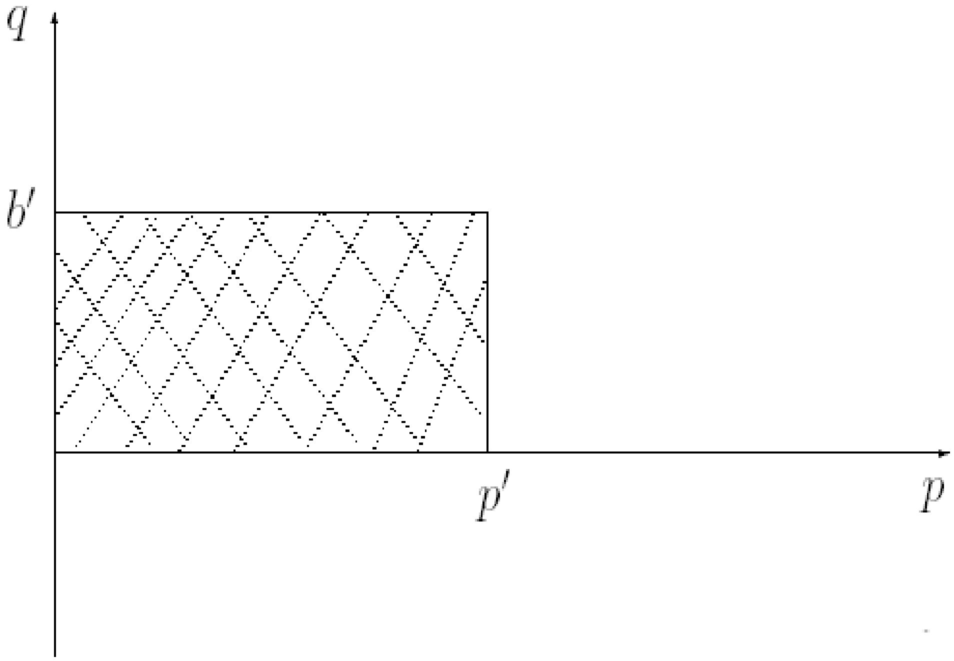
Quantities

$q \in Q \subset [-1, 1]$	continuous or discrete

Orders

$a_i \in A_i$	correspondence $a_i : P \rightrightarrows Q$
	such that
	$0 \in a_i(p) \subset Q$ (no investor can enforce trade)
strategy profiles	$a = (a_0, \ldots, a_N) \in A = A_0 \times \cdots \times A_N$

Example: Buy Limit Order



buy any quantity $q \in [0, b']$

for any market price $p \in [0, p']$

Definition: Deterministic Market Mechanism

A deterministic market mechanism μ is a

$$\text{mapping} \quad \mu : \Delta \times A \longrightarrow P \times \Delta$$

$$\text{with} \quad \mu(\alpha, a) = (p^{\mu}(a), \omega^{\mu}(a))$$

$\longrightarrow$ picks price and ex-post ownership for any profile of orders such that

trade is voluntary

$\tau_i^{\mu}(a) := \omega_i^{\mu}(a) - \alpha_i$ realized or executed net trade of trader i

$\tau_i^{\mu}(a) \in a_i(p^{\mu}(a))$ voluntary trade property

$p^{\mu}(a)\tau_i^{\mu}(a)$ is what investor i has to pay

Call auctions

don't try to read this!

A: Price setting.

1. The price is set to maximize the trade volume $\tau(p)$.[14]
2. Should there be more than one such price, surplus $|s^*(p) - d^*(p)|$ is minimized, not counting fill-or-kill orders.
3. Should there still be more than one potential price, the minimal price will be taken if there is excess supply. For excess demand, the maximum price is taken.
4. Should there still be more than one price, the price closest to a reference price will be chosen and we choose $\bar{v}$ to be the reference price.[15]

B: Allocation rules:

Rule	Amsterdam μ_A	Tokyo μ_T	NYSE μ_N	Absolute Size Priority μ_S
i.)	Orders are executed according to price priority. This rule does not apply to fill-or-kill orders. Stop orders are not executed.			
ii.)	Fill or kill orders are only matched against each other if they cannot be executed against normal bids. The allocation of fill-or-kill orders maximizes executable trading volume.	Fill-or-kill orders are not executed. Orders with limit price p^* are executed using size priority.	Fill-or-kill orders are not executed. Fully executable orders using p^* as limit price are executed first.[16]	Orders with limit price p^* and all fill-or-kill orders are executed according to size priority.
iii.)	Orders with the same priority are executed in a random order.			

Market Game with DP

Market Game $\Gamma(\mu, \alpha)$

Strategies

$i = 0, ..., N$: A_i

asymmetric trading incentive

Payoffs

$i = 1, ..., N$: $u_i(a) = \omega_i^\mu(a) Ev(\omega_0^\mu(a)) - p^\mu(a) \cdot \tau_i^\mu(a)$

$i = 0$: $u_0(a) = \omega_0^\mu(a) Ev(\omega_0^\mu(a)) - p^\mu(a) \cdot \tau_0^\mu(a) - e(\omega_0^\mu(a))$

with $Ev(\omega_0^\mu(a)) = f(e(\omega_0^\mu(a))) \cdot \bar{v} + (1 - f(e(\omega_0^\mu(a)))) \cdot \underline{v}$

$\Delta v = 0$ $u_i(a) = \omega_i \underline{v} - p^\mu(a) \cdot \tau_i^\mu(a) \quad \forall i$

Strategic and Competitive Traders

Nash or Strategic Trader

$$u_i(a) \geq u_i(\tilde{a}_i, a_{-i}) \ \ \forall \tilde{a}_i \in A_i$$

$I^s(a) =$ set of strategic traders in profile a

Walras or Competitive Trader

$$\left(\tau_i^{\mu}(a) - \tau_i^{\mu}(\tilde{a}_i, a_{-i})\right) \cdot \left[Ev\left(\omega_0^{\mu}(a)\right) - p^{\mu}(a)\right] \geq 0 \ \ \forall \tilde{a}_i \in A_i$$

$I^c(a) =$ set of competitive traders in profile a

Equilibria

a^* equilibrium	$I = I^s(a^*) \cup I^c(a^*)$
a^* strategic equilibrium	$I^s(a^*) = I$
a^* competitive equilibrium	$I^c(a^*) = I$

$$SI(a^*) = 1 - \frac{\sum_{i \in I^c(a^*)} \left| \tau_i^\mu(a^*) \right|}{\sum_{i \in I} \left| \tau_i^\mu(a^*) \right|}$$ strategic index of a^*

a^* is

no-trade equilibrium	if $\tau_i^\mu(a^*) = 0$ for all $i \in \{0, 1, ..., N\}$
trade equilibrium	if $\tau_i^\mu(a^*) \neq 0$ for some $i \in \{0, 1, ..., N\}$
true value equilibrium	if $p^\mu(a^*) = Ev\left(\omega_0^\mu(a^*)\right)$
excess returns equilibrium	if $p^\mu(a^*) < Ev\left(\omega_0^\mu(a^*)\right)$

General results

Theorem 1 *Consider the market game* Γ_μ *with sufficiently small tick size* δ. *Suppose effort is continuous* $e \in \mathbb{R}_+$ *and tradable quantities are discrete. Then, the following is true.*

(I) There exists no true value equilibrium under the Amsterdam, Tokyo, and NYSE market microstructure for zero bid ask spread $\gamma = 0$.[20]

(II) However, there exists an excess returns equilibrium under Amsterdam, Tokyo, NYSE, absolute size priority, and Kyle market microstructure for zero bid ask spread $\gamma = 0$.

□

Proposition 1 *For a model without a distinguished player* $\Delta v = 0$ *excess returns equilibria do not exist and therefore traditional no arbitrage is always satisfied.* □

Theorem 2 *Consider the market game Γ_μ with sufficiently small tick size δ. Suppose effort is discrete $e \in \{0, 1\}$ and consider a sufficiently small bid ask spread γ and let prices be discrete.*

(A) Small initial ownership α_0. Let $i = 0$ be a distinguished player with initial stake $\alpha_0 < \frac{c}{\Delta v}$. Then, an excess returns equilibrium exists under any trade volume maximizing market mechanism. Furthermore, an excess returns equilibrium with an equilibrium winner exists under any call auction mechanism (Amsterdam, Tokyo, NYSE, absolute size priority, and Kyle) if $(1 - \frac{1}{M}) \cdot \Delta v \geq c$.

(B) High initial ownership α_0. Let $i = 0$ be a distinguished player with initial stake $\alpha_0 \geq \frac{c}{\Delta v}$. Then, there are initial ownership structures α such that an excess returns equilibrium with an equilibrium winner

(i) exists in the Amsterdam Market mechanism μ_A if the distinguished player $i = 0$ is strictly wealth constrained and

(ii) exists for the Kyle Market Microstructure μ_K. □

Sum up ⟶ Logic of DP-Hypothesis

we have shown

- companies without DP → only true value
- companies with DP → true value does not exist for reasonable assumptions but excess returns equilibria exist
- if excess returns matter, DP-companies should outperform the whole stock market on average

End

Noise Traders and Price Takers

- So far fully rational model: Rests on pivotalness of every single investor

- How can many small price taking investors co-ordinate on such rational behavior?

Two answers:

- In a continuum trader model without noise traders excess returns equilibria break down…same idea as in Bagnoli Lipman.

  However: We know from the no-trade theorem literature: Only no-trade equilibrium exists in this case, once there are transaction costs.

- With noise traders they survive! Second explanation for excess returns besides pivotalness.

Idea

- Noise traders are additional source of liquidity
- With noise traders price and allocation are stochastic

- How does the Excess returns equilibrium work?
  - DP submits limit sell order at a price strictly below equilibrium value
  - All small rational price taking investors buy maximally below this price but will be rationed.

- Now rational small price taking investor faces the following trade-off:
  - Raising the price limit raises the chances to buy below equilibrium price (due to price priority)
  - However at the same time this raises the chances to trade against the player

Main Result.

- We show that tradeoff can be such that no small investor gains in expectation by raising the price limit

- No assumptions on distribution of noise

- Holds for various market mechanisms

Theorem 4 *There exist initial ownership structures α and effort cost c such that for a sufficiently small tick size $\delta > 0$*

(i) an excess returns equilibrium exists under the NYSE market microstructure μ_N for any non-degenerate distribution F,

(ii) an excess returns equilibrium exists under the absolute size priority market microstructure μ_S for any non-degenerate distribution F,

(iii) and an excess returns equilibrium exists under the Tokyo market microstructure μ_T for some non-degenerate distribution F.

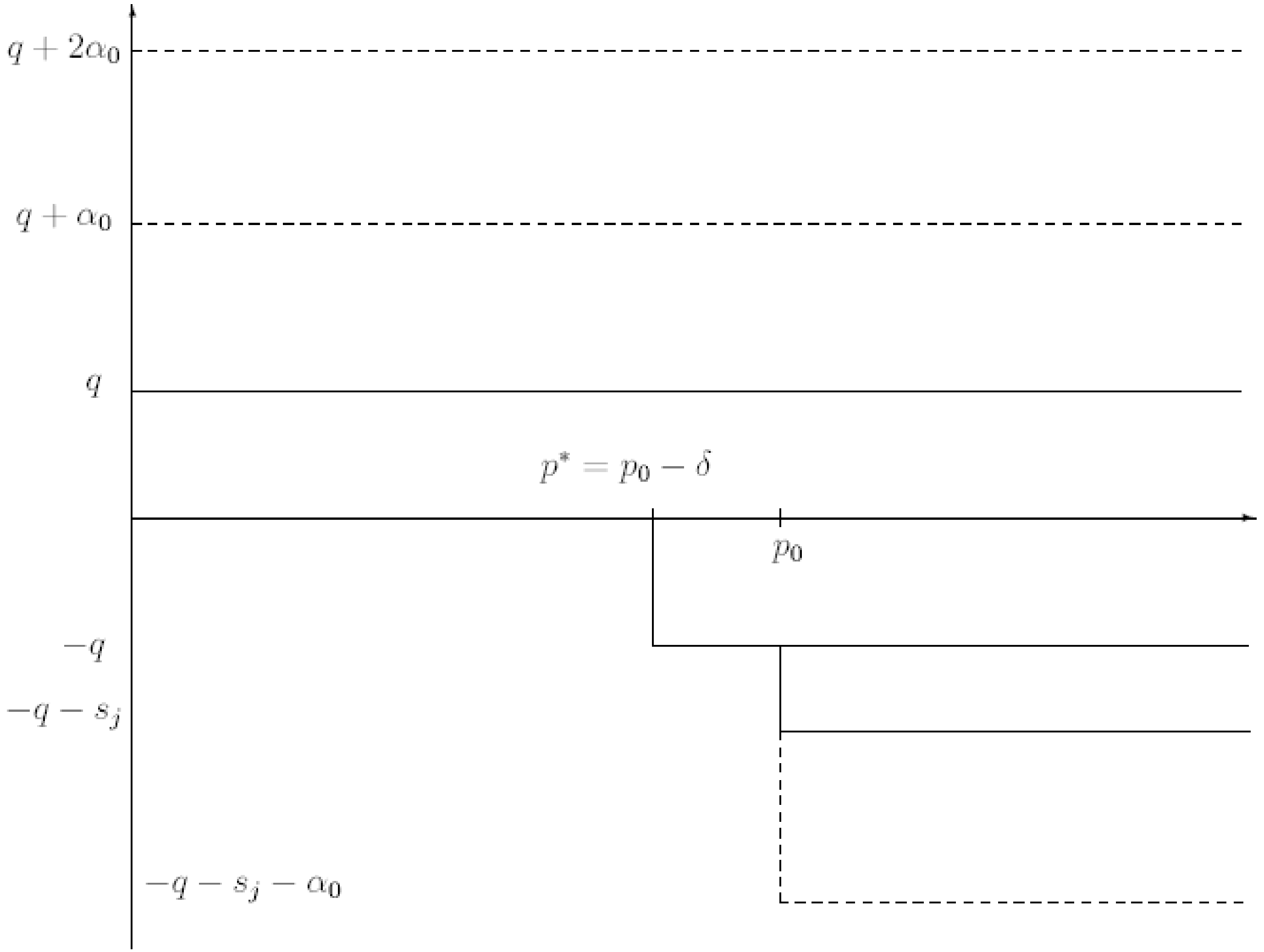
(iv) Suppose noise increases from low noise l to high noise h and the market microstructure is either NYSE μ_N or absolute size priority μ_S. Then, there always exist α_0, c, a^* such that a^* is an excess returns equilibrium under high noise h while a^* is not an equilibrium under low noise l.

(v) Without noise, an excess returns equilibrium cannot exist with a continuum of traders under any call auction mechanism.

(vi) Without a distinguished player ($\bar{v} = \underline{v}$) excess returns equilibria do not exist under the NYSE, Tokyo or absolute size priority market microstructure under any non-degenerate distribution F. □

Existence, Amsterdam Rules

aggregated excess demand correspondence



Interesting directions to proceed

- how do results translate into a dynamic framework?
- does adding incomplete and asymmetric information increase or decrease the likelihood of excess returns?
- theoretical quantification of excess returns, and based on that quantification of equity premium
- Further generalize existence
- implications for derivatives, options
- implications for framework with two types of distinguished players – manager and outside active shareholder