Ripple Effects of Noise on Corporate Investment

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- One important source of external information: Stock prices
  - Aggregate relevant information new to managers (Hayek, 1945)
  - Public good nature (i.e., low cost signals)
- **But** stock prices are noisy signals about fundamentals (e.g. Duffie, 2010)
  - and managers may have imperfect ability to *extract* the info from the signal

Research Question

- Do non-fundamental shocks to prices (noise) affect firm investment and the real economy? *Why?*

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- Do non-fundamental shocks to prices (noise) affect firm investment and the real economy? *Why?*
  - Firms can react to their own stock price misvaluation
    - ... via a financing channel (cost of capital) and incentive channel (CEO "utility")
- Our paper: Non-fundamental shocks to the stock price of one firm affect investment of *other* firms $\Rightarrow$ "ripple effect of noise"
  - Noisy stock prices $\Rightarrow$ "**signal extraction problem**" ...
    - ... because imperfect filtering

What we know and don't know

- Existing research: Non-fundamental changes in prices affect corporate investment through:
  - Financing channel (e.g., positive non-fundamental shock relaxes constraints)
  - Managerial incentive channel (e.g., negative shock increases takeover likelihood)

What we know and don't know

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  - Financing channel (e.g., positive non-fundamental shock relaxes constraints)
  - Managerial incentive channel (e.g., negative shock increases takeover likelihood)
- **Our paper: Is there a direct (faulty) informational effect?**
  - Managers rely on stock prices as a source of information
  - Imperfect ability to distinguish noise from fundamentals (but rational)
  - Noisy prices + signal extraction problem $\Rightarrow$ real effects
  - Lead to (ex-post) inefficient decisions and possible corrections
  - Faulty Informant Hypothesis (Morck, Shleifer, and Vishny (1990))

Why Do We Care?

- Stock market is <u>not</u> a side-show, it has wide-ranging effects on the economy
- Learning: most interested channel as:
  - Affect both listed and private firms
  - Affect listed firms even if:
    - Good corporate governance ($\neq$ pressure channel)
    - No credit constraints ($\neq$ financing channel)

Empirical design

- Q: Do managers imperfectly learn from stock prices?
- Challenges:
  (a) Stock prices reflect information observed **directly** by managers

  (b) Non-fundamental variations affect **cost of capital** and **managers' incentives** (e.g. take-over risks, lay-offs)

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  $\Rightarrow$ Look at **peers' stock prices**
- A: Yes
  - 1 sd decrease in peers' noise $\Longrightarrow$ 1.8 p.p. decrease in investment (5% mean)
  - Ex post difference in **magnitude** (sensitivity to "fundamentals" twice as big) *and* in **correction** between the two components (noise vs "fundamental")

Literature

1. **Asset prices informativeness ⇒ Real Decisions**
   - Theory: Dow and Gorton (1997), Subrahmanyam and Titman (1999), Goldstein and Guembel (2008) or Albagli, Hellwig and Tsyvinski (2014).
   - Empirics: Chen, Goldstein, and Jiang (2006), Bakke and Whited (2010), or Foucault and Fresard (2014)
   - Macro: David, Hopenhayn and Venkateswaran (2016)
   - Macro: Van Binsbergen, and Opp (2018)

2. **Non-fundamental shocks ⇒ Firm Investment**
   - Capex: Baker, Stein, and Wurgler (2003), Hau and Lai (2013)
   - M&A: Edmans, Goldstein, and Jiang (2012)
     - Always a **cost of capital / managers' incentives story**

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– Don’t throw rocks!

Model: Timing

- At date 1, Firm i has a growth opportunity whose payoff at date 2 is:

$$G(K_i, \widetilde{\theta}_i) = \widetilde{\theta}_i K_i - \frac{K_i^2}{2}$$

- K_i is the size of the investment in the growth opportunity
- $\widetilde{\theta}_i$:
  - Marginal productivity of investment (i.e., “fundamental”) unknown at $t = 1$
  - Uncertain $\widetilde{\theta}_i \sim \mathcal{N}(0, \sigma^2_{\theta_i})$
- Date 1, manager chooses K_i conditional on information (Ω_1)
  - $Max_{K_i}\ \mathsf{E}(G(K_i, \widetilde{\theta}_i)\ \Omega_1) = \mathsf{E}(\widetilde{\theta}_i\ \Omega_1)\, K_i - \frac{K_i^2}{2}$
  - **FOC**: $K_i^*(\Omega_1) = \mathsf{E}(\widetilde{\theta}_i\ \Omega_1)$

Model: Information Structure

- Manager has access to several signals:

  1. *Private signal about the fundamental*: $s_m = \widetilde{\theta}_i + \chi_i$
  2. *Signal contained in firm i's stock price*: $P_i = \widetilde{\theta}_i + u_i$ where the noise (or non-fundamental) component is u_i
  3. *Signal contained in peer's stock price*: $P_{-i} = \widetilde{\theta}_i + u_{-i}$ where the noise component is u_{-i}
  4. *Information about the noise in firm i's stock price*: $s_{u_i} = u_i + \eta_i$
  5. *Information about the noise in peer's stock price*: $s_{u_{-i}} = u_{-i} + \eta_{-i}$

- Errors in the manager's signals (χ, u_i, u_{-i}, η_i, η_{-i}) are normally distributed (with zero means) and independent from each other and $\widetilde{\theta}_i$

- Nest perfect information on noise or no information at all

Optimal Investment

$$K_i^*(\Omega_1) = \mathsf{E}(\widetilde{\theta}_i \; \Omega_1) = a_i \times s_{m_i} + b_i \times P_i + c_i \times s_{u_i} + b_{-i} \times P_{-i} + c_{-i} \times s_{u_{-i}}$$

- where a_i, b_i, c_i, b_{-i}, c_{-i} are functions of the variance of each signal

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- K_i^* depends on signal about the noise (s_{u_i} and $s_{u_{-i}}$) even though this signal is **uninformative** about $\widetilde{\theta}$

Prediction: Optimal Investment with Noisy Stock Prices

$$I_i = \overbrace{\alpha S_m}^{\text{Private Signal}} + \overbrace{\gamma_0 U_i + \gamma_1 (P_i - U_i)}^{\text{Firm Stock Price}} + \overbrace{\beta_0 U_{-i} + \beta_1 (P_{-i} - U_{-i})}^{\text{Peers' Stock Price}}$$

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  - Inv. to noise sensitivity $\Rightarrow \beta_0 = 0$
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- Reject of the null = "Faulty informant channel" $\Rightarrow$ **3 predictions**:
  1. $\beta_0 > 0$
  2. $\beta_1 > \beta_0$ (managers can filter out some noise)
  3. β_0 Δ with manager information ($\Downarrow$) and stock price informativeness ($\Uparrow$)

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$\Rightarrow$ *Focus on **peers' stock price** to mitigate alternative stories*

Tests and Results

Two Important Tricks in the Paper

1. Shock on *non*-fundamental

2. Decompose the stock price $\Rightarrow$ finer tests

Step 1: Empirical Proxy for Non-Fundamental Shock

- Use Mutual Funds Fire-Sales as non-fundamental shocks to prices (U_i and U_{-i})
  - Fire sales **stock prices to deviate from its fundamental values** then mean-reblue

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- Use Mutual Funds Fire-Sales as non-fundamental shocks to prices (U_i and U_{-i})
  - Fire sales **stock prices to deviate from its fundamental values** then mean-reblue
- Mutual Funds *Hypothetical* Sales (Edmans Goldstein, and Jiang, 2012)
  - Focus on extreme flows ($>$ 5% of funds' assets)
  - Assume mutual funds keep their portfolio constant (**We do not use real trades!**)
  - Magnitude of trades purely determined by **size of outflow**
- Key assumption: Mutual funds hypothetical trading *not* based on funds private information about the firms' fundamentals

mff-construction

Step 2: Decompose Stock Price (into U and $(P-U)$)

$$Q_{i,t} = \phi \times \underbrace{MFHS_{i,t}}_{\substack{\text{Noise due to} \\ \text{Mutual Funds} \\ \text{fire sales}}} + \lambda_i + \delta_t + \underbrace{\upsilon_{i,t}}_{\substack{\text{“Fundamental”} \\ \text{Component of} \\ \text{Price } (Q^*)}}$$

- ϕ<0 and significant (strong)
- $MFHS_{-i,t}$ = “Firm Non-Fundamentals”
- Construct $Q^*_{-i,t} = \hat{\upsilon}_{-i,t} \Rightarrow$ “Firm Fundamentals”

Step 3: Estimate Investment to Noise Sensitivity to Peers

- Identify **product market peers** (the $-i$)
  - Text-based Network Industry Classification (Hoberg and Philips, 2015) ⇒ Firms share the same **growth opportunities**
  - $\overline{MFHS}_{-i,t}$ = average $MFHS_{i,t}$ over peers of firm i ⇒ "Peers' Non-Fundamentals"
  - $\overline{Q}^{*}_{-i,t}$ = average $Q^{*}_{i,t}$ over peers of firm i ⇒ "Peers' Fundamentals"

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  - $\overline{Q}^*_{-i,t}$ = average $Q^*_{i,t}$ over peers of firm i $\Rightarrow$ "Peers' Fundamentals"
- Estimate **investment-to-noise sensitivity**
  - Compustat sample 1996–2011

Empirical Specification

$$I_{i,t} = \underbrace{\overbrace{\beta_0 \overline{MFHS}_{-i,t-1}}^{\text{Noise due to Mutual Funds fire sales}} + \overbrace{\beta_1 \overline{Q}^*_{-i,t-1}}^{\text{"Fundamental" Component}}}_{\text{Peers' stock prices (Average)}} + \underbrace{\overbrace{\gamma_2 MFHS_{i,t-1}}^{\text{Noise due to Mutual Funds fire sales}} + \overbrace{\gamma_3 Q^*_{i,t-1}}^{\text{"Fundamental" Component}}}_{\text{Own stock price}}$$

$$+ \underbrace{\mathbf{\Gamma X_{i,-i,t-1}}}_{\text{Controls for size and cash-flows (own and peers)}} + \lambda_i + \delta_t + \varepsilon_{i,t}$$

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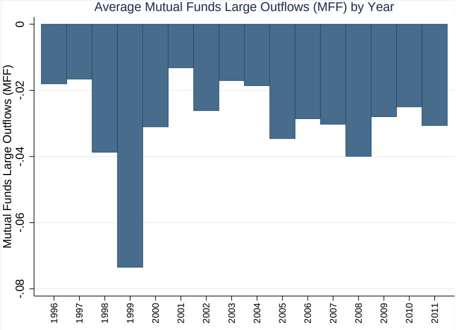
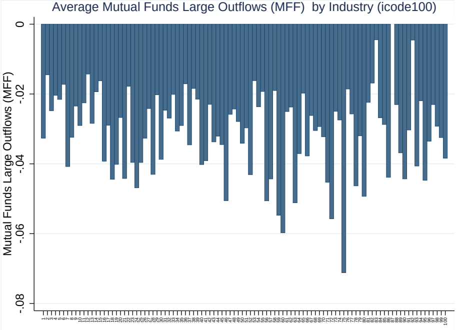
⇒ *Do we really have a* ***localized non-fundamental*** *shock?*

- *MFHS* truly valid instrument?

Instrument Validity I

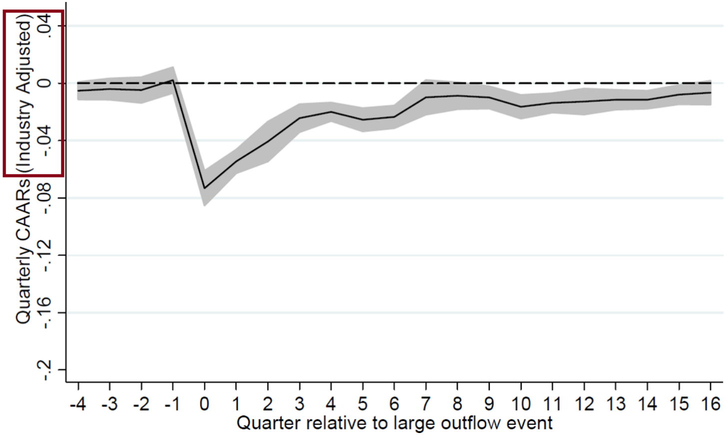




- Panel A: No obvious clustering in time (non-systematic shocks)
- Panel B: No obvious clustering across industries

Instrument Validity II

- Downward price pressure survives *industry adjustment*



- And many other **risk-adjustments**...

Instrument Validity II

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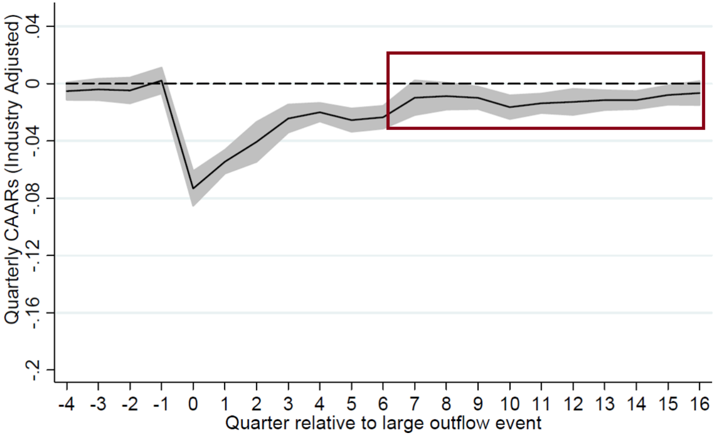
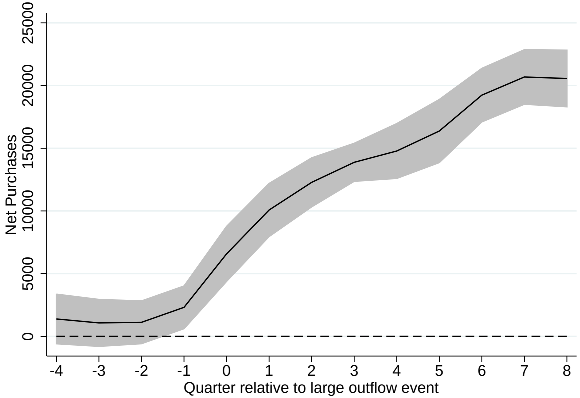


- Non-fundamental shocks really mean-reblue

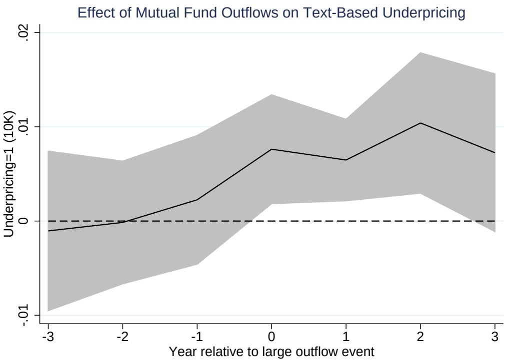
Instrument Validity III

- Insider trading around the fire-sale event



- Managers trade *against* their own price pressure (buy when price drops)
- Some of them detect the noise in their own price

Instrument Validity IV



- Firms mention non-fundamental shocks in their 10K reports
- Keywords: underpricing, underpriced, undervaluation, undervalued

Main Result

- 1 sd decrease in peers' noise $\Longrightarrow$ 1.8 p.p. decrease in investment (5% mean)

Dependent variable	Capex/PPE	
	Coeff	t-stat
$\overline{MFHS}_{-i}$	**0.018*** **	7.51
$\overline{Q}^*_{-i}$	0.029***	12.71
$MFHS_i$	0.011***	6.55
Q^*_i	0.081***	27.52
Obs.	45,388	
Controls	Yes	
Firm FE	Yes	
Year FE	Yes	

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- Investment **two times** more sensitive to "fundamentals"

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Main Result

- Inv. also (*less*) sensitive to noise in own stock price (1.1pp)
- But inv. **8 times** more sensitive to "fundamentals" $\Rightarrow$ Managers **filter out noise better in their own stock price**

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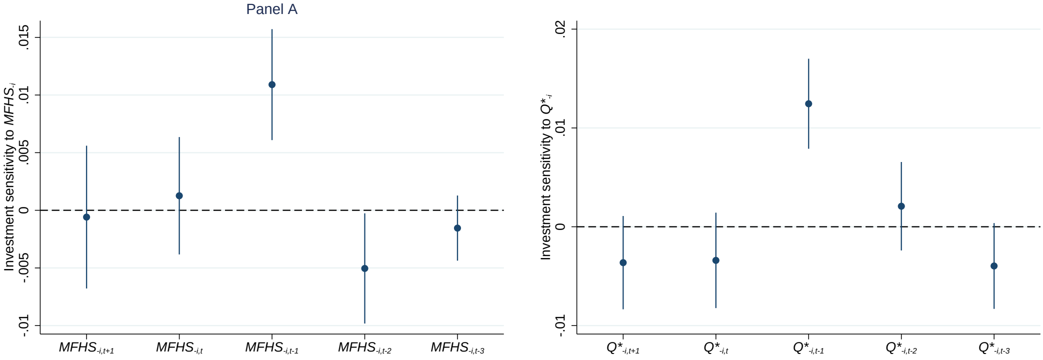
Temporary vs Permanent Effect

– Imperfect filtering: ex-ante rational, but **ex-post mistake** ⇒ Do managers ***correct***?



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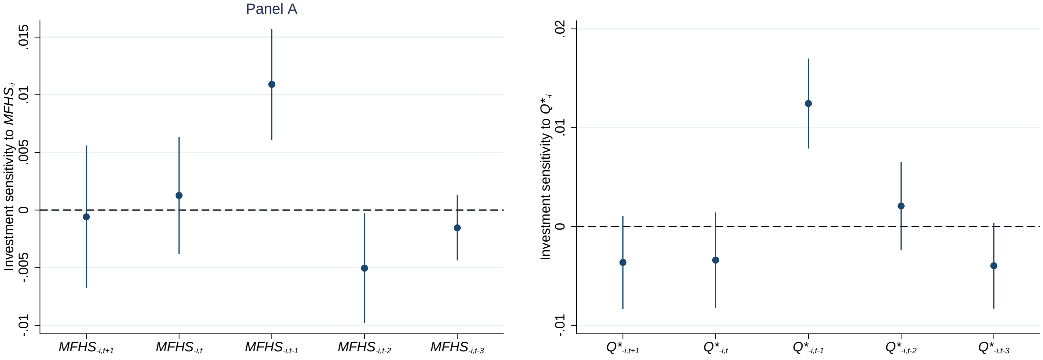

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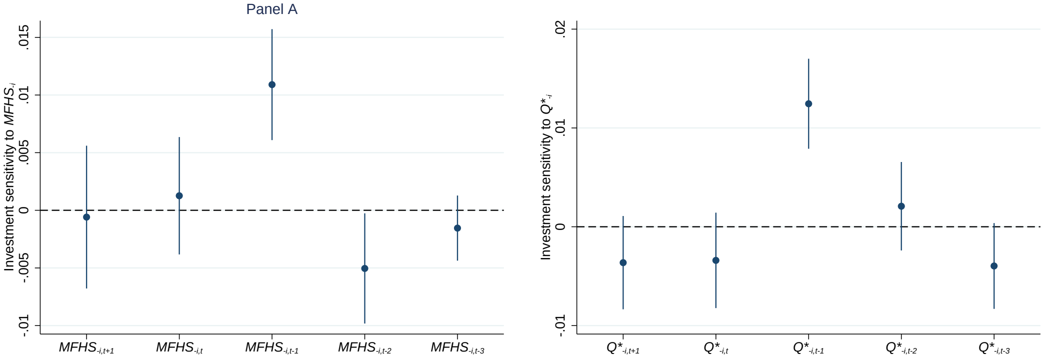

- Non-fundamental shocks: effect **transient** (mistake *corrected*)
- **Fundamental** shock: **Permanent** effect on capital stock (*not corrected*)

Other Results

- In the cross-section investment-to-noise sensitivity

1. ... **decreases** when managers are **better informed**
   - Information about fundamental
   - Information about noise

2. ... **increases** when peers' stock prices are **more informative**
   - Peers' stock price more informative
   - Correlation with fundamental higher

$\Rightarrow$ *Uniquely predicted by the faulty informant channel*

Cross-Sectional Sensitivity

Dependent Variable:	$Capex/PPE_i$							
Cross-Sectional Variation of Interest:	Information about Noise $\sigma^2_{\eta_{-i}}$		Correlation of Fundamentals $\lvert\rho_i\rvert$		Peers' Stock Price Informativeness $\sigma^2_{u_{-i}}$		Information about Fundamentals $\sigma^2_{\chi i}$	
Proxy Variable:	$\overline{Common}$ $\overline{Ownership}_{-i}$	$\overline{Analyst}$ $\overline{Discount}_{-i}$	$\overline{Sales}$ $\overline{Correlation}_i$	$\overline{Assets}$ $\overline{Correlation}_i$	BPS_{-i}	$\overline{AnalystFE}_{-i}$	$Insider$ CAR_i	$Market$ $Share_i$
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
$\overline{MFHS}_{-i}$	0.023***	0.021***	0.007	0.008**	0.014***	0.021***	0.015***	0.017***
	(5.09)	(5.12)	(1.67)	(2.12)	(5.81)	(4.53)	(5.40)	(4.82)
$\overline{MFHS}_{-i} \times \sigma^2_{\eta_{-i}}$	-0.006***	-0.006**						
	(-2.79)	(-2.61)						
$\overline{MFHS}_{-i} \times \lvert\rho_i\rvert$			0.007***	0.004*				
			(3.08)	(1.82)				
$\overline{MFHS}_{-i} \times \sigma^2_{u_{-i}}$					0.002*	0.006***		
					(1.78)	(2.84)		
$\overline{MFHS}_{-i} \times \sigma^2_{\chi_i}$							-0.002	-0.004*
							(-0.90)	(-1.94)
Obs.	45,275	33,350	44,137	42,751	45,275	44,408	45,275	45,127
Controls (Interacted)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Alternative Stories

- **Financing channel** (e.g. Baker et al., 2003; Shleifer and Vishny, 1992)
  - Capital providers (e.g. bankers) rely on peers' stock prices to set lending costs
  - Fire sales of peer stocks trigger real assets fire sales $\Rightarrow$ lower firm collateral value
- **Pressure channel** (e.g. Stein, 1989)
  - Increase risk of being taken over / fired $\Rightarrow$ cut investment to boost **short-term cash-flow (and stock price)**
  - Effort provision due to compensation indexed on peers' performance (RPE)
- **Investment complementarity channel**
  - Investment respond to investment, not stock prices

Alternative Stories

- **Financing channel** (e.g. Baker et al., 2003; Shleifer and Vishny, 1992)
  - Capital providers (e.g. bankers) rely on peers' stock prices to set lending costs
  - Fire sales of peer stocks trigger real assets fire sales ⇒ lower firm collateral value
- **Pressure channel** (e.g. Stein, 1989)
  - Increase risk of being taken over / fired ⇒ cut investment to boost **short-term cash-flow (and stock price)**
  - Effort provision due to compensation indexed on peers' performance (RPE)
- **Investment complementarity channel**
  - Investment respond to investment, not stock prices
- Reminder: **perform several tests to rule out these channels**

Capital Allocation Within Firms

- Similar test, at the **Firm** × **Division** × **Year level**
  - Investment within firm (across divisions)

- Conglomerate: Compustat segment - FF48 industries (Krueger et al. 2014)

- 3,409 distinct conglomerate firms, operating a total of 8,342 divisions over the 1996-2011 period.

- Investment for division d of firm i at year t:

$$I_{i,d,t} = \lambda_{i,d} + \delta_{i,t} + \alpha_0 \overline{Q}^*_{-i,d,t-1} + \alpha_1 \overline{MFHS}_{-i,d,t-1} + \mathbf{\Gamma X_{-i,d,t}} + \varepsilon_{i,d,t}$$

- $\delta_{i,t}$: Firm × Year FE remove *time-varying* unobserved heterogeneity at the *firm* level

Within-Conglomerate: Reallocation Across Divisions?

- Similar test, at the **Firm** × **Division** × **Year level**
- Inv. in division sensitive to **noise** in stock prices of **that division's peers**. Noise influences capital allocation **WITHIN** firm

Dependent variable:	Capex/A	
	Coeff	t-stat
$\overline{MFHS}_{-i}$	0.0044**	(2.43)
$\overline{Q}^{*}_{-i}$	0.0055***	(3.40)
Obs.	63,330	
Firm-Division FE	Yes	
Firm × Year FE	Yes	

Within-Conglomerate: Reallocation Across Divisions?

- Similar test, at the **Firm** × **Division** × **Year level**
- Inv. in division sensitive to **noise** in stock prices of **that** **division's peers**. Noise influences capital allocation **WITHIN** firm
- Spe absorbs **all** **time-varying** firm-level variables (e.g. P_i, U_i, $MFHS_i$, etc.)

Dependent variable:	Capex/A	
	Coeff	t-stat
$\overline{MFHS}_{-i}$	0.0044**	(2.43)
$\overline{Q}^{*}_{-i}$	0.0055***	(3.40)
Obs.	63,330	
Firm-Division FE	Yes	
Firm × Year FE	**Yes**	

Within-Conglomerate: Reallocation Across Divisions?

- Rules out other stories because cost of financing / access to financing / CEO incentives / CEO compensation same across divisions
  - Can explain investment allocation across firms ... BUT NOT across divisions for the SAME firm in the SAME year

Dependent variable:	Capex/A	
	Coeff	t-stat
$\overline{MFHS}_{-i}$	0.0044**	(2.43)
$\overline{Q}^*_{-i}$	0.0055***	(3.40)
Obs.	63,330	
Firm-Division FE	Yes	
Firm × Year FE	**Yes**	

Alternative: Cost of Capital Channel

Dependent Variable:	CDS $Spread_i$	$Debt$ $Spread_i$	$Debt$ $-Cons._i$	$Equity$ $-Cons._i$	$Payout_i$	$Security$ $Issue_i$	$Capex$ $/PPE_i$
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
$\overline{MFHS}_{-i}$	0.077	0.035***	-0.000	0.001	-0.001	0.004	0.014***
	(0.93)	(2.97)	(-0.22)	(1.02)	(-1.32)	(1.59)	(4.85)
$\overline{Q}^*_{-i}$	0.027	-0.022	-0.001	0.000	-0.001**	0.002	0.023***
	(0.38)	(-1.41)	(-1.56)	(0.58)	(-2.29)	(1.17)	(4.97)
$Payout/A_i$							-0.012***
							(-3.69)
$SecurityIssue/A_i$							0.024***
							(3.87)

Alternative: Pressure Channel

Dependent Variable:	HHI_i	$Nb.Peers_i$	$Capex/PPE_i$	$Capex/PPE_i$	$Capex/PPE_i$	$Prob(Target)_i$	$CEO\ Turnover_i$
Sub-sample:				$RPE = 1$	$RPE = 0$		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
$\overline{MFHS}_{-i}$	0.002	-0.000	0.015***	0.016***	0.015**	0.004	0.002
	(0.76)	(-0.02)	(5.59)	(3.56)	(2.69)	(1.13)	(0.57)
$Prob(Acquirer)_{-i}$			0.001				
			(0.39)				
$Prob(Target)_{-i}$			-0.005**				
			(-2.42)				

Alternative: Investment Mimicking Channel

- (1): firms whose peers do not change investment
- (2): firms whose peers increase investment

Dependent Variable:	$Capex/PPE_i$		
	(1)	(2)	(3)
$\overline{MFHS}_{-i}$	0.024**	0.016***	0.007***
	(2.20)	(5.49)	(3.28)
$\overline{Capex/PPE}_{-i}$			0.024***
			(3.85)
$\overline{ContemporaneousCapex/PPE}_{-i}$			0.047***
			(5.80)

Conclusion

- When **filering is imperfect**
  - Non-fundamental shocks to prices (noise) affect investment decisions of peers because investment loads on noise
  - Average manager not able to fully filter out the noise $\Rightarrow$ lead to **(ex post) inefficient decisions**
- Manager rational and conditions on informative but noisy signals (ex-ante efficient)
- Open question: effect on aggregate investment and misallocation?