The Feedback Effect from Financial Markets to the Real Economy

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Information in prices

- A basic premise in financial economics: market prices are very informative about assets fundamentals.
- They gather information from many different participants, who trade on their own money.
- Lots of empirical evidence supporting the idea, e.g., Roll (*AER*, 1984).
- Models of how information gets reflected in the price: Grossman and Stiglitz (*AER*, 1980), Kyle (*Econometrica*, 1985), Glosten and Milgrom (*JFE*, 1985).

The Feedback Effect

The informativeness of prices is important, since it helps facilitate the efficient allocation of resources:

> *An efficient market "has a very desirable feature. In particular, at any point in time market prices of securities provide accurate signals for resource allocation. That is, firms can make production-investment decisions ..."* **Fama & Miller (1972)**

The Feedback Effect – Cont'd

- Evidence: Baker, Stein and Wurgler (*QJE*, 2003), Chen, Goldstein, and Jiang (*RFS*, 2007), Luo (*JF*, 2005): Financial markets are not a **side show**.
- Lots of anecdotal evidence:
  - o The decision to go ahead with an acquisition is affected by price reaction: Quaker Oats & Coca Cola.
  - o Debt ratings are affected by market prices.
- Yet, very few papers have feedback effect in financial-market models.
  - o Recent and ongoing research shows that incorporating the feedback effect in models of financial markets generates new implications for price formation process and resulting firm value.

Manipulation: Goldstein and Guembel (*REStud*, 2008):

- We identify a fundamental limitation inherent in the allocational role.
- The fact that prices perform an allocational role creates a scope for price manipulation, which reduces investment efficiency:
  - Uninformed traders establish short position.
  - Price decreases.
  - Real investment decreases.
  - Value of asset decreases.
  - Uninformed traders make a profit on the short position.
- Note: Profitable manipulation requires two rounds of trade and short sales.

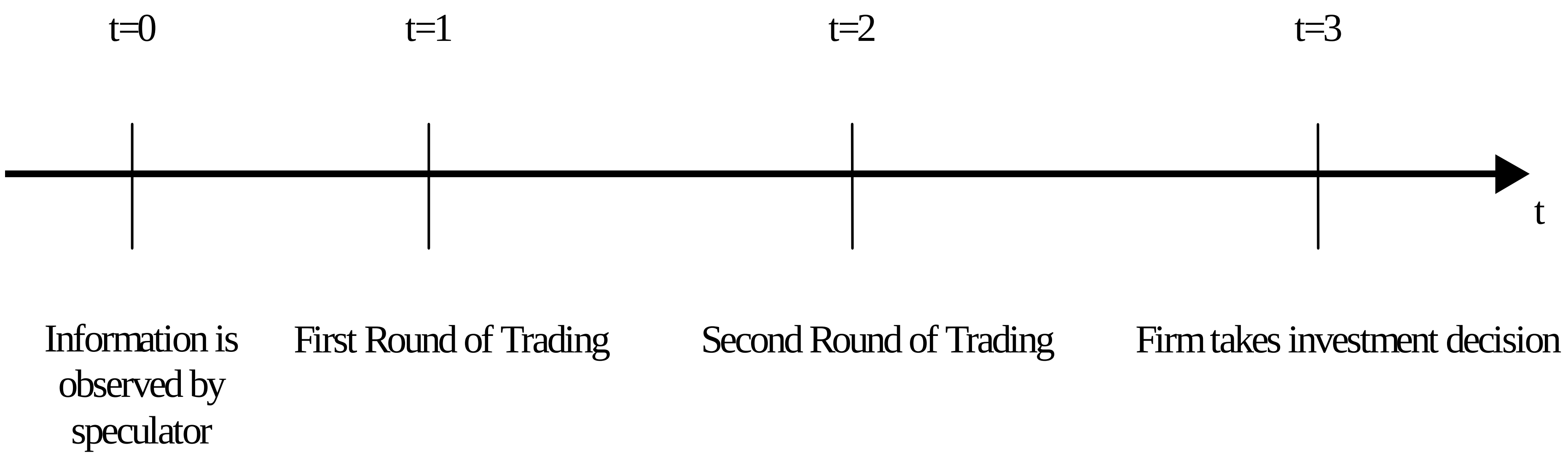
Summary of Contribution

The contribution of the paper is threefold:

- Identifying a limitation inherent in the allocational role of prices, and discussing implications for the effect of prices on investment efficiency.
- Identifying an asymmetry between sell side and buy side speculation, and providing justification for short-sales restrictions.
    - This is implicitly understood in regulatory circles.
- Identifying a new mechanism for trade-based manipulation.
    - Overcoming the problems raised by Jarrow (*JFQA*, 1992).

Basic setup

- Dates $t \in \{0, 1, 2, 3\}$
- Timeline:



The firm's investment problem

- Firm takes an investment decision.

- Two possible states: $\omega \in \{l, h\}$ with equal probability.

- NPV of investment in good (bad) state is V^{+} (V^{-}) :

$$V^{+} > 0 > V^{-}.$$

$\Rightarrow$ The firm wants to invest when $\omega = h$, not when $\omega = l$.

- The firm may learn information about ω from the stock market.

Trade in the financial market

- Risk neutral speculator and noise traders submit orders to a market maker.

- **Noise trade:** At each date, noise trade $n_t \in \{-1, 0, 1\}$ with equal probabilities.

- **Speculator:** With probability α, learns ω: $s \in \{l, h\}$ (probability $1-\alpha$, $s=\emptyset$); submits orders $u_t \in \{-1, 0, 1\}$.

- **Market maker:** Sets Prices after observing total order flow $Q_t = u_t + n_t$. $Q_t \in \{-2,-1, 0, 1,2\}$.

    - $p_t = E[V|Q_t, Q_{t-1}]$ (modification of Kyle, 1985).

Equilibrium

- Perfect Bayesian Nash Equilibrium:
  - A trading strategy by the speculator: $u_1(s)$, $u_2(s, Q_1, u_1)$ that maximizes expected payoff given the price setting rule, the firm's investment strategy, and the information he has.
  - An investment strategy that maximizes firm value, given all available information and other strategies.
  - A price setting rule $p_1(Q_1)$, $p_2(Q_1, Q_2)$ that allows the market maker to break even given order flows and other strategies.

Equilibrium in a model with no feedback

- Suppose that the firm is fully informed about the state of the world.
- The value of the firm does not depend on the trading outcomes:
  - It is V^+ when $\omega = h$, and *0* when $\omega = l$.
  - The speculator may know the value and trade.
- Trading strategies:
  - Positively informed speculator buys in *t=1* with positive probability (or does not trade), and then buys again in *t=2* unless revealed.

- Negatively informed speculator sells in $t=1$ with positive probability (or does not trade), and then sells again in $t=2$ unless revealed.
- Mixing in $t=1$ serves to increase profit in $t=2$.

Proposition 1: In any equilibrium of the no-feedback game, the uninformed speculator never trades in $t = 1$.

- Trading in $t = 1$ without information generates losses because buying (selling) pushes the price up (down), so that the expected price is higher (lower) than the unconditional expected firm value.
- The uninformed trader may trade in $t = 2$. This is when $t = 1$ noise trade moves the $t = 1$ price away from its unconditional mean.

Equilibrium in a model with feedback: Manipulation

- Assume that the firm has no information on ω.

- Project has positive NPV:

$$\overline{V} = \tfrac{1}{2}\left(V^{+} + V^{-}\right) > 0.$$

Proposition 2: In the presence of feedback, there exists equilibrium where the uninformed speculator sells in $t = 1$ with positive probability.

- Condition:

$$\tfrac{\alpha}{2} V^{-} + (1-\alpha)\overline{V} < 0.$$

Equilibrium strategies

- First period:

$$u_1(s=h)=1$$

$$u_1(s=l\ \ or\ \ \phi)=\begin{cases}-1 & prob\ \ 1-\mu \\ 0 & prob\ \ \mu\end{cases}\ \ ;\ \ 1-\mu>\tfrac{2}{3-\alpha}$$

- Second period, positively informed:

$$u_2(s=h,Q_1,u_1=1)=\begin{cases}1\ \ if\ \ Q_1\in\{0,1\} \\ -1,0,or\,1\ \ if\ \ Q_1=2\end{cases}$$

- Second period, negatively informed:

$$u_2(s = l, Q_1, u_1 = -1) = \begin{cases} -1 \ \ if \ \ \ Q_1 = 0 \\ -1, 0, or 1 \ \ if \ \ \ Q_1 \in \{-1, -2\} \end{cases}$$

$$u_2(s = l, Q_1, u_1 = 0) = \begin{cases} -1 \ \ if \ \ \ Q_1 \in \{0,1\} \\ -1, 0, or 1 \ \ if \ \ \ Q_1 = -1 \end{cases}$$

- Second period, uninformed:

$$u_2(s = \phi, Q_1, u_1 = -1) = \begin{cases} -1 \ \ if \ \ \ Q_1 = 0 \\ -1, 0, or 1 \ \ if \ \ \ Q_1 \in \{-1, -2\} \end{cases}$$

$$u_2(s = \phi, Q_1, u_1 = 0) = \begin{cases} -1 \ \ if \ \ \ Q_1 = 1 \\ 0 \ \ \ if \ \ \ Q_1 = 0 \\ -1, 0, or 1 \ \ if \ \ \ Q_1 = -1 \end{cases}$$

Profitability of Manipulation

Three possible Scenarios:

i. Q_1 = -2 or -1: sale is revealed immediately. No investment occurs. The price and real value equal 0. The speculator makes a profit of 0.

ii. $Q_1 = Q_2 = 0$: trade is never revealing. Investment occurs. The expected value is $\overline{V}$. The speculator makes a profit of $p_2(0,0) + p_1(0) - 2\overline{V} > 0$.

iii. $Q_1 = 0$, Q_2 = -2 or -1: sale is revealed in second round. No investment occurs. The speculator makes a profit of $p_1(0) > 0$.

Profit can be attributed to two sources; both rely on multiple rounds of trade.

Manipulation and firm value

Corollary 2: The expected value of the firm is $\frac{1}{9}\overline{V}$ if the uninformed speculator sells in *t=1*, and $\frac{1}{3}\overline{V}$ if he does not trade in *t=1*. Thus, by selling in *t=1*, the speculator decreases the expected value of the firm by $\frac{2}{9}\overline{V}$.

- By selling in *t=1*, the uninformed speculator causes the firm to cancel a profitable investment project.
- This suggests that regulation that restricts short sales may improve value.
  - Important: set a cost of short sale that drives the uninformed speculator out of the market, but not the negatively informed.

Manipulation and price informativeness

Corollary 3: $\Pr(s = h | Q_1 = X) > \Pr(s = l | Q_1 = -X);\ X \in \{1,2\}$

- High prices are more informative about high fundamentals than low prices are about low fundamentals.
    - The uninformed pools with the negatively informed.

Corollary 4: $p_1(X) - p_1(0) > p_1(0) - p_1(-X);\ X \in \{1,2\}$

- Prices react more strongly to positive order flow than to negative one.
    - Two reasons: Feedback effect and manipulation.

Comparative statics

- Condition $\frac{\alpha}{2}V^{-}+(1-\alpha)\overline{V}<0$ can be rewritten as:

$$\alpha > 2\frac{\overline{V}}{\overline{V}+\Delta V}$$

Where $\Delta V = V^{+}-\overline{V}$.

- Thus, manipulation is more likely when:
  - o Speculators have more information.
  - o Projects have lower NPV.
  - o Projects are more uncertain.

Unique equilibrium

- Taking as given the strategy of the negatively informed and positively informed traders, the uninformed trader always wants to manipulate.
    - If he doesn't, $p_1(0)$ goes up, increasing his incentive to manipulate.
- But, things may get complicated by changes in strategies of informed trader.
    - An increase in $p_1(0)$ may lead the positively informed trader to mix, generating less cancellations, and reducing profit from manipulation.

Proposition 3: If feedback is strong (low $\overline{V}$), there is always manipulation.

Buy-side manipulation

- Sell-side manipulation works when the uninformed speculator makes the firm cancel a profitable investment ($\overline{V} > 0$).

- In principle, it is easy to have a model where the uninformed speculator makes the firm overinvest ($\overline{V} < 0$).
  - Such a manipulative trading strategy is feasible but not profitable.

Proposition 4: If $\overline{V} < 0$, there is no equilibrium where the uninformed speculator makes a positive profit from buying in *t=1*.

- Manipulation always decreases firm value, which can be profitable only with a short position.

Additional uninformed trader

- Suppose there is another strategic trader (arbitrageur), who never has information. Can he make a profit by mimicking the strategy of our uninformed trader?
    - This might potentially interfere with the manipulation equilibrium.

Proposition 5: There exists an equilibrium where the additional trader does not trade, and all other strategies remain as in the manipulation equilibrium.

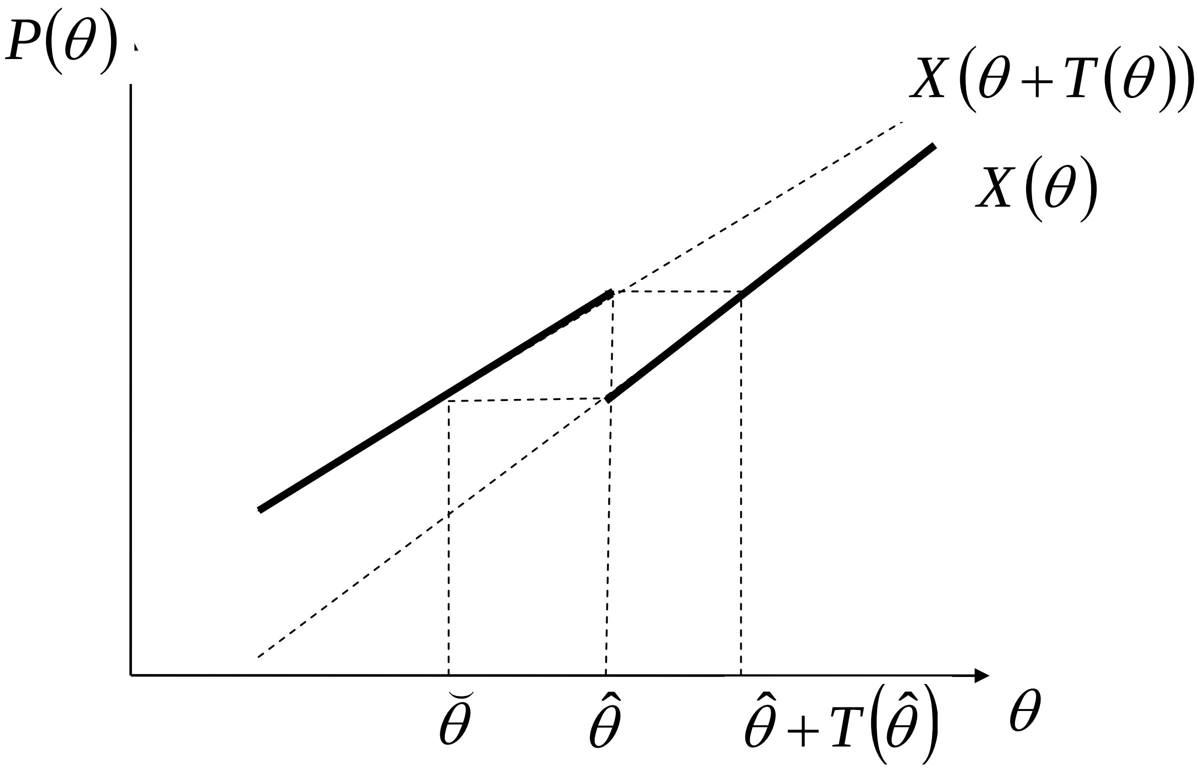
The additional trader cannot condition his trade on the signal of the speculator, and thus ends up losing money when signal is high.

Corrective Actions: Bond, Goldstein, and Prescott (RFS, forthcoming)

- Actions taken to improve value when a problem is perceived.
- **Leading Example:** CEO Replacement, e.g., Jenter and Kanaan (2006), and Kaplan and Minton (2006).
- **Problem:** The expectation of corrective action when fundamentals are bad increases the price and reduces the informativeness about fundamentals.
- **Implications:** Learning from the price is self defeating. Equilibrium outcomes are hard to predict.

  $\Rightarrow$ In a very generic set-up, no rational-expectations equilibrium exists.

Problem with Corrective Actions – Graphic Illustration



What We Do

- We study a rational-expectations model, where an agent learns from the price while his expected action is reflected in the price.

  $\Rightarrow$ Price reflects expected intervention, which depends on the price in a non-trivial way.

- We characterize equilibrium outcomes.

  $\Rightarrow$ Key parameters: information gap between market and agent, and shape of the traded security.

- Problem not analyzed in previous feedback papers; only mention in Bernanke and Woodford (1997).

Other Applications

- Other **corporate-governance** contexts, e.g., shareholder activism:

  $\Rightarrow$ Low price “invites” activists, while expected activism is reflected in price (Bradley, Brav, Goldstein, and Jiang (2008)).

- **Bank supervision**:

  $\Rightarrow$ Proposals call for market-based supervision (Evanoff and Wall (2004)).

  $\Rightarrow$ Direct evidence of non-monotone price function (DeYoung, Flannery, Lang, and Sorescu (2001)).

- **Corporate Investments:** go ahead with an acquisition plan (Luo (2005)).

The Model

- Three periods: {0,1,2}.
- **The Firm**
  - At $t=0$, the price of a firm's security is determined in the market.
  - Absent intervention, the expected cash flow of the firm at $t=2$ is θ, drawn uniformly from $[\underline{\theta},\overline{\theta}]$ and realized at $t=0$.
  - Value of the security without intervention is $X(\theta)$, increasing in θ.
  - Additional value due to intervention:

$$U(\theta) = X(\theta + T(\theta)) - X(\theta).$$

- **The Agent**
    - In *t=1*, the agent can intervene at cost *C*, and increase expected cash flow by $T(\theta)$:
        - $T(\theta)$ decreases in θ, can be negative, $\theta + T(\theta)$ increasing.
    - Benefit from intervention is $V(\theta)$, decreasing in θ.
        - E.g., for directors, $V(\theta) = \alpha\left[X(\theta + T(\theta)) - X(\theta)\right]$.
    - Assume: $V(\underline{\theta}) > C > V(\overline{\theta})$. Thus, if agent knows θ, he chooses to intervene *iff* $\theta < \hat{\theta} \in [\underline{\theta}, \overline{\theta}]$.

- **Information**
  - In *t=0*, the market observes θ.

    $\Rightarrow$ Rational expectation price, $P(\theta)$, is formed.
  - The agent observes $P(\theta)$ and a noisy signal on θ: $\phi = \theta + \xi$.

    $\Rightarrow$ ξ is uniformly distributed over $[-\kappa, \kappa]$,
  - **Robustness:**
    - Allow regulator to have information not available to the market.

Equilibrium

- The agent's intervention policy is the function $I(P,\phi)$.
- ***REE* pricing condition**: $P(\theta) = X(\theta) + E_\phi\left(I(P(\theta),\phi)\middle|\theta\right)\cdot U(\theta)$.
- **Time consistent intervention**:
  - $E_\theta[V(\theta)|P,\phi] > C \Rightarrow I(P,\phi) = 1$,
  - $E_\theta[V(\theta)|P,\phi] < C \Rightarrow I(P,\phi) = 0$.
  - $E_\theta[V(\theta)|P,\phi] = C \Rightarrow I(P,\phi) \in [0,1]$.

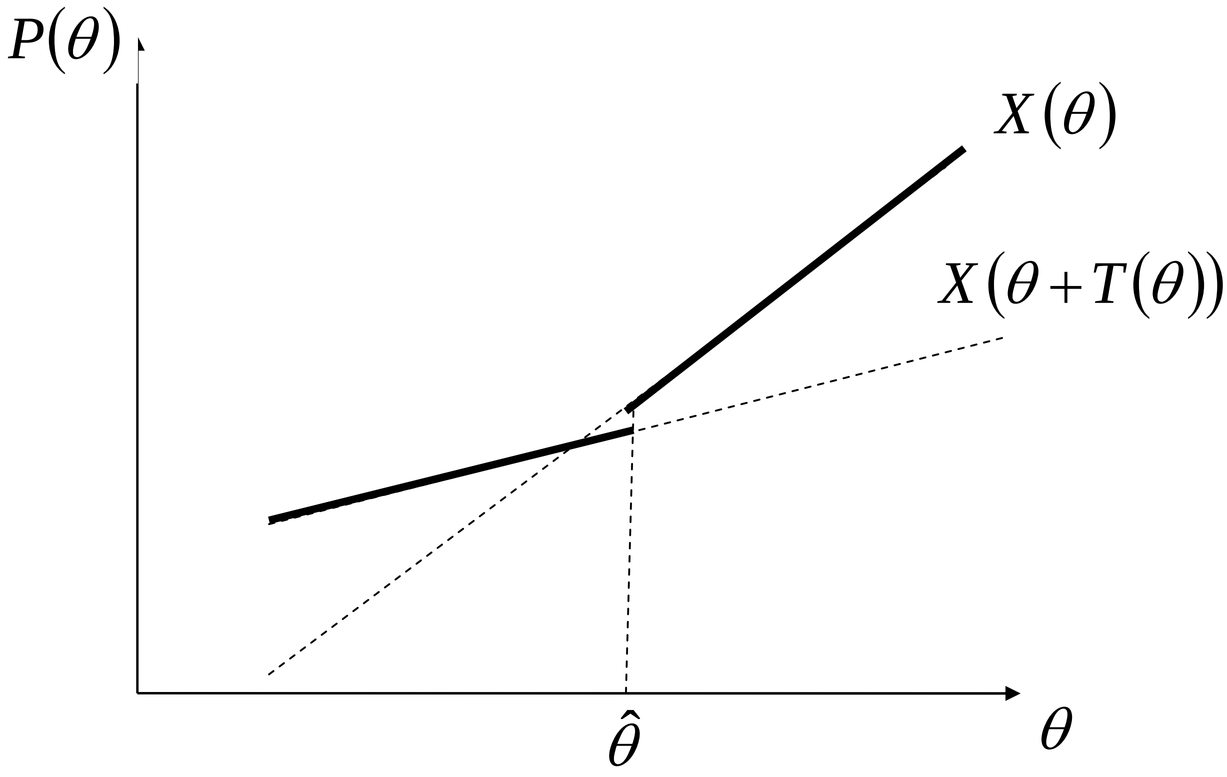
Prices under Agent-Preferred Intervention

- $\forall\,\theta \le \hat{\theta},\ P(\theta) = X(\theta) + U(\theta) = X(\theta + T(\theta))$.
- $\forall\,\theta > \hat{\theta},\ P(\theta) = X(\theta)$.

Simple Case:

- $T(\hat{\theta}) \le 0$: Intervention reduces security value, e.g., in a fire-sale liquidation of bank assets intended to pay back deposits.
- Agent-preferred intervention generates **monotone price function** and is always achieved in equilibrium.

Monotone Price Function: Agent-Preferred Intervention



Involved Case (Our Focus):

- $T\left(\hat{\theta}\right) > 0$: Intervention increases security value.
  - e.g., when directors wish to improve the firm's health, but have to bear a private cost.
  - Note that:

$$V\left(\hat{\theta}\right) = \alpha\left\lfloor X\left(\hat{\theta} + T\left(\hat{\theta}\right)\right) - X\left(\hat{\theta}\right)\right\rfloor = C \qquad \Rightarrow \qquad T\left(\hat{\theta}\right) > 0.$$

- Agent-preferred intervention generates **non-monotone price function** and is not always achieved in equilibrium.

Summary of Equilibrium Results for Non-Monotone Case

- Agent has **precise signal** ⇒ **Unique Equilibrium**.
  - o Agent-preferred intervention.
- Agent has **moderately precise signal** ⇒ **Multiple Equilibria**.
  - o Equilibrium with Agent-preferred intervention.
  - o Equilibria with too much intervention (convex security) or too little intervention (concave security).
- Agent has **imprecise signal** ⇒ **No Equilibrium** (market breakdown).

⇒ Complementarity between agent information and market information.

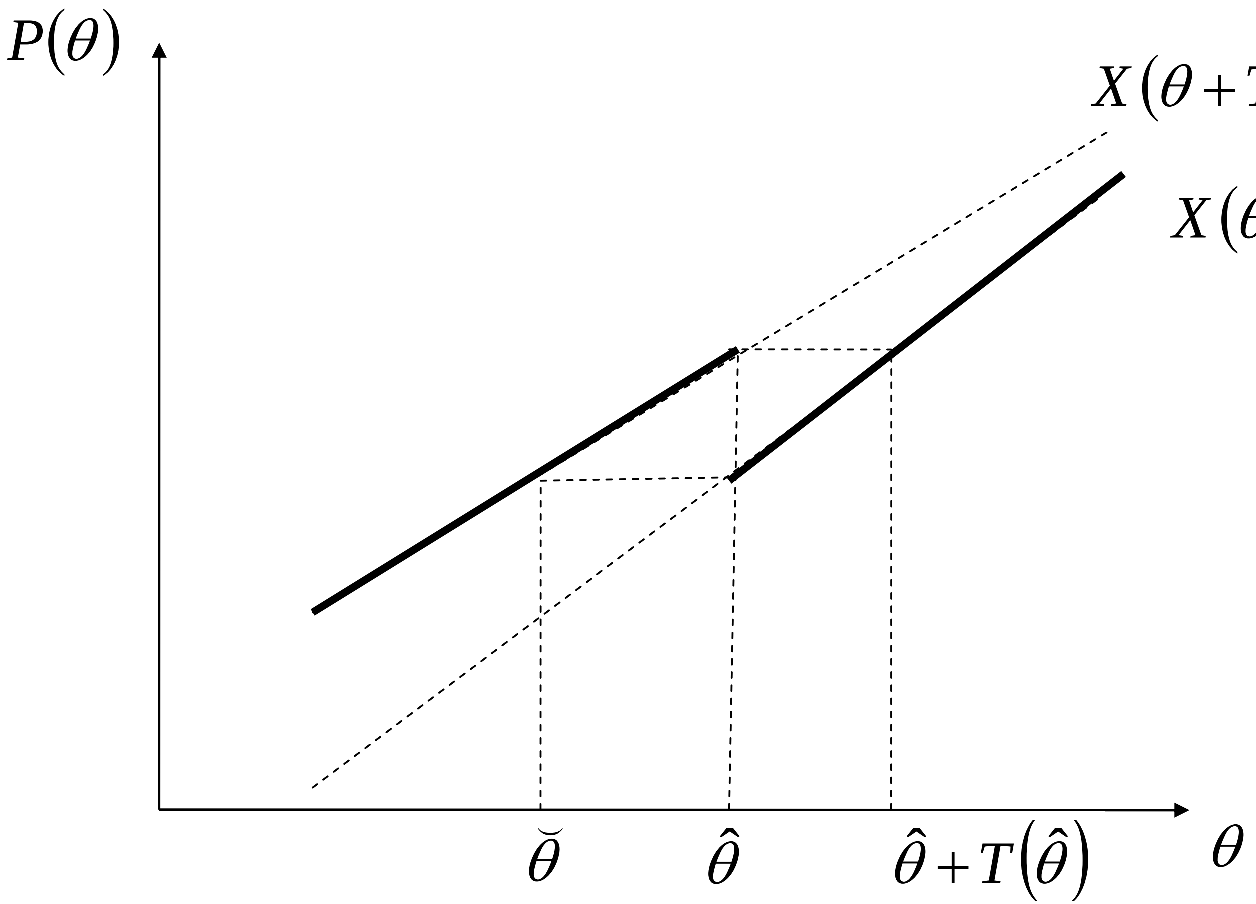
Precise Signal

When $2\kappa < T(\hat{\theta})$***, there is an equilibrium with optimal intervention.***

- Optimal intervention implies that fundamentals at distance T on two sides of $\hat{\theta}$ have the same price. Since $2\kappa < T$, the agent can always tell them apart and act optimally.

- Note that here both the price and the agent's signal are important for the decision. The combination of both enables preferred intervention.

When $\kappa < \bar{\kappa}$***, optimal intervention is a unique equilibrium.***

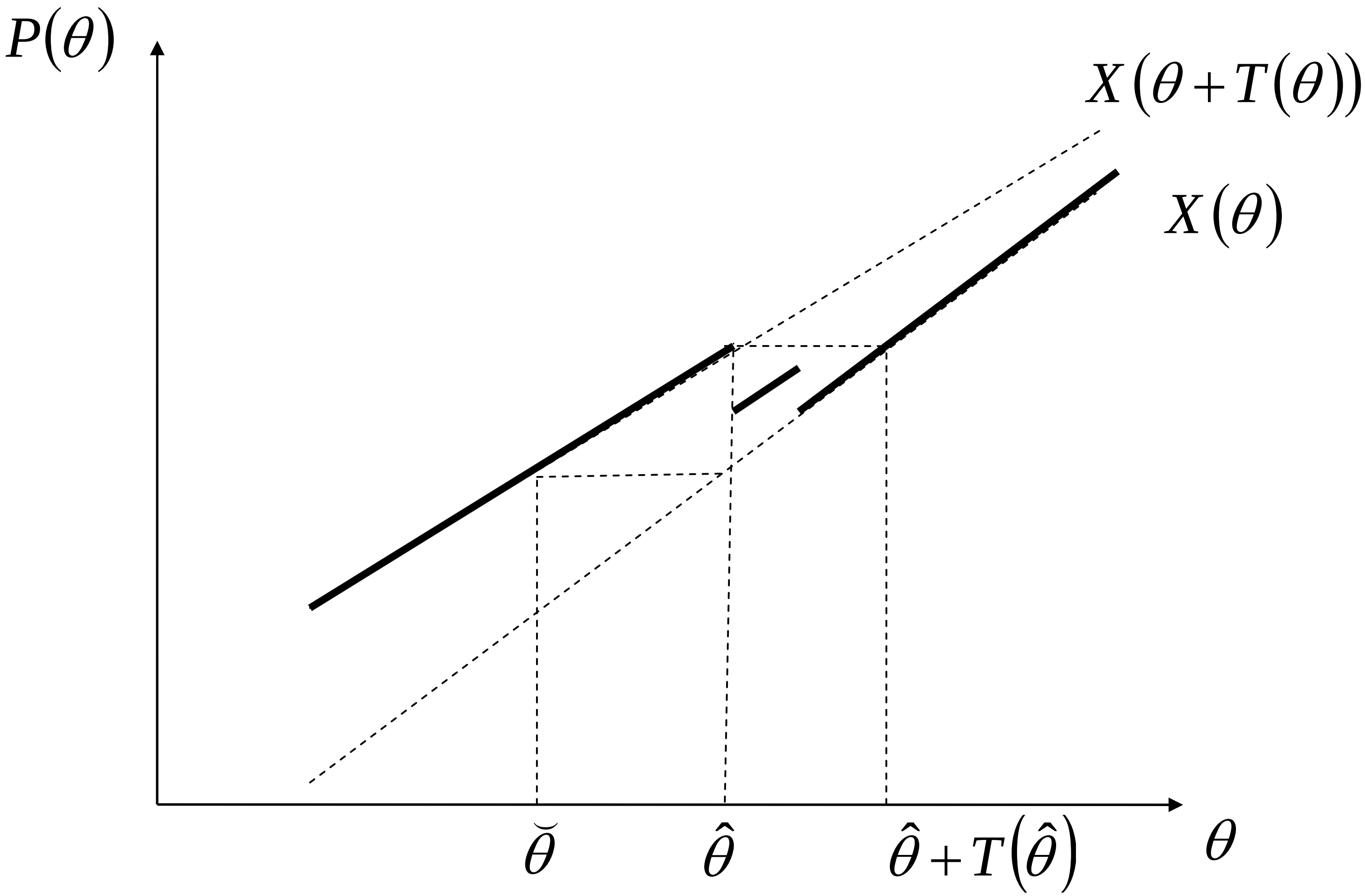


$P(\theta)$
$X(\theta + T(\theta))$
$X(\theta)$
$\breve{\theta}$
$\hat{\theta}$
$\hat{\theta} + T(\hat{\theta})$
θ

Moderately Precise Signal

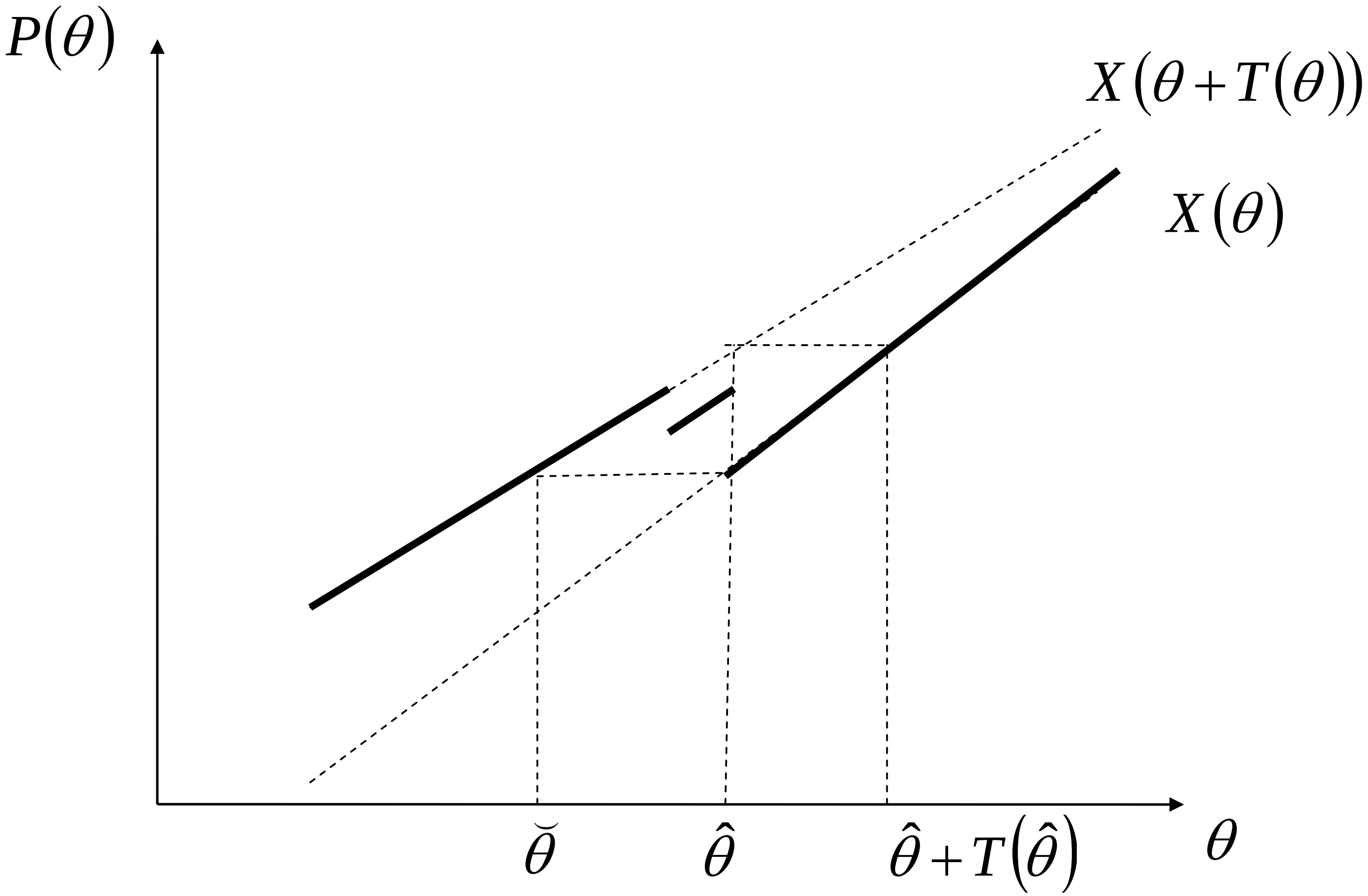
When 2κ is smaller than $T(\hat{\theta})$, but sufficiently close, there can be equilibria that violate the agent-preferred intervention rule.

- We identify two forms of such equilibria:
  - Equilibria with **too little intervention**.
  - Equilibria with **too much intervention**.
- Which one occurs depends on the shape of the security:
  - **Concave**: Typical to our bank-supervision application.
  - **Convex**: Typical to our other applications.


$P(\theta)$
$X(\theta+T(\theta))$
$X(\theta)$
$\breve{\theta}$
$\hat{\theta}$
$\hat{\theta}+T(\hat{\theta})$
θ

Discussion: Equilibria with Too Much Intervention

- Optimal intervention on left line and right line; too much intervention on middle line.
- Fundamentals on middle line are too close to left line, and thus the agent is confused and intervenes too much.
- Source for multiplicity:
  - The high intervention on middle line pushes it close to the left line, and this reinforces the high intervention.
- Convex security gives rise only to equilibria with too much intervention, not to equilibria with too little intervention.


$P(\theta)$
$X(\theta+T(\theta))$
$X(\theta)$
$\breve{\theta}$
$\hat{\theta}$
$\hat{\theta}+T(\hat{\theta})$
θ

The Role of the Shape of the Security

- Let us take fundamental θ_1 on middle line and fundamental θ_2 on right line with the same price. For the under-intervention equilibrium to exist:

$$X(\theta_2) = \left(1 - \frac{\theta_2 - \theta_1}{2\kappa}\right) X(\theta_1) + \frac{\theta_2 - \theta_1}{2\kappa} X(\theta_1 + T(\theta_1))$$

- Under convexity, this implies that:

$$\theta_2 > \left(1 - \frac{\theta_2 - \theta_1}{2\kappa}\right) \theta_1 + \frac{\theta_2 - \theta_1}{2\kappa} (\theta_1 + T(\theta_1))$$

- This implies $2\kappa > T(\theta_1)$; inconsistent with moderately precise signal.

Imprecise Signal

When $2\kappa > T\left(\hat{\theta} - 2\kappa\right)$***, there is no rational-expectations equilibrium.***

- Intuition is best understood for the case where the regulator has no signal.
  - In equilibrium, different fundamentals must have different prices.
    - If they have the same price, the intervention probability has to be the same, but this generates different prices.
  - But, such an equilibrium is fully revealing, so the regulator will intervene optimally.
  - Optimal intervention is inconsistent with fully revealing prices.

Interpreting 'No Equilibrium'

- No rational-expectations equilibrium can be interpreted as a market breakdown in an explicit game form.
- Suppose that speculators and market maker know θ. Market maker sets a price, and speculators submit buy/sell orders at this price.
- The agent observes the price and learns about θ.
- **Results:**
  - All REE equilibria identified thus far, are equilibria in this game.
  - When no REE exists, there is an equilibrium in the game, where the market maker does not post a price for an intermediate range of θ.

Robustness

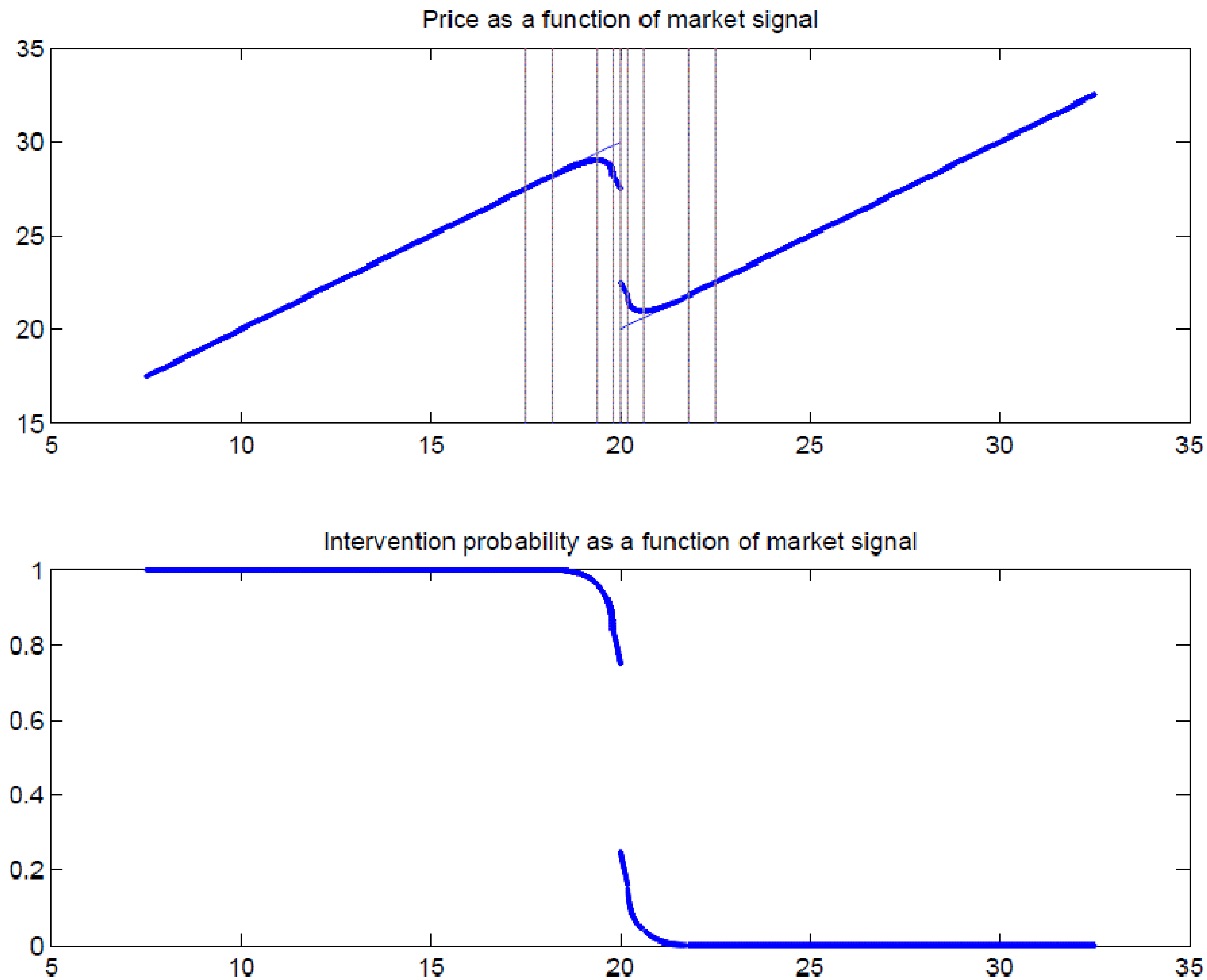
- So far, we assumed that the market knows strictly more than the agent.
- Suppose that with probability $1-\mu$ this is the information structure, but with probability μ the agent knows strictly more.
- Define $X^*(\theta)$ as the value when agent observes superior information.
- Defining:

$$\tilde{X}(\theta) = \mu X^*(\theta) + (1-\mu) X(\theta)$$

$$\tilde{X}\left(\theta + \tilde{T}(\theta)\right) = \mu X^*(\theta) + (1-\mu) X(\theta + T(\theta))$$

- Key properties remain the same and hence results hold for small μ.

- Assuming that both the market and the agent observe noisy signal about the fundamentals, analysis becomes incredibly more complicated.
  - Basic issue with non-monotonicity remains, but finding an equilibrium becomes much more complicated.
- Can analyze the model under special conditions:
  - Small noise in agent's signal and smaller noise in market's signal.
  - Constant T and linear X.
- Obtain an equilibrium of the following form:


Price as a function of market signal
35
30
25
20
15
5
10
15
20
25
30
35
Intervention probability as a function of market signal
1
0.8
0.6
0.4
0.2
0
5
10
15
20
25
30
35

Solution 1: Multiple Securities

If optimal intervention is not an equilibrium when the agent observes the price of one security, it will not be an equilibrium when the agent observes the prices of both securities.

- Intervention transforms the fundamental θ into $\theta + T$ for all investors.
- Thus, under optimal intervention, fundamentals θ and $\theta + T$ will have the same equity price as well as the same debt price.

But, observing the prices of a concave security and a convex security rules out multiple equilibria when $2\kappa < T$.

Solution 2: Transparency / Disclosure

If the agent truthfully discloses his signal to the market before price is being set, multiple equilibria when $2\kappa < T$ are ruled out.

- Source of multiple equilibria is indeterminacy of intervention decision of the agent.
- This is ruled out when the agent discloses his signal to the market.

But, transparency does not solve the problem of non existence when $2\kappa > T$.

Transparency might have other costs.

Solution 3: Event Markets

Optimal intervention always happens in equilibrium if the agent observes the price of a security that predicts intervention policy.

- Suppose that for any θ_i, θ_j, $P(\theta_i) \neq P(\theta_j) \Rightarrow$ Prices are fully revealing, and optimal intervention occurs.
- Suppose that there exist θ_i, θ_j, such that $P(\theta_i) = P(\theta_j) \Rightarrow$ Probability of intervention has to be different across fundamentals. Then fundamental can be identified from the prediction market.
- This requires well functioning event markets and verifiable interventions.

Conclusions

- We study a model of market-based corrective action, where learning from the market is self-defeating, since the expectation of market-based action 'cancels' the information in the price.
- We characterize equilibrium outcomes for different parameters.
- There is a wide range of applications, including CEO turnover, shareholder activism, takeovers, and bank supervision.
- **Positive Implications:**
  - Patterns of actions and prices depend on information gap and shape of security.

- Empirical investigation has to consider bi-directional effects (Bradley, Brav, Goldstein, and Jiang (2008)).
- Equilibrium indeterminacy makes empirical predictions less obvious.

- **Normative Implications:**
  - Complementarity between regulatory information and market information.
    - Unusual role of regulatory information: crucial to interpret the market's signal.
  - Other policy measures can help: multiple securities, transparency, and events markets.