Sorting, Selection, and Announcement Returns in Takeover Markets*

Kei Kawakami†

April 22nd, 2019

Abstract

This paper develops a model of takeovers with two layers of informational issues: at the level of firms and at the level of stock market investors. Each firm owns two factors, non-tradeable "skill" and a tradeable but indivisible "project". Both factors vary in their quality. Takeovers are driven by complementarity between the two factors. We first characterize conditions under which voluntary disclosure by firms leads to positive assortative matching (PAM) despite the incomplete information problem. We then show that empirically documented patterns of announcement returns are consistent with PAM if stock market investors know before the deal announcements either (i) only skill of firms (which leads to target premia and bidder discounts) or (ii) stand alone values of firms but not the two factors separately (which leads to target premia and bidder premia). Our model suggests that variation in investors' pre-deal information about firms might be an important source of variation in announcement returns.

Keywords: Announcement returns, Asymmetric information, Disclosure, Market segmentation, Takeovers.

*I thank seminar participants at University of Toyama for comments and suggestions. All errors are mine. This work was supported by JSPS KAKENHI Grant Number JP18K12745. Financial support from the College of Economics at Aoyama Gakuin University is gratefully acknowledged.

†Department of Economics, Aoyama Gakuin University, e-mail: kei.kawakami@gmail.com

1 Introduction

Announcement returns in takeover markets exhibit systematic patterns. Empirical research finds that while target firms have large and robust announcement returns, bidder announcement returns are highly dispersed and only weakly negative. Moreover, small bidders tend to have positive announcement returns (Eckbo 2014, Moeller et al 2004). What economic forces drive these patterns? Can we see them as evidence for, or against, efficient operations of takeover markets?

We present a simple model of takeovers to answer these questions. The model incorporates two layers of informational issues: at the level of firms and at the level of stock market investors evaluating the value of the firms. Each firm is endowed with non-tradeable skill and one tradeable but indivisible project. Both skill and project vary in their quality across firms, and those are firms' private information. Firms share a common production technology that exhibits complementarity between the two factors. This implies gains from trade between a firm endowed with good skill but a bad project and a firm endowed with a good project but bad skill.

As is standard in the one-to-one matching literature (e.g. Eeckhout and Kircher 2011), we focus on the environment where the first best allocation features positive assortative matching (PAM), and study a competitive equilibrium with a price schedule. While most models in this literature assume exogenous two sides (e.g., worker and firm) and single dimensional type on each side, in our model two sides are endogenously formed (each firm chooses to be a target or a bidder or not to trade) and firm type is two dimensional (each firm is identified by its skill and project quality). To match targets with a given project quality to bidders with a specific skill level, heterogeneity matters on both sides: potential targets are heterogeneous in their skill while potential bidders are heterogeneous in their project quality. Because firms are heterogeneous in their outside options conditional on the matched project quality and skill, a market-clearing condition endogenously determines a price and the number of takeover deals. In this environment, a price schedule plays two roles. First, it guides *sorting* of firms across different markets. Second, it induces *selection* into the two sides of each market to achieve market-clearing. In a standard one-to-one matching model with single dimensional type on each side, efficient sorting immediately implies market-clearing. As this property no longer holds in our environment, it is not obvious under what condition the price schedule can satisfy both efficient sorting and market-clearing.

We characterize conditions under which firms' voluntary disclosure leads to PAM between skill and projects despite the incomplete information problem. Importantly, sorting along the price schedule on the target side as well as on the bidder side imposes incentive constraints.

In line with a context of takeover markets, we assume that firm type is private information but firms can credibly disclose it. Under this assumption, if deviation payoffs for targets and bidders are monotonic along the price schedule, then a standard unravelling mechanism works on both sides. In particular, if the deviation payoffs are increasing in project quality, then the following "minimum disclosure" is sufficient for PAM: "our project quality (or skill) is at least X".[1] This situation can be viewed as takeover activities being disciplined by investors: while all targets and bidders (except the best type on each side) wish they could "move up" the price schedule and pool with better types, the presence of stock market investors who anticipate the minimum disclosure from firms prevents such pooling. We derive conditions in terms of production technology and type distributions which yield this unravelling result.

We then study whether the model is consistent with empirically documented patterns of announcement returns. Under empirically plausible conditions, we show that, for a given takeover deal, a bidder discount and a target premium arise if and only if stock market investors know only skill levels of the firms prior to the deal announcement. More generally, we consider four different combinations of announcement returns for a pair of target and bidder: 1) both positive, 2) positive/negative, 3) negative/positive, 4) both negative. We show that these correspond to four different cases of stock market investors' imperfect knowledge about the two firms prior to the deal announcement: Case (i) only stand alone values, Case (ii) only skill, Case (iii) only project quality, Case (iv) no information. Case (i) leads to positive announcement returns for the bidder and the target, because the deal announcement is a good news to both firms (they have large gains from trade but were pooled with other firms with the same stand alone value but without a prospect for efficiency improving takeovers). Case (ii) leads to target premia and bidder discounts, because the deal announcement is a good news to the target (who has a good project but was pooled with other firms with the same skill and bad projects) while it is a bad news to the bidder (whose bad project was previously not known and pooled with other firms with the same skill and good projects). Case (iii) generates the opposite pattern of Case (ii) (i.e., target discounts and bidder premia), while Case (iv) leads to the opposite pattern of Case (i) (i.e., discounts for both).

Our model offers the following explanation for the observed patterns of announcement returns: PAM at the firm level is rationally anticipated by stock market investors, whose knowledge about firms before the announcement deal is mostly Case (i) or Case (ii). The prevalence of Case (ii) is consistent with the idea that non-tradeable factors of production are more likely to be a part of the identity of firms (more so than tradeable factors of production), and therefore they should be long-lived and slowly-varying in their nature. For investors, this

[1] Although a statement with X smaller than the true value is stil truthfull, there is no incentive to use such a statement.

makes quality of non-tradeable factors of production easier to identify and learn over time than quality of tradeable factors of production. Moreover, the observed size dependence of bidder returns can be rationalized if Case (i) applies more to smaller/younger firms and Case (ii) is more relevant to larger/older firms. Intuitively, investors spend more time and resources to gather information about larger/older firms. If evaluating the stand alone value can be done less costly and more quickly than evaluating quality of non-tradeable factors of production, then we should anticipate that Case (ii) is concentrated among smaller/younger firms. A more general implication from our analysis is that variation in investors' information set might be an important source of systematic variation in announcement returns. The predictions from the model help organize the available evidence on announcement returns, and can guide future empirical studies.

Related literature. Jovanovic and Braguinsky (2004) present a simple model in which target premia and bidder discounts are consistent with efficiency. Our model extends the scope of their analysis and clarifies a role of technological and informational assumptions. In their model, target premia and bidder discounts always occur, and cross-sectional variations are counter-factual.[2] Our model suggests that cross-sectional variation in announcement returns may be due to variation in stock market investors' knowledge about firms. Most empirical research focuses on firm characteristics or deal characteristics (e.g. tender or hostile) as drivers of cross-sectional variation in announcement returns. Our model suggests that which aspects of the firms were known to stock market investors prior to the deal announcement might be crucial for understanding announcement returns.

Section 2 presents a model of takeovers. Section 3 studies a competitive market allocation without any information friction. In Section 4, we introduce information friction and derive a condition under which a voluntary disclosure leads to efficient sorting and selection. Section 5 analyzes announcement returns. Section 6 concludes.

2 Model

There is a unit mass of firms, each endowed with one indivisible project and skill in managing at most one project. Projects are tradeable, but skill is not. Both projects and skill vary in their quality. Firms draw their project quality $A \in [0,1]$ from distribution Φ_A with smooth and positive density ϕ_A. Similarly, firms draw their skill $X \in [0,1]$ from distribution Φ_X with smooth and positive density ϕ_X. Assuming that project quality and skill are independently

[2] Their model has a single market and a single price. Target premia are constant for all targets and bidder discounts become smaller in magnitude for larger bidders.

distributed, for any given $z \in [0,1]$ a mass of firms with skill z is $\phi_X(z)$ and among these firms project quality has distribution Φ_A. Similarly, for any given $z \in [0,1]$ a mass of firms with project quality z is $\phi_A(z)$ and among these firms skill has distribution Φ_X. All firms share a common production technology $Y = F(A, X)$. We assume the following.

Assumption $\frac{\partial F(A,X)}{\partial A} > 0$, $\frac{\partial F(A,X)}{\partial X} > 0$, *and* $\frac{\partial^2 F(A,X)}{\partial A \partial X} > 0$ *for any* $(A, X) \in [0,1]^2$. *Also,* $F(z, 0) = F(0, z) = 0$ *for any* $z \geq 0$.

Assumption means that takeovers are driven by complementarity, and that the first best allocation is PAM between projects and skills. This is represented by the matching function $\mu(z) \equiv \Phi_X^{-1}(\Phi_A(z))$ which specifies the skill level to be matched to project quality $z \in [0,1]$. Firms that sell their projects stop production and leave the economy, We call them *targets*. The targets' payoffs are sales proceeds. We call firms that buy new projects and abandon their initial projects *bidders*. The bidders' payoffs are the production from a new project managed by their non-tradeable skills minus payments to targets. Firms are heterogeneous in their stand alone values (i.e., Y without takeovers) as well as in their prospect as targets or bidders (i.e., expected payoff as targets or bidders in takeovers).

Two remarks are in order. First, we assume that each firm can manage at most one project. In other words, we focus on takeovers as a quality choice, rather than a quantity choice. Allowing for firms to manage multiple projects requires taking a stand on how to model complementarity (or substitutability) between projects as well as between the number of projects and skill.[3] Additionally, if we allow a non-degenerate initial distribution for the number of projects across firms, each firm must be identified with two numbers (skill and the number of projects) *and* quality distribution of the projects. We abstract from these complications to focus on issues associated with information frictions.

Second, to achieve the first best allocation, almost all firms must sell the initial project *and* buy a new project.[4] To make the model consistent with an empirical fact that only a small subset of firms engage in takeovers, we need some restriction on trading. We assume that each firm can either sell a project, or buy a new project, or do neither, but cannot simultaneously buy and sell projects. This restriction on trading gives rise to an endogenous set of firms who choose to be inactive in takeover markets. Moreover, we will show that a competitive market allocation can still be interpreted as a constrained efficient allocation. In the one-to-one matching literature, often search friction is introduced to rationalize inactivity (e.g., unemployment and vacancy in labor markets). In our model, there is no explicit search friction, but inactivity naturally arises from multi-dimensionality of type. In this sense, we

[3] Eeckhout and Kircher (2018) studies this issue in a model with single-dimensional type.

[4] Firms with $(A, X) = (z, \mu(z))$, $z \in [0,1]$, start with efficient endowment.

view the restriction on trading as a complementary approach to search friction.[5]

As we show in Section 5, reallocation of projects in this environment naturally generates announcement returns. Using this model, we study to what extent observed patterns of announcement returns can be rationalized by efficiency improving takeovers driven by complementarity between tradeable and non-tradeable factors of production.

3 Competitive market allocation

We study the following market arrangement: In a market indexed by $z \in [0,1]$, firms with project quality z sell their projects to firms with skill level $\mu(z)$. For a firm with (A, X), this means that it can either go to market indexed by $z = A$ as a target, or go to market indexed by $z = \mu^{-1}(X)$ as a bidder, or not to participate in any market. In this section we take this sorting pattern as given and characterize competitive market allocation. Note that if (A, X) is public, then this market arrangement can be enforced. If (A, X) is private, then firms need to be given incentive to reveal this information. We study such voluntary disclosure (i.e., unravelling) in the next section.

Denote a market-clearing price in market z by P_z. Targets in market z are willing to sell projects of quality z at this price if and only if

$$P_z \geq F(z, X), \tag{1}$$

where X has distribution Φ_X. Bidders in market z have skill $\mu(z)$ and they are willing to buy projects of quality z at this price if and only if

$$\Pi_z \equiv F(z, \mu(z)) - P_z \geq F(A, \mu(z)), \tag{2}$$

where A has distribution Φ_A. To characterize P_z, we need a few more notations. For a given price P, $P = F(z, X)$ defines a maximum skill level $\overline{X}(P, z)$ of firms willing to sell at P in market z. Similarly, $F(z, \mu(z)) - P = F(A, \mu(z))$ defines a maximum project quality $\overline{A}(P, z)$ held by firms willing to buy at P in market z. Therefore, supply and demand at P in market z are given by

$$\begin{aligned} S_z(P) &= \phi_A(z)\, \Phi_X\left(\overline{X}(P, z)\right) \\ B_z(P) &= \mu'(z)\, \phi_X(\mu(z))\, \Phi_A\left(\overline{A}(P, z)\right). \end{aligned}$$

[5] Another issue is that a buy-and-sell strategy makes an interpretation of announcement returns difficult in our static framework. A buy-and-sell strategy and its implication for announcement returns should be analyzed in a fully dynamic framework, and we leave this extension for future work.

A market-clearing condition $S_z(P) = B_z(P)$ determines a market-clearing price P_z. Using $\Phi_A(z) = \Phi_X(\mu(z)) \Leftrightarrow \phi_A(z) = \mu'(z)\,\phi_X(\mu(z))$, the market-clearing condition is

$$\frac{\Phi_X\left(\overline{X}(P,z)\right)}{\Phi_A\left(\overline{A}(P,z)\right)} = 1. \tag{3}$$

It is straightforward to show that the left hand side in (3) is increasing in P and decreasing in z. The existence of a unique market-clearing price $P_z \in (0, F(z,\mu(z)))$ follows from $\overline{X}(0,z) = 0$, $\overline{A}(0,z) = z$, $\overline{X}(F(z,\mu(z)),z) = \mu(z)$ and $\overline{A}(F(z,\mu(z)),z) = 0$. Define $\overline{A}(z) \equiv \overline{A}(P_z,z)$ and $\overline{X}(z) \equiv \overline{X}(P_z,z)$. From (3), we have $\overline{X}(z) = \mu\left(\overline{A}(z)\right)$.

Proposition 1

(a) *For any $z \in (0,1]$, a unique market-clearing price $P_z \in (0, F(z,\mu(z)))$ exists.*

(b) $\overline{A}(z) \in (0,z)$ *is uniquely determined by* $F(z,\mu(z)) = F\left(z,\mu\left(\overline{A}(z)\right)\right) + F\left(\overline{A}(z),\mu(z)\right)$. $\overline{A}(z)$, $\overline{X}(z)$, $P_z = F\left(z,\mu\left(\overline{A}(z)\right)\right)$, *and* $\Pi_z = F\left(\overline{A}(z),\mu(z)\right)$ *all increase in z.*

(c) *The associated trade* $Q_z = \phi_A(z)\,\Phi_A\left(\overline{A}(z)\right)$ *is a solution to*

$$\max_{Q \le \phi_A(z)} \left[QF(z,\mu(z)) - \phi_A(z) \int_0^{\overline{X}} F(z,s)\,\phi_X(s)\,ds - \phi_A(z) \int_0^{\overline{A}} F(s,\mu(z))\,\phi_A(s)\,ds \right] \tag{4}$$

$$\textit{subject to } \overline{X} = \Phi_X^{-1}\left(\frac{Q}{\phi_A(z)}\right) \textit{ and } \overline{A} = \Phi_A^{-1}\left(\frac{Q}{\phi_A(z)}\right).$$

The planner's problem (4) is subject to a constraint that abandoned projects cannot be reassigned to other firms. This corresponds to the restriction in the market that firms cannot simultaneously buy and sell a project. To understand the meaning of Q_z, notice that the maximum possible matching between projects of quality z and firms with skill $\mu(z)$ is $\phi_A(z) = \mu'(z)\,\phi_X(\mu(z))$. By transferring Q projects of quality z to new firms with skill $\mu(z)$, the gross payoff from the transferred projects is $QF(z,\mu(z))$. On the other hand, this transfer results in a measure Q firms to stop production, and another measure Q firms abandoning their initial projects. The lost value of the former firms can be minimized by selecting less skilled firms among $\phi_A(z)$. The associated lost value is $\phi_A(z)\int_0^{\overline{X}} F(z,s)\,\phi_X(s)\,ds$, where $\overline{X} = \Phi_X^{-1}\left(\frac{Q}{\phi_A(z)}\right)$ is the highest skill among Q firms that give away their projects. Similarly, the lost value from abandoned projects can be minimized by selecting firms with projects of lower quality among $\phi_A(z)$. The associated lost value is $\phi_X(z)\int_0^{\overline{A}} F(s,\mu(z))\,\phi_A(s)\,ds$, where $\overline{A} = \Phi_A^{-1}\left(\frac{Q}{\phi_A(z)}\right)$ is the highest project quality among

Q firms that abandon their initial projects.

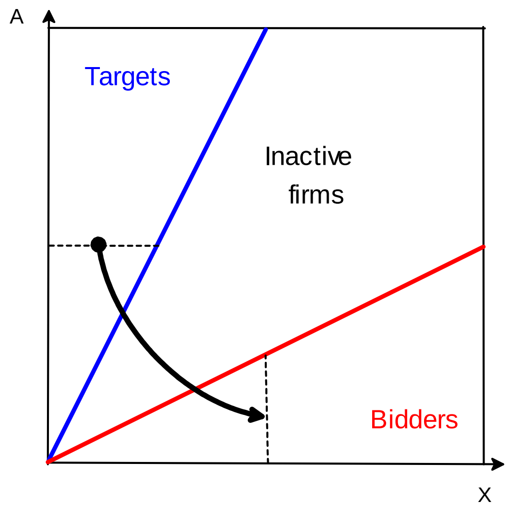


Figure 1. Efficient reallocation

Figure 1 illustrates competitive market allocation. Targets' endowment (A, X) satisfy $X \leq \overline{X}(A)$, so they are in the top-left region. Bidders' endowment (A, X) satisfy $A \leq \overline{A}(\mu^{-1}(X))$, so they are in the bottom-right region. Inactive firms are located in the area between the two lines $\overline{X}(z)$ and $\overline{A}(z)$. Firms that engage in takeovers are those with unbalanced endowment. Recall that this allocation takes sorting of firms as given. If information about (A, X) is public, this sorting can be enforced, say, by the regulatory body. On the other hand, if (A, X) is firms' private information, firms must be given right incentive to sort into a specific market, and select an appropriate side of the market. In the next section, we show that such sorting and selection requires restrictive conditions on distributions of types and the production function. However, we also show that a disclosure scheme that induces unravelling of firms can implement the competitive market allocation under weaker assumptions.

4 Sorting and selection

In this section, we assume that initial allocation of (A, X) is private information of firms. In the presence of information friction at the firm level, we need to check incentive of firms to go to the right market as well as incentive to be a target or a bidder. We assume that truthful disclosure is feasible. Namely, firms can choose not to reveal their type, but they cannot lie about it. Under this assumption, we show below that the following *minimum disclosure* *requirement* is effective: If you want to trade in market z, show us that either your project is no worse than z or your skill is no worse than $\mu(z)$.

First, we consider targets' incentive. Because targets' payoff is simply the price of their projects, their incentive regarding which market to visit is straightforward: they want to go to market with the highest price. Because the price schedule P_z increases in z (**Proposition 1**), potential targets all want to sell their projects at P_1. However, if targets can credibly reveal their project quality, then a standard unraveling result ensues, i.e., the best type (targets with projects of the best quality) always find it optimal to reveal its type, so in equilibrium all but the lowest type would be worse off by not revealing its type. For this unraveling to work, the minimum disclosure is sufficient: targets with projects of quality z disclose that their projects have quality of *at least* z.

Next, we consider bidders' incentive. Bidders with skill level $\mu(z)$, by trading in market z, obtain $F(z, \mu(z)) - P_z$. By deviating to market $z' \neq z$, they would obtain $F(z', \mu(z)) - P_{z'}$. Therefore, they have no incentive to go to any market other than z if and only if

$$\begin{cases} \frac{P_{z'} - P_z}{z' - z} \geq \frac{F(z', \mu(z)) - F(z, \mu(z))}{z' - z} & \forall z' > z, \\ \frac{P_{z'} - P_z}{z' - z} \leq \frac{F(z', \mu(z)) - F(z, \mu(z))}{z' - z} & \forall z' < z. \end{cases}$$

Therefore, we have the following result.

Proposition 2

The minimum disclosure requirement leads to competitive market allocation if and only if for any z, $\frac{d}{dz} P_z \leq \frac{\partial F(A, \mu(z))}{\partial A}|_{A=z}$, *which is equivalent to*

$$\frac{\phi_A(z)\, \phi_A\left(\overline{A}(z)\right)}{\phi_X(\mu(z))\, \phi_X\left(\mu\left(\overline{A}(z)\right)\right)} \leq \frac{F_A\left(\overline{A}(z), \mu(z)\right)}{F_X\left(z, \mu\left(\overline{A}(z)\right)\right)} \frac{F_A(z, \mu(z)) - F_A\left(z, \mu\left(\overline{A}(z)\right)\right)}{F_X(z, \mu(z)) - F_X\left(\overline{A}(z), \mu(z)\right)}. \tag{5}$$

If (5) with inequality holds, bidders with skill $\mu(z)$ *disclose it to trade in market* z.

If (5) with equality holds, bidders with skill $\mu(z)$ *choose market* z *without disclosure.*

To interpret (5), suppose that A and X have the same distribution. Then (5) becomes

$$F_X\left(z, \overline{A}(z)\right)\left\{F_X(z, z) - F_X\left(\overline{A}(z), z\right)\right\} \leq F_A\left(\overline{A}(z), z\right)\left\{F_A(z, z) - F_A\left(z, \overline{A}(z)\right)\right\},$$

where $F(z, z) = F\left(z, \overline{A}(z)\right) + F\left(\overline{A}(z), z\right)$ determines $\overline{A}(z) \in (0, z)$. In this case, (5) requires that the production function exhibit asymmetry in favor of project quality. Additionally , if $F(A, X) = A^\alpha X$, then $\overline{A}(z)$ solves $\frac{A}{z} + \left(\frac{A}{z}\right)^\alpha = 1$ and the above condition then becomes $1 \leq \alpha$.[6] As this example shows, if both distributions and the production technology are symmetric, then $\frac{d}{dz}P_z = \frac{\partial F(A,\mu(z))}{\partial A}|_{A=z}$ holds for any z. This is the case where no disclosure is necessary on bidders' side.

In a standard one-to-one matching model with one dimensional type, $\frac{d}{dz}P_z = \frac{\partial F(A,\mu(z))}{\partial A}|_{A=z}$ is an equilibrium condition that pins down the price schedule (See Eeckhout and Kircher 2011). This is so because once the price schedule induces buyers' sorting, each market immediately clears. A key difference in our model is that firms are heterogeneous in their outside options (i.e., stand alone values) conditional on a given match between project and skill. In general, the price schedule that exactly induces bidders' sorting cannot clear the market. Conversely, the price schedule that clears each market for a given sorting pattern must satisfy an additional condition to satisfy bidders' incentive for that sorting pattern.

Unravelling in the opposite direction can occur on bidders' side if $0 < \frac{\partial F(A,\mu(z))}{\partial A}|_{A=z} < \frac{d}{dz}P_z$ for any z. This is the situation where the marginal decrease in project quality is more than compensated by saving in the price paid for a project. In this case, the *maximum disclosure scheme* is necessary on the bidders' side: If you want to trade in market z, show us that your skill is no better than $\mu(z)$. This "race to the bottom" unravelling among bidders is a theoretical possibility, but it seems quite counter-factual.

5 Announcement returns

In this section, we investigate implications of the efficient reallocation for announcement returns. Recall that $P_z = F\left(z, \mu\left(\overline{A}(z)\right)\right)$ is equilibrium payoff for targets and $\Pi_z = F(z, \mu(z)) - P_z$ is that for bidders in market z. We assume that stock market investors rationally anticipate the following ex post firm value:.

$$V(A, X) = \begin{cases} P_A & \text{if } X \leq \overline{X}(A), \\ \Pi_{\mu^{-1}(X)} = F\left(\mu^{-1}(X), X\right) - P_{\mu^{-1}(X)} & \text{if } A \leq \overline{A}\left(\mu^{-1}(X)\right), \\ F(A, X) & \text{otherwise.} \end{cases} \quad (6)$$

[6] $\overline{A}(z) = \frac{z}{2}$ for $\alpha = 1$ and $\lim_{\alpha\to\infty} \overline{A}(z) = z$.

The first line in (6) is the case where a firm becomes a target, while the second line is for a firm to be a bidder. **Figure 2** illustrates the ex post firm value (6).

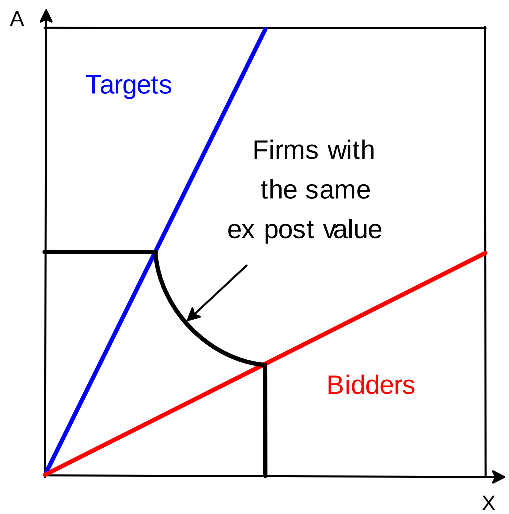


Figure 2. Ex post firm value

If investors can perfectly observe (A, X) before a deal announcement, then (6) should be the pre-announcement stock price. In this case, the deal announcement reveals no information and the associated announcement return should be zero. For announcement returns to be non-zero, the deal announcement must reveal some information to investors. We study announcement returns under the following four mutually exclusive cases:

Case (i) Pre-announcement stock price reflects $Y = F(A, X)$ but not (A, X), i.e.,

$$q(Y) = E[V(A, X) | F(A, X) = Y].$$

Case (ii) Pre-announcement stock price reflects X but not A, i.e.,

$$q(X) = E[V(A, X) | X].$$

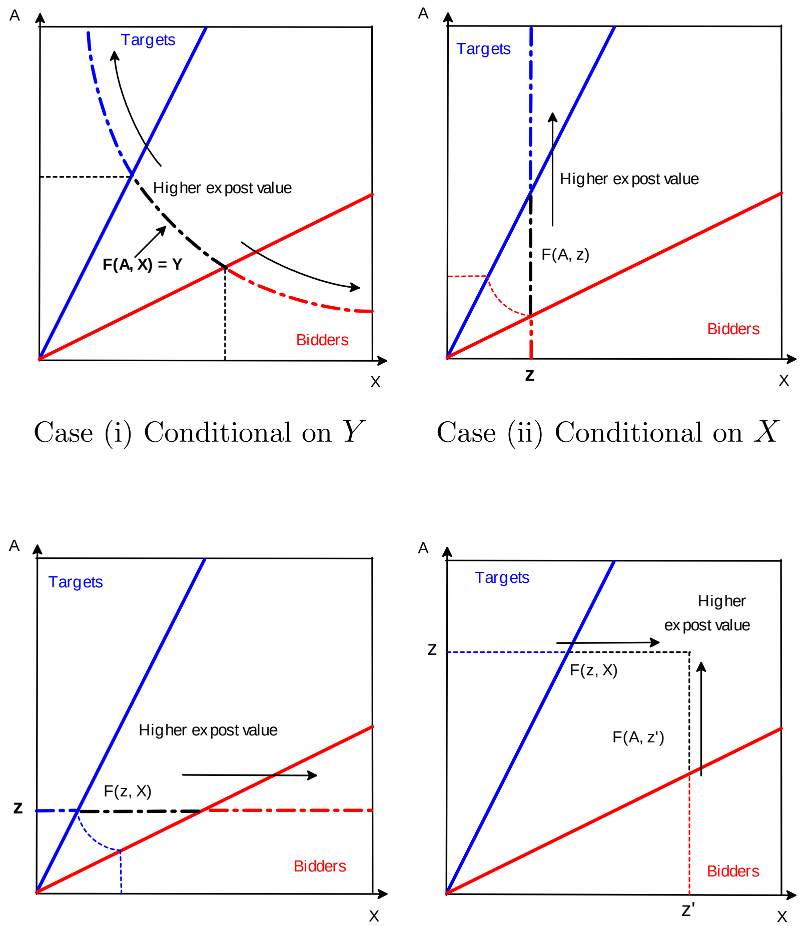
Case (iii) Pre-announcement stock price reflects A but not X, i.e.,

$$q(A) = E[V(A, X) | A].$$

Case (iv) Pre-announcement stock price reflects no information about (A, X), i.e.,

$$q = E\left[V\left(A, X\right)\right].$$

An important observation is that $F\left(A, X\right) > \max\left\{P_A, \Pi_{\mu^{-1}(X)}\right\}$ holds for non-trading firms. To consider Case (iv), fix arbitrary $z \in (0, 1]$. For targets with project quality z and the ex post value P_z, there exists a set of non-trading firms with higher ex post values $F\left(z, X\right)$, $X \in \left(\overline{X}\left(z\right), \mu\left(z\right)\right]$. Similarly, for bidders with skill $z' = \mu\left(z\right)$ and the ex post value Π_z, there exists a set of non-trading firms with higher ex post values $F\left(A, \mu\left(z\right)\right)$, $A \in \left(\overline{A}\left(\mu\left(z\right)\right), z\right]$. As we change z from zero to one, we can cover all firms without any overlap. if a number of firms involved in takeovers is small relative to that of non-trading firms *or* gains from trade are shared not too unequally between targets and bidders, then the information revealed by the deal announcements is mostly about the difference between participation and non-participation. This indicates that an announcement of takeover deals, as targets or bidders, typically reveals a bad information about the firm's ex post value on average. Thus, target discounts and bidder discounts arise for Case (iv).



Case (i) Conditional on Y Case (ii) Conditional on X

Case (iii) Conditional on A Case (iv) No information

Figure 3. Announcement returns

Going through similar reasoning, one can verify that the other cases are associated with particular patterns of average announcement returns for bidders and targets. In fact, it turns out that unless a measure of non-trading firms is too small, only Case (ii) is consistent with target premia and bidder discounts.

To state the results formally, we need additional notations. For Case (i), we denote by $m_T(Y)$ the measure of targets whose stand-alone value is Y (i.e., with initial (A, X) such that $F(A, X) = Y$). We denote by $m_B(Y)$ the measure of bidders and by $m_N(Y)$ that of non-trading firms, all with the same stand-alone value Y. We denote the value of targets conditional on Y by $V_T(Y)$, and that of bidders by $V_B(Y)$. Then, whenever targets and bidders with stand-alone value Y exist, $Y < \min\{V_T(Y), V_B(Y)\}$ holds. Before the deal announcement, the firm value conditional on Y is

$$q(Y)=\frac{m_T(Y)V_T(Y)+m_B(Y)V_B(Y)+m_N(Y)Y}{m_T(Y)+m_B(Y)+m_N(Y)Y}.$$

Using these notations, target premia and bidder premia arise when $q(Y)<\min\{V_T(Y),V_B(Y)\}$.

For Case (iv), we denote the unconditional value of targets by V_T, that of bidders by V_B, and that of non-trading firms by V_N. Then $\max\{V_T,V_B\}<V_N$ holds. We denote by m_N the unconditional measure of non-trading firms. Before the deal announcement, the unconditional firm value is

$$q=m_NV_N+\frac{1-m_N}{2}(V_T+V_B).$$

Using these notations, target discounts and bidder discounts arise when $\max\{V_T,V_B\}<q$.

Proposition 3

For Cases (i)-(iv), the efficient reallocation generates the following patterns of announcement returns:

Case (i) Conditional on Y, target premia and bidder premia arise if and only if

$$\max\left\{m_T(Y)\frac{V_T(Y)-V_B(Y)}{V_B(Y)-Y},m_B(Y)\frac{V_B(Y)-V_T(Y)}{V_T(Y)-Y}\right\}<m_N(Y). \tag{7}$$

Case (ii) Conditional on X, target premia and bidder discounts arise.

Case (iii) Conditional on A, target discounts and bidder premia arise.

Case (iv) Unconditionally, target discounts and bidder discounts arise if and only if

$$\frac{\max\{V_T,V_B\}-\frac{1}{2}(V_T+V_B)}{V_N-\frac{1}{2}(V_T+V_B)}<m_N. \tag{8}$$

The conditions (7) and (8) both state that for a given degree of asymmetry between the target value and the bidder value, the measure of non-trading firms must be sufficiently large. In particular, if distributions and the production function are sufficiently symmetric, then the two sides share gains from trade equally and both (7) and (8) are satisfied. Intuitively, if the underlying environment exhibits extremely strong complementarity and one factor is disproportionately more productive or scarce relative to the other factor, then the measure of non-trading firms is small *and* one side of takeover reaps most gains from trade. This makes announcement returns largely driven by the difference between targets and bidders. In such a situation, target announcement returns and bidder announcement returns must move in the opposite directions, regardless of investors' pre-announcement knowledge about the firms.[7] Empirically, however, only a small subset of firms are involved in takeovers, so conditions (7) and (8) are likely to be satisfied. Table 1 below summarizes **Proposition 3** assuming (7) and (8).

Table 1. Investors' pre-announcement information and announcement returns

Pre-announcement information about (A, X)	Announcement returns	
	Target	Bidder
Case (i) $Y = F(A, X)$	**Premia**	**Premia**
Case (ii) X	**Premia**	**Discounts**
Case (iii) A	Discounts	Premia
Case (iv) $no\ info$	Discounts	Discounts

Empirically, while target firms have large and robust announcement returns, bidder announcement returns are highly dispersed and only weakly negative. Moreover, small bidders tend to have positive announcement returns (Eckbo 2014, Moeller et al 2004). According to **Table 1**, the combination of Case (i) and Case (ii) generates robust target premia and dispersed bidder returns, where bidder premia are associated with Case (i). Thus, our model offers the following explanation to this empirical observations: Case (i) and Case (ii) are prevalent in stock markets, with Case (i) being particularly pertinent to small firms. First, we argue that Case (ii) is more relevant than Case (iii) for stock market investors, because non-tradeable factors have high persistence over time and hence stock market investors can learn about them. Second, if stock market investors can learn about persistent non-tradeable factors, then Case (ii) more plausible for larger firms. For small firms, it would be more difficult to separately asses the contribution of tradeable and non-tradeable factors in their value creation process, because they tend to be young firms and have no experience of being bidders in the past. For small firms, Case (i) seems more reasonable because even when it is hard to tell whether the source of profitability is A (tradeable) or X (non-tradeable), it may be possible to obtain a good estimate of Y from firms' overall performance. In short, to the extent that Case (i) and Case (ii) are a better description of what stock market investors know about firms than Case (iii) and Case (iv) are, **Proposition 3** can rationalize the observed patterns of announcement returns.

[7] In Case (i), the violation of (7) is equivalent to $\min\{V_T(Y), V_B(Y)\} \leq q(Y) < \max\{V_T(Y), V_B(Y)\}$. In Case (iv), the violation of (8) is equivalent to $\min\{V_T, V_B\} < q \leq \max\{V_T, V_B\}$.

6 Conclusion

We proposed a simple model of takeovers that incorporates two layers of informational issues: at the level of firms and at the level of stock market investors. In the model, firms are heterogenous in their endowment of the two factors, tradeable projects and non-tradeable skill. Takeovers are driven by complementarity between the two factors, so reallocation of projects is efficiency improving, but subject to information friction. We characterized conditions in terms of distribution of factors and a production function under which voluntary disclosure by firms leads to PAM despite the incomplete information problem. We then showed that empirically documented patterns of announcement returns are consistent with PAM if stock market investors know before the deal announcements either (i) only skill of firms (which leads to target premia and bidder discounts) or (ii) stand alone values of firms but not the two factors separately (which leads to positive announcement returns for bidders and targets). The result suggests that variation in investors' information set might be an important source of variation in announcement returns. These predictions from the model help organize the available evidence on announcement returns, and can guide future empirical studies.

Our model can be viewed as a model of labor market, where A is an effective work input and X is management skill, targets are workers receiving wage, and bidders are entrepreneurs managing workers. In this context, non-active agents are self-employed workers or independent contractors. To proceed in this direction, it is important to allow entrepreneurs to hire and manage multiple workers. The most simple model would let A additive across workers. This is similar to Jovanovic (1994), but his model lacks self-employed workers. On the other hand, his model allows for general correlation between A and X. The analysis along this line may have an important implication for the behavior of wages and firm size distribution.

David (2017), Dimopoulos and Sacchetto (2017), Levine (2017), and Wang (2018) embed a takeover process in a dynamic model to assess its quantitative implication, but they do not study the incomplete information problem. Our simple static framework allows us to identify a key economic condition under which voluntary disclosure by firms can overcome the incomplete information problem in takeover markets. Combining the two approaches would likely to deliver more insights into dynamic aspects of takeover markets.

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