Sorting, Selection, and Announcement Returns in Takeover Markets*

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Abstract

We present a competitive model of takeovers that explains two robust features of the data: target premia and size-dependent bidder returns. Takeovers are driven by complementarity between two factors, non-tradeable "skill" and a tradeable "project". Firms are heterogeneous in both dimensions. After characterizing a condition under which positive assortative matching (PAM) of skill and projects occurs, we show that announcement returns identify stock market investors' pre-deal information about the firms. The two robust features are consistent with PAM if stock market investors know (i) only skill of firms or (ii) only stand-alone values of firms, before the deal announcements.

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

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1 Introduction

Announcement returns in takeover markets exhibit systematic patterns. While target firms have large announcement returns, bidder announcement returns are highly dispersed and weakly negative on average. Moreover, a robust size effect exists for bidder returns: small bidders tend to have positive announcement returns (Eckbo 2014, Moeller et al 2004).[1] What economic forces drive these patterns? Can they be seen as evidence 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 (a bidder) and a firm endowed with a good project but bad skill (a target).

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 induce both efficient sorting and market-clearing.

We first characterize conditions under which firms' voluntary disclosure leads to PAM

[1] According to Moeller et al (2004), this size effect is "robust to firm and deal characteristics, and it is not reversed over time."

between skill and projects. 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 (or skill), then all targets and bidders (except the best type on each side) wish they could "move up" the price schedule and pool with better types. However, the presence of investors who anticipate the disclosure from firms prevents such pooling. We derive conditions in terms of production technology and type distributions which ensures this unravelling result.

We then study whether the model is consistent with the observed patterns of announcement returns. Under empirically plausible conditions, we show that 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' pre-deal information about the two firms: 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 many 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). Thus, through the lens of our model, announcement returns identify investors' pre-deal information about the firms.

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 deal announcement is Case (i) or Case (ii). First, Case (ii) is consistent with the idea that non-tradeable factors of production are a part of the identity of firms, and therefore long-lived and slowly-varying. On the other hand, tradeable factors occasionally move across firms and also may change their quality more frequently. This makes quality of non-tradeable factors of production easier to identify and learn over time for investors than quality of tradeable factors of production. Second, 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 needs less time and resources than identifying non-tradeable factors of production and evaluating their quality, then Case (i) should be concentrated among smaller/younger firms. A more general implication from our analysis is that, if takeovers are driven by reallocation of resources to be matched with complementary, but non-tradeable, resources, then variation in investors' information set becomes 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 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 (e.g. a measure of corporate governance) or deal characteristics (e.g. tender/hostile, payment methods) as drivers of cross-sectional variation in announcement returns, yet the size effect is robust to these characteristics (Moeller et al 2004). Our model suggests that knowing what stock market investors know prior to the deal announcement is 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 derive a condition under which a voluntary disclosure leads to efficient sorting and selection despite information friction. 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*. Targets' payoffs are sales proceeds. We call firms that buy a new project and abandon their initial projects *bidders*. 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).

Two remarks are in order. First, in order to focus on takeovers as a quality choice rather than a quantity choice, we assume that each firm can manage at most one project. Allowing for firms to manage many 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][4] 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 over the projects. We abstract from these complications to focus on issues associated with information frictions.

Second, the first best allocation requires that almost all firms sell their initial projects *and* buy a new project.[5] To make the model consistent with an empirical fact that only a small subset of firms engage in takeovers[6], we need some restriction on trading. We assume that firms cannot be a bidder and a target simultaneously. This restriction on trading gives rise to an endogenous set of firms who choose to be inactive in takeover markets.[7]

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

[4] We can allow bidders to manage two projects. Let a gross payoff of a bidder with (A, X) buying a target with A' to be $F(A, (1-\beta)X) + F(A', \beta X)$, where $\beta \in (0,1]$ is a fraction of skill allocated to a new project. We present results only for $\beta = 1$ but all the results can be proven for $\beta \in (0,1)$ with an additional assumption $F_{XX} \leq 0$. An online appendix contains details.

[5] Firms with $(A, X) = (z, \mu(z))$, $z \in [0,1]$, start with efficient endowment, so they do not need to trade.

[6] Eckbo (2014) documents that annual fraction of publicly traded Center for Research in Security Prices firms that delists due to merger is at most 8% during the years 1926-2012.

[7] In practice, a manager of a firm can either (i) first sell a firm and later purchase a new project, or (ii) first

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 construct the following market equilibrium: 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 a market indexed by $z = A$ as a target, or go to another 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 information, then this sorting pattern can be enforced. If (A, X) is private information, 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 they are heterogeneous in X with 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 they are heterogeneous in A with 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. Given PAM, the measure of potential targets and that of potential bidders are $\phi_A(z) = \mu'(z)\, \phi_X(\mu(z))$.

buy another firm and later sell his firm. An exclusion of the first strategy is innocuous in our model because the subsequent purchase is irrelevant to the value of the firm that disappears by then. An exclusion of the second strategy may not be as innocuous because a bidder operates as a continuing public firm. However, there is high level of uncertainty regarding whether and when a subsequent deal occurs. Our static model should be viewed as a benchmark where the second round trade is fully discounted by investors.

Therefore, supply and demand at P in market z are given by

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

A market-clearing condition $S_z(P) = B_z(P)$, which can be written as

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

determines a price P_z. We define $\overline{A}(z) \equiv \overline{A}(P_z,z)$ and $\overline{X}(z) \equiv \overline{X}(P_z,z)$.

Proposition 1

For any $z \in (0,1]$, a unique market-clearing price $P_z \in (0, F(z,\mu(z)))$ exists. Also, $\overline{A}(z)$, $\overline{X}(z)$, $P_z = F\left(z,\mu\left(\overline{A}(z)\right)\right)$, and $\Pi_z = F\left(\overline{A}(z),\mu(z)\right)$ all increase in z.

Proof:

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 follows from $\overline{X}(0,z) = 0$, $\overline{A}(0,z) = z$, $\overline{X}(F(z,\mu(z)),z) = \mu(z)$ and $\overline{A}(F(z,\mu(z)),z) = 0$. From (3), we have $\overline{X}(z) = \mu\left(\overline{A}(z)\right)$. The marginal types $\overline{X}(z)$ and $\overline{A}(z)$ satisfy $P_z = F\left(z,\overline{X}(z)\right) = F\left(z,\mu\left(\overline{A}(z)\right)\right)$ and $\Pi_z = F(z,\mu(z)) - P_z = F\left(\overline{A}(z),\mu(z)\right)$. Therefore, $\overline{A}(z) \in (0,z)$ is uniquely determined as a solution to $F(z,\mu(z)) = F\left(z,\mu\left(\overline{A}\right)\right) + F\left(\overline{A},\mu(z)\right)$. By the implicit function theorem, $\overline{A}(z)$ increases in z, and other results follow from the properties of F and μ. ■

Figure 1 illustrates competitive market allocation.

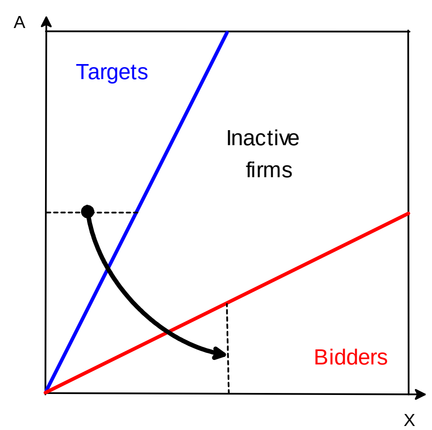


Figure 1. Competitive market allocation

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 middle, i.e., $\overline{X}(A) < X$ and $\overline{A}(\mu^{-1}(X)) < A$. Firms that engage in takeovers are those with unbalanced endowment. This reallocation pattern ensures that bidders have no incentive to be targets given their project quality, and targets have no incentive to be bidders given their skill.

Recall that this allocation takes sorting of firms as given. If information about (A, X) is public information, 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 to select an appropriate side of that market. In the next section, we study such sorting and selection.

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 derive a condition under which the following *minimum disclosure* is effective: To trade in market z, firms must disclose that either their projects are *at least* z (targets) or their skill is *at least* $\mu(z)$ (bidders).

First, we consider targets' incentive. Because targets' payoff is 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, potential targets all want to sell their projects at the highest price P_1. However, if targets can credibly reveal their project quality, then a standard unraveling result ensues, i.e., the best targets (with projects of the best quality) always find it optimal to reveal their 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: in market z projects must 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 instead obtain $F(z', \mu(z)) - P_{z'}$. 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 on both sides 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*

$$\frac{\phi_A(z)\,\phi_A\left(\overline{A}(z)\right)}{\phi_X(\mu(z))\,\phi_X\left(\mu\left(\overline{A}(z)\right)\right)} \leq \frac{F_A\left(\overline{A}(z),\mu(z)\right)}{F_X\left(z,\mu\left(\overline{A}(z)\right)\right)} \times \frac{F_A(z,\mu(z)) - F_A\left(z,\mu\left(\overline{A}(z)\right)\right)}{F_X(z,\mu(z)) - F_X\left(\overline{A}(z),\mu(z)\right)}. \tag{4}$$

Proof:

From $P_z = F\left(z,\mu\left(\overline{A}(z)\right)\right)$, $\frac{d}{dz}P_z = F_A\left(z,\mu\left(\overline{A}(z)\right)\right) + \mu'\left(\overline{A}(z)\right)\frac{d}{dz}\overline{A}(z)\,F_X\left(z,\mu\left(\overline{A}(z)\right)\right)$. Recall that $\overline{A}(z)$ is determined by

$$\Gamma\left(z,\overline{A}\right) \equiv F(z,\mu(z)) - F\left(z,\mu\left(\overline{A}\right)\right) - F\left(\overline{A},\mu(z)\right) = 0.$$

By the implicit function theorem,

$$\frac{d}{dz}\overline{A}(z) = -\frac{\frac{\partial\Gamma}{\partial z}}{\frac{\partial\Gamma}{\partial A}} = \frac{F_A(z,\mu(z)) - F_A\left(z,\mu\left(\overline{A}(z)\right)\right) + \mu'(z)\left\{F_X(z,\mu(z)) - F_X\left(\overline{A}(z),\mu(z)\right)\right\}}{F_A\left(\overline{A}(z),\mu(z)\right) + \mu'\left(\overline{A}(z)\right)F_X\left(z,\mu\left(\overline{A}(z)\right)\right)}.$$

Then, $\frac{d}{dz}P_z \leq \frac{\partial F(A,\mu(z))}{\partial A}|_{A=z} = F_A(z,\mu(z))$ can be written as

$$\mu'\left(\overline{A}(z)\right)\frac{d}{dz}\overline{A}(z)\,F_X\left(z,\mu\left(\overline{A}(z)\right)\right) \leq F_A(z,\mu(z)) - F_A\left(z,\mu\left(\overline{A}(z)\right)\right).$$

Dividing both sides by $F_X\left(z,\mu\left(\overline{A}(z)\right)\right) > 0$ and letting $K \equiv \frac{F_A(z,\mu(z)) - F_A\left(z,\mu\left(\overline{A}(z)\right)\right)}{F_X\left(z,\mu\left(\overline{A}(z)\right)\right)}$,

$$\frac{\mu'\left(\overline{A}(z)\right)}{\frac{F_A\left(\overline{A}(z),\mu(z)\right)}{F_X\left(z,\mu\left(\overline{A}(z)\right)\right)} + \mu'\left(\overline{A}(z)\right)}\left\{K + \mu'(z)\frac{F_X(z,\mu(z)) - F_X\left(\overline{A}(z),\mu(z)\right)}{F_X\left(z,\mu\left(\overline{A}(z)\right)\right)}\right\} \leq K$$

$$\Leftrightarrow \mu'\left(\overline{A}(z)\right)\mu'(z)\frac{F_X(z,\mu(z)) - F_X\left(\overline{A}(z),\mu(z)\right)}{F_X\left(z,\mu\left(\overline{A}(z)\right)\right)} \leq \frac{F_A\left(\overline{A}(z),\mu(z)\right)}{F_X\left(z,\mu\left(\overline{A}(z)\right)\right)}K$$

$$\Leftrightarrow \mu'\left(\overline{A}(z)\right)\mu'(z) \leq \frac{F_A\left(\overline{A}(z),\mu(z)\right)}{F_X\left(z,\mu\left(\overline{A}(z)\right)\right)}\frac{F_A(z,\mu(z)) - F_A\left(z,\mu\left(\overline{A}(z)\right)\right)}{F_X(z,\mu(z)) - F_X\left(\overline{A}(z),\mu(z)\right)}.$$

Using $\mu'(z) = \frac{\phi_A(z)}{\phi_X(\mu(z))}$, this is equivalent to (4). ■

Proposition 2 derives a condition under which all bidders have weak incentive to move up the price schedule, leading to unravelling of natural direction (i.e., from top to bottom). Intuitively, the marginal product of project quality must be greater than the marginal increase in price, which depends on the relative measure of projects to that of skill. To interpret (4), suppose that $\Phi_A = \Phi_X$ (i.e., iid assumption). Then (4) 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 $F(z,z) = F\left(z, \overline{A}\right) + F\left(\overline{A}, z\right)$ determines $\overline{A}(z) \in (0, z)$. This condition states 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 (4) becomes $1 \leq \alpha$. 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 and no disclosure is necessary on the bidder 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 sorting, each market immediately clears. A key difference in our model is that firms are heterogeneous in their outside options conditional on a given match between project and skill. In general, the price schedule that induces bidders' sorting without unravelling (i.e., (4) with equality) 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.

In theory, reverse unravelling (i.e., from bottom to top) can occur on the bidder side if $0 < \frac{\partial F(A,\mu(z))}{\partial A}|_{A=z} \leq \frac{d}{dz}P_z$ 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 target. In this case, the *maximum disclosure* is necessary on the bidders' side: To bid in market z, skill must be *at most* $\mu(z)$. In sum, while the model predicts that the direction of unravelling on the target side should be from top to bottom, on the bidder side the direction of unravelling can go either way. Moreover, if the direction of inequality in (4) changes as z increases, then unravelling may not work. In such a situation alternative disclosure schemes (e.g. mandatory rather than voluntary) are necessary on the bidder side to achieve PAM.

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:

$$V(A,X) = \begin{cases} P_A & \text{if } X \leq \overline{X}(A), \\ \Pi_{\mu^{-1}(X)} & \text{if } A \leq \overline{A}(\mu^{-1}(X)), \\ F(A,X) & \text{otherwise.} \end{cases} \tag{5}$$

The first line in (5) is the case where a firm with (A, X) becomes a target in a market A, while the second line the case where it becomes a bidder in a market $\mu^{-1}(X)$. An important observation is that $F(A,X) > \max\left\{P_A, \Pi_{\mu^{-1}(X)}\right\}$ holds for inactive firms. **Figure 2** illustrates the ex post firm value (5).

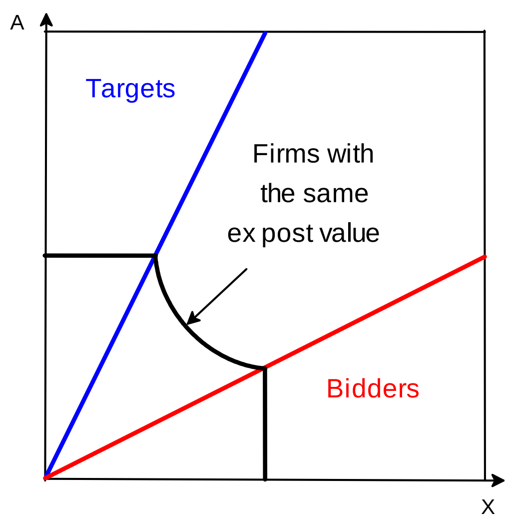


Figure 2. Ex post firm value

If investors can perfectly observe (A, X) before a deal announcement, then (5) 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 new 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.,

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

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

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

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

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

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

$$q \equiv E[V(A,X)].$$

As an example, consider Case (iv). For targets with project quality $z \in (0,1]$ and the ex post value P_z, there exists a set of inactive firms with higher ex post values $F(z,X)$, $X > \overline{X}(z)$. Because this holds for any $z \in (0,1]$, the expected value of a target is smaller than that of an inactive firm. Similarly, for bidders with skill $\mu(z)$ and the ex post value Π_z, there exists a set of inactive firms with higher ex post values $F(A,\mu(z))$, $A > \overline{A}(z)$, which implies that the expected value of a bidder is smaller than that of an inactive firm. We denote the expected value of a target by V_T, that of a bidder by V_B, and that of a non-trading firm by V_N. Then the above argument implies $\max\{V_T, V_B\} < V_N$. Denoting by m_N the measure of non-trading firms, the unconditional firm value before the deal announcement is

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

Using these notations, we say target discounts and bidder discounts arise when $\max\{V_T, V_B\} < q$. If a number of firms involved in takeovers is small relative to that of inactive firms *or* gains from trade are shared not too unequally between targets and bidders, then the information revealed by being a target or a bidder is mostly about separating from inactive firms. This indicates that an announcement of takeover deals, as a target or a bidder, reveals a bad information about the firm's ex post value *on average*. Thus, target discounts and bidder discounts arise for Case (iv).

Going through similar reasoning, one can verify that Cases (i) through (iv) are associated with four different combinations of announcement returns for bidders and targets, unless a measure of inactive firms is too small relative to a degree of asymmetry between a target value and a bidder value. 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 inactive 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

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

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

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

$$\max\left\{m_T(Y)\frac{V_T(Y) - V_B(Y)}{V_B(Y) - Y}, m_B(Y)\frac{V_B(Y) - V_T(Y)}{V_T(Y) - Y}\right\} < m_N(Y). \tag{6}$$

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

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

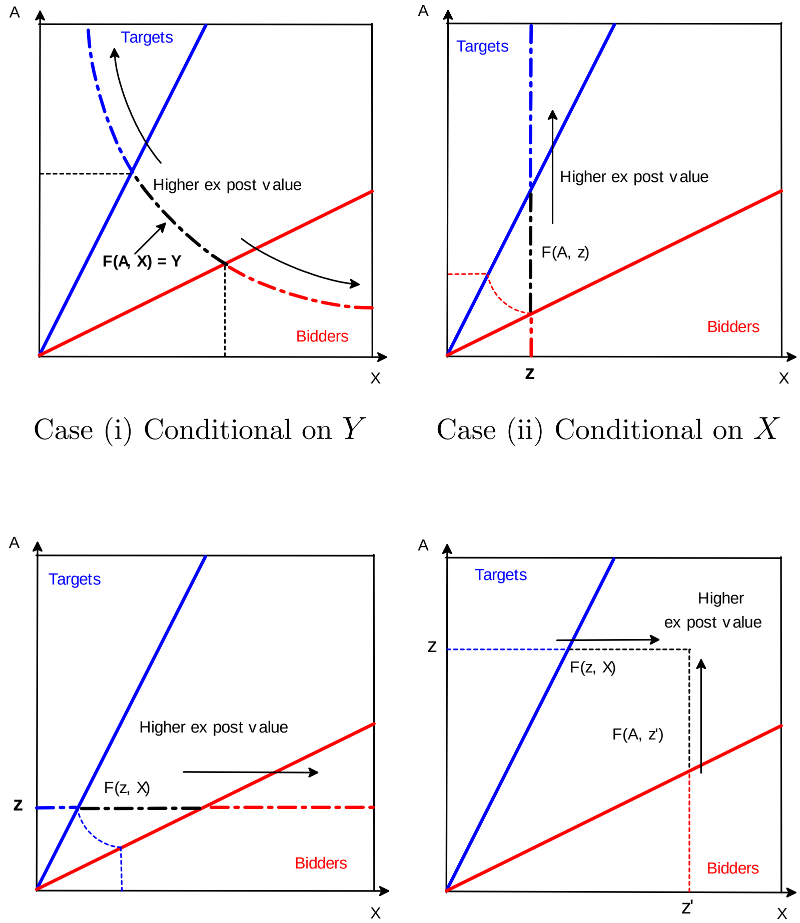
Case (iv) Unconditionally, target discounts and bidder discounts arise if and only if

$$\frac{\max\{V_T, V_B\} - \frac{1}{2}(V_T + V_B)}{V_N - \frac{1}{2}(V_T + V_B)} < m_N. \tag{7}$$

Proof:

For Case (i), manipulating $q(Y) = \frac{m_T(Y)V_T(Y)+m_B(Y)V_B(Y)+m_N(Y)Y}{m_T(Y)+m_B(Y)+m_N(Y)} < \min\{V_T(Y), V_B(Y)\}$, noting that $Y < \min\{V_T(Y), V_B(Y)\}$, yields (6). For Case (iv), manipulating $\max\{V_T, V_B\} < q = m_N V_N + \frac{1-m_N}{2}(V_T + V_B)$, noting that $\max\{V_T, V_B\} < V_N$, yields (7). For Case (ii), conditional on X, the ex post firm value increases in A. Because targets have larger A than inactive firms, who in turn have larger A than bidders, being a target reveals a good information while being a bidder reveals a bad information relative to the pre-announcement average. For Case (iii) one just needs to switch the role of A and X, and that of targets and bidders, in the reasoning of Case (ii). ■

Figure 3 illustrates the four cases.



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

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

Figure 3. Announcement returns

The conditions (6) and (7) state that, for a given degree of asymmetry between the target value and the bidder value (the left hand sides), the measure of non-trading firms must be sufficiently large. In terms of underlying economic structure, if distributions and the production function are sufficiently symmetric, then the two sides share gains from trade equally and both (6) and (7) are satisfied. If extremely strong complementarity exists and one factor is disproportionately more productive or scarce than the other factor, then the measure of inactive firms is small *and* one side of takeover reaps most gains from trade. In the latter situation, separation from inactive firms has little effect and announcement returns are largely driven by the difference between targets and bidders. Hence, target announcement returns and bidder announcement returns should move in the opposite directions, regardless of investors' pre-announcement knowledge about the firms.[8] Empirically, however, only a small subset of firms are involved in takeovers, so conditions (6) and (7) are likely to be satisfied. Table 1 below summarizes **Proposition 3** assuming (6) and (7).

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

It is well known that target firms have large announcement returns, while bidder announcement returns are highly dispersed and weakly negative on average. 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 pertinent to small firms.

Why is investors' information set typically Case (i) or Case (ii), with a particular size-dependence? 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) is more plausible for large firms than for small firms. For small firms, it would be more difficult to separately assess the contribution of tradeable and non-tradeable factors in their value creation process, either because they tend to be young firms and have no experience of being bidders in the past, or because investors are not willing to incur an information production cost for such detailed information. For small firms, Case (i) seems more reasonable because even when it is hard to tell the contribution of A (tradeable) or X (non-tradeable), it may be possible to obtain a good estimate of Y. Finally, Moeller et al (2007) report that bidders with analyst forecasts are much larger in size than bidders without such forecasts. This is consistent with our informational story where the size-effect is driven by differences in investors' information about bidders.[9]

[8] In Case (i), the violation of (6) 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 (7) is equivalent to $\min\{V_T, V_B\} < q \leq \max\{V_T, V_B\}$. Either way, target value and bidder value move in the opposite direction relative to the pre-announcement average value.

[9] Moeller et al (2007) find that "the mean announcement abnormal return of firms with analyst data is

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 improves efficiency, but it is 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 announcement returns identify stock market investors' pre-deal information about the firms. The predictions from the model help organize the available evidence on announcement returns, and can guide future empirical studies.

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 a companion paper (Kawakami, 2019), we use the framework presented in this paper to study efficiency of different disclosure schemes. David (2017) embeds a takeover process in a dynamic model to assess its quantitative implication, but he does not study disclosure schemes.[10] Combining the two approaches would likely to deliver more insights into dynamic and institutional aspects of takeover markets.

roughly 150 basis points less than the mean announcement abnormal return of firms in the unrestricted sample" and attribute it to the size-effect. See p.2056 of their paper.

[10] See also Dimopoulos and Sacchetto (2017), Levine (2017), Wang (2018), and Xu (2017).

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