# Are Takeovers Really Bad Deals for the Acquirers?

Wenyu Wang*

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**Abstract**

I document strong empirical evidence showing that in the face of unexpected industry shocks a majority of acquirers may pursue takeovers to catch up with competitors. This overriding motive for takeover leads to an important self-selection problem that is largely overlooked in previous studies: acquirers are more likely to be the firms that have high potential to create value in takeovers, but may not have performed as well if they were forced to stand alone. Traditional estimates of takeover gains, measured from both post-merger operating performance and stock market reaction, are downward biased, creating puzzles that appear contradictory. I build a dynamic search model to explicitly account for this self-selection problem. Once estimated to match key data moments, the model produces a significantly positive takeover gain of acquirers as high as 12% and implies a sizable bias of -16% in traditional empirical estimates. Moreover, my model yields a few novel implications which I first verify in the data.

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# 1 Introduction

Do mergers and acquisitions create value? What do acquirers and targets gain from takeovers? The prevailing answer in the literature seems that while mergers and acquisitions create value for the combined firm overall, the target is the ultimate winner, and the acquirer does not gain much. Indeed, a large number of studies investigating stock market reactions to takeover announcements (e.g., Andrade et al. (2001); Bhagat et al. (2005); Betton et al. (2008b); Bradley and Sundaram (2006); Fuller et al. (2002); Moeller et al. (2007); Savor and Lu (2009) and among many others) document virtually universal evidence: on average, the combined firm value rises 1% to 3%; the target enjoys a positive abnormal return as high as 15% to 30%, while the acquirer barely breaks even, with a 50% of likelihood of suffering a loss. Though status of target and mode of payment are also important determinants[1], main conclusions remain qualitatively unchanged. Consistent with this evidence, takeovers do not appear to lead to a significant improvement in acquirers' post-merger operating performance. Kaplan (1989); Healy et al. (1992); Switzer (1996); Heron and Lie (2002); Ramaswamy and Waegelein (2003) and Diaz et al. (2004) find only modest increases in combined firms' operating performance, which seems too small economically to compensate for the high premium paid to targets in takeovers[2], reinforcing the claim that acquirers are likely to lose in these deals.

This conventional wisdom of "acquirers subsidizing targets in takeovers", however, creates two puzzles that seem contradictory: first, if acquirers on average gain nothing or even lose in takeovers, what motivates their active participation? Second, if acquirers indeed benefit from takeovers, why can't we observe strong positive reactions in stock market or significant improvements in post-merger operating performance? These puzzles stand in stark contrast to the neoclassical theory of merger

[1] For example, Fuller et al. (2002); Bradley and Sundaram (2006); Moeller et al. (2007); Betton et al. (2008a) find that the acquirers' announcement period return is on average negative when target is public and is positive when target is private. Savor and Lu (2009); Moeller et al. (2007); Betton et al. (2008a) among many others find that equity bidders suffer from much worse performance than cash bidders.

[2] The findings of operating performance improvement due to mergers and acquisitions are actually quite mix. For example,Meeks (1977); Ravenscraft and Scherer (1987),Dickerson et al. (2000); Knapp et al. (2005); Amel-Zadeh (2009) and among others even find that acquirers slightly underperform their matching firms after takeovers.

and acquisition, in which the transfer of assets from targets to acquirers is motivated by enhancing utilization of the combined firm's assets. During the past decades, several models that feature other possible motives of M&A emerge as important alternative explanations for these puzzles. In agency cost theory (Jensen (1986)), entrenched managers in acquiring firms have strong empire-building motives, and they may overpay targets and carry out value-destructive takeover deals. Hubris theory (Roll (1986)) suggests that bidding firm managers make mistakes in evaluating target firms, but undertake acquisitions presuming that their valuations are correct. Market timing theory (Shleifer and Vishny (2003)) predicts that overvalued acquirers may use their stock as cheap currency to purchase real assets from targets, and the deals generate no operation synergy. It is reasonable to assume that these theories are partial or even complete motivations in some transactions, but they seem to offer limited guidance on the overriding motivations in a majority of mergers and aquisitions. For example, they are silent on the well-established empirical findings that a large number of takeovers are actually driven by industry shocks such as technology innovation, regulatory changes, or shifts in demand for goods and services (e.g., Gort (1969); Mitchell and Mulherin (1996); Harford (2005) and others. Lately, Kaplan (2000) concludes "it is striking that most of the mergers and acquisitions were associated with technological or regulatory shocks."). Also, none of them predict the convergence of bidder's and target's market-to-book ratios identified in Rhodes-Kropf and Robinson (2008) as a prevailing pattern in the data.

I revisit these puzzles in this paper and demonstrate that they can be reconciled with the neoclassical theory of mergers and acquisitions[3] because traditional estimates of takeover gains to acquirers are downward biased. To do so, I first argue that traditional estimates of takeover gains made strong implicit assumptions that had not been justified in literature. I conduct a direct test on these assumptions using a quasi-experimental design in which I construct a sample of exogenously failed bids[4]. I use this sample to establish a valid proxy for bidders' hypothetic stand-alone

[3]Note that q-theory is only one possible interpretation of the neoclassical theory of M&A. In this paper, I propose a new interpretation of the neoclassical theory based on asset complementarity and economic shocks, which is different from the traditional q-theory. In fact, traditional q-theory is not consistent with the empirical fact of "like-buys-like" documented in Rhodes-Kropf and Robinson (2008).

[4]The exogenously failed bid sample includes all unsuccessful takeover bids that fail for reasons uncorrelated with bidders' prospect of future performance during year 1980 to 2006. The construction of this exogenously failed bid sample and the details of the quasi-experimental design are

performance and to identify the new information revealed upon takeover announcements regarding bidders' stand-alone value. In the test, I find that these implicit assumptions made by traditional estimates are severely violated in data. Specifically, traditional estimates measured using operating performance assumes that acquirers would continue to perform similarly as their matched firms if they stood alone, but the quasi-experimental study shows strong evidence that acquirers' hypothetic stand-alone performance is actually much worse than their matched firms after takeover announcements. Also, traditional estimates measured using stock market reaction assumes that the takeover announcement does not carry substantial information regarding acquirers' stand-alone value. However, the quasi-experimental study shows that stock market on average revaluates the acquirers' stand-alone value by more than -8% on takeover announcements, reflecting a revelation of significant negative information previously held private by bidders. These violations cast serious doubt on the traditional estimates and suggest that the conventional wisdom needs to be interpreted with great caution.

Though the quasi-experimental design establishes convincing evidence against traditional estimates of takeover gains, the evidence by itself provides very limited insight into the economic driving forces of these empirical findings. For example, the quasi-experimental study provides little hint on why acquirers' hypothetic performance would become much worse than their matched firms' performance during the post-merger period[5]. It also remains unclear what new information is revealed upon takeover announcements that makes the market to revaluate the acquirers' stand-alone value. To answer these questions, I propose a new interpretation of takeover motives: a majority of acquirers actually pursue takeovers as a strategy to catch up with their competitors and/or maintain their superior performance. This motive of "takeover for catching up" provides direct answers to these fundamental questions raised above by identifying a severe self-selection problem in data: acquirers are overrepresented by firms that have high potential to create value in takeovers but may fall behind their competitors if they stood alone. In other words, the weaker prospect of acquirers' future stand-alone performance (with respect to the matched firms) is exactly the driving force that motivates their pursuit of takeovers. I then construct a search model to further explore the fundamental causes and con-

described in the Appendix. I discuss the validity of this approach carefully later in the paper.

[5]Note that these acquirers perform quite similarly as their matched firms during pre-merger period as stand-alone firms

sequences of this takeover motive. My model contains three main building blocks: (i) asset complementarity increases firms' profitability; (ii) industry shocks create dynamics in asset complementarity; and (iii) mergers and aquisitions accommodate large scale asset reallocation. As Grossman and Hart (1986); Hart (1990); Hart and Moore (1990) suggest, binding complementary assets together under common ownership reduces the hold-up problems and underinvestment that result from incomplete contracting. Thus firms optimize their production by developing complementary assets over time. Asset complementarity, however, is not static. Industry shocks may break existing complementarities and build new ones. As a result, firms whose asset complementarity needs to be improved or restored may optimally pursue takeovers to catch up with their competitors. Acquisition of growth options (e.g., Tian and Sevilir (2011); Levine (2011)), industry consolidation (e.g., Cummins et al. (1999); Berger et al. (1999)) and outsourcing R&D through acquisitions (e.g., Higgins and Rodriguez (2006)) are just a few possible examples. In my model, "takeover for catching up" emerges as an equilibrium outcome due to firms' value maximization decisions. Traditional empirical puzzles can be reconciled in model equilibrium: in the simulated data, takeovers indeed create values for acquirers, but if traditional approaches of measuring takeover gains are performed, the obtained estimates are downward biased towards zero or even become negative.

I then estimate my structural model to produce a valid estimate of takeover gains and quantify the bias in traditional measures. The quasi-experimental design used in this paper and previous studies (e.g., Masulis et al. (2011); Tang (2010); Malmendier et al. (2011b)) cannot accomplish these goals, because it can not disentangle the effect of information revelation regarding bidders' stand-alone value from the effect of bidders' option of pursuing future takeover activities[6]. The ideal experiment that facilitates this decomposition is the one in which bidders are permanently prevented

[6] More specifically, when the bids are initiated on announcements and subsequently withdrawn upon failure, two pieces of new information are revealed to the market. The first is that bid announcements may reveal new information regarding bidders' stand-alone value (or the so-called "revelation effect"), and the second is that bidders still maintain an option of participating in future M&A activities even though the current bids fail. Only the first component (i.e., the revelation effect) should be used to quantify the bias in traditional estimates and to establish a valid measure of takeover gains. However, the quasi-experimental design used in this paper and previous work only captures the combination of these two effects and can not clearly disentangle them. The second component is economically important and significant. As my structural estimation delivers, the value of the second component can be as high as 20%-30% of the total takeover gains, so confounding these two components will understate the takeover gain by 20-30%.

from pursuing future takeovers once the current bids fail. This experiment, however, is counterfactual and can not be implemented in data. As a result, I use structural estimation in this paper to measure takeover gains. The estimated model delivers a sizable takeover gains to acquirers, which stands at 12% of the total firm value on average. Traditional estimates, however, severely understate this measure by 16%, resulting in a negative estimate that is quite misleading.

My model also generate a few novel implications that have not been documented and tested in previous studies. I find strong empirical evidence supporting these implications in data. Specifically, my model predicts that, during merger waves when industry shocks are larger, acquirers would underperform their matched firms more pronouncedly and earn more negative abnormal return if the planned takeovers fail. Consistent with my model prediction, during merger waves, the measure of acquirers' underperformance (benchmarked against the matched firms) is twice as large as that during regular periods. During merger waves, acquirers on average earn a cumulative abnormal return of -10% within the event window that covers bid announcement and subsequent withdrawal, and acquirers only earn a cumulative abnormal return of -5% within the same event window during regular periods. These novel empirical findings lend strong support to my model implications. Also consistent with my model prediction, "takeover-for-catching up" is found to be a pervasive motive in data. And after controlling for this "catching up" motive, the mode of payment and acquirers' characteristics lose much of their prediction power on acquirers' abnormal return.

My study makes three valuable contributions to this literature. First, I show that the puzzling conventional wisdom of "acquirers subsidizing targets in takeovers" is simply not true, because tradtional estimates of takeover gains, measured using both operating performances and stock market reactions, are contaminated by a common source of self-selection problem. To the best of my knowledge, this paper is the first to propose and empirically identify this self-selection problem as the main cause of the long-standing value creation puzzles in M&A literature[7]. Second, my work provides the first structural estimate of takeover gains to acquirers and quantifies the

[7]The only related work is the research of diversification discount, in which some papers pointed out that the divisions in a multi-segment firms (diversified firms) don't perform as well as the divisions in single-segment firms. My results are not driven by the deals of corporate diversification, and are applied to the full sample of takeover deals.

bias in traditional measures, neither of which can be accomplished through the quasi-experimental design used in previous studies. The estimated model produces a quite sizable takeover gain to acquirers, reinforcing the neoclassic theory of M&A. My model also provides careful interpretation of the economic driving forces of bidders' self-selection behavior and generates a few novel implications that are consistent with data. Last but not least, my findings echo recent comments in Betton et al. (2008b)[8] and stress the importance of implementing correction for self-selection in providing unbiased estimates when bidder returns are involved.

The literature examining takeover gains is vast, and several papers are closely related to my work. In the stream of theoretical research, Rhodes-Kropf and Robinson (2008) build a search model to demonstrate how the "like-buys-like" pattern of market-to-book ratio emerges in equilibrium when acquirers' assets and targets' assets are complementary. Though their model also features asset complementarity and search and matching in M&A market, their model can not be used to address the self-selection problem that is centeral to my paper, because the participant sets (acquirers and targets) are exogenously given in their model. My model allows firms to optimally decide on participating in the M&A market or staying alone according to their own characteristics, and thus opens the door for studying firms' self-selection behavior. Jovanovic and Braguinsky (2004) propose a competitive equilibrium model which can generate bidder discount and target premia around takeover announcement. My argument of bias in traditional estimates from stock market reactions follows a similar line of reasoning, but my work goes beyond their model by providing a thorough analysis of self-selection bias in data and carrying out a comprehensive structural estimation. Levine (2011) develops a seed model to characterize a competitive equilibrium in which takeovers are motivated by transferring growth options that are not fully explored from targets to acquirers. The motive of "acquiring growth" in Levine (2011) acts as a good example of the "takeovers for catching up" motive I put forward in this paper. The main goal of his paper is to propose and model a new motive of takeovers while my focus in this paper is to produce a unbiased measure of takeover gains. The search model I build in this

[8]Betton et al. (2008b)point out "Finally, because bidder managers time takeovers based on private information, consistent estimation of parameters in cross-sectional models with bidder returns as the dependent variable requires a correction for self-selection (Eckbo, Maksimovic, and Williams, 1990). While such cross-sectional regressions are commonly presented in the literature, this (or other equivalent) correction is rarely implemented."

paper also generates a few predictions that are more realistic than what those competitive equilibrium models can deliver. For example, in competitive equilibrium, the unit price of target asset is uniform across all trades and thus the percentage target premium are the same in equilibrium for all bids. However, target premium varies significantly across different bids in data. In my search equilibrium, targets receive different unit price for their assets depending on the acquirers they meet, and this allows different target premium across different deals. Another appealing feature of my search model is that it predicts endogenous failure of takeover bids in equilibrium. When the matching can not generate enough synergy to make both parties better off, bids is predicted to fail endogenously in the model. Competitive equilibrium, however, does not leave any room for bid failure. A contemporary work by David (2012) also creates a search model to investigate the aggregate impact of M&A on economic growth. His paper does not attempt to investigate the issues of takeover gains to acquirers and potential bias in traditional measures. So my work and David (2012) make complementary contribution to the growing literaure of applying search models in M&A study from different aspects. In the stream of empirical studies, Grinblatt and Titman (2002); Hietala et al. (2003) suggest that announcement of takeovers may reveal important information of acquirers' standalone value together with the potential synergy gains. My work strongly supports this statement and implies that this revelation effect is negative, confirming the findings documented in several recent empirical papers such as Masulis et al. (2011); Tang (2010); Malmendier et al. (2011a); Savor and Lu (2009). But moreover, my structural estimation provides the estimate of takeover gains and the measure of bias in traditional estimates, which are not accomplished in these papers. My model also provides solid interpretation of the fundamental driving forces of their empirical findings.

The balance of the paper is organized as follows. Section 2 describes the M&A data set used in this study. Section 3 carries out the formal tests of assumptions made in traditional estimates and discuss how the violation of these assumption in data creates bias. In section 4, I put forward the motive of "takeovers for catching up" and develop a dynamic search and matching model framework for takeovers. A few novel model implications are presented and tested against data. Section 5 embeds a seed model into the search and matching framework. I estimate this model and report the model implied takeover gains to acquirers. Section 6 concludes.

## 2 Data

I get merger and acquisition data from Thomson Reuters SDC Platinum which provides details on all announced takeovers during 1980 to 2010. I merge this dataset with CRSP/Compustat merged dataset for accounting and stock return data. To be included in the final sample, a bid has to satisfy the following criteria:

1. The announcement date falls between 1980 and 2006. This guarantees that I have accounting data at least three years after the mergers and acquisitions.
2. The acquirer is a U.S. public firm.
3. Relevant data on the acquirer are available from CRSP and CRSP/COMPUSTAT.
4. The acquirer has not engaged in another bid in the previous three years using the same merger consideration.
5. For successful bids, the date of announcement is available. For failed bids, both date of announcement and date of withdrawal are available.

The sample of exogenously failed bids used for quasi-experimental design is constructed from this full sample of bids. The detail of constructing the exogenously failed sample is described in Appendix. The sample of successful bids used for estimating the model is simply the subset of bids that eventually complete.

## 3 Traditional Estimates of Takeover Gains

The main challenge in estimating takeover gains using operating performance measure stems from the fact that the only valid benchmark is counterfactual. That is, after any successful takeover, acquirer's stand-alone performance (i.e., the only valid benchmark for computing takeover gains) becomes unobservable. To overcome this difficulty, previous studies have developed two main approaches. The first approach adjusts the acquirer's pre-merger performance and the combined firm's post-merger performance with their contemporaneous industry mean respectively, and then use these industry-adjusted performance to compute takeover gains. This approach implicitly assumes that industry shocks have homogeneous impacts on all firms in the same industry and thus the acquirer's pre-merger relative performance (with respect to industry mean) would persist if the acquirer stood alone. The second approach tries to create a proxy benchmark using the performance of a matched firm control group. The control group is constructed based on a matching procedure according to industry, size, book-to-market ratio and/or pre-merger performance obtained one year before the takeover announcement[9]. Also, to be qualified as matched firms in the control group, the firms can not involve in any takeover activities so that their stand-alone performances are directly observable. A strong implicit assumption behind this matched firm approach is that acquirers would continue to perform similarly as their matched firms if they stood alone.

To measure takeover gains from stock market reaction, the standard practice in literature is to investigate acquirers' abnormal return within a short event window (usually 3 to 5 days) around takeover announcements (i.e., the announcement effect). However, as Grinblatt and Titman (2002) and Hietala et al. (2003) point out, the announcement of takeovers may contain important information regarding acquirers' stand-alone value (i.e., revelation effect) as well as the potential synergistic benefit (i.e., merger effect). The validity of taking the announcement effect as a measure of takeover gains thus relies heavily on the implicit assumption that the revelation effect is on average close to zero.

Despite of their great importance, these implicit assumptions have not been justified carefully in literature[10]. Testing these assumptions poses the same empirical obstacle as measuring takeover gains: it effectively requires a comparison between the proxy quantity that is measurable and the true quantity that is unobservable[11].

[9]The matching procedures used in literature are summarized in Appendix. I also describe the procedure I employ to create matched firms in this paper after the summary. My approach follows the general idea of traditional approaches and improves the accuracy of matching. All conclusions and results still hold if traditional matching procedures are strictly followed.

[10]The only relevant exception is Savor and Lu (2009) and Masulis et al. (2011), which show that the revelation effect is statistically different from zero. Savor and Lu (2009) documents that stock-bid announcement reveals negative information regarding bidders' stock price, and the authors take this finding as evidence supporting the market timing theory. Masulis et al. (2011) shows that the revelation effect for bidders and for targets comove strongly in both cash-bids and stock-bids, implying that M&A creates value for bidders.

[11]The proxy quantity is the the proxy benchmark in operating performance measure or the announcement effect in stock market reaction measure, and the true quantity is the true benchmark

To tackle this problem, I follow a quasi-experimental design developed in recent work by Savor and Lu (2009) and Masulis et al. (2011). These authors argue that in a sample of bids that fail for exogenous reasons, bidder's abnormal return in the event window that covers bid announcement and subsequent withdrawal will only reflect the revelation of bidder's new information. This provides a way to test the assumption made in traditional measures of takeover gains from stock market reaction. Though not explored by Savor and Lu (2009) and Masulis et al. (2011), this quasi-experimental design can also facilitate the test on the assumption made in traditional measures of takeover gains from operating performance. In this exogenously failed bid sample, no successful takeovers actually take place, so bidders still stand alone after takeover announcements. Meanwhile, their stand-alone performance is expected to well represent bidders' hypothetic stand-alone performance in the sample of successful takeovers, because those unsuccessful bids fail for exogenous reasons that are uncorrelated with bidders' future stand-alone operating performance[12].

The construction of this exogenously failed bid sample is described in detail in Appendix. I obtained all failed bids made during year 1980 and 2006, with bidders and targets being US public corporations. The bids failing for reasons that might correlate with bidders' performance (or known as endogenously failed bids in Savor and Lu (2009) and Masulis et al. (2011)) are explicitly excluded. These endogenously failed bids include, for example, target's refusal of the offer, disagreement over bid premium and merger terms, significant change in bidders' or targets' valuation and bidders' lose to competing offers. The remaining bids are arguably considered as exogenously failed bids, most of which were called off by regulation or disapproval from government. Armed with the data, I perform direct tests on the implicit assumptions made in traditional estimates of takeover gains.

in operating performance measure or the merger effect in stock market reaction measure.

[12]Note that if the reasons that cause bids to fail are perfectly exogenous, this unsuccessful bid sample will resemble a pure natural experiment that randomly draw and break down bids from all successful takeover bids and make bidders' hypothetic stand-alone performance observable.

## 3.1 Test of Implicit Assumptions

### 3.1.1 Operating Performance

I first test the assumptions made by the traditional estimate of takeover gains measured from operating performance. Recall that the industry-adjustment method assumes that bidders' pre-merger relative performance will persist even if bidders stood alone, and the matched firm approach assumes that matched firms' performance is a good proxy for bidders' hypothetic stand-alone performance after successful takeovers. I examine four accounting variables that have been widely used in literature as main measures of firms' operating performance : Return on Assets ($ROA$) and Operating Cash Flow ($OPCF$) summarize the overall profitability of firms, and Asset Turnover rate ($AT$) and Profit Margin ($PM$) further decompose $ROA$ to capture firms' revenue-generating ability and operating efficiency, respectively. For firm $i$ at year $t$, the four measures are formally defined as follows:

$$ROA_{i,t} = \frac{NI_{i,t}}{Asset_{i,t-1}} \quad ; \quad OPCF_{i,t} = \frac{EBITDA_{i,t}}{Asset_{i,t-1}}$$
$$AT_{i,t} = \frac{Sale_{i,t}}{Asset_{i,t-1}} \quad ; \quad PM_{i,t} = \frac{NI_{i,t}}{Sale_{i,t}}$$

The definitions of variables above are in the Appendix. Though a strict measure of operating cash flow can be created by its accounting definition, I proxy it by $EBITDA$ because the construction of operating cash flow involves a few accounting items from COMPUSTAT and any missing value of these items results in a missing value in operating cash flow. Empirically, this problem greatly reduces the sample size. Since $EBITDA$ is available for most bidders in my sample and is proven a good proxy for operating cash flow in the accounting literature, I employ $EBITDA$ in this study. Recent work by Heron and Lie (2002); Yen and Andre (2007) also use $EBITDA$ as a main measure of operating performance [13]. Keeping with convention, the book value of total asset at the end of period $t-1$ (or equivalently at the beginning of period $t$) is used to scale the accounting measures at period $t$ whenever

[13]Healy et al. (1992) and some of its descendants also approximate operating cash flow using ($Sale - COGS - SG\&A + Depreciation$). This measure, however, is criticized by Amel-Zadeh (2009) for possible "double counting" of depreciation and amortization.

necessary. I standardize all four measures such that within each industry/year the cross-sectional mean is zero and the standard deviation is one:

$$perm_{i,t}^{std} = \frac{perm_{i,t} - \mu_{ind(i),t}}{\sigma_{ind(i),t}} \tag{1}$$

where $perm_{i,t}^{std}$ is the standardized measure of operating performance for firm $i$ at year $t$ and $perm$ can be any one of the four measures; $\mu_{ind(i),t}$ and $\sigma_{ind(i),t}$ represent the mean and standard deviation of the operating performance measure across the industry to which firm $i$ belongs. The normalization is done for two reasons. First, the normalization makes the operating performance comparable across industries. Since some industries are by nature more volatile than others, statistics calculated from raw measures inevitably overweight observations from high volatile industries when bidders from all industries are pooled together. Normalization makes each measure equally volatile across all industries and thus puts equal weight to each observation when pooling. Second, the normalization allows for convenient comparison among bidders, their matched firms and the average firms in any industry/year. The standardized measures benchmark bidders' operating performance against the industry mean. To facilitate the tests, I also create abnormal operating performance measures by benchmarking bidder's performance against their matched firms:

$$perm_{i,t}^{abn} = perm_{i,t}^{std} - perm_{mt,t}^{std} \tag{2}$$

where $perm_{mt,t}^{std}$ is the standardized measure of operating performance for bidder $i$'s matched firm. I will refer to the operating performance before standardization as raw measures, $perm_{i,t}^{std}$ as standardized measures and $perm_{i,t}^{abn}$ as abnormal operating performance henceforth.

Panel (a) of Figure 1 depicts the standardized measures of operating performance (return on assets and operating cash flow) for bidders and their matched firms within a seven-year event window centered at the year of takeover announcement ($t = 0$) for the exogenouly failed bid sample. Detailed results are reported in Table 1. Consistent with findings in previous studies, bidders are much better than average firms in their industries during the pre-announcement period according to both return on assets and operating cash flow. Specifically, during the period $[-3\,yr,\,0)$, bidders' return on assets (operating cash flow) is on average 0.12 (0.09) standard deviation higher than the industry mean. The outperformance in both measures is statistically significant at 1%. Panel (b) of Figure 1 decomposes the return on assets into asset turnover rate and profit margin, I find that bidders' superior performance in return on assets is mainly driven by high profit margin, indicating that bidders are on average more efficient in operation. Within the same pre-announcement period, matched firms are able to track bidders very closely in all four measures of operating performance. The negligible differences between them, usually less than 0.03 standard deviation, show that my approach of creating matched firm control groups effectively identifies firms that resemble bidders in multiple dimensions during pre-announcement period. Figure 1 also illustrates a remarkable trend of decline in bidders' return on assets and operating cash flow during the post-announcement period $[0, 3\,yr]$, with a prominent turning point around the year of takeover announcements ($t = 0$). In particular, both measures quickly revert to industry means during this period. The decline in return on assets is driven by a significant deterioration in asset turnover rate, which drops as much as 0.1 standard deviation on average. On the contrary, I find no change in matched firms' performances within the whole event window. All measures of matched firms in the post-announcement period $[0, 3\,yr]$ remain similar to their levels in pre-announcement period $[-3\,yr, 0)$. A formal t-test of difference-in-mean is conducted to test the statistical significance of findings documented above. The results are reported in the last two columns of Table 1. As we expect, the hypothesis that bidders and matched firms have the same operating performance cannot be rejected by the test for the pre-announcement period, but is strongly rejected at 1% significance level for the post-withdrawal period. Overall, the findings documented above establish the first two stylized facts about bidders' operating performance for the exogenously failed bid sample:

***Stylized Fact 1.*** *Bidders significantly outperform the industry mean before the year of takeover announcement. Their performance, however, quickly reverts to industry mean after the planned takeovers fail.*

***Stylized Fact 2.*** *Bidders and their matched firms perform quite similarly before the year of takeover announcement. However, bidders significantly underperform their matched firms after the planned takeovers fail.*

Since the post-announcement performance of bidders in this exogenously failed sample can well represent the hypothetic stand-alone performance of bidders after successful takeovers, these stylized facts cast serious doubt on the implicit assumptions made by traditional estimates of takeover gains from operating performance. Specifically, bidders' pre-merger relative performance (with respect to industry mean) would not persist if the bidders stood alone. It implies that the industry-adjustment method tends to overstate bidders' hypothetic stand-alone performance and thus understate the takeover gains to bidders. Bidders, if stood alone, are also likely to underperform their matched firms, and this induces a similar downward bias in the estimate of takeover gains computed using matched firm approach.

#### 3.1.2 Stock Market Reaction

I move on to perform a formal test on the assumption made by the traditional estimate of takeover gains measured from stock market reaction. The assumption requires that the revelation effect is zero on average (or equivalently, takeover announcement delivers neutral news or no news about bidders' stand-alone value). To fully capture bidders' price run-up before initial announcement and allow for slow market reaction to bid withdrawal, I study bidder's abnormal return over a long event window, commencing one hundred days prior to the initial bid announcement and ending one hundred days after the bid withdrawal. Denote the window as $[DA - 100\,day,\ DW + 100\,day]$ in which DA means "date of announcement" and DW means "date of withdrawal". Similar long event windows have been used in Malmendier et al. (2011a); Masulis et al. (2011). Researchers commonly utilize CARs in short-term event studies, but they find numerous flaws to using them in longer-term studies: CARs bear little resemblance to the returns accrued by a long-term investor and the process of aggregating short-term abnormal returns over a longer time-period is likely to result in the emergence of spurious upward or downward drift due to market microstructure issues, according to Conrad and Kaul (1993). Fortunately, there are two main methodological approaches specifically designed for long-horizon event studies: characteristic-based matching approach, also known as the BHAR (buy-and-hold abnormal returns), and the calendar-time portfolio approach (see Eckbo, Masulis and Norli (2000) and Fama (1998)). I employ BHAR approach in this study because it allows me to use the same matched firm as the benchmark for a given bidder in calculating the abnormal stock return and abnormal operating performance. This inherent linkage greatly facilitates the investigation of correlation between these two quantities, which I explore in detail after this subsection. Using calendar-time portfolio approach loses this important linkage because it adjusts bidders' raw return for risk factors rather than for any benchmark return. The BHAR during a period $[t_1, t_2]$ is defined as

$$BHAR_{t_1,t_2} = (\prod_{t=t_1}^{t_2}(1 + r_t) - 1) - BR_{t_1,t_2}$$

where $BR_{t_1,t_2}$ is the cumulative return earned by the benchmark firm during the period $[t_1, t_2]$.

With the matched firms identified in the previous subsection as benchmarks, I plot the path of BHAR for bidders with its 90% confidence interval in Figure 2. Since the interval between the bid announcement and withdrawal varies from deal to deal, I divide the whole event window $[DA-100\,day, DW+100\,day]$ into three subperiods. BHAR during the pre-announcement period $[DA-100\,day, DA-1\,day]$ and the post-withdrawal period $[DW+1\,day, DW+100\,day]$ are plotted in seven-day increments. The subperiod $[DA, DW]$ is normalized to have the same length by cumulating returns to match the proportion of elapsed trading days, similar to the approach used in Malmendier et al. (2011b). In the exogenously failed bid sample, bidders earn a negative abnormal return of about -8% on average which is highly significant at 1% level. The price run-up starts about one month before bid announcement and peaks at about 2.5% (not statistically significant) before the announcement date. Cumulative BHAR fluctuates during the subperiod $[DA, DW]$ and gradually drops toward the date of withdrawal, indicating a consecutive revision of the market-perceived probability of bid failure. My findings accord with the results presented by Masulis et al. (2011), in which authors find bidders earn a BHAR of about -10% during a similar long event window from a larger sample of exogenously failed bids for four major "Anglo" developed economies (Australia, Canada, the United Kingdom and the United States).

Since bids are eventually terminated in the exogenously failed bid sample, no confounding effect from successful takeover (i.e., merger effect) is capitalized in bidders' BHAR in the event window that covers bid announcement and subsequent withdrawal. As a result, BHAR in this event window can be clearly attributed to two main components. The first is that investors reassess bidders' stand-alone value according to the new information revealed upon bid announcements (e.g., the revelation effect). The second is that investors realize and price bidders' option of pursuing future takeover activities. Since this option value (i.e., the second component) is always nonnegative, the revelation effect (i.e., the first component) is thus at least -8%. This establish the third stylized fact.

***Stylized Fact 3.*** *Bid announcement and subsequent withdrawal on average reveal negative information regarding bidders' stand-alone value.*

Stylized fact 3 challenges the assumption that the revelation effect is close to zero. In fact, takeover announcements on average deliver bad news regarding bidders' stand-alone value to the market. Ignoring this negative revelation effect causes traditional estimate to understate the takeover gains to bidders. The negative revelation effect also echos the findings I documented in previous section that bidders underperform their matched firms and are unable to maintain their superior performance with respect to industry mean after the planned takeovers fail.

# 4 A Search Model of Takeover

The quasi-experimental design above produces direct evidence showing that traditional estimates of takeover gains are downward biased. However, it provides very limited insight on the economic driving forces of the equilibrium. These economic factors are central for us to answer more fundamental questions such as "why would bidders underperform their matched firms if the planned takeovers fail", "why should revelation effect on average negative", "what is the main motivation of most takeovers" and "how to produce a unbiased estimate of takeover gains". In this section, I propose a motive of takeover that can generate predictions that are consistent with the stylized facts above. I argue that this takeover motive induces a self-selection problem that is largely overlooked in literature: firms that need to catch up with their competitors or maintain their superior performance are more likely to pursue takeovers. A direct consequence of this self selection problem is that, in data, acquirers are overrepresented by firms that have high potential to create value in M&A but would not perform as well if they stood alone. The self selection problem causes downward bias in traditional estimates of takeover gains.

## 4.1 Motive of Takeover: Takeover-for-Catching up

Recent development in M&A research has established several pronounced findings that advance our understanding of takeover activities. First, industry shocks are identified as one of the most important driving forces of merger and acquisition activities. In particular, Harford (2005) finds strong evidence that industry shocks predict merger waves, and Kaplan (2000) concludes that most mergers and acquisitions are associated with technological or regulatory shocks. Second, firms respond heterogenously to industry shocks. Various measures of firm's performance become more dispersed within merger waves. Third, asset complementarity emerges as a promising alternative explanation of M&A to classic $q$-theory. For example, instead of asset reallocation from low-$q$ firms to high-$q$ firms as predicted by $q$-theory, Rhodes-Kropf and Robinson (2008) find that mergers actually pair together firms with similar $q$. The authors interpret this assortative matching as evidence in favor of asset complementarity (e.g.,Grossman and Hart (1986); Hart (1990); Hart and Moore (1990)): mergers redraw firms' boundary and bind together complementary assets under common ownership.

Drawing on the three key ingredients, I reinterpret the main motive of takeover as a strategy for bidders to catch up with their competitors. My reasoning follows: firms develop complementary assets to optimize their productivity over time. The complementarity among assets, however, is not static. Unexpected industry shocks, such as technological innovation, demand shock and regulatory change may break some existing complementarities and create new ones[14]. The newly created complementarity sometimes requires combinations of assets under different firms' control, and mergers and acquisitions in this case accommodate efficient asset reallocation. If firms respond heterogenously to industry shocks, then those firms that would fall behind their competitors if stood alone may optimally pursue takeovers to restore their competitiveness.The motive leads to a self-selection problem: acquirers are more likely to be the firms that have high potential to generate synergistic benefits

[14]For example, when technology innovation occurs, existent complementarity between an efficient distribution network and ongoning technology may be replaced by a new complementarity between the same distribution network and the emerging technology. Similarly, negative demand shocks may make it suboptimal to pair small scale of operation with small market share of output because the increasing fixed cost may outweigh the flexibility of small business. The shrinkage of total demand thus makes the complementarity between large scale operation and large market share more pronounced, possibly leading to consolidation in industry.

in takeovers but may not have performed as well as their competitors if they stood alone.

"Takeover-for-catching up" and the self selection problem yield predictions that are completely consistent with the stylized facts I established in the previous section. In particular, if bidders pursue takeovers to catch up with competitors and the planned takeovers eventually fail for exogenous reasons, then the bidders can not capture the expected synergistic benefit and thus will underperform their matched firms[15], resulting in the first two stylized facts in data. If the prospect of firms' future performance is not directly observable by investors[16], the takeover announcement will convey negative signal of bidder's stand-alone value due to the self-selection problem. The market also learns the loss of possible synergistic benefit of the planned takeovers on bid withdrawal. So in a long event window that covers bid announcement and subsequent withdrawal, bidders' cumulative abnormal return is negative for the sample of exogenously failed bids, consistent with stylized fact 3.

## 4.2 A Search Model of Takeover

Mergers and acquisitions resemble marriage in a few important respects: both markets are decentralized with some search friction; the total gain from the activities depends on the overall fit of two parties involved; commitment is made voluntarily to serve mutual benefit and thus certain matchings can fail endogenously; and division of total gain between two parties is determined by their outside options and bargaining power. To capture all these salient features, I construct a dynamic search model of takeovers.

I assume that there exists a continuum of firms with infinite lifetimes in this economy. Time is discretized and firms are rational in the sense that they maximize their value by making optimal decisions of production and/or undertaking takeovers. To

[15]Note that by construction matched firms choose to stand alone, which implies that they don't need to pursue takeovers to restore their competitiveness. So matched firms are more likely to maintain their good performance as stand-alone firms. This is also consistent with my findings in last section, which shows that matched firms' performance remains quite stable over the whole event window.

[16]This is very likely during unexpected industry shocks when both aggregate and idiosyncratic uncertainty are high.

capture the role of asset complementarity, I assume that the profit firm $i$ makes at time $t$ is determined by its state variable $X_{i,t} = (x_{i,t,1}, x_{i,t,2})$ in which $x_{i,t,1}$ and $x_{i,t,2}$ are complementary inputs for firm's profit function $y(X_{i,t}) = y(x_{i,t,1}, x_{i,t,2})$. $x_1$ and $x_2$ are called complementary in function $y(x_1, x_2)$ if the profit function $y : \mathbb{R} \times \mathbb{R} \rightarrow \mathbb{R}$ has increasing difference in $(x_1, x_2)$, that is,

$$y(x_1^{'}, x_2^{'}) - y(x_1^{'}, x_2) \geq y(x_1, x_2^{'}) - y(x_1, x_2) \qquad \forall x_1^{'} > x_1 \, and \, x_2^{'} > x_2$$

When profit function $y(x_1, x_2)$ is twice continuously differentiable, increasing differences is equivalent to $\partial^2 y(x_1, x_2)/\partial x_1 \partial x_2 \geq 0$ for all $x_1$ and $x_2$.

In my nodel, industry shocks (or firms' decision to enter into a new product market) change firms' asset complementarity by altering the state variables. In most cases, industry shocks only affect firms on specific dimension (e.g. technological innovation only changes firm's production line and does not change firm's distribution network). So without loss of generality, I will assume that industry shocks only change $x_{i,t,2}$ and have no impact on $x_{i,t,1}$. Since it usually requires more information and expertise to judge firm's specific response $x_{i,t,2}$ after industry shocks, I assume $x_{i,t,2}$ is only observable to firm's managers and is unobservable to the market (i.e. investors and econometricians). $x_{i,t,1}$ is assumed to be observable to the market.

Overall, my baseline model extends the heterogenous-agent search model pioneered by Lu and McAfee (1996) in two important dimensions. First, participants (acquirers and targets in this paper) are endogenously determined in equilibrium in my model while they are exogenously assumed as given in traditional search model. This extension is central to my analysis because allowing firms to make optimal participating decision naturally lead to endogenous participant sets, which characterize the equilibrium outcome of self selection. Simply put, participants are fundamentally different from non-participants and the differences are exactly caused by participants' self selection behavior. Second, I impose rational expectation to discipline the equilibrium outcome. With endogenous participant sets, firm's optimal decisions are now interdependent because one firm's decision to participate as an acquirer (or a target) depends on its expectation of the acquirer and target population in equilibrium. Rational expectation requires that each firm's ex-ante expectation of equilibrium outcome is fulfilled ex-post. To demonstrate the unique implications generated by these two extensions more clearly and intuitively, I restrain my baseline model from other complications by adopting two standard assumptions in traditional search model:

- Firm's state variable is time-invariant
- After a successful merger, the combined firm leaves the M&A market permenantly and the acquirer and target are replaced by their clones.

Since industry shocks change firm's state variables, I maintain the first assumption by allowing only one round of shock in my baseline model. The economy starts at the time point when the shock takes place, and each firm draws its own state variable and sticks to it. The second assumption guarantees that the cross sectional distribution of firms participating in the M&A market is time-invariant. This greatly facilitate the analysis of equilibrium, but excludes the possibility of repeat mergers and acquisitions for the same firm. These two restrictive assumptions, however, do not drive the key results in my baseline model, and all implications can carry over to a full version of the search model, in which I relax these two assumptions by opening the channel of repeat industry shocks and allowing firms to undertake multiple merger and acquision transactions.

Now I describe the dynamics of the economy. Each firm $i$ draws its first component of state variable $x_{i,t,1}$ from a cross sectional distribution $f_1(x)$ as it was born. Industry shocks, when occur, force firm $i$ to redraw its $x_{i,t,2}$ conditional on its own $x_{i,t,1}$ from a conditional distribution $f_2(x|y)$ such that $x_{i,t,2} \sim f_2(x|x_{i,t,1})$. In my baseline model, the economy begins with one round of industry shock and no more shocks take place afterwards. As a result, firm's state variables remain constant over time. I suppress the time subscript and denote the state variable as $X_i = (x_{i,1},\, x_{i,2})$ hereafter in this subsection of baseline model. The joint distribution of state variable $(x_{i,1}, x_{i,2})$ is then given by $f(x_1, x_2) = f_1(x_1)f_2(x_2|x_1)$. At the beginning of each period, firms can choose to stay alone or participate in M&A market to search for a partner for merger and acquisition. Firms need to pay a cost $L$ (e.g. brokage fee or advisory fee to investment banks) if they decide to participate in M&A market. The probability of a successful matching with a partner is endogenous and determined by the relative population of acquirer group and target group in equilibrium. If a firm successfully matches with a partner, they announce a takeover neogotiation.

During the negotiation, they learn the unobservable component of each other's state variables and then make decisions based on this full information set. If this merger or acquisition is beneficial to both parties, the deal succeeds. Otherwise, the deal breaks down and bidder withdraws. I assume that takeover negotiation completes within the same period of takeover announcement. So if no matching occurs or takeover negotiation breaks down, firms remain stand-alone that period and they can make their optimal decision again next period. The information set available to each party and the value functions I am going to use in different stages are summarized in Table 2. Before a matching actually happens, managers only know the state variables of their own firms. Econometricians observe nothing in market, so they don't know who are seeking for partners for merger and acquisition. The value function is denoted as $V_k^{MP|nm}$ for $k \in \{A, T\}$, indicating that the firm (potential acquirer or target) is in the stage of "merger is possible but no matching yet ($MP|nm$)". Once matching occurs, takeover announcement is made to the market and econometricians learn the observable component of state variables of bidder and target. The bidder and target also immediately learn the observable component of state variables of their partner. The value function at this stage is denoted as $V_k^{MP|m}$ for $k \in \{A, T\}$, indicating "merger is possible and matching occurs ($MP|m$)". Before decision is made, both parties already have full information set. Econometricians still can't observe the unobservable component of state variables of acquirer and target. If takeover completes, acquirer gets its share of $V_A^M$ and target gets its share of $V_T^M$. Otherwise, two parties remain stand alone this period and get their continuation value next period. Regardless of firms' decisions, each firm generates a cash flow $y(X)$ that is determined by the firm's state variable $X$ each period. If takeover completes, the combined firm quits the M&A market and earns a perpetuity of joint profit $yc(X_A, X_T)$ which is determined by state variables of acquirer and target, i.e. $X_A$ and $X_T$ respectively.

Each period, firms choose to stand alone or participate in M&A market as potential acquirers or targets according to their value functions:

$$V(X) = max\{V_{SA}(X),\ V_T^{MP|nm}(X),\ V_A^{MP|nm}(X)\}$$

Firm's value functions are derived by Bellman equations:

$$
\begin{aligned}
V_A^{MP|nm}(X) &= \alpha_A \int_{M_A(X)} V_A^M(X,Y) q_T(Y) dY + (1-\alpha_A F(X)) \beta V_A^{MP|nm}(X) \\
&\quad - L + y(X) \qquad (3)\\
V_T^{MP|nm}(X) &= \alpha_T \int_{M_T(X)} V_T^M(Y,X) q_A(Y) dY + (1-\alpha_T G(X)) \beta V_T^{MP|nm}(X) \\
&\quad - L + y(X) \qquad (4)\\
V_{SA}(X) &= \beta V_{SA}(X) + y(X) \qquad (5)
\end{aligned}
$$

Where the acceptance set for an acquirer (or target) with state variable $X$, i.e. $M_A(X)$ (or $M_T(X)$), is defined by:

$$
\begin{aligned}
F(X) &= \int_{M_A(Y|X)} q_T(Y) dY \\
G(X) &= \int_{M_T(Y|X)} q_A(Y) dY \\
M_A(X) &:= \{Y \in T : \frac{\beta y c(X,Y)}{1-\beta} - I - \beta V_A^{MP|nm}(X) - \beta V_T^{MP|nm}(Y) \geq 0\} \\
M_T(X) &:= \{Y \in A : \frac{\beta y c(Y,X)}{1-\beta} - I - \beta V_A^{MP|nm}(Y) - \beta V_T^{MP|nm}(X) \geq 0\}
\end{aligned}
$$

Set $A$ and $T$ are acquirer set and target set, respectively, and $q_A(X)$ and $q_T(X)$ are the distributions of state variables for acquirer set and target set. As I will show shortly, all of them are endogenous and have to be solved in equilibrium together with firm's value functions. Also note that the probability for an acquirer (a target) to match with a target (an acquirer), i.e. $\alpha_A$ ($\alpha_T$), is also endogenous and is determined by the ratio of acquirer's population to target's population in equilibrium. Equations 3 and 4 deliver the value functions for acquirer and target before matching: the first term on RHS captures the firm value if matching occurs and takeover eventually completes (matching partner is in the acceptance set); the second term represents the discounted continuation value that firm receives if firm remains stand-alone (i.e. no matching occurs or takeover breaks down). Firm needs to pay a cost $L$ for participation and receives $y(X)$ anyway each period. Equation 5 is self explanatory. When acquirer and target meet and negotiate, their discounted continuation values serve as reservation points (or so-called outside option). If the combined firm value is higher than the sum of two parties' reservation points after expensing the integration cost $I$, takeover can go through and the surplus is divided between acquirer and target. As a result, for any given acquirer (target) characterized by its state variable $X$, there exists a subset of targets (acquirer) that this given acquirer (target) will agree to merge with. This subset of targets (acquirers) is defined as the acceptance set for this given acquirer (target). The size of acceptance set is determined by search friction. Intuitively, when matching is unlikely and discounting is high, firms are more impatient and tolerant, so the size of acceptance set becomes larger.

The division of combined firm value between acquirer with state variable $X$ and target with state variable $Y$ in a successful takeover is governed by Nash bargaining problem:

$$
\begin{aligned}
\max_{V_A^M, V_T^M} \quad & (V_A^M(X,Y) - \beta V_A^{MP|nm}(X))^{\theta}(V_T^M(X,Y) - \beta V_T^{MP|nm}(Y))^{1-\theta} \\
s.t. \quad & V_A^M(X,Y) + V_T^M(X,Y) = \tfrac{\beta yc(X,Y)}{1-\beta} - I
\end{aligned}
$$

Where $\theta$ is aquirer's bargaining power, and $1-\theta$ is target's bargaining power. $I$ is the integration cost in merger. The solution to the Nash bargaining problem is:

$$
\begin{aligned}
V_A^M(X,Y) &= \beta V_A^{MP|nm}(X) + \theta(\frac{\beta yc(X,Y)}{1-\beta} - I - \beta V_A^{MP|nm}(X) - \beta V_T^{MP|nm}(Y)) \\
V_T^M(X,Y) &= \beta V_T^{MP|nm}(Y) + (1-\theta)(\frac{\beta yc(X,Y)}{1-\beta} - I - \beta V_A^{MP|nm}(X) - \beta V_T^{MP|nm}(Y))
\end{aligned}
$$

Substituting the solution above into Bellman equation, I solve $V_A^{MP|nm}(X)$, $V_T^{MP|nm}(X)$ and $V_{SA}(X)$ as:

$$
\begin{aligned}
V_A^{MP|nm}(X) &= \frac{\alpha_A \theta}{1-\beta}\int_{M_A(X)}(\frac{\beta yc(X,Y)}{1-\beta} - I - \beta V_A^{MP|nm}(X) - \beta V_T^{MP|nm}(Y))q_T(Y)dY \\
&\quad -\frac{L}{1-\beta} + \frac{y(X)}{1-\beta} \\
V_T^{MP|nm}(X) &= \frac{\alpha_T(1-\theta)}{1-\beta}\int_{M_T(X)}(\frac{\beta yc(Y,X)}{1-\beta} - I - \beta V_T^{MP|nm}(X) - \beta V_A^{MP|nm}(Y))q_A(Y)dY \\
&\quad -\frac{L}{1-\beta} + \frac{y(X)}{1-\beta} \\
V_{SA}(X) &= \frac{y(X)}{1-\beta}
\end{aligned}
$$

Now I decompose the value function for acquirer and target before matching into two components. The first component represents acquirers' and targets' value if they were forced to stand alone. The second component captures the option value of participating in M&A market minus the fixed cost of participation.

$$V_A^{MP|nm}(X) = V_{SA}(X) + v_A^{MP|nm}(X) \quad (6)$$
$$V_T^{MP|nm}(X) = V_{SA}(X) + v_T^{MP|nm}(X) \quad (7)$$

Define $s(X,Y) = \beta\frac{yc(X,Y)-y(X)-y(Y)}{1-\beta} - I$ as the net operation synergy generated by combining two firms, and the solution to Bellman equation can be expressed more intuitively regarding the option value of participating in M&A market, i.e. $v_A^{MP|nm}(X)$ and $v_A^{MP|nm}(X)$:

$$v_A^{MP|nm}(X) = \frac{\alpha_A\theta}{1-\beta}\int_{M_A(X)}(s(X,Y) - \beta v_A^{MP|nm}(X) - \beta v_T^{MP|nm}(Y))q_T(Y)dY - \frac{L}{1-\beta} \quad (8)$$

$$v_T^{MP|nm}(X) = \frac{\alpha_T(1-\theta)}{1-\beta}\int_{M_T(X)}(s(Y,X) - \beta v_A^{MP|nm}(Y) - \beta v_T^{MP|nm}(X))q_A(Y)dY - \frac{L}{1-\beta} \quad (9)$$

With the acceptance sets be reinterpretted in terms of net operation synergy $s(X,Y)$ and option value of participating in M&A market as

$$M_A(X) := \{Y \in T : s(X,Y) - \beta v_A^{MP|nm}(X) - \beta v_T^{MP|nm}(Y) \geq 0\}$$
$$M_T(X) := \{Y \in A : s(Y,X) - \beta v_A^{MP|nm}(Y) - \beta v_T^{MP|nm}(X) \geq 0\}$$

The option value of participating in M&A market to acquirer (target) equals the discounted continuation value plus expected gain from successful takeover, as demonstrated in 8 and 9. Acquirer's (or taget's) expected gain from successful takeover explicitly accounts for the matching probability $\alpha_A$ (or $\alpha_T$), its share of gain $\theta$ (or $1-\theta$) and the average gain to be divided. The interpretation of firm's optimal decision and their acceptance sets also become more intuitive: firms choose to participate in M&A market if their option value of participation is no less than the fixed cost of participation. Participating firms accept their partners only when the net operation synergy generated by combining two parties is higher than the sum of two party's outside option. It follows that firm's optimal decision (i.e. stand alone, or become acquirer or target) and the acceptance sets only rely on firm's option value of participation and the net operation synergy, but do not depend on firm's stand-alone value $V_A(X)$. As a result, I focus on solving firm's option value of participation, i.e. $v_A^{MP|nm}(X)$ and $v_T^{MP|nm}(X)$, in equilibrium and derive the total firm value by adding back the stand-alone value component $V_A(X)$, as shown in equation 6 and 7.

It is easy to read from equation 8 and 9 that firm's optimal decisions are interdependent in equilibrium. For example, when a firm assesses its value as a potential acquirer (i.e. $v_A^{MP|nm}$), it must form expectation of target set and acquirer set in equilibrium to evaluate the matching probability $\alpha_A$, cross sectional distribution of target's state variable $q_T(Y)$ and acceptance set $M_A(X)$. Any reasonable equilibrium, if exists, must fulfill this expectation ex post. To characterize this interdependence, I define a Rational Expectation Steady State Equilibrium (RESSE).

**Definition.** A Rational Expectation Steady State Equilibrium (RESSE) consists of $(T, A, T(X), A(X), q_T(X), q_A(X), M_A(X), M_T(X), \alpha_A, \alpha_T, v_A^{MP|nm}(X), v_T^{MP|nm}(X))$ such that:

1. **Value Maximization:** given the belief of $(T, A, T(X), A(X), q_T(X), q_A(X), M_A(X), M_T(X), \alpha_A, \alpha_T)$ and firm's specific state variable $X_i$, firm $i$ evaluates its option value of participating as an acquirer or a target versus 0 (i.e. $v_A^{MP|nm} v.s. v_T^{MP|nm} v.s. 0$), and chooses the activity (i.e. act as an acquirer or a target or stand alone) that yields highest value. If firm $i$ decides to act as an acquirer or a target, it also specifies its own acceptance set $M_A(X_i)$ or $M_T(X_i)$.

2. **Rational Expectation:** when we aggregate the individual firms' optimal decisions, the equilibrium outcome is consistent with the firms' ex ante belief.

More specifically, the following conditions need to hold:

$$a. \qquad T = \cup_i \{ i : \; v_T^{MP|nm}(X_i) > max(v_A^{MP|nm}(X_i),\, 0) \}$$
$$A = \cup_i \{ i : \; v_A^{MP|nm}(X_i) > max(v_T^{MP|nm}(X_i),\, 0) \}$$

$$b. \qquad T(X) = \cup_i \{ X_i : i \in T \}, \quad A(X) = \cup_i \{ X_i : i \in A \}$$

$$c. \qquad q_T(X) = \frac{f(X) \cdot 1\{X \in T(X)\}}{\int_{T(X)} f(X) dX}, \quad q_A(X) = \frac{f(X) \cdot 1\{X \in A(X)\}}{\int_{A(X)} f(X) dX}$$

$$d. \quad M_A(X) = \{ Y \in T : \; s(X, Y) - \beta v_A^{MP|nm}(X) - \beta v_T^{MP|nm}(Y) \geq 0 \}$$
$$M_T(X) = \{ Y \in A : \; s(Y, X) - \beta v_A^{MP|nm}(Y) - \beta v_T^{MP|nm}(X) \geq 0 \}$$

$$e. \qquad \alpha_A = \phi\left(\frac{\int_{T(X)} f(X) dX}{\int_{A(X)} f(X) dX}\right), \quad \alpha_T = \phi\left(\frac{\int_{A(X)} f(X) dX}{\int_{T(X)} f(X) dX}\right)$$

The value maximization condition is self explanatory and I elaborate on the rational expectation condition. Condition (a) demonstrates that in equilibrium the target set (acquirer set) is created by aggregating all firms that choose to become target (acquirer) based on their value maximization behavior. It also requests that $T$ and $A$ formed by aggregation in equilibrium are consistent with firms' ex ante belief for making optimal decisions. Condition (b) builds the subset of state variables that are associated with target set and acquirer set. Condition (c) imposes conditional distribution formula on deriving the distribution of state variables for target and acquirer set. Condition (d) forms the acceptance set for target and acquirer given their state variables. Condition (e) requires that firms' expected matching probability is consistent with the true matching probability, which is determined by the relative population of target and acquirer in equilibrium through matching function $\phi(\cdot)$.

Focusing on the Rational Expectation Steady State Equilibrium (RESSE) defined above, I deliver several important propositions of RESSE that help establish the testable implications in next section. In particular, I show that these propositions do not depend on the empirical specification of state variables and the form of profit functions as long as certain properties are satisfied. As a result, any takeover models that specify the state variables and profit functions can be easily embeded into this search and matching framework to quantify the takeover gains, and their predictions will be qualtatively similar as long as their specifications satisfy certain properties.

I now specify some regularity condtions for state variables and profit functions that are used to construct RESSE. I assume that state variable set is bounded and compact, so $X \in D = [\underline{x_1}, \overline{x_1}] \times [\underline{x_2}, \overline{x_2}]$ for any firm. The profit function $y(X)$ and joint profit function $yc(X_A, X_T)$ are continuous, bounded and non-decreasing. The cross sectional distribution of state variables, $f(X) : D \to R$, is bounded and smooth.

**Proposition 1.** *If there exists at least one pair* $(X_A, X_T) \in D \times D$ *satisfying* $s(X_A, X_T) > 0$*, then there exists a threshold* $L^* > 0$ *such that for any* $0 < L \leq L^*$*, a non-degenerate RESSE exists and can be solved by fixed point theory.*

*Proof.* See Wang (2012). □

The condition for the existence of $L^*$ and RESSE is quite intuitive. It just requires that for at least one pair of firms in the economy, the combined firm is more productive than the sum of these two stand-alone firms even after substracting integration cost, or equivalently the net operation synergy is strictly positive.

**Proposition 2.** *When RESSE exists and the profit function* $y(X) = y(x_1, x_2)$ *exhibits supermodularity between* $x_1$ *and* $x_2$ *and the joint profit function* $yc(X_A, X_T) = yc(x_{A,1}, x_{A,2}, x_{T,1}, x_{T,2})$ *is supermodular in* $x_{A,1}$ *and* $x_{T,2}$ *or in* $x_{A,2}$ *and* $x_{T,1}$*, there exist two continuous and nondecreasing functions* $A : [\underline{x_1}, \overline{x_1}] \to [\underline{x_2}, \overline{x_2}]$ *and* $T : [\underline{x_1}, \overline{x_1}] \to [\underline{x_2}, \overline{x_2}]$ *that define the boundary of acquirer set and the boundary of target set respectively.*

*Proof.* See Wang (2012). □

The search model itself does not distinguish acquirer and target. It only predicts merger and acquisition between two firms that own complementary assets but are bounded in some dimensions. To fit my model to data, I need to label acquirer and target based on other empirical facts. In data, acquirers are usually large in size and more efficient, so I label firms that have relative strength in dimension $x_1$ as acquirer and firms that have relative strength in dimension $x_2$ as target. This labeling is also consistent with the seed model I will entertain in next section.

**Corollary 3.** *If the conditions in Proposition 2 satisfy and the joint profit function* $yc(X_A, X_T) = yc(x_{A,1}, x_{A,2}, x_{T,1}, x_{T,2})$ *is supermodular in* $x_{A,1}$ *and* $x_{T,2}$*, then the acquirer set is defined as* $A = \{X \in D : x_2 \leq A(x_1)\}$ *and the target set is defined as* $T = \{X \in D : x_2 \geq T(x_1)\}$*, and for all* $x_1 \in [\underline{x_1}, \overline{x_1}]$, $T(x_1) \geq A(x_1)$ holds.

*Proof.* See Wang (2012). □

Figure 3 clearly illustrates the implication of proposition 2 and corollary 3. Acquirers are firms with strong comparative advantage in $x_1$ and targets are firms with strong comparative advantage in $x_2$. Other firms whose $x_1$ and $x_2$ are relatively balanced choose to stand alone. The firms that lie exactly on the boundary of $A(x_1)$ (or $T(x_1)$) are indifferent to become acquirer (or target) or stand alone.

## 4.3 Testable Implications

Armed with the model solution, I first deliver two implications that help reconcile the puzzles: takeover indeed creates values for acquirers but traditional estimates are downward biased. These implications are consistent with stylized facts I have documented. The model also generates a few novel implications that have not been documented and tested in previous studies. I show that these new implications generated by my model match data very well, but they can hardly be explained by most existing models of takeovers.

***Implication 1.*** *Without successful takeovers, acquirers underperform the stand-alone firms with the same* $x_1$*.*

This implication is a direct prediction of corollary 3. It is also very intuitive from firms' optimal decisions illustrated in Figure 3. Note that traditional matching procedure is done based only on observable dimensions ($x_1$ is observable and $x_2$ is unobservable), so the matched firms used in tradtional estimates exactly corresponds to the stand-alone firms that have the same $x_1$ as the bidders in my model. As a result, Stylized Fact 2 I documented before directly verifies this model implication. From this implication, it is also clearly in the Panel (a) of Figure 4 that traditional estimate obtained from matched firm approach is biased. Note that the true takeover gain is defined as

$$\begin{aligned} true\,gain &= perm_{comb} - perm_{acq|SA} \\ &= \underbrace{(perm_{comb} - perm_{mt})}_{traditional\,estimate} + \underbrace{(perm_{mt} - perm_{acq|SA})}_{benchmark\,bias} \end{aligned}$$

where $perm_{comb}$ is operating performance measure of the combined firm and $perm_{acq|SA}$ is the operating performance measure of acquirer if it was forced to stand alone. The first equality is the definition of takeover gain of acquirers. It equals to the operating performance of the combined firm minus the hypothetical operating performance of acquirer as a stand alone firm. It can be decomposed into the traditional estimate that is computed from matched firm approach and the benchmark bias which equals to the difference between matched firm's performance and bidders' stand-alone performance. As we observe clearly in Panel (a) of Figure 4, matched firm has much higher $x_2$ than acquirer. If $x_2$ contribute positively to firm's operating performance, the benchmark bias is positive on average, i.e., $E[perm_{mt} - perm_{acq|SA}] > 0$. Traditional estimate understates the takeover gains to acquirers.

***Implication 2.*** *Takeover announcement on average brings to the market negative information regarding bidders' stand-alone value.*

Since $x_2$ is unobservable to the market, market's expectation of acquirer's $x_2$ is simply its expected value conditional on the observable $x_1$ before the takeover announcement. On the announcement, the market realizes that the acquirer belongs to the acquirer set and thus $x_2 \in A(x_1)$, so it immediately revises the expected value of acquirer's $x_2$ to $E[x_2|x_1, x_2 \in A(x_1)]$. From Figure 3, it is clear that $E[x_2|x_1, x_2 \in A(x_1)] < E[x_2|x_1]$. This implication simply indicates that the revelation effect is negative, and this is verified by the Stylized Fact 3 I documented before. Panel (b) of Figure 4 illustrates how this implication also implies that the traditional estimate of takeover gains measured using announcement effect as proxy is downward biased.

The announcement effect is

$$
\begin{aligned}
Ann\,Eff &= E[V_A^{MP|m}(X)|x_1, x_2 \in A(x_1)] - E[V_{SA}(X)|x_1] \\
&= \underbrace{E[V_{SA}(X)|x_1, x_2 \in A(x_1)] - E[V_{SA}(X)|x_1]}_{revelation\,effect} \\
&+ \underbrace{E[V_A^{MP|m}(X)|x_1, x_2 \in A(x_1)] - E[V_{SA}(X)|x_1, x_2 \in A(x_1)]}_{merger\,effect.}
\end{aligned}
$$

The first equality defines the announcement effect. The second equality further decomposes the total announcement effect into a "revelation effect" and a "merger effect". The first term on RHS is the revelation effect, which reflects the reevaluation of acquirer's stand alone value. The second term on RHS is the merger effect and it measures the true takeover gain of acquirers scaled by the probability of success. Implication 2 indicates that the revelation effect is negative, so taking announcement effect as a proxy for takeover gain produces a downward biased estimate.

The two implications above demonstrate that traditional estimates of takeover gains measured using operating performance and stock market reaction are downward biased due to the self-selection problem. Beyond those, my model also generates a few novel implications that have not been documented and tested before.

First, it is intuitive to see from Figure 3 that increasing the dispersion of $x_1$ and $x_2$ and decreasing the correlation between these two state variables will tilt more distribution density towards the upper left and lower right corners (i.e., the target and acquirer set respectively). It implies that the average hypothetic stand-alone performance of acquirers will be lower in this case, because more density is shifted to acquirers with lower $x_2$. This implication, however, can not be tested directly in data because $x_2$ is unobservable. Practically, it is not possible to measure the dispersion of $x_2$ and the correlation between $x_2$ and $x_1$ from data. I overcome this empirical difficulty by using merger waves as proxy for periods of highly dispersed state variables. I consider merger waves as a good proxy for two reasons. First, large industry shocks cause more radical disturbance to the economy, which is expected to make $x_1$ and $x_2$ more dispersed (as Harford (2005) documented, most economic variables become more dispersed before and during merger waves). Large industry shocks may also lead to merger waves. So the periods with highly dispersed $x_1$

and $x_2$ are likely to coincide with merger waves. Second, my model implies that increasing the dispersion of $x_1$ and $x_2$ and decreasing the correlation between these two state variables will increase the takeover activities because more distribution density is tilt towards the acquirer and target set. This is consistent with the fact that mergers and acquisitions cluster and peak during merger waves.

If merger waves proxy for periods of highly dispersed $x_1$ and $x_2$, it follows that the average hypothetic stand-alone performance of acquirers will be lower during merger waves. Acquirers' hypothetic stand-alone performance can be represented by bidders' post-withdrawal performance in the sample of exogenously failed bids through the quasi-experimental design, so the following implication should hold in data:

***Implication 3.*** *Bidders' underperformance after the failure of planned takeovers, as identified in Implication 1, is more pronounced if the failed bids were made in merger waves.*

To test this implication, I first follow a similar approach used in Harford (2005) to identify merger waves, with some minor modifications tailored to fit my empirical design. Details of the approach are provided in the Appendix. I then divide the exogenously failed bid sample into two subsamples: bids made within merger waves (i.e., the in-wave subsample) and bids made out of merger waves (i.e., the out-of-wave subsample). Figure 5 illustrates bidders' operating performance together with their matched firms' performance for these two subsamples. Matched firms in both subsamples perform similarly, and their return on assets and operating cash flow remain stable over the whole event window, exhibiting mean reversion as suggested by Barber and Lyon (1996). Bidders in both subsamples experience stark declines in operating performance from the pre-announcement period to post-announcement period. The performance drop in the in-wave subsample is more striking: standardized return on assets drops 0.08 standard deviation in the out-of-wave subsample and drops 0.16 in the in-wave subsample; standardized operating cash flow declines 0.08 standard deviation in the out-of-wave subsample and declines 0.18 in the in-wave subsample. The difference between two subsamples is statistically significant at 5% level. These findings lend strong support to Implication 3.

According to the model, the revelation effect in stock market captures the market's revaluation of bidders' stand-alone performance upon takeover announcement. If bidders' underperformance is expected to be more pronounced in merger waves as suggested by Implication 3, the new implication below should hold in data.

***Implication 4.*** *The negative revelation effect, as identified in Implication 2, is more pronounced if the bids were made in merger waves.*

Again, the revelation effect can be directly measured from the sample of exogenously failed bids, so I still use the in-wave and out-of-wave subsamples to test this implication. Figure 7 compares bidders' BHAR in these two subsamples during an event window of $[DA - 100\,day, DW + 100\,day]$. Bidders in the in-wave subsample experience a more negative BHAR of -10%, which doubles the magnitude of BHAR earned by bidders in the out-of-wave subsample. The difference between these two subsamples is statistically significant at 10% level, establishing strong evidence supporting Implication 4.

Finally, I present and test two implications that help distinguish my model from competing explanations. My model predicts that "takeover-for-catching up" is the overriding motive for a majority of takeovers, so it is important to rule out the possibility that bidders' underperformance is driven by a subgroup of firms with certain characteristics. Formally, the following implication should hold in data.

***Implication 5.*** *Bidders' underperformance, identified in Implication 1, is pervasive in the sample of exogenously failed bids, and is not driven by a subgroup of bidders with certain characteristics.*

To do so, I regress the change in bidders' abnormal operating performance (represented by return on assets) onto an in-wave dummy and several important characteristics of bidders. The change in bidders' abnormal operating performance (represented by return on assets) is defined as:

$$\triangle ROA_i^{abn} \quad = \quad ROA_{i,2}^{abn} - ROA_{i,-2}^{abn} \tag{10}$$

where $ROA_{i,t}^{abn}$ is bidder $i$'s abnormal operating performance of return on assets at year $t$ and is defined in equation 2. As usual, $t = 0$ denotes the year of announcement and $t = -2$ and $t = 2$ denote two years before and after announcement, respectively[17]. The first column of Table 3 reports the coefficients and t-statistics for this regression. Standard deviation used to form t-statistics is adjusted for heteroskedasticity and bidder clustering. The in-wave dummy variable has a coefficient of -0.044 with a significance level of 5%, indicating that bidder's abnormal operating performance of return on asset drops 0.044 standard deviation more in merger waves, consistent with Implication 3. Other control variables, including a dummy of cash deal, bidder's size, market-to-book ratio, recent investment and excess cash holding are insignificant in the regression. The overall results are consistent with Implication 5.

Previous studies have documented that bidders' characteristics are important determinants of bidders' abnormal return in announcement period. For example, Savor and Lu (2009); Masulis et al. (2011) find that bidders earn more negative abnormal return in equity-bids. Harford (1999, 2005) show that large bidders and cash-rich bidders tend to earn lower abnormal return. Rau and Vermaelen (1998); Shleifer and Vishny (2003) document that high-$q$ acquirers underperform their matched firms. My model suggests that "takeover-for-catching up" is the main motive for a majority of takeovers and the revelation effect captures the weaker prospect of bidders' future stand-alone performance. As a result, if the motive of "takeover-for-catching up" dominates these competing explanations in data, bidders' characteristics should not have strong explanatory power on revelation effect once the prospect of bidders' future stand-alone performance is fully controlled. Formally,

***Implication 6.*** *The revelation effect, identified in Implication 2, is mainly driven by the the prospect of bidders' future stand-alone performance. Bidders' characteristics should become irrelevant to the revelation effect once the prospect of bidders' future performance is controlled.*

I first regress the revelation effect (measured by bidders' BHAR in the exogenously failed bid sample) onto the in-wave dummy and cash-bid dummy as well as a full set of bidders' characteristics such as size, market-to-book ratio and excess cash holding. The prospect of bidders' future performance is not included in this specification. The regression coefficients and t-statistics are tabulated in the second column of Table 3.

[17]Using abnormal operating performance represented by operating cash flow as the dependent variable or changing the time subscript from 2 to 1 (or 3) does not change the main results presented in Table 3.

Both dummy variables enter into the regression significantly. The in-wave dummy has a coefficiet of -0.05, implying that bidders on average lose 5% more in BHAR if they are in merger waves, consistent with Implication 4. The cash deal dummy, which is equal to one if the bid is made with 100% of cash and zero otherwise, has a positive coefficient of 0.12. I also find that bidders with high $q$ are likely to earn more negative abnormal return in my sample of exogenously failed bids and large bidders and cash-rich bidders tend to earn lower abnormal return. Overall, the first specification of regression model in Table3 confirms that bidders' characteristics are important determinants of bidders' abnormal return. Though the revelation effect is more pronounced for a group of bidders with certain characteristics, I show that the explanatory power of these characteristics is greatly subsumed when bidders' future operating performance is fully controlled. I add the change in bidders' abnormal operating performance (i.e. $\triangle ROA^{abn}$) defined through equation**??** into the horse-racing regression as an additional regressor, forming specification (2) in Table 3. The coefficient of $\triangle ROA^{abn}$ is positive with a t-statistics of 3.42 while all other coefficients associated with bidders' characteristics now become insignificant. In particular, the t-statistic of cash deal dummy drops from 1.79 in specification (1) to 1.20 in specification (2) and the t-statistic of bidders' $q$ also declines from -2.54 to -0.93. The significance of other control variables are also largely subsumed by $\triangle ROA^{abn}$. Overall, the sign and significance of regression coefficients in specification (2) strongly confirm Implication 6 and identify the "takeover-for-catching up" as the dominant motive.

In the last column of Table 3, I undertake a robustness check for the results presented in specification (2). Basically, it is possible that BHAR responds to the release of news about bidders' abnomal operating performance within the event window $[DA-100\,day, DW+100\,day]$. If abnormal operating performance is persistent, this can create a positive correlation between BHAR and $\triangle ROA^{abn}$ that is uncorrelate with the prospect of bidders' future performance. To control for this effect, I add bidders' abnormal operating performance at the year of bid announcement as an additional regressor and form specification (3). The sign and significance of all coefficients are nearly unaffected by the inclusion of this new regressor. The loading of BHAR on this new regressor is also insignificant, implying that the results I deliver in specification (2) are not driven by this concern of persistence in abnormal operating performance.

### 4.4 Search Equilibrium v.s. Competitive Equilibrium

Several studies such as Levine (2011); Jovanovic and Braguinsky (2004) investigate takeovers in a framework of competitive equilibrium. Though competitive equilibrium can characterize takeover reasonablly well, the search equilibrium I establish in this paper fits the context better. I compare a few important implications of competitive equilibrium and search equilibrium in Table 4. First, competitive equilibrium usually occurs in centralized market while search equilibrium achieves in decentralized market. Takeover, like marriage, usually involves bilateral meeting and thus can be better described as trade in decentralized market. Second, in competitive equilibrium, law of one price holds and the unit price of target asset is uniform across all trades, which implies the percentage premium for all targets should be the same. However, in search equilibrium, unit price of target asset may differ in each takeover, which allows different premium for targets in different deals. This obviously fits data better. Third, competitive equilibrium assumes that targets are perfectly divisible, so acquirers can buy whatever quantity they want. But this is usually not the case in real world. In search equilibrium, targets are usually modeled as indivisible and thus acquirers get a take-it-or-leave-it offer, which resembles reality better. Fourth, another appealing feature search equilibrium provides is the endogenous failure of takeover negotiation. When the matching can not generate enough synergy to make both parties better off, takeover is predicted to fail endogenously. Competitive equilibrium, however, does not allow any failure. Fifth, there is no post-merger uncertainty in competitive equilibrium in the sense that the post-merger performance of an acquirer is uniquely pinned down by its state variable before mergers. Search equilibrium, on the other hand, provides more flexibility. Since acquirer agrees to merge with any targets in its acceptance set, the post-merger performance of the acquirers with the same pre-merger state variable can still differ significantly depending on who they meet and merge with. This adds more variation to post-merger performance of acquirers.

## 5 Seed Model in Search and Matching Framework

I have established a qualitative analysis showing that self selection is likely to cause downward bias in traditional estimates of takeover gains. To quantify the size of this bias, the model has to specify the state variables and profit function in the economy. As I discussed above, any takeover model that gives empirical specification of state variables and profit function can be embeded into this search and matching framework to characterize a search equilibrium. In this section, I entertain a seed model that is similar to the one used in Levine (2011). In seed model, takeovers are motivated by transfering growth options that are not full explored from targets to acquirers. Basically, acquirers operate efficiently and want to expand. However, they lack growth options (or valuable projects) to grow. Targets, on the other hand, have plenty of growth options but suffer from high operation cost, making these growth options under explored. As a result, each party has its own comparative advantage in one dimension but is bounded in the other. Growth options (or seed) and operation efficiency are complementary inputs for profit function, so placing them together under the same firm's control motives the takeovers.

## 5.1 Seed Model Specification

Operation efficiency is easy to gauge, but growth options (or seeds) are usually hard to measure especially when they are not fully explored. So I pick $x_1$ as a measure of operation efficiency and $x_2$ as a measure of seeds. As my search model requires, acquirers have comparative adavantage in $x_1$ and targets have comparative advantage in $x_2$. The profit function is specified as

$$\Pi_{i,t} = Z_i K_{i,t}^{\alpha} - c_i K_{i,t} - f + \varepsilon_{i,t}$$

where $K_{i,t}$ is firm's choice of capital, $Z_i$ is firm-specific productivity, $c_i$ is the variable cost parameter and $f$ is the fixed cost of operation. In order to reduce the total number of state variables I need to keep track of, I set $Z_i = \bar{Z}$ as the average industry productivity in model estimation. As a result, the profit function is

$$\Pi_{i,t} = \bar{Z} K_{i,t}^{\alpha} - c_i K_{i,t} - f + \varepsilon_{i,t}$$

I assume that there is no capital adjustment cost, but for each unit of capital installed, a unit of seeds is required. If firms always have enough seeds, the optimal capital choice is given by regular F.O.C.:

$$
\begin{aligned}
K_{i,t}^{opt} &= \left(\frac{\alpha\bar{Z}}{c_i}\right)^{\frac{1}{1-\alpha}} \\
&= e^{\frac{1}{1-\alpha}\left(ln(\alpha)+ln\left(\bar{Z}\right)-ln(c_i)\right)}
\end{aligned}
$$

Now define $x_{i,1} = -ln\,(c_i)$, and it measures firm's operation efficiency. In this seed model, each unit capital needs to be paired with one unit of seeds, so firms may not be able to expand to optimal capital level if they don't have enough seeds. define $x_{i,2,t}$ to be the logarithm of firm $i$'s seeds, so $x_{i,2,t} = ln\,(S_{i,2,t})$. The actual capital level a firm with state variable $X_{i,t} = (x_{i,1}, x_{i,2,t})$ choose is

$$
\begin{aligned}
K_{it}^{*} &= min\left\{S_{i,2,t},\ K_{i,t}^{opt}\right\} \\
&= min\left\{e^{x_{i,2,t}},\ e^{\frac{1}{1-\alpha}\left(ln(\alpha)+ln(\bar{Z})+x_{i,1}\right)}\right\}
\end{aligned}
$$

The cash flow $y(X_{i,t})$ the firm receives each period is thus equal to

$$
y(X_{i,t}) = \begin{cases} (1-\alpha)e^{\frac{1}{1-\alpha}\left(ln(\bar{Z})+\alpha ln(\alpha)+\alpha x_{i,1}\right)} - f + \varepsilon_{i,t} & if\ x_{i,2,t} > \frac{1}{1-\alpha}\left[ln(\alpha\bar{Z}) + x_{i,1}\right] \\ e^{ln(\bar{Z})+\alpha x_{i,2,t}} - e^{x_{i,2,t}-x_{i,1}} - f + \varepsilon_{i,t} & if\ x_{i,2,t} \leq \frac{1}{1-\alpha}\left[ln(\alpha\bar{Z}) + x_{i,1}\right] \end{cases}
$$

The profit function for the combined firm is intuitive: acquirer gets the original cash flow generated by the target and additionally, all unused seeds of target are transferred to acquirer and can be used to expand acquirer's capital if necessary. So after takeover, the seeds that can be used by acquirer in the combined firm increases to $e^{x_{C,2,t}} = e^{x_{A,2,t}} + max\left\{0, e^{x_{T,2,t}} - e^{\frac{1}{1-\alpha}[ln(\alpha)+ln(\bar{Z})+x_{T,1}]}\right\}$. Now the cash flow $yc(X_{A,t}, X_{T,t})$ the combined firm receives is thus equal to

$$
yc(X_{A,t}, X_{T,t}) = \begin{cases} \left[(1-\alpha)e^{\frac{1}{1-\alpha}\left(ln(\bar{Z})+\alpha ln(\alpha)+\alpha x_{A,1}\right)} - f + \varepsilon_{i,t}\right] + y(X_{T,t}) & if\ x_{C,2,t} > \frac{1}{1-\alpha}\left[ln(\alpha\bar{Z}) + x_{A,1}\right] \\ \left[e^{ln(\bar{Z})+\alpha x_{C,2,t}} - e^{x_{C,2,t}-x_{A,1}} - f + \varepsilon_{i,t}\right] + y(X_{T,i}) & if\ x_{C,2,t} \leq \frac{1}{1-\alpha}\left[ln(\alpha\bar{Z}) + x_{A,1}\right] \end{cases}
$$

I parameterize the cross sectional distribution of state variables $f(X)$ as $f(X) \sim N(\mu, \Sigma)$, in which $\mu = (\mu_1, \mu_2)$ and $\Sigma = \begin{bmatrix} \sigma_1^2 & \rho\sigma_1\sigma_2 \\ \rho\sigma_1\sigma_2 & \sigma_2^2 \end{bmatrix}$.

## 5.2 Identification and Choice of Moments

This section defines the moments used in SMM and discusses how they help identify model parameters from the data. The parameters include a discount factor $\beta$, acquirer's surplus share $\theta$, the explicit and implicit search cost $L$, the arrival rate of matching $\lambda$, the concavity of production function $\alpha$, the average productivity $ln(\bar{Z})$, fixed cost of production $f$ and the paramters that govern the joint distribution of state variables $\mu_1$, $\mu_2$, $\sigma_1$, $\sigma_2$, $\rho$. I set the discount factor $\beta$ to 0.93, a plausible value given investors' annual discount factor. Changing $\beta$ between 0.9 and 0.95 has negligible impact on the quatitative results. Larger change in $\beta$ moves the point estimates of other parameters, but the qualitative model implications hold for any value of $\beta \in (0, 1)$.

Next I provide intuition for how the remaining parameters are identified. I use 14 moments in data to identify the 11 parameters in my model. First, the state variable $x_1$ is specified as the measure of operating efficiency, and thus its mean $\mu_1$ and standard deviation $\sigma_1$ can be directly estimated from accounting data. In the model, the total operating cost is $c_i K = e^{-x_{i,1}} K$. It corresponds to the sum of cost of good sold (COGS) and the Selling, General and Administrative Expenses (SG&A) in data. I construct an empirical measure of $x_1$ as

$$\tilde{x_1} = ln\left(\frac{K}{COGS + SG\&A}\right)$$

and estimate $\mu_1$ and $\sigma_1$ as the sample mean and standard deviation of this empirical measure for all firms.

The production function concavity parameter $\alpha$ and the average productivity $ln(\bar{Z})$ is identified by regressing firms' sales on the total asset. In the model, the revenue generated by firm $i$ is equal to $Sale_{i,t} = \bar{Z} K_{i,t}^{\alpha}$. I estimate the regression equation and estimate $\alpha$ and $ln(\bar{Z})$ as regression coefficients:

$$ln\left(Sale_{i,t}\right) = ln\left(\bar{Z}\right) + \alpha ln\left(K_{i,t}\right) + \epsilon_{i,t}$$

The fixed cost parameter $f$ is identified off the average book-to-market ratio of stand-alone firms. Book-to-market ratio is increasing in $f$, because higher fixed cost decreases the capitalized profit and thus reduces the market value of the firms given the book value of asset in place. Acquiring and target firms are not used because their market values can move significantly on bid announcements for reasons that are uncorrelated with the fixed cost of operation.

Acquirer's surplus share $\theta$ (or acquirer's bargaining power in my model) determines how the synergistic benefit from takeover is divided between acquirers and targets. Tradtional approach that compares the abnormal return of acquirers and targets upon bid announcements usually concludes that acquirers gain nothing in takeover, which implies that $\theta$ should be close to zero in my model. However, as I have demonstrated, acquirers' abnormal return on bid announcements captures not only their share of synergistic benefit from takeover but also the new information revealed regarding their stand-alone values. The revelation effect is significantly negative, and failing to control it can cause severe downward bias in estimating $\theta$. In this paper, I overcome this empirical difficulty by using the abnormal return of acquirers and targets on bid withdrawal to identify the parameter $\theta$. The intuition of my approach is that new information regarding bidders' and targets' stand-alone value has been fully revealed on bid announcement, so the subsequent bid withdrawal only brings the news that the potential synergistic benefit from current bid is lost if the bids fail for exogenous reasons. As a result, in the exogenously failed bid sample that I construct for quasi-experimental design, the abnormal return of bidders and targets on bid withdrawal is informative of the bargaining power parameter $\theta$. In particular, if acquirers' share of surplus is high, they should lose more than targets when the planned takeover fail. Several caveats are important here. First, there is clear evidence of information leakage regarding the bid failure before the date of bid withdrawal in Figure 2. Specifically, the BHAR gradually drops after the bid announcement until the bid withdrawal. In order to capture this information leakage, I define the abnormal return on bid withdrawal as the cumulative abnormal return earned in the period between bid announcement and bid withdrawal. Second, acquirers are usually much larger than targets, so even if acquirers lose more in dollar value on bid failure, it does not necessarily imply that the abnormal return of acquirers has to be more negative than that of targets on bid withdrawal. So I convert the abnormal return of bidders and targets to dollar values for estimating $\theta$. Third, both acquirer and target maintain the options of pursuing future takeovers, so the potential synergistic benefit of takeover is not fully lost even if the current bid fails. The value lost in current bid failure simply reflects that current matching breaks down and future synergistic benefit has to be scaled by the probability of matching and then discounted back for the number of waiting periods. As a result, though bidders' and targets' abnormal return on bid withdrawal are the most informative moments for estimating $\theta$, other moments that determines bidders' and targets' option value of future takeovers also have some impacts on $\theta$. All these moments are included in SMM and used for identifying other parameters such as $\mu_2$, $\sigma_2$ and $\rho$ as well.

The total value lost (bidders' value lost plus targets' value lost) on bid withdrawal in the exogenously failed bid sample helps identify $\lambda$, the arrival rate of matching in the model. The total value lost on bid withdrawal is a decreasing function of $\lambda$. If $\lambda$ is high, the cost of current bid breakdown is low because next matching is expected to occur soon.

Next I use the volume of acquirers and targets to identify the search cost parameter $L$. These two moments are most sensitive to $L$, because firms in the model make optimal participation decision by weighing the potential benefit from takeovers against the search cost they need to pay. Increasing search cost prevents more firms from participating M&A, and effectively decreases the volume of acquirers and targets in equilibrium (given the joint distribution of $x_1$ and $x_2$, increasing search cost moves the boundaries of acquirer set and target set, that is $A(x)$ and $T(x)$, towards the corners in Figure 3).

The identification of $\mu_2$, $\sigma_2$ and $\rho$ is more challenging, because the state variable $x_2$ is unobservable and can hardly be estimated directly from accounting data. The profitability of acquirers and targets in the pre-merger periods is not informative of their $x_2$ at the time of takeover, because it is exactly the unobservable change in $x_2$ that motivates their pursuit of takeovers. Thus, consistent with data, my model also implies that firms' pre-merger performance can not well predict takeovers. In the model, $\mu_2$ determines the scarcity of seeds in the economy. Lower value of $\mu_2$ indicates that more firms are likely to need extra seeds to expand, and thus more firms may become acquirers. Meanwhile, it also implies that fewer firms have unexplored seeds and thus less firms can become targets. So I use the volume of acquirers and targets to identify $\mu_2$. These two moments have been used to identify the search cost $L$ above, but $L$ and $\mu_2$ have different impacts on these two moments, which makes the identification feasible. Specifically, low $L$ increases both the volume of acquirers and the volume of targets, while low $\mu_2$ only increases the volume of acquirers but decreases the volume of targets. I then use the abnormal return earned by targets on bid announcement to identify $\sigma_2$. $\sigma_2$ determines the dispersion of seeds across firms in my model. When $\sigma_2$ is high, targets have more seeds to sell and acquirers need more seeds to expand, and thus my model predicts that targets' abnormal return on takeover announcement is an increasing function of $\sigma_2$.

So far, I have used ten moments in data to identify the ten parameters in my model. These data moments are most sensitive to only one or two model parameters and thus help imporve the identification precision. The remaining four moments are in general sensitive to multiple model parameters, and they are included in SMM to achieve overidentification. They are the failure rate of takeover bids, bidders' abnormal return on takeover announcement, the average size (book value) of acquirers and the average size of targets. In data, takeover negotiation can break down if the bidder and the target can not agree on the transaction price (or equivalently, they disagree on how to divide the combined firm value). This corresponds to the endogenous failure of matching in my model, in which the matching does not generate sufficient synergistic benefit that can make both parties better off. This endogenous failure of matching is more likely to happen when one party (bidder or target) has significantly higher value of outside option and thus is more selective in the party it merges with. For example, if the seed is very scarce in the economy, my model predicts that targets on average have higher value of outside option than bidders, so targets are more likely to reject the bids if they meet with the bidders whose potential of generating synergistic benefit is low (e.g., the bidders with relatively low $x_1$). Similarly, high value of discount rate $\beta$ and low value of search cost $L$ make it less costly to forgo the current matching and thus would increase the failure rate of takeover bids predicted by the model. Also, high dispersion in state variables (i.e., high value of $\sigma_1$ and $\sigma_2$), low correlation between two state variables and high arrival rate of matching increase the possibility of meeting with a better partner in the next matching and thus make current matching more likely to break down. Overall, my model predicts that the bid failure rate is an increasing function of the relative scarcity of two complementary assets (seeds and efficient operation), the dispersion of two state variables, the arrival rate of matching, and the discount rate, and is a decreasing function of the search cost and the correlation between two state variables. The remaining three moments are also sensitive to multiple model parameters and thus quite informative of the overall model fit in overidentification test.

### 5.3 Estimation Method

I estimate the parameter $\Theta = \{\mu_1, \sigma_1, \alpha, f, \theta, \lambda, L, \mu_2, \sigma_2, \rho\}$ using simulated method of moments (SMM). SMM estimates parameter values by matching certain data moments and model-implied moments as closely as possible. When the number of data moments is larger than the number of parameters to estimate, the model is overidentified. SMM effectively retrieves part of information from the data moments to identify the parameters, and the remaining information that is not used for identification is then used for the test of overidentification.

The SMM estimator $\hat{\Theta}$ is derived through

$$\hat{\Theta} = \underset{\Theta}{argmin} \left( \hat{M} - \frac{1}{S} \sum_{s=1}^{S} \hat{m}^s(\Theta) \right)' W \left( \hat{M} - \frac{1}{S} \sum_{s=1}^{S} \hat{m}^s(\Theta) \right)$$

where $W$ is chosen to be the efficient weighting matrix and is the inverse of the estimated covariance of moments $M$. The efficient weighting matrix is constructed using the seemingly unrelated regression (SUR) procedure described in appendix. $\hat{M}$ is the vector of moments estimated from data, and $\hat{m}^s(\Theta)$ is the corresponding vector of moments estimated from the sth sample simulated using parameter $\Theta$. Following Hennessy and Whited (2007) and Taylor (2010), I use a simulated annealing optimization algorithm to avoid local minima.

### 5.4 Estimation Results

Parameter estimates from the seed model are reported in Table 5. The estimated concavity of production function $\alpha$ is 0.77 and the fixed cost of production is around 5% of total capital in place. They are consistent with the numbers generally used in literature. The search cost is estimated to be 2% of total firm value. This parameter is unique to the search model, and thus no contrast is available in the literature. Search cost may include the brokerage fee paid to investment banks, any interruption to firms' operation, managers' efforts of searching and investigating the potential merging firms, and any implicit costs associated with the possible leakage of firm's private information through the searching and responding process. Most of these costs are difficult to measure from data, but if we add up all these costs, the estimated search cost as 2% of total firm value is not unreasonable. Bidders' average surplus share is estimated at 0.72, indicating that bidders on average receive 72% of the total synergy benefit generated by the mergers and acquisitions. This lion share of takeover gain captured by bidders sharply contrasts the traditional estimates which conclude that acquirers on average gain nothing from M&A. The striking discrepancy results from the fact that traditional estimates rely on the abnormal returns on bid announcement which can be contanimated by the revelation effect. My estimate of surplus share is expected to be more accurate because it is identified from the value lost on exogenous bid failure, which is free of confounding effects. The arrival rate of matching $\lambda$ is estimated to be 0.73 per year. It implies that the probability for an acquirer candidate (target candidate) to match a target candidate (acquirer candidate) is 73% if the populations of target candidates and acquirer candidates are equal[18]. The average efficiency measure $\mu_1$ is estimated to be -1.53, implying that the average cost of operation (COGS plus SG&A) is about 7.8 times of the total capital in place (PP&E). The dispersion of efficiency measure $\sigma_1$ is 1.26 and this translates into a cross sectional standard deviation of 9.23 for the cost of operation scaled by the total capital in place. Both numbers are well in line with the data. The correlation between operation efficiency and seeds is estimated to be 0.62. The positive correlation indicates that firms possess complementary assets in the economy. The correlation, however, is only medium and it makes mergers and acquisitions valuable for asset reallocation.

## 5.5 Model Fit and Predictions

I examine the 14 moments in Table 6 to gauge how the model fits the data overall. The first four moments correspond to four parameters in my model respectively and

[18]In this paper, acquirer candidates (target candidates) refer to the firms that are actively seeking for target firms (acquiring firms). When acquirer candidates (target candidates) meet target firms (acquiring firms), they announce the bids and become acquirers (targets).

thus are matched perfectly in SMM. The observed volume of acquirers and targets (i.e., the number of acquirers and targets as a percentage of total firms) is 7% in the data and my model produces a slightly higher value of 9%. My model does a good job in matching the target's abnormal return on announcement, the probability of endogenous bid failure, the ratio of value lost on bid withdrawal as well as the bidders' and targets' abnormal return on bid failure. These data moments lie within one standard deviation of model implications. The model, however, fails to match other three data moments closely. Specifically, the model implied size of acquirers is too high while the model implied size of targets is too low. This mismatch is not surprising though in the context of the parsimonious seed model, which ignores the capital adjustment costs. When firms face adjustment costs in the real world, they expand or constract slowly in face of industry shocks, which may make the actual distribution of acquirers' and targets' size less disperse.

With the estimated model, I can decompose the announcement effect into the revelation effect and merger effect. As reported in Table 7, the revelation effect is measured to be $-15.6\%$ and the merger effect is estimated to be 11.8%. It implies that traditional estimate, which takes the abnormal return around announcement as the takeover gain of acquirers, severely understates the true value by about 16%. My estimate that corrects for self selection bias find that acquirers actually benefit significantly in takeover deals, as high as about 12% of the firm value on average.

# 6 Conclusion

In the data, mergers and acquisitions are found to benefit targets, but surprisingly do not seem to create value for acquirers: acquirers suffer a insignificant abnormal return on the takeover announcements and do not exhibit significant improvement in post-merger operating performances. In this paper, I show that traditional estimates of takeover gains can be significantly contaminated because of the acquirers' self-selection behavior. Motivated by the strong evidence of "takeover for catching up" that I identify in the data, I develop a dynamic structural model which features search and matching to address this self-selection issue. I show that after accounting for the bias, mergers and acquisitions produce significant benefits to acquirers. In the model, the average takeover gain to acquirers can be as high as 12% of the firm value, which implies a sizable bias of -16% in the traditional empirical estimates. Moreover, my model yields several novel implications that I am able to verify in data. Overall, my work challenges the conventional wisdom of "acquirers subsidizing targets in takeover deals" and reinforces the neoclassic theory of M&A.

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Table 1: Operating performance of bidders in an exogenously failed merger and acquisition sample. Measures are standardized within each industry/year. The event window covers 7-year period centered at takeover announcement year ($t = 0$). Four standardized measures of operating performance are reported: ROA, Operating Cash Flow, Asset Turnover and Profit Margin. The t-test of difference-in-mean is conducted using paired data. Results are robust using unpaired data.

| | Year | Bidder | | Match. Firm | | Diff. in Mean. | |
|---|---|---|---|---|---|---|---|
| | | Mean | Std.err. | Mean | Std.err. | Mean | Std.err. |
| ROA | -3 | 0.122*** | 0.036 | 0.083*** | 0.033 | 0.038 | 0.041 |
| | -2 | 0.148*** | 0.031 | 0.139*** | 0.032 | 0.009 | 0.033 |
| | -1 | 0.100*** | 0.029 | 0.112*** | 0.029 | -0.012 | 0.022 |
| | 0 | 0.034 | 0.032 | 0.145*** | 0.028 | -0.111*** | 0.037 |
| | 1 | 0.028 | 0.034 | 0.142*** | 0.034 | -0.113*** | 0.041 |
| | 2 | 0.027 | 0.035 | 0.165*** | 0.034 | -0.137*** | 0.044 |
| | 3 | -0.007 | 0.038 | 0.135*** | 0.037 | -0.142*** | 0.047 |
| Asset Turnover | -3 | -0.051 | 0.042 | -0.092** | 0.040 | 0.042 | 0.049 |
| | -2 | -0.034 | 0.041 | -0.060 | 0.038 | 0.026 | 0.045 |
| | -1 | -0.056 | 0.037 | -0.029 | 0.036 | -0.026 | 0.038 |
| | 0 | -0.082** | 0.035 | -0.021 | 0.037 | -0.061 | 0.040 |
| | 1 | -0.126*** | 0.038 | -0.043 | 0.039 | -0.082* | 0.045 |
| | 2 | -0.142*** | 0.038 | -0.044 | 0.042 | -0.098** | 0.049 |
| | 3 | -0.163*** | 0.041 | -0.041 | 0.040 | -0.122** | 0.050 |
| Profit Margin | -3 | 0.111*** | 0.040 | 0.134*** | 0.041 | -0.023 | 0.049 |
| | -2 | 0.139*** | 0.037 | 0.188*** | 0.035 | -0.049 | 0.042 |
| | -1 | 0.107*** | 0.037 | 0.158*** | 0.034 | -0.051 | 0.038 |
| | 0 | 0.132*** | 0.034 | 0.126*** | 0.035 | 0.006 | 0.042 |
| | 1 | 0.166*** | 0.035 | 0.139*** | 0.036 | 0.027 | 0.047 |
| | 2 | 0.167*** | 0.036 | 0.173*** | 0.037 | -0.006 | 0.046 |
| | 3 | 0.162*** | 0.037 | 0.185*** | 0.038 | -0.023 | 0.048 |
| Cash Flow | -3 | 0.086** | 0.041 | 0.060* | 0.035 | 0.026 | 0.044 |
| | -2 | 0.111*** | 0.037 | 0.102*** | 0.036 | 0.009 | 0.037 |
| | -1 | 0.083** | 0.035 | 0.086** | 0.035 | -0.002 | 0.027 |
| | 0 | 0.021 | 0.034 | 0.105*** | 0.036 | -0.084** | 0.036 |
| | 1 | 0.007 | 0.035 | 0.107*** | 0.036 | -0.100** | 0.042 |
| | 2 | 0.000 | 0.036 | 0.118*** | 0.038 | -0.117*** | 0.044 |
| | 3 | -0.023 | 0.038 | 0.109*** | 0.041 | -0.132*** | 0.050 |

Table 2: Information set and value functions in each stage

| Stage | | Before Matching | Matching Occurs | Decision is Made |
|---|---|---|---|---|
| Information | Acq Mgr | $\{x_{1,A}\ x_{2,aA}\}$ | $\{x_{1,A}\ x_{2,A}\}\{x_{1,T}\}$ | $\{x_{1,A}\ x_{2,A}\}\ \{x_{1,T}\ x_{2,T}\}$ |
| | Tar Mgr | $\{x_{1,T}\ x_{2,T}\}$ | $\{x_{1,T}\ x_{2,T}\}\{x_{1,A}\}$ | $\{x_{1,A}\ x_{2,A}\}\ \{x_{1,T}\ x_{2,T}\}$ |
| | Econ's | N.A. | $\{x_{1,A}\}\ \{x_{1,T}\}$ | $\{x_{1,A}\}\ \{x_{1,T}\}$ |
| Firm Value | Acq | $v_A^{MP\|nm}$ | $v_A^{MP\|m}$ | $v_A^M$ if suc, $\beta v_{CON}$if fail |
| | Tar | $v_T^{MP\|nm}$ | $v_T^{MP\|m}$ | $v_T^M$ if suc, $\beta v_{CON}$if fail |

Table 3: Bidder's abnormal operating performance and BHAR

| | $\Delta ROA^{abn}$ | BHAR | | |
|---|---|---|---|---|
| | | 1 | 2 | 3 |
| Dummy | | | | |
| In-wave | -0.0439** | -0.0497* | 0.0170 | 0.0105 |
| | (-2.13) | (-1.75) | (0.41) | (0.32) |
| Cash-bid | 0.0231 | 0.1095* | 0.0976 | 0.1036 |
| | (0.16) | (1.79) | (1.20) | (1.29) |
| Bidder Characteristics | | | | |
| *Log*(Asset) | 0.0273 | -0.0174 | -0.0106 | -0.0115 |
| | (0.97) | (-0.67) | (-0.31) | (-0.33) |
| $q$ | 0.0363 | -0.0201** | -0.0129 | -0.0109 |
| | (1.14) | (-2.54) | (-0.93) | (-0.70) |
| Investment | 0.2409 | -0.4301 | -0.1105 | -0.0946 |
| | (0.50) | (-1.56) | (-0.43) | (-0.35) |
| Excess cash holding | -0.2554 | -0.1941 | -0.1393 | -0.1734 |
| | (-1.03) | (-1.23) | (-0.62) | (-0.77) |
| Other Controls | | | | |
| $E(\Delta ROA^{abn})$ | | | 0.1089*** | 0.1011*** |
| | | | (3.42) | (3.65) |
| $ROA_0^{abn}$ | | | | 0.0141 |
| | | | | (0.35) |
| Intercept | -0.2352 | 0.1171 | 0.0073 | 0.0129 |
| | (-1.16) | (0.48) | (0.02) | (0.04) |

Table 4: Predictions of competitive equilibrium and search equilibrium for takeover deals

| | Competitive Equilibrium | Search Equilibrium |
|---|---|---|
| Market | Centralized | Decentralized |
| Unit price of target asset | Uniform for all takeovers | Vary in different deals, depending on the matched partners |
| Target asset traded | Perfectly divisible, bidders get exact quantity needed | Indivisible, bidders get take-it-or-leave-it offer |
| Endogenous deal failure | Impossible | Possible if synergy is not large enough to compensate for outside options |
| Post-merger performance | No uncertainty given bidder | Uncertain, depending on the quality of the target firm matched |
| Reallocation efficiency | High | Low because of search friction |

Table 5: Model estimation: parameter values

| Notation | Parameter | Estimate | Std. err. |
|---|---|---|---|
| $\alpha$ | Production function concavity | 0.77 | 0.08 |
| $f$ | Fixed cost of production | 0.05 | 0.02 |
| $ln\left(\bar{Z}\right)$ | Average productivity | 2.30 | 0.04 |
| $L$ | Search cost as % of firm value | 0.02 | 0.01 |
| $\theta$ | Acquirer's share of surplus | 0.72 | 0.16 |
| $\lambda$ | Arrival rate of matching | 0.73 | 0.22 |
| $\mu_1$ | $E[x_1]$ | -1.53 | 0.24 |
| $\mu_2$ | $E[x_2]$ | 2.21 | 0.31 |
| $\sigma_1$ | $Stdev[x_1]$ | 1.26 | 0.37 |
| $\sigma_2$ | $Stdev[x_2]$ | 1.98 | 0.62 |
| $\rho$ | $Corr(x_1, x_2)$ | 0.62 | 0.27 |

Table 6: Moments used in SMM estimation

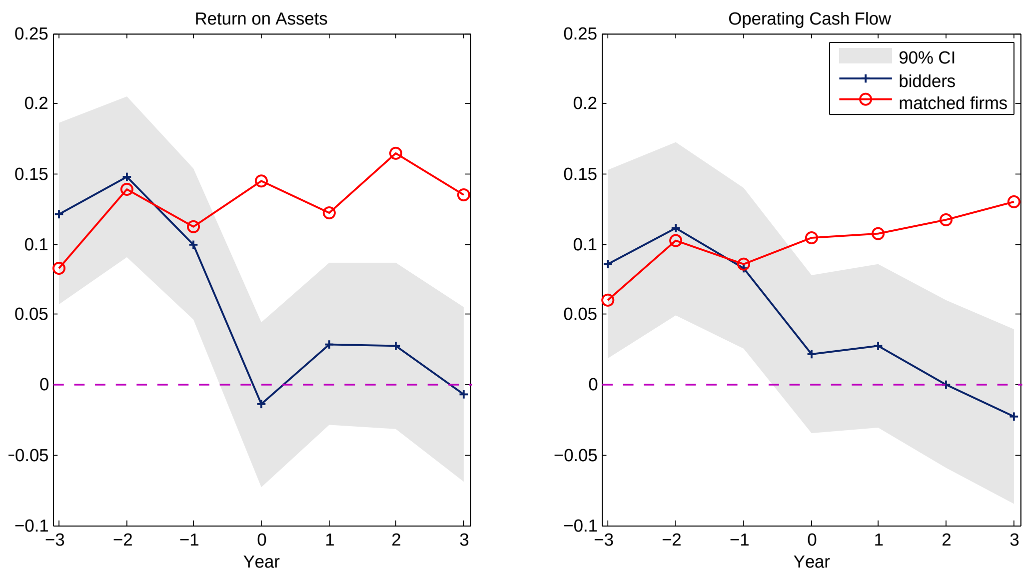
| Moment | Notation | Empirical value | Simulated value | Standard error |
|---|---|---|---|---|
| Production concavity | $\bar{\alpha}$ | 0.77 | 0.77 | 0.01 |
| Average productivity | $\bar{z}$ | 2.30 | 2.30 | 0.02 |
| Avg. efficiency | $\bar{\mu}$ | -1.53 | -1.53 | 0.02 |
| $Var$(efficiency resid) | $\bar{\sigma}^2$ | 1.58 | 1.58 | 0.06 |
| Obs. acq. as % of all firms | $P_A$ | 0.07 | 0.09 | 0.01 |
| Obs. tar. as % of all firms | $P_T$ | 0.07 | 0.09 | 0.01 |
| Acq's CAR on announcement | $r_A^{Ann}$ | -0.00 | -0.04 | 0.03 |
| Tar's CAR on announcement | $r_T^{Ann}$ | 0.16 | 0.18 | 0.04 |
| Standardized size of acq | $SZ_A$ | 0.51 | 1.12 | 0.52 |
| Standardized size of tar | $SZ_T$ | 0.04 | -0.92 | 0.58 |
| End. failed bids as % of all bids | $F$ | 0.07 | 0.08 | 0.02 |
| Ratio of value lost on bid withdrawal | $\chi$ | 0.60 | 0.62 | 0.22 |
| Acq's CAR on exogenous bid failure | $\ell_A$ | -0.08 | -0.07 | 0.02 |
| Tar's CAR on exogenous bid failure | $\ell_T$ | -0.17 | -0.15 | 0.04 |

Table 7: Bias in traditional estimates: stock market reaction

| | | Data | Model |
|---|---|---|---|
| Acquirer | Revelation Effect | $N.A.$ | $-15.6\%$ |
| | Synergy Effect | $N.A.$ | $11.8\%$ |
| | Announcement Effect | $-3.5\% \sim 0.7\%$ | $-3.8\%$ |
| | Bias | $N.A.$ | $-15.6\%$ |
| Target | Revelation Effect | $N.A.$ | $0.0\%$ |
| | Synergy Effect | $N.A.$ | $18.8\%$ |
| | Announcement Effect | $15\% \sim 30\%$ | $18.8\%$ |
| | Bias | $N.A.$ | $0.0\%$ |

Figure 1: Standardized operating performance measures of bidders and matched firms in the exogenously failed bid sample

(a) Return on Assets and Operating Cash Flow




(b) Asset Turnover and Profit Margin

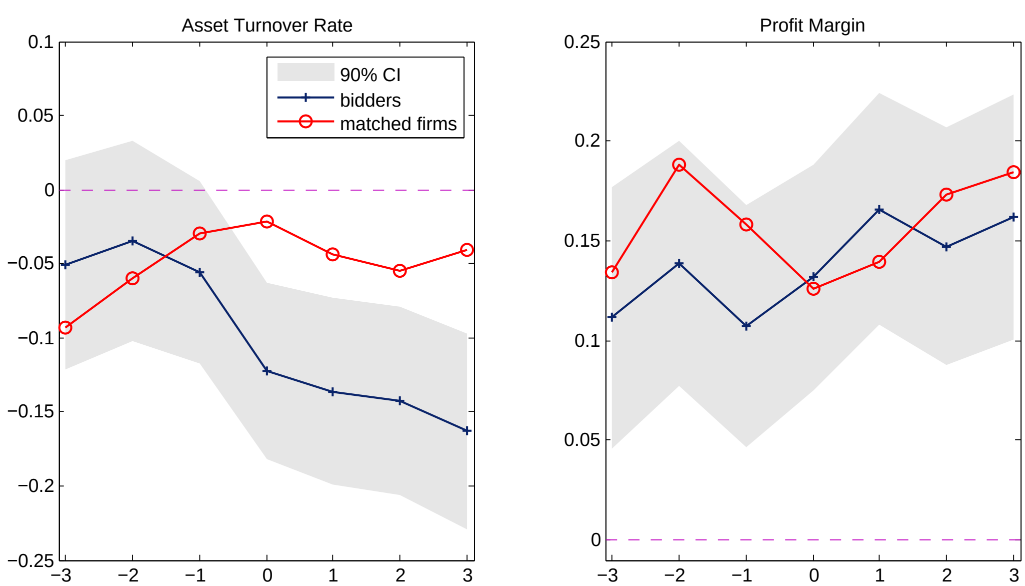


Figure 2: Buy-and-hold abnormal return (BHAR) of bidders in the exogenously failed bid sample.

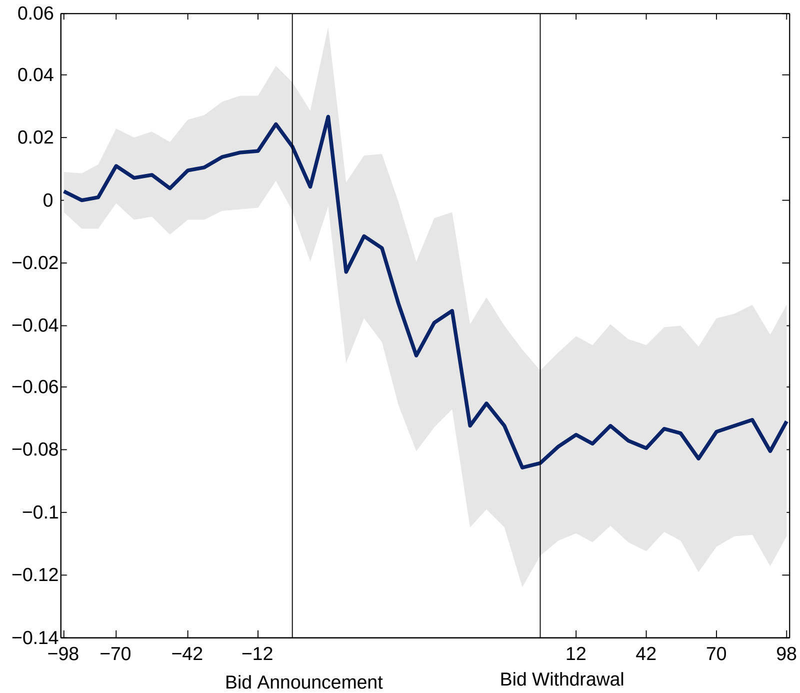



Figure 3: Optimal takeover decisions in state variable space

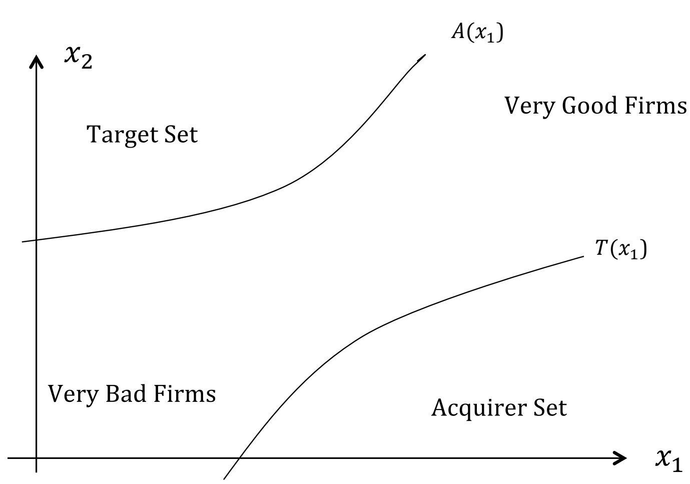
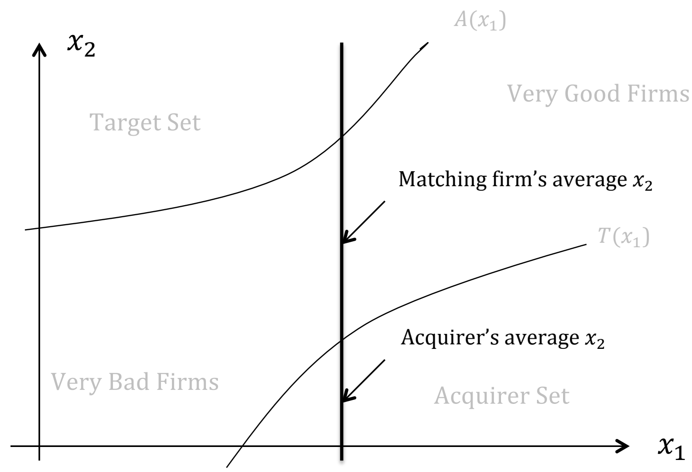


Figure 4: Bias in traditional empirical estimates of takeover gains of acquirers induced by self selection

(a) Bias in estimate with operating performance




(b) Bias in estimate with stock market reaction

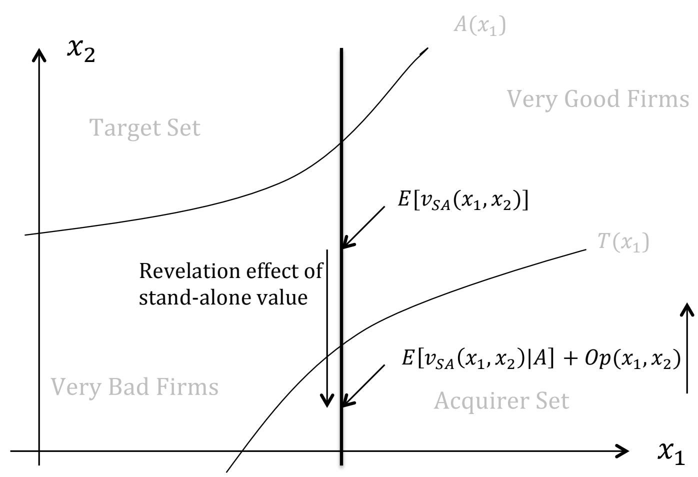


Figure 5: Standardized operating performance measures (ROA and OPCF) of bidders and matched firms in the subsample of exogenously failed bids made within merger waves (in-wave subsample) and the subsample of exogenously failed bids made out of merger waves (out-of-wave subsample).

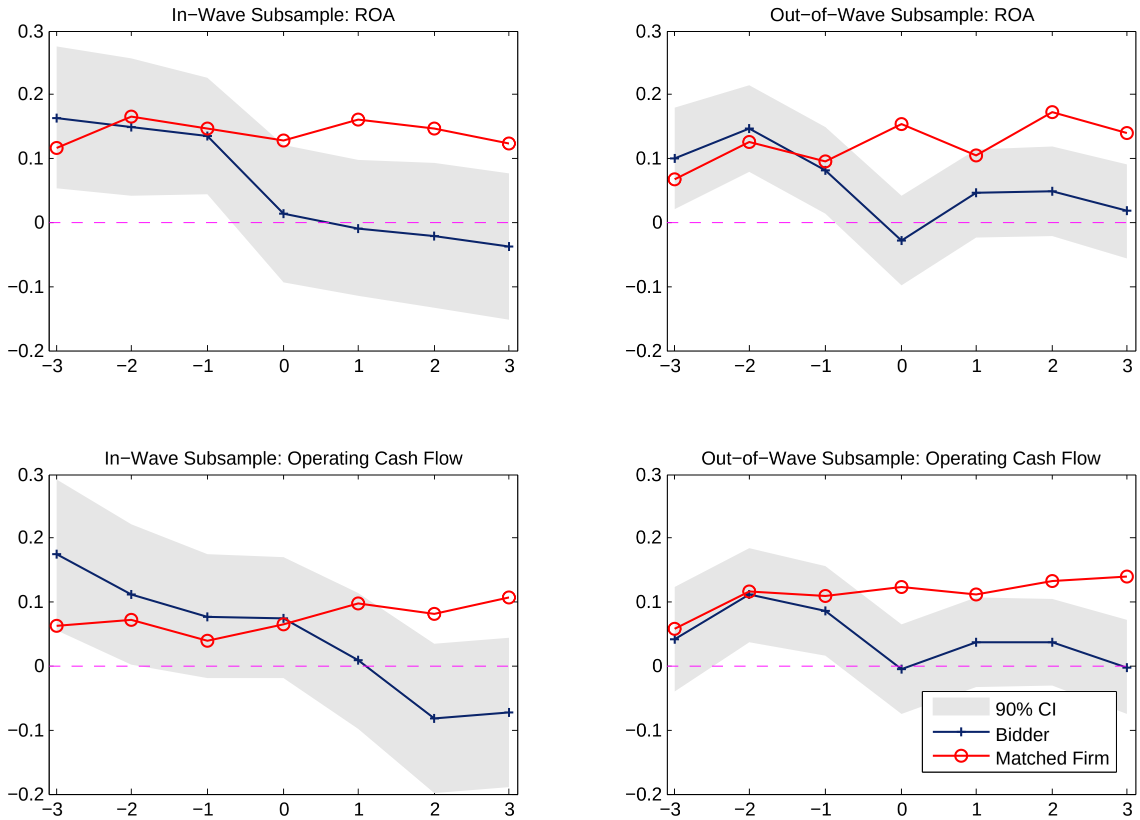


Figure 6: Decomposition of ROA for bidders and matched firms in the subsample of exogenously failed bids made within merger waves (in-wave subsample) and the subsample of exogenously failed bids made out of merger waves (out-of-wave subsample).

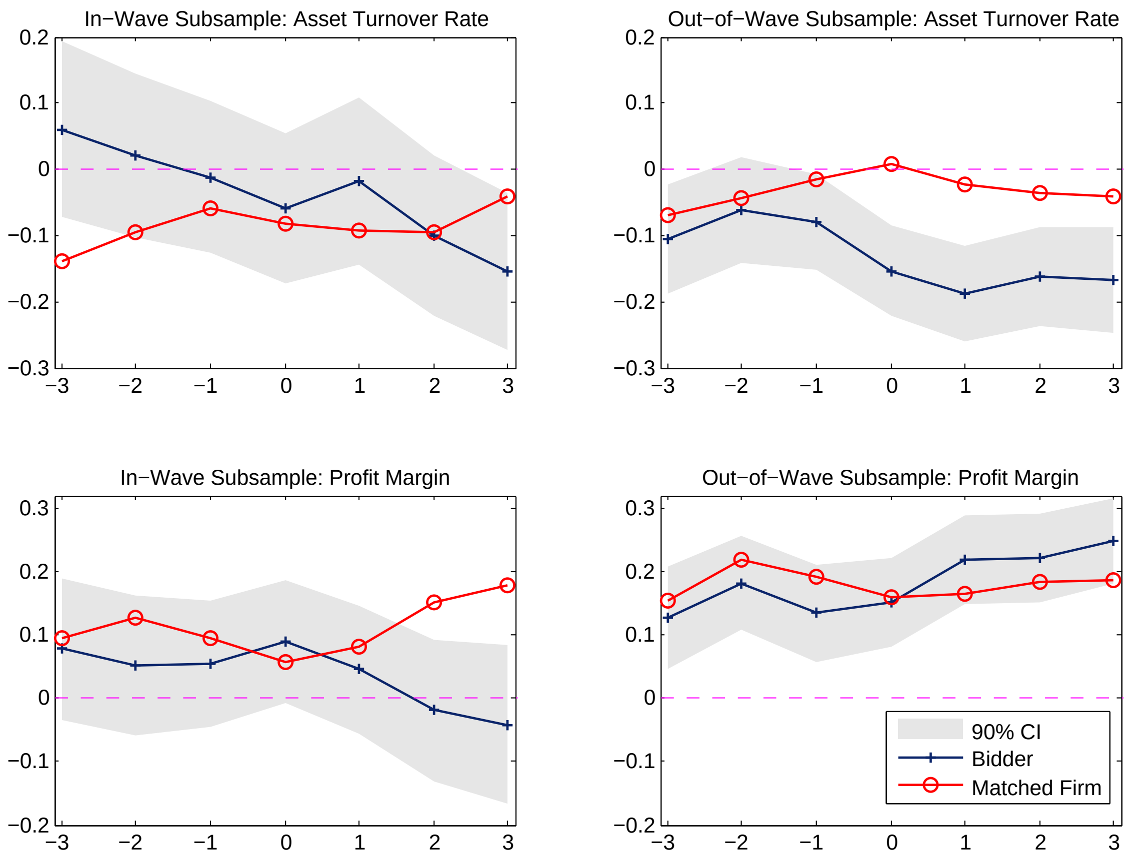
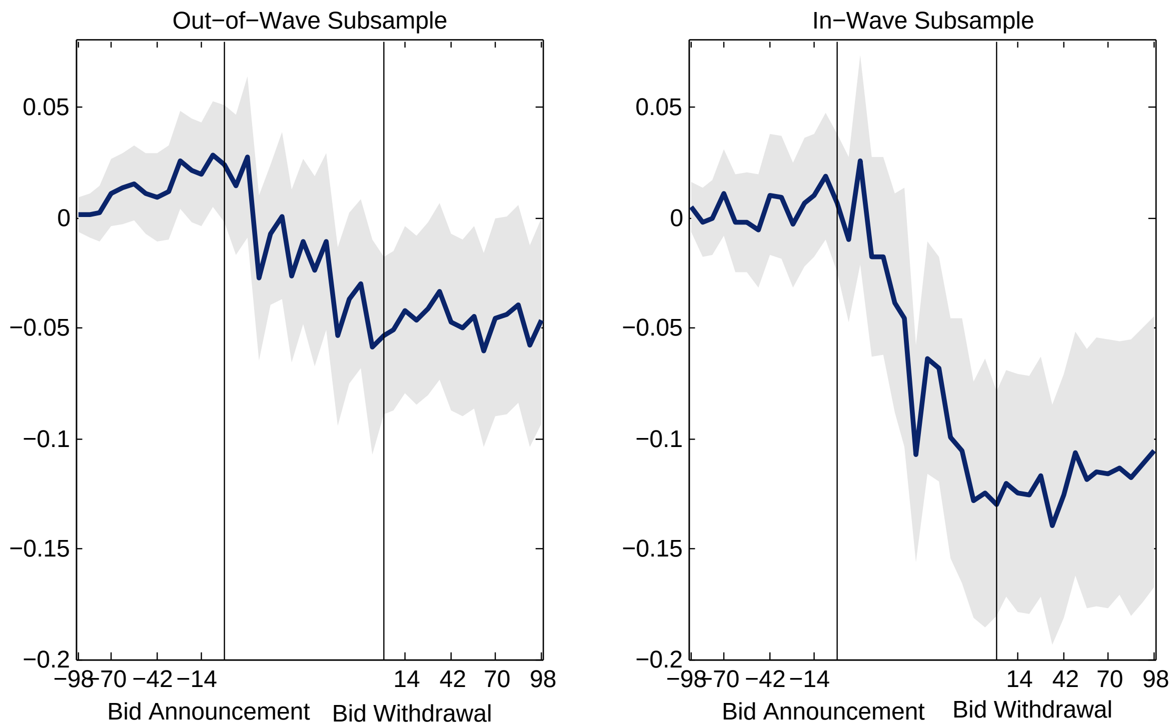


Figure 7: Buy-and-hold abnormal return (BHAR) of bidders in the subsample of exogenously failed bids made within merger waves (in-wave subsample) and the subsample of exogenously failed bids made out of merger waves (out-of-wave subsample).



# Appendix

## Matching Firm Approach

The standard matching procedure employed in literature is to match on industry, size, market-to-book ratio and/or pre-merger operating performance. Matched firms are required to be in the same industry as acquirers, and they are restricted to be the stand-alone firms in the sample. The matching is usually done one year prior to the year of takeover announcement. Usually, the matching procedure also requires that the size of matched firms is in the range of 30% to 200% of acquirers' size. From the stand-alone firms that satisfy the industry and size condition, matched firms are picked to be the one whose market-to-book ratio or pre-merger performance is closest to that of acquirers.

This standard matching procedure, however, does not work quite well if we need to match on more dimensions. In this paper, I need to match on industry, size, market-to-book ratio and also pre-merger operating performance. So I set up a measure of the matching error:

$$me_i = e'\Sigma e$$

where $e = (\frac{sz_i - sz_{mt}}{sz_i}, \frac{q_i - q_{mt}}{q_i}, \frac{op_i - op_{mt}}{op_i})$ is a vector of matching error that measures the percentage deviation of matched firms' size, market-to-book ratio and pre-merger operating performance. $\Sigma$ is the weight matrix which is used to control the accuracy of matching on different dimensions.

For each acquirer, my matching procedure is carried out by finding the stand-alone firm that minimizes the matching error.

## Sample Construction

I establish the sample of takeovers that fail for exogenous reasons by explicitly excluding several important types of endogenous failure defined in Savor and Lu (2009); Masulis et al. (2011). I exclude the bids that fail within 14 days after announcement, bids in which acquirers lose to competing offers, bids in which targets refuse the offer and bids in which targets and acquirers can not agree on the premium. The leaves me with 362 transactions. The number is larger than that in Savor and Lu (2009) because they only include pure cash bids and equity bids and I include all bids regardless of their mode of payment. My sample is also longer than theirs.

## Variable Definition

## Identification of Merger Waves