The Role of Private Equity in Corporate Asset Sales: Theory and Evidence

by

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September 2009

Abstract

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Keywords: Private equity, auctions, restructuring.
JEL: G32, G34.

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1. Introduction

Since the early 1990s private equity has become a major force in financial markets and an important bidder for corporate assets in a market previously dominated by strategic buyers. In this paper we conduct a theoretical and empirical analysis of the role of private equity in the sale of large corporate assets. We develop an auction-based model that addresses five key questions. One, how does private equity decide whether or not to enter into the competitive bidding for an asset? Two, how do the bidding behavior of private equity and the bidding behavior of strategic competitors interact? Three, how are the gains to a selling firm affected by the type of acquirer: strategic buyer versus private equity? Four, do private equity firms enhance the enterprise value of the assets they hold? And five, if the evidence suggests that they do, are the gains in value due to private equity’s managerial skills at restructuring and improving businesses it acquires or due to its ex ante ability to identify undervalues assets? We then provide empirical evidence about private equity within the context of our theory.

Corporate asset sales are a useful venue for analyzing the bidding interaction between private equity and strategic firms within an auction-type setting because these transactions are invariably non-hostile and are typically seller-initiated, with the selling firm’s management team continuing in place after the transaction. Also, it is logical to assume that a seller seeks to structure the sale process to spur competition. In contrast to a merger, which requires the approval of seller shareholders, shareholders have no role in asset sales. Instead, an asset sale is a managerial decision governed by the business judgment rule, which gives managers broad discretion as to how to conduct the sale and insulates the transaction from shareholder voting and shareholder litigation.
framework allows managers to identify assets for sale and establish the rules for an auction without reference to shareholder involvement or concerns that a court may be called upon to second guess the merits of a decision. Thus, an auction-based approach closely conforms to the institutional and legal framework governing asset sales.

Several novel aspects of our work allow us to contribute to the private equity literature in a manner that differs from prior studies, which have often focused on whether or not there are excess returns to fund investors (Kaplan (1989); Muscarella and Vetsuypens (1990); Kaplan and Schoar (2005)). Our study also contributes to the literature on asset sales, given that there is no prior analytical or empirical treatment of the role of the type of buyer (public or private operating firm or private equity) and prior empirical work focuses almost exclusively on gains in wealth to seller firms (Jain (1985); Hite, et al. (1987); John and Ofek (1995); Sicherman and Pettway (1992)).

Our auction-based theory endogenizes private equity’s decision to enter the bidding based on a choice as to whether or not it should invest in acquiring the information needed to prepare a bid. The model predicts that the participation of private equity and the aggressiveness of its bidding are related to the uniqueness of its skills relative to strategic bidders. We assume that strategic buyers generate bids that reflect the value of the synergies between their assets and the asset for sale. This approach is consistent with the work of Maksimovic and Phillips (2001) who analyze plant-level data and conclude that asset sales generate productivity gains because assets move from relatively low productivity sellers to more productive buyers. Synergy gains do not apply to private equity, but we consider two sources of value creation for private equity.

One, private equity may unlock incremental value from an operating asset in ways not available to or feasible for strategic (operating) firms. Specifically, private equity may have organizational
skills needed to alter corporate strategies, devise and implement effective restructuring plans, enforce management discipline, and execute controversial strategies with little consideration of fractious interests. In auction parlance, the bidding competition between private equity and strategic buyers is governed by a private values structure since the potential restructuring (synergistic) gains that can be obtained by private equity (strategic bidders) cannot be generated by strategic bidders (private equity). Two, private equity may be able to identify undervalued assets not recognized by other market participants and to bid for them opportunistically. In this view, private equity has a comparative advantage at gathering information, but once the information is identified, any market participant with access to it could use it, including strategic buyers. This environment can be characterized as a common values structure and implies that a private equity bid reflects more accurate pricing for the asset.

In modeling the auction, we treat the private value and common value components as polar cases of a continuum that encompasses all possible combinations about the relative importance of these two potential sources of value. The first decision private equity must make is to determine whether it should expend the resources needed to analyze the asset for sale and prepare a bid. In the private values framework, for private equity to enter the bidding it is necessary that the (ex-ante) expected restructuring gains be sufficiently large. In the common values framework, it is the (ex-ante) uncertainty regarding the intrinsic value of the asset that must be sufficiently large to induce private equity to participate; otherwise, private equity’s information advantage would be too small to make the competition with strategic bidders profitable. Thus, under the private values assumption private equity will bid for an asset when the expected gains from restructuring exceed strategic bidder synergies, while in the common values framework private equity will bid
for an asset that is undervalued by strategic bidders. The analysis of the auction model shows how the participation strategy of private equity affects the bidding behavior of all participants and the expected winning bid. The model implies empirical predictions that allow us to discriminate empirically between the two hypotheses on private equity’s source of value. We show by means of simulations that in the private values format, seller average revenue is higher when private equity is the winner, implying a more favorable market reaction for the seller at news of an asset being sold to private equity rather than a strategic buyer. In contrast, in the common values format, the simulation results indicate that seller average revenue is higher when a strategic buyer wins.

In practice, a strategic buyer may be either a public or private operating firm since each possesses expected synergies between its operating assets and the asset for sale. However, private operating firms are exempt from public reporting and have strong equity-based links between managers and owners, thus sharing some of the characteristics of private equity. We provide empirical insight about private strategic bidders by analyzing the effects on seller shareholder wealth for each of the three types of buyers.

We take our model to the data by analyzing a comprehensive sample of asset sales from 1994 through 2004, a time span during which private equity was an active participant in the market. Our main finding supports the view that the bidding behavior of private equity is consistent with a private values format since sellers earn large positive excess returns at sales of assets to private equity, 3.78%, that are significantly greater than the returns when the buyer is a public operating firm, 1.25%, or a private operating firm, 0.95%. There are positive excess returns to public strategic buyers, 0.48%, indicating that these buyers extract a rent for their private information about expected synergies and that their behavior does not entail the overbidding that would occur if
asset purchases reflected agency problems at acquirers (Bargeron, et al. (2008)). There is a similar pattern of results when the wealth gains are scaled by transaction size.

Two, there are no intra-industry gains at news of asset sales, irrespective of the type of buyer, suggesting that the private information conveyed by an asset sale is asset-specific. This evidence further supports the private values format. The empirical results also indicate that private strategic buyers are similar to public strategic buyers rather than private equity.

Three, when we evaluate the annualized change in the enterprise value of each operating asset during the period it is under private equity ownership, and compare these data to figures for public firms that are benchmarks for the assets, the assets acquired by private equity sustain significantly greater increases in enterprise value. Although such gains are not a direct measure of profitability for private equity fund investors, they are a useful metric of the business success of the entity and the skills of private equity managers. Such gains suggest that private equity buyers have effective restructuring skills, and are consistent with the assumption that the auction is governed by a private values structure.

Four, private equity leaves money on the table for the seller in the case of assets that subsequently prove to be a particularly rich source of value for private equity buyers. We find that private equity exits occur relatively quickly (on average in about three years), suggesting that private equity ownership is not a long-term form of organizational structure. The preponderance of exits is by IPO or strategic sale (69%), followed by secondary buyouts (a sale to another private equity firm - 18%), and bankruptcy (13%); 26% of the deals have not yet exited original private equity ownership. Returns to sellers at the original sale are related to the form of exit as well as to the subsequent gain in the asset’s enterprise value, with sellers earning significantly greater gains.
at deals in which exit is by IPO or strategic asset sale rather than bankruptcy or secondary buyout.

Interpreted within the context of our theoretical analysis, these findings are consistent with the view that private equity buyers have valuable restructuring skills and that they are willing to bid aggressively to win an auction, and to share the gains with the seller, when they expect to be able to significantly increase an asset’s value.

The paper is organized as follows. In Section 2, our theoretical model is presented. Section 3 describes sample construction. Section 4 contains empirical results for the valuation effects of asset sales, detailing the differential effects of alternative buyers. Conclusions are in Section 5.

2. The theoretical model

A firm, the seller, is to sell an indivisible, tangible, productive asset. There are two types of potential buyers: $N$ operating firms, henceforth strategic bidders, and private equity, henceforth $PE$. We denote with $\bar{x}_i$ the strategic bidder $i$’s idiosyncratic operating synergies between its own assets and the asset for sale. We assume that synergies are i.i.d. among the strategic bidders according to a distribution function that has positive density $f$ on the interval $[0, x_H]$. We denote with $F$ the cumulative distribution of $\bar{x}_i$. Strategic bidder $i$ privately knows $\bar{x}_i$, and its valuation of the asset is the sum of two components: its idiosyncratic synergies $\bar{x}_i$, and a component equal to $\theta \tilde{v} + (1 - \theta)v_L$ that is common to all strategic bidders, where $\tilde{v}$ represents the value of the asset to $PE$, and $\theta \in [0, 1]$ and $v_L \geq 0$ are commonly known parameters. We assume that $\tilde{v}$ is a random variable that is independently distributed from $\bar{x}_i$ and has a value in $\{v_L, v_H\}$, where $0 < v_L < v_H$. We denote with $p$ the ex-ante probability that $\tilde{v} = v_L$. The parameter $\theta \in [0, 1]$ is fixed and plays a key role in the interpretation of our model with respect to the valuation of the asset by $PE$.

Although there are no operating synergies with the asset for sale, $PE$ may attach a value to
the asset that exceeds that of a strategic bidder. We distinguish two sources of value generation by PE. One source relates to the fact that PE can possess a unique ability to restructure the asset for sale and increase its value. For instance, PE is not subject to the regulatory and reporting environment of public companies and thus, it can be more effective in enhancing the asset’s value through restructuring. In this setting the random variable $\tilde{v}$ represents the potential wealth gains from the ability of PE to restructure the asset. More formally, when $\tilde{v} = v_H$, a restructuring of the asset’s operations generates an increase in cash flow. In contrast, when $\tilde{v} = v_L$, restructuring the asset will not increase cash flow. Since restructuring pertains solely to PE, the value of $\tilde{v}$ does not affect a strategic bidder’s valuation of the asset. This situation is reflected in our model when parameter $\theta = 0$, so a strategic bidder values the asset at $v_L + \tilde{x}_i$, which is independent of the valuation of the asset $\tilde{v}$ by PE. We refer to this situation as the restructuring case or the private values format.

An alternative source of competitive advantage is PE’s information acquisition ability, that is, an ability to identify assets of high intrinsic quality; i.e., assets that will generate large future cash flows, independent of the buyer’s identity. In this setting, $\tilde{v}$ represents a common value component relevant to all bidders. When $\tilde{v} = v_L$, the asset for sale will generate low future cash flows. In contrast, when $\tilde{v} = v_H$, the asset has a high potential to generate large future cash flows. This situation is reflected in our model when parameter $\theta = 1$. We refer to this situation as the intrinsic quality case or the common values format. The intermediate case, $\theta \in (0, 1)$, represents a situation in which both components of value are present.

While the value of parameter $\theta$ is commonly known, we assume that only PE has the ability to learn $\tilde{v}$. To gain information, PE must devote resources $\alpha > 0$ to the analysis of the asset. We also
assume that the process of learning $\bar{v}$ and determining the bidding strategy cannot be disjoined. In other words, $PE$ can choose whether or not to spend $\alpha$, but the expenditure of $\alpha$ must precede any bid by $PE$. We assume that $x_H + v_L \leq v_H$, which implies that the strongest synergy cannot fully compensate for a low intrinsic quality of the asset or for $PE$ restructuring abilities when $\bar{v} = v_H$.

Prior to the asset sale, the seller’s total market capitalization is $Y + w$ where $w \leq v_L$ represents the value of the asset to the seller and $Y$ represents the value of the seller’s remaining assets. At time 0, the seller solicits bids from potential buyers, strategic bidders privately learn the magnitude of their synergies with the asset, and $PE$ decides whether to spend $\alpha > 0$ to learn $\bar{v}$. At time 1, the auction takes place. We model the competitive bidding as a first-price sealed-bid auction with a minimum acceptable bid of $v_L$, which is the asset’s value to a buyer in the worst possible case. Strategic bidders do not know, but correctly anticipate, the decision by $PE$ to invest $\alpha$.

2.1. Equilibrium analysis

As a first step we study the decision by $PE$ to spend $\alpha$ and participate in the auction, and how this decision changes with the prior belief $p$ and the parameter $\theta$, elements commonly known to all bidders. $PE$’s decision to acquire information on $\bar{v}$ depends on a comparison between $\alpha$, the cost of learning, and the expected profit from competing with strategic bidders in the auction.

Let $\Pi_H$ and $\Pi_L$ denote the $PE$ profit that is expected from participating in the auction given that $\bar{v} = v_H$ and $\bar{v} = v_L$, respectively. Note that $\Pi_L = 0$ since $PE$ cannot win the auction when $\bar{v} = v_L$ given that strategic bidders value the asset at more than $v_L$. Hence at time 0, $PE$ will spend $\alpha$ to learn $\bar{v}$ only if its ex ante expected profit from participating in the action exceeds the cost $\alpha$:

\[(1 - p)\Pi_H \geq \alpha \quad (1)\]
We denote with \( NP \subseteq [0,1] \times [0,1] \) the set of values for parameters \((\theta, p)\) such that equation (1) is not satisfied; that is the set \( NP \) represents the values for the parameter \( \theta \) and the prior belief \( p \) that induce \( PE \) not to spend \( \alpha \) and thus to abstain from bidding. The following Proposition describes \( NP \):

**Proposition 1:** \( \theta = 0 \): In the private value case \( PE \) does not participate in the auction when \( p \) is large, i.e. when it is sufficiently likely that restructuring will not increase the value of the asset.

\( \theta = 1 \): In the common value case the \( PE \) does not participate in the auction when \( p \) is close enough to 0 or to 1, i.e., when the uncertainty of the intrinsic value of the asset is low.

\( 0 < \theta < 1 \): The thresholds of \( p \) delineating \( NP \) are a continuous and monotonic function of \( \theta \).

The shaded area in Figure 1 illustrates the participation region for a numerical example.\(^5\) A prior belief of \( p \) close to 1 indicates that \( \bar{v} \), the value of the asset to \( PE \), is most probably \( v_L \); hence, an investment of \( \alpha \) by \( PE \) is not justified. In the common value case, \( PE \) will also not participate in the auction when \( p \) is close to 0, indicating that the asset’s expected intrinsic quality \( \bar{v} \) is sufficiently high. To understand this result note that for \( \theta \) close to 1, \( \bar{v} \) directly affects the valuation of all strategic bidders. Thus, when \( p \) is small, strategic bidders have a strong prior belief that the asset’s intrinsic quality is high. Hence, they bid more aggressively compared to when they are less optimistic about the asset’s quality. Thus, when \( p \) is close to 0, strong competition from strategic bidders reduces the profit that \( PE \) expects to obtain from participating in the auction, which deters the investment of \( \alpha \). In other words, for \( \theta \) close to 1, \( PE \) does not participate in the auction when the ex ante uncertainty on the common value component \( \bar{v} \) is small.

In general, in the absence of \( PE \), the competition resulting from the strategic bidders reduces to
a standard first-price sealed-bid auction where bidders’ valuations for the asset are independently and identically distributed. The following proposition can be obtained from applying well-known results in auction theory (see the Appendix):

**Proposition 2:** If \((\theta, p) \in NP\), then there exists a symmetric equilibrium in which a strategic bidder with synergy \(x\) bids

\[
C(x) := v_L + \theta(1-p)(v_H - v_L) + x - \int_0^x \left( \frac{F(z)}{F(x)} \right)^{N-1} dz \tag{2}
\]

Consider now the case where \((\theta, p) \notin NP\). In this instance \(PE\) learns \(\bar{v}\) and participates in the auction with positive probability. The following proposition provides a qualitative description of the equilibrium bidding strategies for this case. A formal description of the bidding function is provided in the Appendix.

**Proposition 3:** If \((\theta, p) \notin NP\), then there exists a continuously increasing function \(c : [0, x_H] \to \mathbb{R}\), a cumulative density function \(G : [0, x_H] \to [0, 1]\) and \(x \in [0, x_H]\) such that:

(i) A strategic bidder with synergy \(x\) bids \(c(x)\);

(ii.a) \(PE\) invests \(\alpha\) to learn \(\bar{v}\) with probability \(1 - G(x)\);

(ii.b) If \(PE\) learns that \(\bar{v} = v_L\), then its bid is \(c_{PE} = v_L\);

(ii.c) If \(PE\) learns that \(\bar{v} = v_H\), then its bid follows the mixed strategy with support \([c(x), c(x_H)]\) and distribution

\[
Pr(c_{PE} \leq c(x)) = G(x) \text{ for all } x \in [\underline{x}, x_H].
\]

The equilibrium of Proposition 3 is symmetric in the sense that two strategic bidders with the same level of synergies will bid the same amount. \(PE\) invests \(\alpha\) with some positive probability,
possibly one, and its bidding strategy depends on \( \bar{v} \). If after spending \( \alpha \) PE learns that \( \bar{v} = v_L \), then the best it can do is to bid the reserve price \( v_L \) and realize zero profit. If \( \bar{v} = v_H \), PE bidding strategy involves randomization of the bid on the support \([c(\bar{x}), c(x_H)]\), where \( \bar{x} \in (0, x_H) \) and is itself part of the equilibrium characterization. When PE learns positive information about the asset, it will certainly beat bidders that have synergies smaller than \( \bar{x} \) but there is also a positive probability that it will beat strategic bidders with stronger synergies.

To summarize, we can distinguish three different regimes depending on the values of parameters \( \theta \) and \( p \). First, when \( (\theta, p) \in NP \), the expected PE gain from the auction is below \( \alpha \) and PE does not participate in the auction. In this case, a standard private values auction takes place among strategic bidders. Second, if the expected PE gain from the auction is strictly larger than \( \alpha \), then the PE gathers information on \( \bar{v} \) and participates (dark area in Figure 1). Third, when PE is perfectly indifferent between participating in the auction or not, PE gathers information and bids with some positive probability but not with certainty (shaded area in Figure 1). Note that because of the discrete distribution of \( \bar{v} \), whenever PE learns that \( \bar{v} = v_H \), its bid is the outcome of a mixed strategy. Of course the equilibrium entry probability of PE affects the equilibrium bidding strategy of strategic bidders.

2.2. Empirical implications

In addition to the analytical solution of the auction model presented in the previous subsection, our model also allows us to discriminate between the two hypotheses on the source of PE’s value gains, the private values and the common values cases. The intuition is that in the common values case, strategic bidders will bid more aggressively if they expect the high value \( v_H \) to arise with a large probability; this will raise the probability of a high bid by a winning strategic bidder,
and hence increases the seller gain when a strategic bidder wins relative to a winning bid by $PE$.

However, for the purpose of deriving testable predictions, we need to determine the average gains of sellers as a function of the realizations of the random variables $\tilde{v}$ and $x_i$. We use simulations since these averages cannot be sufficiently characterized in analytical form. We determine numerically the average levels of $\bar{x}$ and $\Pi_H$ in simulations of about 30,000 auctions, and we do so for different levels of the exogenous parameters $\theta$, $p$, and $F$. We assume that the bidding strategies are those provided in Propositions 2 and 3, depending on the values of $(p, \theta)$ being in $NP$ or not, respectively.\footnote{6}

The first goal is to determine whether the revenue to the seller and the seller’s market value change with the typology of the buyer (strategic buyer or private equity buyer). Since the magnitude of seller revenue is scaled by the level of $v_L$, we focus on the difference in the seller’s average revenue when the asset is sold to $PE$ versus a strategic buyer. As illustrated by the simulation results in Table 1, whether the seller gains are higher on average when selling to a strategic buyer or to $PE$ depends on the nature of $PE$ information. If $PE$ private information mainly reflects its ability to restructure the asset, that is, $\theta$ is close to 0, then the seller’s average revenue is higher when PE wins the auction relative to when a strategic buyer wins. In contrast, if $PE$ private information mainly reflects private information about the intrinsic quality of the asset, that is, $\theta$ is close to 1, the seller’s average revenue is higher when a strategic buyer wins the auction relative to when $PE$ wins.

Consider the restructuring case (i.e., $\theta$ close to 0). $PE$ will participate in the auction when it believes that restructuring will improve the value of the asset (i.e., when $p$ is not close to 1, as illustrated in Figure 1). Strategic bidders and $PE$ compete on the basis of their independently distributed private values. Thus, strategic bidders value the asset on the basis of their operating
synergies with the asset whereas PE values the asset because of its restructuring ability. When $\bar{v} = v_H$, the value PE can generate from the asset is similar to the value generated by a strategic bidder with a high level of operating synergies. Thus, the average revenue that is paid to the seller when PE wins exceeds what is paid when strategic bidders win.

In the intrinsic value case (i.e., $\theta$ close to 1), several other factors enter the picture. One, when PE is expected to participate in the auction, the presence of a common value component privately known by PE means that strategic bidders face the winner’s curse, which has the effect of inducing less aggressive bids from both strategic bidders and PE. Two, PE will find it promising to participate in the auction only when strategic bidders are not too bullish about the intrinsic value of the asset. As shown in Proposition 1 and Figure 1, when $\theta$ is large and $p$ is sufficiently low, PE will not bid and thus strategic bidders will bid aggressively for two reasons: first, they believe that the intrinsic value of the asset is high and second, there is no winner’s curse to hamper their bids since PE does not enter the auction. As a result, strategic bidders will tend to win at high prices the auctions for assets that are already known to have high intrinsic value, while PE will tend to win, at relatively low prices, the auctions for assets that unexpectedly turn out to have high intrinsic values. Thus, on average, under the intrinsic value hypothesis, seller average revenue is lower when PE wins the auction relative to when a strategic bidder wins the auction, a pattern that is contrary to the case when the restructuring assumption applies.

Note that the change in market capitalization, that is, the excess return, of the seller at the announcement of an asset sale is directly related to the revenue from the sale. This discussion leads to the following empirical predictions.

**Implication 1** *(Seller returns from PE versus strategic buyers)*  In the restructuring case, the
seller’s excess return when PE buys the asset should be higher than the seller’s excess return from a strategic buyer. In the intrinsic value case, the seller’s excess return from a strategic buyer should be higher than the seller’s excess return from PE.

While Implication 1 is the main metric we will use to discriminate the private value assumption from the common value assumption, the model has other empirical implications that hold independently of the value of $\theta$. First, PE expected bids and profits are an increasing function of $v_H$, that is, PE valuation for the asset whenever its bid is above $v_L$. Also, Table 1 shows that seller revenue decreases with the parameter $p$. This effect results from two factors. In the restructuring case, the smaller $p$, the greater the probability that PE will participate in the auction. Thus, strategic bidders will bid more aggressively as they expect to face relatively aggressive PE bidding. As a result, seller revenue decreases with $p$. An increase in the weight of $\theta$ increases the sensitivity of the valuations of strategic bidders to the component $\bar{v}$ whose expected value decreases with $p$. Hence, in this case strategic bidders will also bid aggressively when $p$ is small. For assets that are sold to PE, a measure of $v_H$ and $(1 - p)$ is given by the increase in the value of the asset during the period the asset is under PE control. This leads to our second empirical implication:

**Implication 2 (PE performance and seller return)** In the case of a sale to PE, the seller’s return should be positively correlated with the increase in the value of the asset that occurs while it is under PE control.

Note also that strategic buyers are privately informed about the level of their industrial synergies, which assures them an information rent. In other words, the equilibrium expected profit of a strategic buyer is positive. The magnitude of this profit, however, depends on the level of
competition in the auction and the size of industrial synergies compared to PE valuation for the asset. This leads to a third empirical implication.

**Implication 3 (Strategic buyers return)** On average strategic buyer excess returns are non-negative.

A similar argument applies to PE with the noticeable difference that the information rent gained in the auction must compensate for the cost $\alpha$ that PE incurs to become privately informed about $\bar{v}$. In other words, the model predicts that the PE equilibrium expected payoff contingent on participating in the auction must be at least $\alpha$. Not surprisingly, the simulation results show that average PE profit exceeds the average profit to synergistic buyers. This leads to our fourth empirical implication:

**Implication 4 (PE buyer return)** On average the return to PE buyers is strictly positive and larger than the return to strategic buyers.

3. Sample

We obtain corporate sales of operating assets from the SDC Acquisition Database for 1994 through 2004. We confirm that each event is an asset sale, and obtain the initial announcement date and relevant data about each transaction from several sources, including SEC filings, Factiva, Lexis-Nexis, the Wall Street Journal, and Standard and Poor’s Stock Reports, Stock Guide, and Directory of Corporations. Sub-samples are categorized by type of buyer; namely, private equity, public operating firms, and private operating firms. We require that the asset sold is an operating business, wholly owned by a public (CRSP) firm that is not in bankruptcy or divesting the asset due to a regulatory or judicial mandate, and that the transaction transfers the seller’s full ownership
of the asset to the buyer. Portfolios of financial securities, real estate assets, patents and licenses, and related transactions that entail the transfer of property rather than an operating business are excluded. The identity of the acquirer and terms of the transaction must be publicly reported. To minimize reporting bias, the minimum transaction price is $100 million, a condition that increases the probability that an asset is of sufficient size and stature to be material, and that for sales to private equity buyers, is likely to warrant sufficient subsequent interest from the business press to generate coverage of the type and date of the transaction by which the original private equity buyer exits its investment.

The final sample consists of 146 deals with private equity buyers, 287 deals with publicly traded strategic buyers, and 48 deals with private strategic buyers. Of the private equity deals, 108 have a subsequent exit; 38 are still private and controlled by the original private equity firm. We note that 22 of the 38 deals occur in 2004 or near-end 2003. Descriptive statistics for the three buyer samples are reported in Table 2. Dollar values are reported in constant (1997) dollars. These asset sales are major transactions for seller firms with an average (median) value of $398 ($212) million for sales to private equity buyers, PE, $644 ($255) million for sales to public strategic buyers, SAS, and $308 ($222) million for sales to private strategic buyers, SPAS. None of the differences in means (medians) is statistically significant, and the median transaction values are almost identical for the three subgroups, suggesting that private equity has been an effective competitor in large asset deals. The mean (median) market capitalization of sellers is $22 ($4.6) billion, $21 ($5.2) billion, and $8 ($2.6) billion for deals with private equity buyers, public strategic buyers, and private strategic buyers, respectively, and for public buyers it is $22 ($2.7) billion. The median ratios of transaction price to seller market value are of similar magnitude in the three samples. A broad
range of industries is represented in each sample, given 105, 156, and 38 different 4-digit SIC codes for the assets sold.

4. Empirical Results

4.1 Valuation effects of corporate asset sales

In Table 3, market model two-day average excess returns, proportion of returns positive, and median returns at the asset sale announcement are reported. For asset sales to public strategic buyers, the average excess return to sellers is significantly positive, 1.25%, t-statistic of 6.10 (median of 0.27%), and is similar to results reported in prior studies such as Jain (1985), Hite, et al. (1987), John and Ofek (1995), Sicherman and Pettway (1992), and Hege, et al. (2009). Since the ratio of sale price to seller market capitalization has considerable variance, we also report the median transaction return, 2.85% (p=0.29), calculated as the change in seller firm value scaled by deal size, which provides a metric for the economic importance of seller gains generated by these transactions. Thus, on average, the market views this set of asset sales as having positive net present value for sellers, but the typical change in seller value is small relative to the size of the asset and is well below the premiums of 25% or more that are observed for target firms in studies of mergers.

For asset sales to private strategic buyers, the average excess return to sellers is positive, 0.95%, t-statistic of 2.19 (median is 0.46%), and is not significantly different from the results for public buyers. The median seller transaction return, 3.68%, also closely parallels deals with public buyers.

For assets acquired by private equity buyers, the average excess return to sellers is positive and large, 3.78%, t-statistic of 12.42 (median of 2.06%), and the proportion of returns positive is 82%. Both the mean and median returns are significantly greater than returns to sellers in deals with public buyers (p=0.00), and private operating firms (p=0.01). Thus, sellers receive significantly
greater excess returns in deals with private equity buyers than with public or private operating firms. Similarly, the median seller transaction return, 22.25% (p=0.00), is significantly greater than the comparable returns for public and private operating firms (p=0.00). Overall, this pattern of significantly greater seller returns in private equity deals matches the simulation results generated by our theoretical model when private equity’s information relates to its restructuring abilities. Thus, within the context of our auction-based theory, the event study evidence is consistent with a private values format for private equity.

Our finding of greater returns to sellers at sales to private equity buyers runs counter to Bergeron, et al. (2008) who report greater gains (premiums) to merger targets that are acquired by public firms rather than private equity. They ascribe their results to overbidding that reflects agency problems at public acquirers; alternatively, their results are consistent with an auction with a common values format. However, we find positive average returns to public strategic buyers in assets sales, 0.48%, t-statistic of 3.10 (median of 0.33%), implying that public buyers extract a rent for their private information about expected synergies and that their acquisition behavior is not characterized by overbidding or driven by agency problems such as hubris or empire building as discussed in the merger literature (Thaler (1988); Barberis and Thaler (2003); Baker, Ruback, and Wurgler (2007).

To assess whether bids by private equity could reflect common value information, we examine share price responses of public firms whose activities are similar to the asset being sold. If an asset sale conveys common value information and if such information has industry common elements, then share prices of public firms in the same industry as the asset should increase at the sale announcement. We identify CRSP firms with the same 4-digit SIC code as the divested asset, use

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these firms to construct an industry portfolio for each event (equally weighting rival firms per event), and obtain the average portfolio excess return over all of the events in each sample. The share price effects on industry rivals for each of the three sets of asset sales are small and not significant. Thus, an asset sale announcement does not affect the value of other firms in the same industry, implying that there is little industry common information conveyed by the sale, irrespective of the type of buyer. This finding supports the conclusion that the sale of an asset to a private equity buyer is consistent with a private values format.

4.2. Cross-sectional regression analysis

While seller gains are consistent with the results generated by our theory when a private values approach is used to explain the bidding behavior of private equity, we also test whether there are seller and asset characteristics that might explain why sellers fare so well in deals with private equity buyers relative to strategic buyers. We estimate cross-sectional regressions in which the dependent variable is either the transaction return or the excess return to sellers. In each regression, we include two qualitative variables for the type of buyer. One variable takes on the value of unity for private equity transactions and zero otherwise, and a second variable takes on the value of unity for sales to private strategic buyers and zero otherwise. If characteristics of the seller or the asset can explain the differences across seller returns, the qualitative variable for private equity should not be statistically significant. We test an array of independent variables, but in the interests of economy of presentation, we report only a subset of results that are representative of a large set of alternative specifications. For brevity, we discuss only the transaction return regressions since the excess return results are broadly similar.

In each specification the qualitative variable for private equity is large and significant, suggesting
that the finding that sellers obtain greater gains in deals with private equity buyers is robust with respect to the inclusion of other variables. Overall, we find no evidence that the greater gains to seller firms in private equity deals are related to seller or asset characteristics, and such variables provide modest explanatory power once the type of buyer is specified.

Among the seller variables reported in Table 4 are the size of the transaction relative to enterprise value, market capitalization, prior cumulative stock price performance, operating performance (ROA), market to book ratio, insider holdings, and a qualitative variable for the use of proceeds (equal to one when proceeds are used to reduce debt or repurchase equity rather than retained).

Other seller variables tested and found to be not statistically significant (not reported in the table) are leverage, dividend payout, time listed on CRSP, growth in intangible assets and R&D, and various alternative measures of size and capital structure. We also tested variables that gauge focus, complexity, and opacity, including whether the asset has a similar SIC code to that of the parent (or to the buyer when it is a public firm), the number of seller business segments, the relative importance of the segment in which the asset is sold, and whether the seller is a conglomerate, but found that these variables have little effect on the pattern of returns.

We also included variables for buyer insider ownership for deals with public acquirers. Lewellen, et al. (1989) suggest that high insider ownership mitigates agency problems at buyers, and Bargeron, et al. (2008) report greater returns to targets acquired by public acquirers with low insider ownership. However, we find that insider buyer ownership does not affect returns to sellers of assets (not reported in the table).

We address the issue of whether higher seller returns in private equity deals are related to financial market conditions. For example, private equity may be able to benefit from market
timing opportunities, given the cycle in private equity funding, and evidence that well-established private equity funds benefit from market fluctuations (Gompers and Lerner, 1998; Gompers, et al. 2008; Ljungqvist, et al. 2006). We tested variables that reflect the state of financial markets at the time of a deal announcement. Variables for the state of the equity market include 1-year and 3-year lagged performance of the S&P500 index and the Nasdaq, S&P500 operating performance, and dividend yields; for debt markets, the bond term spread and the corporate credit spread; for exit markets, Fama-French book-to-market ratio, number of IPOs, IPO first-day returns, and percentage of positive IPO first-day returns; and for the relationship of capital supply and capital disbursements in the private equity industry, capital raised but not yet invested by funds over the past five years. The regression results reported in Table 4 are robust with respect to the inclusion of all of these variables, with the qualitative variable for private equity deals remaining consistently, highly significant.

4.3. Exit transactions for private equity deals

Our auction model implies that private equity bids communicate private information about expectations about future payoffs. Since the change in seller market value at the sale announcement reflects the difference between the price paid to the seller and the market’s prior assessment of the asset’s value to the seller, seller gains should be related to private equity’s expectations about its ability to generate value and exit the investment successfully. Thus, if ex post realizations and ex ante expectations are related, seller returns should be related to the type of exit and the ex post gains in asset enterprise value.

We test this prediction by investigating the subsequent status of the entities acquired by private equity. Because our sample includes all eligible operating assets sold by public corporations from
1994 through 2004, our findings about subsequent outcomes should not be subject to selection bias. Once acquired by private equity, these businesses are not public firms and thus there is little systematic disclosure about their performance or capital structure, although the limited reporting available in public databases suggests that most of these entities are highly levered during the period of private equity ownership.

As reported in Table 5, the average time to exit is 3.1 years, indicating that private equity ownership is typically of modest duration. The largest category of exits, 41, consists of IPOs completed, on average, in 2.13 years. There are 33 sales to strategic buyers, which also occur quickly, in 3.02 years. The 20 secondary buyouts (sales to other private equity interests) occur after 4.83 years, significantly longer than for IPOs and strategic asset sales (p=0.00). This result suggests that secondary buyouts are likely to be regarded as less successful outcomes, or perhaps cases of incomplete restructuring. There are 14 asset sales that culminate in a Chapter 11 filing (none prepackaged), after an average of 3.66 years.

We calculate the enterprise value, that is, the market value of equity plus the book value of its debt, of the entity at exit and compare this value to the original asset sale price. This difference measures the ex post (annualized) rate of increase in enterprise value of the entity during the period of private equity ownership. Although this metric does not provide a direct measure of the profitability of the deal for the fund investors in private equity, it provides a useful gauge of the economic performance of the unit while under private equity ownership and allows us to test the prediction of our model that transactions that culminate in an IPO or a strategic asset sale should generate greater gains to the original selling firm than assets that exit via a secondary buyout or bankruptcy filing.
The mean (median) annual growth rate in enterprise value for the 108 transactions with an exit is 54.72% (24.07%). As a benchmark, we measure the annual growth rate in enterprise value for public firms that have the same 4-digit SIC code and have the closest enterprise value to the original asset sale price. The average (median) annual growth rate in enterprise value for benchmark firms is 23.52% (6.32%) and the difference in means (medians) between sample and benchmark firms, Excess EV, is statistically significant, p=0.00 (p=0.00), indicating that entities under private equity ownership achieve considerable business success relative to public benchmarks. This evidence is consistent with the view that private equity possesses valuable business skills. At the same time, there is a high correlation, 0.74, between changes in enterprise value at sample entities and benchmark firms, suggesting that ex post the degree of private equity's success is correlated with industry developments.

We disaggregate the gain in enterprise value by type of exit. Entities that enter Chapter 11 retain very little value, given an average (median) annual decline in enterprise value of -34.09% (-27.35%). Moreover, these 14 filings exceed the six filings by benchmark firms (p=0.06). In principle, private ownership of an asset could still increase the enterprise value of a unit despite a bankruptcy filing in the case of a sustainable business that becomes overlevered, a difficulty that can be rectified by a reorganization negotiated between equity holders and creditors, either through a prepackaged bankruptcy or under the guidance of a bankruptcy judge. Our sample of bankrupt entities, however, consists almost entirely of failed businesses. In ten of the 14 cases, the business is liquidated with only minimal payments made to unsecured creditors, and equity is cancelled (no payment to private equity). In three cases, a reorganized entity emerges, but almost all enterprise value is lost, with unsecured creditors absorbing large losses and equity interests cancelled. In only
one case is there a reorganization in which some of the interests of the private equity holders are conveyed to debtholders, allowing the firm to emerge from bankruptcy with a less levered capital structure. We conclude that for assets sold to private equity, a bankruptcy filing occurs after almost complete business failure, resulting in the loss of the stake held by private equity as well as large losses to unsecured creditors.

The systematic pattern to the business success achieved by type of outcome suggests a pecking order for the type of exit with respect to the gain in enterprise value. The highest mean (median) annual rate of growth in enterprise value occurs for the IPO group, 111.52% (43.64%), and is significantly greater than the growth rates of their benchmark firms, indicating the success of private equity management. The next highest mean (median) annual growth rate is for sales to strategic buyers, 40.65% (25.52%), also significantly greater than the benchmark growth rate. Although secondary buyouts can be viewed as a form of asset sale (except that the acquirers are other private equity firms rather than strategic buyers), their mean (median) annualized growth rate in enterprise value, 23.69% (12.69%), is significantly less than that of assets sold to strategic buyers (p=0.00). Thus, private equity is likely to view a secondary buyout as a relatively unfavorable business outcome. However, the growth rate is more favorable than benchmark firms.

The pattern of the growth in enterprise value for the benchmark samples shows the same rank order as the sample firms, with the highest growth rate for the benchmarks of IPOs and the poorest for benchmarks of assets that sustain bankruptcy. This evidence is consistent with the conclusion that industry developments are a factor in determining the success of a private equity deal. Nevertheless, for each outcome category, except for bankruptcies, the average (median) growth rate in enterprise value for assets acquired by private equity buyers exceeds that of benchmark
firms, indicating the ability of private equity to generate business improvements at the entities they acquire.

Consistent with our auction model, there is a relationship between the type of exit and seller excess (transaction) returns. Specifically, there are large statistically significant gains for sellers of assets that eventually exit private equity via an IPO or a strategic asset sale, with median transaction returns of 45.05% \( (p = 0.00) \) and 23.87% \( (p = 0.00) \), respectively. By contrast, there are only modest gains to sellers of assets that subsequently file bankruptcy, with a median transaction return of only 5.81%, not statistically significant \( (p = 0.22) \). These results indicate that when private equity expects to be able to generate only modest gains, it submits lower bids that reflect these modest expectations. The result is weaker gains to sellers. Median seller transaction returns when exit is via a secondary buyout are significantly positive, 16.80% \( (p = 0.00) \), which is smaller than seller gains when exit is by IPO or sale to strategic buyers, but greater than for assets that file Chapter 11. Thus, the pattern of seller gains parallels the changes in enterprise value.

As a further test, we estimate regressions in which the dependent variable is the excess growth rate in asset enterprise value (defined as the growth rate in the enterprise value of the asset minus the growth rate for its benchmark) as a function of seller transaction return. The results, reported in Table 6, show significant positive coefficients. Thus, the seller’s share price reaction at an announcement of a private equity deal provides a metric for the future success of the private equity investment. Similar results are obtained using a profitability index as the dependent variable. There is some evidence that deals conducted during the high tech bubble (1999-2001) generated lower subsequent gains in enterprise value. Although it is speculative to extrapolate, the relatively low announcement returns for sellers of assets that have not yet exited from private equity ownership
suggest reduced optimism about the future performance of these assets relative to earlier deals.

We estimate a binomial logit model of the relative success (IPO or asset sale) versus failure (bankruptcy or secondary buyout) of a private equity deal, where the value function for the logit is specified as a linear function of the seller’s transaction return. The coefficients provide an estimate as to how an increase in the seller’s transaction return affects the marginal likelihood that an asset sold to a private equity buyer will exit via an IPO or asset sale. Our theory predicts that a private equity bid, and in turn seller gains, convey information about expectations about future payoffs and private equity’s ability to exit the investment successfully. Consistent with this prediction, the seller transaction return is significant. Although a qualitative variable for the high tech bubble years is associated with a lower subsequent growth rate in enterprise value, it has a positive coefficient in the logit regression, suggesting that these deals were more likely to exit through IPOs and asset sales. There is no evidence that the success of a private equity deal is related to the size of the transaction. Overall, the logit results are consistent with a central implication of our theoretical model, namely, that a private equity buyer’s expectations about future payoffs affect its bidding for an asset, and in turn the gain to the selling firm.

5. Conclusions

In this paper we conduct a theoretical and empirical analysis of the participation of private equity firms in the competition for large corporate assets. We develop an auction-type model of bidding competition that integrates the bidding behavior of private equity interests with that of strategic buyers, providing a theoretical framework that conforms to the institutional and legal structure of the corporate asset sales market. Our findings suggest that there are important gains generated by the participation of private equity in the market for corporate assets, gains that reflect
its skill at restructuring and improving businesses.

Our auction model revolves upon the calculation as to whether it is in private equity’s interest to expend the resources needed to acquire the private information necessary to participate in the asset auction, and explains how the entry of private equity bidders interacts with the bidding behavior of strategic bidders. We show that competitive bidding conveys private information held by strategic buyers and private equity about the values they can expect to generate contingent on having control of the asset for sale. We show that the gains in seller wealth are affected by the type of bidder that acquires the asset and use simulations to generate testable predictions about the source of the gains in value generated by sales of assets to private equity.

We test the empirical implications of our model by analyzing of sales of corporate operating assets over the period 1994 through 2004. On average sellers earn large positive excess returns at sales of assets to private equity, gains that are significantly greater than returns sellers obtain from strategic (industry) buyers, regardless of whether the industry buyer is public or private. We also find that there are no intra-industry gains at news of corporate asset sales, irrespective of the type of buyer, so that the private information conveyed by a corporate asset sale is asset-specific rather than having industry-common elements. The pattern of our results leads us to conclude that it is private information about the potential to restructure an asset, a private value, that underlies the bidding behavior of private equity.

We evaluate the change in the enterprise value of the assets acquired by private equity over the period from its acquisition until the asset exits from the original private equity buyer’s ownership and we find that the annual growth rate in the enterprise value of these assets is significantly greater than that of firms that serve as benchmarks for the assets, suggesting the economic importance
of the business skills possessed by private equity. We also determine the disposition of the assets acquired by private equity. The preponderance of outcomes consists of IPOs and strategic asset sales, with a modest percentage of secondary buyouts (purchases by another private equity entity), and bankruptcies. We find that the seller’s return at the original asset sale announcement is directly related to the subsequent gain in enterprise value and to the form of exit from private equity, with the seller earning a significantly greater gain for an asset that exits by a sale to a strategic buyer or to the public via an IPO rather than a bankruptcy filing. Thus, private equity acquirers leave substantial money on the table for selling firms in the case of assets that prove to be a rich source of value for private equity.
Appendix

Proof of Propositions 1 and 2: It can be easily verified that $C(x)$ as defined in (2) is the symmetric equilibrium bidding function of the $N$ strategic bidders when the PE does not participate to the auction. In fact, in the absence of the PE, the competition among strategic bidders is equivalent to a first price private value auction where a strategic bidder with synergies $x$ values the asset $\theta E[\bar{v}] + (1 - \theta)v_L + x$ and synergies $\bar{x}_i$ are i.i.d.

Let $\Pi^*_N(p)$ be the PE’s expected gain from participating in the auction given first, that the strategic bidders do not anticipate that the PE will bid, and second, that $\bar{v} = v_H$. In this instance the $N$ strategic bidders adopt strategy $C(\cdot)$. Thus by unexpectedly participating to the auction, the PE can guarantee

$$\Pi^*_N(p) := F(x^*(p))^N(v_H - C(x^*(p)))$$

where $C(x^*(p))$ is the PE’s unexpected bid, with

$$x^*(p) := \arg \max_{y \in [0, v_H]} F(y)^N(v_H - C(y)).$$

Thus, if

$$(1 - p)\Pi^*_N(p) < \alpha,$$  \hspace{1cm} (3)

then it is optimal for the PE not to enter the auction.

The region $NP$ is defined by the values of $p$ and $\theta$ that satisfy inequality (3) while its frontier is given by the values of $p$ and $\theta$ such that $(1 - p)\Pi^*_N(p) = \alpha$.

**Remark 1:** The left hand side of (3) is continuous in $p$ and $\theta$.

**Remark 2:** Inequality (3) is always satisfied for $p$ close enough to 1. This because $\Pi^*_N(p)$ is bounded for all levels of $p$ and $\theta$.

**Remark 3:** If $\theta = 1$ and $p = 0$, then $\Pi^*_N(p) = 0$. This is because when $\theta = 1$ and $p = 0$, it results that $C(x) \geq v_H$ implying that a strategic bidder’s bid will always be above the PE’s asset valuation.

**Remark 4:** $\Pi^*_N(p)$ is increasing in $p$ and decreasing in $\theta$. To see this point, note first that $x^*(p)$ is equal to the $y \in (0, x_H)$ that solves the first order condition

$$1 - \theta(1 - p)(v_H - v_L) + \frac{1}{N} \int_0^y \left( \frac{F(z)}{F(y)} \right)^{N-1} dz - y = 0,$$  \hspace{1cm} (4)

whenever such $y$ exists. If (4) has no interior solution then $x^*(p) = x_H$. If $x^*(p) \in (0, x_H)$, i.e. in case of the interior solution, then by differentiating (4) with respect to $p$ and with respect to $\theta$, we conclude that $x^*(p)$ is increasing in $p$ and decreasing in $\theta$. Using (4), evaluated at $y = x^*(p)$, to rewrite $\Pi^*_N(p)$ results in

$$\Pi^*_N(p) = \frac{N - 1}{N} F(x^*(p)) \int_0^{x^*(p)} \left( \frac{F(z)}{F(x^*(p))} \right)^{N-1} dz$$

that is increasing in $x^*(p)$, and hence increasing in $p$, and decreasing in $\theta$. If $x^*(p) = x_H$ then

$$\Pi^*_N(p) = (v_H - v_L)(1 - \theta(1 - p)) - x_H + \int_0^{x_H} F(z)^{N-1} dz$$

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that is non-decreasing in $p$ and non-increasing in $\theta$.

Remarks 2-4 imply that the left hand side of (3) is less than $\alpha$ for $p$ large, it is maximal for $\theta = 0$ and $p = 0$ and it is nil for $\theta = 1$ and $p = 0$. Then, Proposition 1 follows from Remark 1.

**Proof of Proposition 3:** In order to have the a formal description of the equilibrium outlined in Proposition 3, we need first to detail the functions $c(.)$ and $G(.)$:

$$c(x) := \begin{cases} \frac{\theta(1-p)G(x)(v_H - v_L)}{p + (1-p)G(x)} + v_L + x - \int_{x_L}^{x} \left( \frac{F(z)}{f(z)} \right)^{N-1} \, dz & \text{for } x \in [0, x_L] \\ v_H - \frac{\Pi_H(x)}{f(x)} & \text{for } x \in [x_L, x_H] \end{cases}$$  \hspace{1cm} (5)

$$G(x) := \begin{cases} 0 & \text{for } x < 0 \\ 1 - \int_{x}^{x_H} \Phi(t, \Pi_H(x)) \, dt & \text{for } x \in [0, x] \\ 1 - \int_{x}^{x_H} \Phi(t, \Pi_H(x)) \, dt & \text{for } x \in [x_l, x_H] \\ 1 & \text{for } x > x_H \end{cases}$$  \hspace{1cm} (6)

where

$$\Phi(t, \Pi) := \frac{p f(t)}{(1-p)f(t)} \left( \frac{-\Pi + (1-\theta)(v_H - v_L) - z (n-1) \Pi f(t)}{\Pi + (1-\theta)(v_H - v_L) - z (n-1) \Pi f(t)} \right)^N \exp \left( \int_{x}^{x_H} \frac{f(z)}{f(t)} \frac{\Pi + (1-\theta)(v_H - v_L) - z (n-1) \Pi f(t)}{\Pi + (z - (1-\theta)(v_H - v_L)) f(t)} \, dz \right)$$

In the first part of the proof we show that for such functions $c(.)$ and $G(.)$ the strategy profile described in Proposition 3 forms an equilibrium when

$$\Pi^*_H(p) \geq \alpha.$$  \hspace{1cm} (7)

Lemma 1 completes the proof by showing that there exists $x \in [0, x_H]$ such that inequality (1) and $G(x) \geq 0$ are both satisfied and at most one of these two inequalities is strict. Recall that $G(x)$ is the equilibrium probability that PE does not enter the auction and hence it must be non-negative. If the expected payoff from learning $\tilde{v}$ is strictly larger than its cost $\alpha$, the PE strictly prefers to learn $\tilde{v}$ and hence $G(x) = 0$. However, when $G(x)$ is positive but less than one, the PE will either learn $\tilde{v}$ or not with positive probability, and this is optimal only if the PE is indifferent between entering the auction or not, i.e., when the participation constraint (1) is binding.

We first show that bidding $c(x)$ is a best reply for a strategic bidder with synergies $x$ when the other strategic bidders bidding function is $c(.)$ and the PE strategy is the one described in the Proposition. Note that $c(x)$ is increasing and that the expression of $\Pi_H$ guarantees that $c(x)$ is continuous on the entire interval $[0, x_H]$. 

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We will denote with $\pi(x, y)$ the expected payoff of a strategic bidder with synergies $x$ when it bids $c(y)$. We shall show that $\pi(x, y)$ is maximized for $y = x$. Given the structure of the PE bidding strategies, we have to distinguish two cases.

First, suppose the bidder bids $c(y)$ with $y \in [0, x]$. Then, if $\tilde{v} = v_H$, it results $c_{PE} > c(y)$ with probability $1 - G(x)$, i.e., the probability that the PE decides to learn $\tilde{v}$. Therefore the strategic bidder will beat the PE with probability $G(x)$. However, if $\tilde{v} = v_L$, the strategic bidder will surely beat the PE as the latter either does not participate or it bids $c_{PE} = v_L < c(y)$. In order to win the auction however the bidder has also to beat the other strategic bidders and this happens if the highest of the competitors’s synergies is not larger than $y$. Thus, the bidder expected payoff is

$$\pi(x, y) = p(v_L + x - c(y))F(y)^{N-1} + (1 - p)G(x)(\theta(v_H - v_L) + v_L + x - c(y))F(y)^{N-1}$$ \hspace{1cm} (8)

Second, suppose the bidder bids $c(y)$ with $y \in [x, x_H]$. Then, when $\tilde{v} = v_L$, the bidder will win if the highest of the competitors’s synergies is not larger than $y$. However, if $\tilde{v} = v_H$, in order to win, the strategic bidder will also have to bid more than the PE and this occurs with probability $G(y)$. Thus the bidder expected payoff is

$$\pi(x, y) = p(v_L + x - c(y))F(y)^{N-1} + (1 - p)G(y)(\theta(v_H - v_L) + v_L + x - c(y))F(y)^{N-1}$$ \hspace{1cm} (9)

The first order condition is $\frac{\partial\pi(x, y)}{\partial y}|_{y=x} = 0$. For $x \in [0, x]$, the relevant first order condition is the one derived from differentiating the right hand side of (8):

$$\left.\frac{\theta(1-p)G(x)(v_H - v_L)}{p+(1-p)G(x)}+v_L+x-c(y)\right\}F(y)^{N-1}\bigg|_{y=x} = 0$$

This leads to a differential equation in $c(x)$ whose solution together with the transversality condition $c(0) = \theta(1-p)G(x)(v_H - v_L) + v_L$ provides the expression for $c(x)$ that is given in (5) for $x \in [0, x]$. 8

The relevant first order condition for $x \in [x, x_H]$ is the one obtained by differentiating expression (9) and keeping in mind that $c(y) = v_H - \frac{\Pi_H(x)}{F(x)}$ for $y \in [x, x_H]$:

$$\left.\frac{\partial}{\partial y} \left[pv_L + (1 - p)G(y)(\theta(v_H - v_L) + v_L) + \left( x - v_H + \frac{\Pi_H(x)}{F(x)} \right) (p + (1 - p)G(y))F(y)^{N-1} \right] \right|_{y=x} = 0$$

This leads to the following differential equation in $G(x)$:

$$\frac{(1-p)F(x)}{f(x)} \left( \Pi_H(x) + (x - (1 - \theta)(v_H - v_L)) F(x)^N \right) G'(x) = (1 - p) \left( \Pi_H(x) + (n - 1) ((1 - \theta)(v_H - v_L) - x) F(x)^N \right) G(x)$$

$$+ \left( \Pi_H(x) + (n - 1)(v_H - v_L - x) F(x)^N \right) \left( \Pi_H(x) + (n - 1)(v_H - v_L - x) F(x)^N \right)$$ \hspace{1cm} (10)

This equality is a necessary condition on the mixed strategy $G$ used by the PE to induce a strategic bidder with synergies $x \in [x, x_H]$ to bid $c(x) = v_H - \frac{\Pi_H(x)}{F(x)}$. Direct substitution of the expression of $G$ given in (6) shows that differential equation (10) is satisfied.
In order to prove the second order condition, we show that the bidder’s objective function is pseudoconcave, i.e. \( \partial^2 \pi(x, y)/\partial xy \geq 0 \). Using expression (8) we obtain \( \partial^2 \pi(x, y)/\partial xy = (N-1)f(y)F(y)^{-2} > 0 \). Expression (10) provides \( \partial^2 \pi(x, y)/\partial xy = (N-1)(p + (1-p)G(y)) f(y)F(y)^{-2} + (1-p)G'(y)F(y)^{-1} > 0 \).

Consider now \( y < x \), then \( \partial^2 \pi(x, y)/\partial xy > 0 \) implies \( \partial \pi(x, y)/\partial y > \partial \pi(y, y)/\partial y = 0 \), which means that \( \pi(x, y) \) is increasing for \( y < x \). Similarly, for \( y > x \) we have \( \partial \pi(x, y)/\partial y < \partial \pi(y, y)/\partial y = 0 \), which implies that \( \pi(x, y) \) is decreasing for \( y > x \).

We turn now to the PE’s best reply to strategic bidders bidding strategy. We will denote with

\[
\pi_{PE}(v, y) = (v - c(y)) F(y)^n
\]

the PE expected payoff from bidding \( c(y) \) when \( \bar{v} = v \), where \( c(y) \) is the equilibrium bid of a synergistic buyer with synergies \( y \). Note that \( \pi_{PE}(v, y) \) is a continuous function in \( y \) because of the continuity of \( c(y) \).

Considering that \( c(y) \geq v_L \), it follows that \( \pi_{PE}(v_L, y) \) is maximized for \( c_{PE} = c(0) = v_L \). When \( v = v_H \), we have to distinguish three cases. First, for \( y \in [0, x] \), it results that

\[
\pi_{PE}(v_H, y) = \frac{F(y)}{p + (1-p)G(z)} \pi(v_H - v^*, y)
\]

where \( v^* := \frac{pwL + (1-p)G(z)(\theta(c(v_H - v_L)) + v_L)}{p + (1-p)G(z)} \) and \( \pi(.) \) is given by expression (8). We know from the first part of the proof that \( \pi(x, y) \) is increasing in \( y \) for \( y < x \). If \( G(z) = 0 \), then \( v^* = v_L \). But as \( y \leq z < x < v_H - v_L \), it follows that \( \pi_{PE}(v_H, y) \) is increasing for \( y < x \). Consider now \( G(z) > 0 \). Note that \( \partial \pi_{PE}/\partial y \geq 0 \) if

\[
y \leq (v_H - v^*) + \frac{1}{N} [ F(z) F(y) ]^{N-1} d\mu
\]

Since \( p(v_H - v_L) < (v_H - v^*) \), a sufficient condition is

\[
y \leq p (v_H - v_L) + \frac{1}{N} [ F(z) F(y) ]^{N-1} d\mu
\]

It can be easily verified that this inequality is met for \( y \leq x^*(p) \). Thus if \( v < x^*(p) \), then \( \partial \pi_{PE}/\partial y \geq 0 \) for \( y \leq x \). We will show in Lemma 1 that \( x < x^*(p) \) whenever \( G(z) > 0 \).

Second, for \( y \in [x, x_H] \), direct substitution of \( c(y) \) leads to \( \pi_{PE}(v_H, y) = \Pi_H(z) \). Third, when \( c_{PE} > c(x_H) \), the PE payoff is clearly decreasing in \( c_{PE} \) as the PE has no interest in bidding strictly more than the highest possible bid from competitors.

It remains to determine \( x \) such that the PE’s participation constraint (1) is satisfied and the probability that the PE learns \( \bar{v} \) is not larger than 1 (i.e. \( G(z) \geq 0 \)). This will also provide the transversality condition for differential equation (10).

We shall show that

**Lemma 1**: There always exists \( x \in (0, x_H] \) such that both inequality (1) and \( G(z) \geq 0 \) are satisfied but at most, one is strict. If \( G(z) > 0 \), then \( x \in (0, x^*(p)) \).
Proof: Let \( \hat{x} \) be such that

\[
\hat{\Pi}_H(\hat{x}) := F(\hat{x})^N \left( v_H - v_L - \hat{x} + \int_{0}^{\hat{x}} \left( \frac{F(z)}{F(x)} \right)^{N-1} dz \right) = \alpha/(1-p)
\]

Considering that \( \hat{\Pi}_H(x) \geq F(x)^N (v_H - C(x)) \), condition (7) implies \( \hat{\Pi}_H(x^*(p)) > \alpha/(1-p) \). From \( F(0) = 0 \), it follows that \( \hat{x} \) exists and is between 0 and \( x^*(p) \). Consider the expression

\[
\tilde{G}(x) := 1 - \int_{x}^{x_H} \Phi(t, \hat{\Pi}_H(x)) dt
\]

The function \( \tilde{G}(x) \) is continuous and reaches 1 for \( x = x_H \). Thus, if \( \tilde{G}( \hat{x} ) \leq 0 \), then there exists \( \tilde{x} \) between \( \hat{x} \) and \( x_H \) such that \( \tilde{G}(\tilde{x}) = 0 \). Moreover, as \( \hat{\Pi}_H(x) \) is increasing and \( \tilde{x} \geq \hat{x} \), we have \( (1-p)\hat{\Pi}_H(x) \geq \alpha \). This implies that when choosing such a level of \( \tilde{x} \), it results that \( G(\tilde{x}) = \tilde{G}(\tilde{x}) = 0 \) and \( (1-p)\Pi_H(x) = (1-p)\hat{\Pi}_H(x) > \alpha \).

Suppose now that \( \tilde{G}(\tilde{x}) > 0 \). Let \( \tilde{G}(x) \) solves

\[
F(x)^N \left( v_H - v_L - \theta \frac{(1-p)\tilde{G}(x)(v_H - v_L)}{p + (1-p)\tilde{G}(x)} - x + \int_{x}^{\tilde{x}} \left( \frac{F(z)}{F(x)} \right)^{N-1} dz \right) = \alpha/(1-p)
\]

Clearly \( \tilde{G}(\hat{x}) = 0 \) by definition of \( \hat{x} \). Moreover from condition (7) we deduce that \( \tilde{G}(x^*(p)) > 1 \). Define now

\[
\overline{G}(x) := 1 - \int_{x}^{x_H} \Phi(t, \alpha/(1-p)) dt
\]

and note that \( \overline{G}(x_H) = 1 \) while by definition of \( \hat{x} \), \( \overline{G}(\hat{x}) = \tilde{G}(\hat{x}) > 0 \). Considering that both \( \overline{G} \) and \( \tilde{G} \) are continuous, we can conclude that there exists \( \overline{x} \in (\hat{x}, x^*(p)) \) such that \( \overline{G}(\overline{x}) = \overline{G}(\overline{x}) \in (0,1) \). By selecting such \( \overline{x} \) for the equilibrium, we obtain \( (1-p)\Pi_H(x) = \alpha \) and \( G(\overline{x}) = \overline{G}(\overline{x}) \in (0,1) \). □

This concludes the proof Lemma 1 and hence of Proposition 3. ■
Footnotes

1 Eckbo and Thorburn (2008) report that on average asset sales make up 38% of all merger and acquisition transactions over the period from 1970 to 2006.

2 The laissez-faire approach of corporate law to asset sales is justified since both seller and buyer managers continue to operate subject to the discipline and monitoring of financial markets so that the concern about final period problems that pervades the legal treatment of mergers is not applicable to asset sales (Gilson, 1981).

3 Provided that private equity firms share similar characteristics so that they have similar valuations of the asset for sale, more than one PE bidder would not change the equilibrium.

4 In practice, asset sales are typically conducted in private and do not require any public disclosure or registration of information. To reflect this institutional setting, we assume that bidders do not know their competitors’ bids when submitting their offers. Thus, we model asset sales as a first-price sealed-bid auction.

5 The specification of the model in Figure 1 is as follows: $v_L = x_L = 0$, $v_H = x_H = 1$, $N = 3$, $F(x_i) = x_i$, $\alpha = 0.035$.

6 For our simulations we assume that there are three strategic bidders participating in each auction ($N = 3$), we choose $F(x) = x^\gamma$ with $\gamma \in \{1/2, 1, 3/2\}$, we vary $(v_H - v_L) \in \{1, 5/4, 3/2\}$ and we set $\alpha = 0.035$.

7 For example, Kaplan (1989) has argued that Campeau’s acquisition of Federated Department Stores added value even though it ended in bankruptcy.

8 Note that this case is homeomorphic to a private value auction where strategic bidders with synergy $x$ values the asset $\theta \frac{1-p(\gamma)(v_H - v_L)}{p(1-p)G(x)} + v_L + x$ and synergies are i.i.d.

9 Note that $\Phi(x, \Pi_H(x)) > 0$ because $x \leq v_H - v_L$, thus $G'(x) > 0$ for $x \in [x_L, x_H]$.

10 In act $\hat{\Pi}'_H(x) = F(x)^{n-1} f(x) \left( n(v_H - v_L - x) + \int_0^x \left( \frac{F(z)}{F(x)} \right)^{N-1} dz \right)$ is positive because $x < v_H - v_L$. 

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References


The model: PEF participation region

- PEF does not invest α.
- PEF invests α with certainty.
- PEF invests α with positive probability.
Table 1
Results of simulations

Results of simulations of the auction of an asset to determine how the revenue to the seller of an asset and the seller’s market value change with respect to the type of buyer (strategic buyer versus private equity) and to the nature of private equity’s information. The table reports the average revenue to sellers and transactions returns (TR) to sellers and to buyers for 30,000 simulations of auctions with three strategic buyers and one private equity bidder (PE), for differing values of the parameters \( \theta \) and \( p \). The parameter \( \theta \) relates to the nature of private equity’s information, with \( \theta = 1 \) reflecting the common values format and \( \theta = 0 \) reflecting the private values format. The parameter \( p \) is the ex ante probability that the random variable \( v \), the value of the asset to private equity, is \( v_L \). Seller revenue is scaled by the level of \( v_L \).

<table>
<thead>
<tr>
<th></th>
<th>( \theta = 0 )</th>
<th>( \theta = 1/4 )</th>
<th>( \theta = 3/4 )</th>
<th>( \theta = 1 )</th>
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<td></td>
<td>PE</td>
<td>Strategic</td>
<td>PE</td>
<td>Strategic</td>
</tr>
<tr>
<td>Panel A. Seller average revenue</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>( p=0.25 )</td>
<td>1.19</td>
<td>1.12</td>
<td>1.27</td>
<td>1.33</td>
</tr>
<tr>
<td>( p=0.5 )</td>
<td>1.17</td>
<td>1.02</td>
<td>1.22</td>
<td>1.14</td>
</tr>
<tr>
<td>( p=0.75 )</td>
<td>1.16</td>
<td>0.50</td>
<td>1.17</td>
<td>1.01</td>
</tr>
<tr>
<td>All</td>
<td>1.18</td>
<td>1.03</td>
<td>1.23</td>
<td>1.15</td>
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</table>

Panel B. Seller and buyer average transaction return

<table>
<thead>
<tr>
<th></th>
<th>Seller TR</th>
<th>Buyer TR</th>
</tr>
</thead>
<tbody>
<tr>
<td>( p=0.25 )</td>
<td>0.70</td>
<td>0.35</td>
</tr>
<tr>
<td>( p=0.5 )</td>
<td>0.66</td>
<td>0.31</td>
</tr>
<tr>
<td>( p=0.75 )</td>
<td>0.71</td>
<td>0.31</td>
</tr>
<tr>
<td>All</td>
<td>0.72</td>
<td>0.26</td>
</tr>
</tbody>
</table>

\( \theta \) relates to the nature of private equity’s information, with \( \theta = 1 \) reflecting the common values format and \( \theta = 0 \) reflecting the private values format. The parameter \( p \) is the ex ante probability that the random variable \( v \), the value of the asset to private equity, is \( v_L \). Seller revenue is scaled by the level of \( v_L \).
Table 2
Descriptive statistics

Statistics for means, and medians in parentheses, are reported for cash asset sales of $100 million or more conducted by publicly traded sellers listed on NYSE/ASE/Nasdaq over the sample period 1994 through 2004 for firms, obtained from the SDC Acquisition Database. Transactions are disaggregated on the basis of the type of buyer into 287 asset sales to public traded strategic buyers (SAS), 48 asset sales to private operating firm buyers (SPAS), and 146 asset sales to private equity buyers (PE). The value of the transaction is reported in millions of constant (1997) dollars. Firm market value is calculated as the number of shares outstanding multiplied by stock price prior to the event announcement, and reported in millions of constant (1997) dollars.

<table>
<thead>
<tr>
<th></th>
<th>PE</th>
<th>SPAS</th>
<th>SAS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Seller</td>
<td>N=146</td>
<td>N=48</td>
<td>N=287</td>
</tr>
<tr>
<td>Buyer</td>
<td>N=287</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Transaction value ($1997,m)</td>
<td>397.90</td>
<td>308.12</td>
<td>643.73</td>
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<td></td>
<td>(211.81)</td>
<td>(222.25)</td>
<td>(255.00)</td>
</tr>
<tr>
<td>Market value ($1997,m)</td>
<td>21,694.95</td>
<td>7,817.36</td>
<td>20,721.6</td>
</tr>
<tr>
<td></td>
<td>(4,614.09)</td>
<td>(2,560.66)</td>
<td>(5,228.31)</td>
</tr>
<tr>
<td>Asset/MV</td>
<td>0.26</td>
<td>0.52</td>
<td>0.31</td>
</tr>
<tr>
<td></td>
<td>(0.07)</td>
<td>(0.09)</td>
<td>(0.07)</td>
</tr>
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</table>
Table 3

Empirical results for share price responses at asset sales

Empirical results are reported for excess returns at cash asset sales of $100 million or more conducted by publicly traded sellers listed on NYSE/ASE/Nasdaq over the sample period 1994 through 2004, obtained from the SDC Acquisition Database. The metrics are (Panel A) two-day (-1, 0) announcement cumulative excess returns (CARs) for sellers and for publicly traded buyers and (Panel B) two-day median transaction returns (TR), measured as the dollar gains in value scaled by transaction size. Excess returns and transaction returns in percent are in response to 146 asset sales to private equity firms (PE), 287 asset sales to publicly traded strategic buyers (SAS), and 48 asset sales to private operating firms (SPAS). To obtain rival CARs, CRSP firms with the same 4-digit SIC code as the asset are used to form an industry portfolio for each event (equally weighting rival firms per event), and then are averaged over all events. Combined returns weight the buyer and seller returns by market capitalization. Excess returns are calculated using market model methodology; t-statistics are in parentheses, proportion of returns positive is in brackets. Median returns are in braces. The statistical significance of median returns is based on the Wilcoxon signed ranks test. Statistical significance for the difference between types of buyers is obtained by the Satterthwaite test for the difference in means and by the Wilcoxon signed ranks test for the difference in medians. Market model parameters are estimated using least squares over the pre-event period, t = -160 to -41, where day 0 is the date of the announcement in the Wall Street Journal. Statistical significance is denoted as: *** for the 1% level, **, for the 5% level, and *, for the 10% level.

<table>
<thead>
<tr>
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<th>SPAS</th>
<th>p-difference in means</th>
<th>SAS</th>
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<td>Seller</td>
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<td>Buyer</td>
</tr>
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<td>N=146</td>
<td>N=287</td>
<td>N=48</td>
<td></td>
<td>N=287</td>
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<td><strong>Panel A: Excess return</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Two-day CAR (-1, 0)</td>
<td>3.78%</td>
<td>1.25%</td>
<td>0.95%</td>
<td>0.00</td>
<td>0.48%</td>
</tr>
<tr>
<td></td>
<td>(12.42)***</td>
<td>(6.10)***</td>
<td>(2.19)**</td>
<td>(3.10)***</td>
<td>(1.40)</td>
</tr>
<tr>
<td></td>
<td>{2.06%}***</td>
<td>{0.27%}**</td>
<td>{0.46%}</td>
<td>{0.00}</td>
<td>{0.33%}</td>
</tr>
<tr>
<td></td>
<td>[0.82]</td>
<td>[0.54]</td>
<td>[0.52]</td>
<td></td>
<td>[0.55]</td>
</tr>
<tr>
<td>Rival CAR (-1, 0)</td>
<td>0.05%</td>
<td>0.12%</td>
<td>-0.52%</td>
<td>0.93</td>
<td>0.73%</td>
</tr>
<tr>
<td></td>
<td>(0.47)</td>
<td>(0.61)</td>
<td>(0.91)</td>
<td></td>
<td>(2.46%)</td>
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</tbody>
</table>

**Panel B: Transaction return**

| Two-day median TR | {22.25%}*** | {2.85%} | {3.68%} | {0.00} | {0.00} | {0.57} | {0.73%} | {2.46%} |
Table 4
Regressions of seller announcement returns

Regressions explain excess returns to sellers of assets over the period 1994 through 2004. In regressions (1) – (4), the dependent variable is TR (transaction returns), and in regressions (5) – (8) seller CR (cumulative excess returns). Qualitative variables, which take on the value of one for the relevant characteristic and zero otherwise, are defined as: PE is one for a private equity buyer; POF is one for a private operating firm; Focus is one when the seller and asset sold have the same 4-digit SIC code; and Proceeds is one when the seller pays out the proceeds to reduce debt or repurchase equity. Quantitative variables are defined as follows: Log EV is logarithm of the asset’s sales price; Pre-return is the seller’s cumulative six month excess period prior to the sale date; ROA is the seller’s return on assets; Asset/EV is the value of the asset scaled by the seller’s enterprise value; Insiders is the percentage of seller shares held by members of its Board of Directors and senior management; and M/B is the seller’s market to book ratio. N is the sample size and t-values are in parentheses below the coefficients. Statistical significance is denoted as: *** for the 1% level, **, for the 5% level, and *, for the 10% level.

<table>
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<th>(6)</th>
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<tr>
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<td>112.74</td>
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<td>2.52</td>
<td>2.44</td>
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<tr>
<td></td>
<td>(4.51)***</td>
<td>(3.96)***</td>
<td>(3.86)***</td>
<td>(3.89)***</td>
<td>(4.20)***</td>
<td>(3.85)***</td>
<td>(3.96)***</td>
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<td>POF</td>
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<td>-3.73</td>
<td>-0.40</td>
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<td>-0.58</td>
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<tr>
<td></td>
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<td>(-0.36)</td>
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<tr>
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<td>-33.44</td>
<td>-2.17</td>
<td>-2.23</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>(-1.23)</td>
<td>(-1.21)</td>
<td>(-2.62)**</td>
<td>(-2.73)**</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>ROA</td>
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<td>412.73</td>
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<td></td>
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<td>(1.87)*</td>
<td>(1.84)*</td>
<td>(-1.62)</td>
<td>(-1.49)</td>
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<tr>
<td></td>
<td>(0.77)</td>
<td>(0.62)</td>
<td>(0.90)</td>
<td>(0.30)</td>
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<tr>
<td>Insiders</td>
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<td>-0.66</td>
<td>0.04</td>
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<td></td>
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<td>M/B</td>
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<td>(-0.78)</td>
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<tr>
<td>Proceeds</td>
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<td>0.91</td>
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<td>(2.31)**</td>
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<td>-81.43</td>
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<td>(-1.23)</td>
<td>(-1.10)</td>
<td>(-0.84)</td>
<td>(3.50)**</td>
<td>(1.74)*</td>
<td>(1.67)*</td>
<td>(4.00)**</td>
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<tr>
<td>N</td>
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<td>444</td>
<td>481</td>
<td>448</td>
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<td>0.0551</td>
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<td>2.58</td>
<td>17.67</td>
<td>5.74</td>
<td>5.53</td>
<td>6.70</td>
</tr>
</tbody>
</table>
Table 5

Excess returns to sellers at asset sales with private equity buyers and subsequent changes in asset enterprise value

Excess returns (CAR) and transaction returns (TR) to sellers at announcements of asset sales to private equity buyers over the period 1994 through 2004 for sellers and the annualized rate of change in enterprise value implied by the difference between the asset’s enterprise value at exit and the value at the original asset sale. Average excess returns reported are the two-day (-1, 0) announcement average excess returns for sellers and the average two-day gain in seller value scaled by transaction size; median returns are in braces. Excess returns are calculated using market model methodology. The statistical significance of medians is based on the Wilcoxon signed ranks test. Market model parameters are estimated using least squares over the pre-event period, t = -160 to -41, where day 0 is the date of the announcement in the Wall Street Journal. The duration of the interval from the asset sale to the date of the exit transaction is reported. Annualized changes in enterprise value are reported for benchmark firms which are public (CRSP) firms with the same 4-digit SIC code as the asset sold that are closest in enterprise value to the value of the asset. Excess EV is the difference between the growth rate of the relevant asset and its benchmark. Private equity exits are disaggregated into IPOs, sales to strategic buyers (SAS), secondary buyouts (SB - sales to other private equity firms), and Chapter 11 filings. N is the sample size and statistical significance is denoted as: *** for the 1% level, **, for the 5% level, and *, for the 10% level.

<table>
<thead>
<tr>
<th></th>
<th>Full Sample</th>
<th>Exits from PE</th>
<th>IPO</th>
<th>SAS</th>
<th>SB</th>
<th>Chapter 11</th>
<th>No Exit</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(1)</td>
<td>(2)</td>
<td>(3)</td>
<td>(4)</td>
<td>(5)</td>
<td>(6)</td>
<td>(7)</td>
</tr>
<tr>
<td>N</td>
<td>146</td>
<td>108</td>
<td>41</td>
<td>33</td>
<td>20</td>
<td>14</td>
<td>38</td>
</tr>
<tr>
<td>Exits</td>
<td>100%</td>
<td>74%</td>
<td>28%</td>
<td>23%</td>
<td>14%</td>
<td>10%</td>
<td>26%</td>
</tr>
<tr>
<td>Time in PE {years}</td>
<td>3.10</td>
<td>2.13</td>
<td>3.02</td>
<td>4.83</td>
<td>3.66</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>{2.59}</td>
<td>{1.82}</td>
<td>{2.58}</td>
<td>{4.94}</td>
<td>{3.22}</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Seller CAR</td>
<td>3.78%</td>
<td>4.33%***</td>
<td>5.11%***</td>
<td>3.45%***</td>
<td>5.74%***</td>
<td>2.14%*</td>
<td>2.19%</td>
</tr>
<tr>
<td></td>
<td>{2.06%}***</td>
<td>{2.28%}***</td>
<td>{2.38%}***</td>
<td>{1.93%}***</td>
<td>{2.64%}***</td>
<td>{0.39%}*</td>
<td>{1.92%}*</td>
</tr>
<tr>
<td>Seller TR</td>
<td>135.93%***</td>
<td>161.34%***</td>
<td>230.89%***</td>
<td>187.19%</td>
<td>81.64%</td>
<td>31.87%</td>
<td>63.73%</td>
</tr>
<tr>
<td></td>
<td>{22.25}***</td>
<td>{24.07%}***</td>
<td>{45.05%}***</td>
<td>{23.87%}***</td>
<td>{16.80%}***</td>
<td>{5.81%}</td>
<td>{18.32%}</td>
</tr>
<tr>
<td>EV growth rate</td>
<td>54.72%</td>
<td>111.52%</td>
<td>40.65%</td>
<td>23.69%</td>
<td>-34.09%</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>{23.80%}</td>
<td>{43.64%}</td>
<td>{25.52%}</td>
<td>{12.69%}</td>
<td>{-27.35%}</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rival EV growth rate</td>
<td>23.52%</td>
<td>37.03%</td>
<td>20.63%</td>
<td>11.95%</td>
<td>7.33%</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>{6.32%}</td>
<td>{9.45%}</td>
<td>{6.42%}</td>
<td>{1.74%}</td>
<td>{8.59%}</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Excess EV</td>
<td>31.20%***</td>
<td>74.49%***</td>
<td>20.02%***</td>
<td>11.74%</td>
<td>-41.43%</td>
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<td></td>
</tr>
<tr>
<td></td>
<td>{16.81%}***</td>
<td>{45.88%}***</td>
<td>{21.20%}***</td>
<td>{14.90%}*</td>
<td>{-44.48%}***</td>
<td></td>
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</tr>
</tbody>
</table>
Table 6
Analysis of private equity success

The first metric, Excess EV Annual Growth Rate, is the difference in the annualized rate of change in enterprise value (EV) implied by the difference between the asset’s enterprise value at exit and its value at the original asset sale, minus the annualized rate of change in the enterprise value of the benchmark firm over the same period. The second metric, Excess EV Profitability Index, is the profitability index of the entity’s enterprise value at exit and the value at the asset sale, calculated using a discount rate of 15%, minus the annual change of the enterprise value of the benchmark firm over the same horizon. The third metric, Exit Success, is a dummy variable that is equal to one if PE exits from the asset via an IPO or a trade sale, and 0 otherwise. Regressions (1) through (4) are OLS regressions using (White) heteroskedasticity-consistent standard errors; regressions (5) and (6) are logit regressions. The independent variables are defined as follows: TR is the seller transaction return generated from event studies as described in Table 3; Ln TV is the log of the value of the asset sale transaction; and Year 1999-2001 is a qualitative variable that takes on the value of one for an asset sale during 1999-2001, years generally accepted as a period of hot IPO markets. The sample size is 108 and the t-value is in parentheses, below the coefficient. Statistical significance is denoted as: *** for the 1% level, **, for the 5% level, and *, for the 10% level.

<table>
<thead>
<tr>
<th></th>
<th>Excess EV Annual Growth Rate</th>
<th>Excess EV Profitability Index</th>
<th>Exit Success</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(1)</td>
<td>(2)</td>
<td>(3)</td>
</tr>
<tr>
<td>Seller TR</td>
<td>0.0013</td>
<td>0.0015</td>
<td>0.0031</td>
</tr>
<tr>
<td></td>
<td>(1.75)*</td>
<td>(2.11)**</td>
<td>(1.98)**</td>
</tr>
<tr>
<td>Ln TV</td>
<td>0.0053</td>
<td>0.0063</td>
<td>0.1911</td>
</tr>
<tr>
<td></td>
<td>(0.09)</td>
<td>(0.04)</td>
<td>(1.33)</td>
</tr>
<tr>
<td>Year 1999-2001</td>
<td>-0.264</td>
<td>-0.9936</td>
<td>2.9928</td>
</tr>
<tr>
<td></td>
<td>(-2.00)**</td>
<td>(-1.89)*</td>
<td>(4.96)***</td>
</tr>
<tr>
<td>Constant</td>
<td>0.1955</td>
<td>0.1978</td>
<td>0.0311</td>
</tr>
<tr>
<td></td>
<td>(3.38)***</td>
<td>(0.56)</td>
<td>(0.18)</td>
</tr>
<tr>
<td>R-squared/Pseudo R-squared</td>
<td>0.0829</td>
<td>0.0732</td>
<td>0.0199</td>
</tr>
</tbody>
</table>