ON THE ANTICIPATION OF IPO UNDERPRICING: EVIDENCE FROM EQUITY CARVE-OUTS†

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ABSTRACT

We examine the first-trading day performance for a sample of 217 equity carve-out IPOs offered during the period of 1980-1998. Unlike IPOs examined in previous studies, where trading during the pre-IPO book-building period does not exist, and trading on the IPO date is rationed, investors can trade in the non-rationed market for shares in the parent, which holds a significant fraction of the subsidiary. We find an unconditional positive first-trading day return and that the returns to both the carved-out subsidiary and the parent on the IPO date are predictable conditional on the return to the parent during the book-building period. We provide evidence of cross-subsidization; specifically, initial returns to the subsidiary are related to price revisions to the subsidiary during the book-building period and in the market value of the remaining assets of the parent over the same period. Initial trading day returns to both the parent and the subsidiary are significantly related to market performance during the offer period, but the relation is negative.
1. INTRODUCTION

In both the empirical and theoretic paradigms, one of the most examined phenomena in the finance literature is the behavior of pricing of Initial Public Offerings (IPOs, hereafter). Arguably, the primary attraction of this subject to researchers is the empirically identified first (trading) day return that exceeds 15%, on average (Ibbotson, Sindelar and Ritter, 1994). Under the standard financial paradigm of efficient markets, such a predictable one day return should not exist.

One of the many explanations\(^1\) that have been offered in the literature argues that this observed initial return represents equilibrium compensation for the provision of information (Benveniste and Spindt 1989). This body of theory predicts that an issuer conditions its final offer price and share quantity (or total proceeds) on information acquired through its underwriter's book-building effort, and initial returns (underpricing) are compensations to induce investors to reveal their private information. This information is presumably reflected in offer price or proceeds revisions. Empirically, initial returns are positively related to price revisions of the book-building period. This is informally referred to as the partial adjustment phenomenon.

An alternative explanation is that some portion of the initial return (under-pricing) reflects a supra-equilibrium return and that the efficient market hypothesis is violated. However, access to these undervalued securities is rationed. Some evidence that this market is inefficient is provided by Loughran and Ritter (2002) who demonstrate that initial IPO returns are correlated with public information, which they proxy using the contemporaneous return to the market.

The primary objective of our study is to re-examine the efficiency of the IPO market by studying the pricing of equity carve-outs during both the pre- and post-offer periods. We define

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equity carve-outs as initial public offerings of the equity in a parent firm's subsidiary. The parent firm sells a fraction of its subsidiary to the public, yet retains some portion (typically a controlling one) of the shares in the new carved-out entity (see Slovin, Sushka and Ferraro (1995), and Hand and Skantz (1998, 1999)). In contrast, equity spin-offs are pro rata stock dividends, usually tax-free, where the entire control rights to the new entity are apportioned to the shareholders of the parent firm (see Allen (1998), Allen and McConnell (1998) and Schipper and Smith (1986)).

Our approach offers a number of useful characteristics in investigating this primary objective. Most importantly, in contrast to typical IPOs, the parent (or parents in the case of joint-ventures; see the data section for details) typically owns a significant fraction of the carve-out both before and after the IPO. Further, the post-carve-out equity stake of the subsidiary held by the parent represents a non-trivial fraction of the parent's assets. As a result, value revisions in the subsidiary should be reflected in the price of the publicly- and non-rationed-traded parent. The existence of such an unencumbered, indirect avenue for participation in the subsidiary's equity even during the pre-IPO market allows us the ability to track changes in the valuation of the non-traded pre-IPO subsidiary during its book-building stage, indirectly through the value of its parent.

The second advantage of our experimental design is that we can more closely investigate whether any inefficiencies can be arbitraged away. Since the shares in the parent are freely traded throughout the pre-IPO process, arguments concerning rationing are not pertinent. This allows us an opportunity to evaluate the degree of anticipation of the subsidiary's underpricing. For example, if the IPO underpricing were not or under anticipated ex ante, then we should expect to see the parent's return during its subsidiary's book-building period that were significantly positively correlated with the subsidiaries initial return. In contrast, if returns to the carved-out subsidiary

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2 Participants at workshops have questioned whether this assumption is violated by the presence of a “when-issued” market. However, “when-issued” trading is prohibited for all IPOs including equity carve-outs in the US.
were, on average, unbiasedly forecasted, then such returns would be incorporated in the parents' book-building period returns and the parents' first day returns would be uncorrelated with their subsidiaries contemporaneous performance.

The third advantage of our methodology is that the existence of a continuously traded parent yields a unique proxy for public information. Loughran and Ritter (2002) argue that initial returns depend not only on the acquisition of private information, but on the acquisition of public information, which they define as information about a common factor. The existence of a continuously-traded parent allows us to investigate this hypothesis more closely. Presumably, information revelation concerning common factors that would impact the managerial wealth acquisition, and hence the pricing of the carve-out could and should be incorporated into the price of the parent. As a result, we argue that the positive relation between the common factor during the book-building period and the IPO initial return should be subsumed by the information contained in the parent's book-building period returns and / or its components.

Aside from our primary goal -- to investigate the efficiency of the IPO market, our experimental design also allows us to examine a secondary issue which we believe has yet to be documented in the finance literature. Specifically, although the announcement day effects of equity carve-outs have been studied extensively,3 we believe that previous investigators have not considered whether the impact of the announcement of a carve-out captures the complete valuation effects on the parent. Indeed, here we explicitly examine whether the book-building process for the carve-out subsidiary not only provides information about the inherent valuation of the carve-out, but also reveals information about the remaining assets of the parent.

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Before we begin our primary investigation, we parallel extant IPO studies to determine the degree to which our assertions and conclusions are pertinent to "regular" IPOs. Like traditional IPOs, we document a positive and significant first-trading day return: 8.99% for our sample. We next find evidence consistent with the "partial adjustment" phenomenon -- predicted by Benveniste and Spindt (1989) and empirically confirmed by Hanley (1993) -- that the correlation between the book-building period return and first trading day return of the subsidiaries is positive and significant.

Our subsequent tests can be categorized into three sets. In our first set of tests, we explore the relations between value revisions in the IPO market for the carve-out and in the continuous market for the parent. We posit that these tests provide experimental evidence on the marginal impact of the existence of a non-rationed and continuously-traded equity vehicle on the pricing efficiency of the subsidiary. That is, we examine whether the performance of the parent during the pre-IPO period provides any additional explanatory power for predicting first trading day returns. We show that the pre-IPO returns to both the parent and the subsidiary are both econometrically and economically valuable for predicting the subsidiary's first-trading day returns. Further, when we parse parent company returns into the returns to their holding in the subsidiary, and returns to the remaining assets of the parent firm, we find that each of the components has predictive power. We also find a strong relation between the first day return to the parent and its subsidiary. Surprisingly, the relation is negative, which is inconsistent with the null joint-hypothesis that (i) the subsidiary's initial return is unanticipated and (ii) the unanticipated component of the subsidiary's return is not reflected in the parent's shares.

In this first set of tests, we also provide evidence that the degree of the underpricing is related to the value revisions of both the subsidiary and the parent during the book-building period. Following Benveniste and Spindt (1989), this seems to suggest that potential investors are
compensated for investigating the inherent value of both the carve-out subsidiary and the remaining assets of the parent through the IPO pricing process.

In our second set of tests, we explore whether the equity returns to the parent during their subsidiary's IPO date can be predicted. Given that shares to the parent are not subjected to rationing, any predictability cannot be attributed to market frictions, but must be interpreted as violations of market efficiency. We find that these returns are predictable using the pre-IPO performance of both the subsidiary and the parent. However, despite statistical significance, economic significance depends crucially on one's assumption of transaction costs.

Finally, our third set of tests investigates the relation between the acquisition of public versus private information during the book-building period. Consistent with Loughran and Ritter (2002), we find a positive correlation between the IPO's initial return and market performance in the book-building period. However, our results indicate that, after including parent company return information during this period in the specification, the partial correlation between the initial return and the market performance during the book-building period is significant but negative.

In the next section, we present our empirical framework and discuss how we partition the parent company's returns on both the first-trading day and the book-building period. We next discuss our sample and define the return metrics we employ in our study. We then discuss our empirical results. Finally, we provide conclusions and implications of subsequent research. All mathematical derivation, constructions of figures and tables are in Appendices.

2. EMPIRICAL FRAMEWORK

Consider a parent company $P$ that is comprised of a subsidiary $S$, which the parent is planning to carve out, and $R$, the remaining (residual) assets of the firm excluding $S$. We value the

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4 Detailed descriptions and derivations of the variables described here are given in Appendix A.
parent and its two components over two periods in time: the book-building phase (also referred as registration period) and the initial trading period. For the purpose of this study, we define the book-building phase of the offering as the period between the filing day (when a company files a preliminary prospectus with the SEC) and the pricing day (when the final offer price is set). We define the initial trading period as the period between the pricing date and the offer day (when the issue is first traded publicly). A parent company usually holds a fraction $\beta$ of shares of its subsidiary before the offering (so $\beta<1$ in the case of joint-ventures) and retains a fraction $\alpha$ of its subsidiary after the IPO.

For example, consider the alphabetically first observation in our dataset: the carve-out of Advanced Mammography Systems by Advanced NMR Systems. The prospectus was filed on November 6th, 1992, and was priced on January 25th, 1993. The first trading day was the same day. In this case, since the subsidiary was wholly owned prior to its IPO, $\beta=100\%$, and $\alpha=75.6\%$.

2.1 Revisions and returns during the book-building period

Book-building theories such as Benveniste and Spindt (1989) predict that an issuer conditions its offer price and share quantity (or the aggregate proceeds) upon information acquired through its underwriter’s book-building effort, where potential investors are induced to reveal valuable information through after market underpricing. Focusing on revisions to offer prices, a growing body of empirical research has provided supporting evidence for this hypothesis.\(^5\) Similar to Benveniste, Ljungqvist, Wilhelm and Yu (2003), we use revisions to total proceeds to capture the underwriter’s and parent’s reaction towards information generated during this registration period.

Spin-off theories including Habib, Johnsen and Naik (1997) and Chang and Yu (2002) suggest that by spinning off one business unit from the parent generates information about the subsidiary and the remaining units. Although we cannot directly observe the revisions in value of the remaining asset of the firm, we can infer these changes from the difference between the change in value of the parent and the change in value of the subsidiary.

We use $S_{BBR}$ to describe the amount of change in value of the subsidiary during its book-building period. This is weighted by the size of the parent company’s market capitalization at the beginning of this period. Similarly, $R_{BBR}$ is the change in value of the remaining units within the parent company weighted by the size of the parent. The return of the parent during this booking building period, $P_{BBR}$, is the sum of $R_{BBR}$ and $\beta S_{BBR}$.

Following our previous example, the revision in value to the parent (Advanced NMR Systems) is $R_{BBR}^P = 3.74\%$. Since all return calculations use the market value of the parent as the denominator, this total return can be dichotomized into the revision in value of the subsidiary, $R_{BBR}^S = 1.86\%$, and the revision in value of the remaining assets of the firm, $R_{BBR}^R = 1.88\%$.

### 2.2 Returns during the initial trading period

In addition to the commonly adopted measure of underpricing, which is the first day closing price divided by the final offer price minus 1, this initial return can also be captured as the change in the holding of the subsidiary by the parent company during the initial trading period. The dollar value of the underpricing as defined in the IPO literature, is therefore the difference between the market capitalization of the subsidiary on the initial trading day, and the value of the subsidiary on the pricing day. In addition, since both the values of the parent and carved-out subsidiary are
observable during this period, the dollar change in the remaining assets of the parent, can be easily calculated.

The above analysis demonstrates that the parent company's return on the first trading day contains two components:

(1) The proportion contributed by the carved-out subsidiary through holding $\alpha$ fraction of shares of the subsidiary, $\alpha R_{IT}^S$, where $R_{IT}^S$ approximates the underpricing of subsidiary $S$ weighted by the size of the parent company at the pricing day, and

(2) The proportion contributed by the remaining divisions within the parent firm, $R_{IT}^R$, derived from the implied change in value of remaining business units weighted by the size of the parent company on the pricing day.

For our example of Advanced Mammography Systems, during the first trading day, the return to its parent Advanced NMR Systems, $R_{IT}^P$, was -3.70%, and initial return to the subsidiary was 3.48%. The revision in value to equity claims on the remaining assets of the firm on that day was -6.33%.

3. SAMPLE SELECTION AND DATA DESCRIPTION

3.1 The data set

Our sample contains subsidiaries of publicly-traded parent companies that completed an initial public offering between January 1980 and December 1998. Thomson Financial’s Security Data Company (SDC) listed 653 completed carve-out IPOs for this period. We follow Hand and Skantz (1999, fn. 3) in extracting equity carve-outs from the SDC database.

After excluding unit offers, closed-end fund (including REITs), ADRs, and financial institutions (SIC code 6000-6999), Our search of SDC yielded 501 issues. We next removed 31
issues where either the subsidiaries or the parents are partnerships. Then we manually checked the remaining 470 issues for misclassifications. This led to our exclusion of 9 issues where the parent or subsidiary is, in fact, an ADR (including one double count), 1 issue where the parent’s ownership in the subsidiary did not change, and 3 issues where the parent and subsidiary are identical and cannot be verified with other resources. In addition, we added 38 companies that were reported in the 1999 SDC but not included in its 2002 database. We manually verified that these 38 issues are indeed IPOs and meet the definition of an equity carve-out. This yields a sample of 495 carve-outs.

We next obtained both the daily closing prices and shares outstanding of each parent company from the Center for Research in Securities Prices (CRSP) daily stock data tape. As in Lowry and Schwert (2000), we use the first closing price from CRSP as the first trading-day closing price of a particular subsidiary issue if the price data are available within 6 days of the offer date. If CRSP data are not available for the subsidiary within 6 days but are available for the parent, we try to obtain the first trading-day closing price of the subsidiary from SDC.6

Using SEC’s EDGAR services, Global Access, COMPUSTAT, news sources such as Dow Jones Interactive and Lexis-Nexis, and several online financial services including Hoovers.com and Morningstar.com, we double-checked and hand-filled required data items such as filing date, initial filing price range, number of shares filed and offered, offer price, as well as firm characteristics (CUSIPs, percentage of the subsidiary held by parent before and after its IPO, number of shares outstanding after IPO). There are 259 cases where we were unable to locate the required firm-specific and pricing information in either SDC or our other sources.7 These missing data, for example the fraction of subsidiary owned by parent prior and after the IPO or prices of the parent,

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6 In the majority of cases in our sample, the pricing day is at least one business day before the first trading day of the subsidiary. In the 158 cases where the pricing day is the same as the first trading day, we follow Aggarwal (2000) and Ellis, Michaely and O’Hara (2000) and re-define the pricing day as one business day prior to the original pricing day.

7 This also includes multiple cases where different verification sources return conflicting information about the issue.
are generally attributable to the fact that the parent company is not publicly traded or not traded on the US stock markets. From our sample, we also eliminated 2 issues due to unverifiable pricing errors in CRSP, 2 issues qualified as simultaneous spin-offs from the same parent, 5 issues where it proved impossible to verify parent’s stake-hold in the subsidiary. We deleted a further 10 observations where the market capitalization of the subsidiary was at least three times the market capitalization of the parent. Our results are robust to alternative relative size screens.

There were a further 12 out of the 217 remaining issues where CRSP mistakenly reported total shares offered as number of shares outstanding. We manually corrected these errors. We also corrected 7 cases where SDC reported incorrect filing information (such as filing day and indicative filing price range).\(^8\) Ljungqvist and Wilhelm (2003) document significant inconsistencies between the number of shares outstanding reported in SDC and those reported in CRSP or other sources. This is especially true during 1996-2000. In our remaining sample, there are 42 issues offered between 1996 and 1998, the end of our sample. Of these, 26 issues have differing numbers of shares outstanding after the IPO between CRSP and SDC.\(^9\) Five of these differences are economically trivial. We attribute theses differences to rounding errors. We cross-checked remaining 21 issues to the dataset used in Ljungqvist and Wilhelm (2003).\(^{10}\) Roughly, half the time CRSP’s record of shares outstanding is incorrect. The other half the time SDC’s numbers are in error.

### 3.2 Summary statistics

\(^8\) There are inconsistencies between SDC’s filing information and other sources as well. We did not change any filing information unless we were able to verify this information from multiple sources.

\(^9\) In the complete sample, there are 123 issues with inconsistent shares outstanding.

\(^{10}\) The issue of inconsistency of number of shares outstanding between SDC and CRSP was discussed in Ljungqvist and Wilhelm (2003). A detailed discussion of the errors they found in the SDC data can be found at http://pages.stern.nyu.edu/~aljungqv/research.htm. We thank Ljungqvist and Wilhelm for sharing their 1996-2000 data with us.
The additions and subtractions described above yielded a final sample of 217 equity carve-outs. In Table 1, we present summary statistics that describe the data for these equity carve-outs. Valued at the filing date, the average parent (including their subsidiary) has a market capitalization at around $3.224 billion with a median of over $447.278 million. The difference between these two measures is due to the skewness of the data caused by non-negativity in general, and to the presence of outliers in particular. For example, AT&T's market capitalization at the time of their carve-out of Lucent was $103.670 billion. The subsidiaries, valued at the mid-point of their filing range, average $418.569 million with a median of $136 million. The ratio of the means (medians) between the subsidiary and the parent is 13% (30%), suggesting that, absent Jensen's inequality, non-trivial proportions of assets are carved out on average. The average file price range indicated in the prospectus is $2.05 wide, close to its median of $2. The last line of Panel A provides information about the proportion of the subsidiary held by the parent. About 20% of the subsidiaries are not wholly owned by the parents, with a minimum majority holding of 62.2% (Guilford Pharmaceuticals).

Panel B presents similar information valued at the pricing date, the end of the book-building period. Not surprisingly, descriptive statistics for the values of the parents are statistically unchanged. The third row of Panel B reports statistics describing $\alpha$, the fraction of the subsidiary retained after the offering. The mean and median, which are 63.282% and 70%, suggest that the parent retains a significant and controlling proportion of the subsidiary on average. A back-of-the-envelope calculation indicates that the parents' equity stake in their subsidiaries averages around 10% ($=13\%\times 63.282\%$) of the assets of the parent. There is variation in the percent of the subsidiary held by the parent -- $\alpha$ varies from 0 (with 13 observations) to over 95% (IP Timberlands).
Table 2 provides summary statistics on the various return metrics. In Panel A, we report on
the returns from the filing to the pricing date.\textsuperscript{11} On average, the parent share price increases by 7%,
but with a median of only 0.8\%.\textsuperscript{12} As mentioned above, this return can be dichotomized into the
(weighted) returns to the subsidiary and the remaining firm. On average, the subsidiary falls in
value during the book-building period, which is consistent with the empirical estimates provided by
Hanley (1993) in her study of IPOs. When weighted by $\beta$, the proportion held by the parent in the
book-building period, the mean subsidiary return becomes less negative, suggesting some positive
correlation between $\beta$ and the parent's pre-market return.\textsuperscript{13}

The mean return to the remaining assets of the parent is 9.957\% and is economically
significant at any traditional level of significance; however, the median is only 2.085\%.
Further, this information is, on average, significantly positive.

By construction, the return to the firm as a whole must equal the sum of the return to the
subsidiary and the ($\beta$-adjusted) return to the remaining assets, as must their means. To distinguish
whether the positive return to the firm is associated with some kind of announcement effect due to
the carve-out (perhaps due to increased focus), or it represents revaluation concurrent with the IPO
process, we plot the time-series process of this return in a scaled event space in Figure 1. Details on

\textsuperscript{11} At this point, it is imperative that we admit that our sample suffers from the classic symptoms of ex poste selection
bias, since we only observe completed equity carve-outs. Unfortunately, the data sets concerning withdrawn offers are,
at best, noisy (see Busaba, Benveniste and Guo (2001)). Busaba, Benveniste and Guo (2001) find around 14\% of issues
are later withdrawn during the period of 1984-1994. During the period of 1980-1998, SDC lists 653 completed and 37
withdrawn carve-out offers.

\textsuperscript{12} Although not reported here, the average market-adjusted return for the parent during this period is 4.972\% with a
median of -0.249\%. The correlation results in Table III remain statistically and economically unchanged although the
magnitude of the coefficients varies slightly.

\textsuperscript{13} The largest outlier of $R_{BBR}$ in Table 2 is the Entree Corp carve-out from Farm House Foods Corp. in 1987. The mid-
point of the subsidiary's filing range is $5.00 with 5 million shares filed. On the offer date, the final offer price and the
number of shares offered drop to $3.50 and 1.5 million, respectively. The market capitalization of the parent company
on the filing date is $35.065 million. Based on the derivation from Appendix A, we have $R_{BBR} = -301.416\%$. This outlier
reflects the small market capitalization of the parent relative to the size of the carve-out, and the dramatic downward
revision of offer price and shares offered.
the construction of this figure are provided in the Appendix. As Figure 1 shows, revisions in the value of the parent occur towards the end of the book-building period.

In Panel B of Table 2, we examine summary statistics for the returns during the first trading date. The return associated with the parent is either slightly negative, based on the mean, or unchanged, based on the median. However, the seemingly small reaction based on this aggregate measure belies the magnitude of the underlying determinants. The value gain to the parent due to their holding of the subsidiary is around 3%. Further, the implied gain to the remaining assets averages 11.339%, which is roughly twice the median.

In Table 3, we report correlations between our various return metrics. The lower left-hand half of the table reports Pearson correlations, while the upper right-hand triangle reports Spearman rank correlations. Of the twenty-eight correlations reported, we highlight four here. Of primary importance is the correlation between the initial return \( R_{IT}^S \) and the value revision of the issue during its book-building period \( R_{BB}^S \), which captures the partial adjustment phenomenon. Consistent with Benveniste and Spindt and the empirical results of Hanley (1993), the correlation is positive and significant, consistent with the presence of partial adjustment, despite the availability of non-rationed parent stock. The analogous measure for the parent -- the correlation between their offer period return and their first trading day return -- is negative, but the significance varies depending on the correlation method used. This may represent some evidence consistent with over-reaction in the revaluation of the parent stock during the book-building period. We also highlight the two cross-correlations. There is no evidence of a relation between the re-valuation of the subsidiary during the book-building period and the parent's first day return. In contrast, however, there is a highly significant positive correlation between the return to the parent during the book-building period and the subsidiary's first trading day return. This final result is at least consistent with the
hypothesis that the first trading day return of the subsidiary is partially anticipated by traders in the parent's stock.

4. RESULTS

In this section, we present the results of our empirical strategy outlined above. We first examine the predictability of the first day performance of the carved-out subsidiary. Our primary focus is on determining whether the additional information from having a publicly-traded parent provides economically important predictive powers beyond those measures previously identified in the literature. We next focus on the cross-market correlations between the first-trading-day performance of the carved-out subsidiary and the parent. Finally, we turn our attention to the relations between pre-offer information -- for both the parent and the subsidiary -- and the predictability of returns to the parent on the subsidiary's first trading day. Since shares and trading on the parent are not rationed, any such predictability cannot be attributed to informational rents, but must be interpreted as an arbitrage profit.

4.1 Announcement day returns

Although of only tertiary interest to this study, we nonetheless collected and examined the announcement (event-study) returns for our sample. We do so to confirm that our sample has similar "announcement-day" characteristics to the samples employed in previous studies of carve-outs. As in past studies, our event date is confounded by the presence of a simultaneous initial filing in a non-trivial subset of cases. To verify the robustness of our findings, we compute announcement effects for the subset of carve-out announcements that are not contaminated by these filings as well as the subset of announcements that were affected.
We find, consistent with previous empirical studies, a positive and significant effect associated with the announcement of a carve-out.\textsuperscript{14} Regardless of the existence of contamination, we find, consistent with existing literature, a positive and significant reaction to the announcement of an equity carve-out. The two-day announcement period excess return for the parent averages 2.98% (\(t\)-statistic = 5.23) in our entire sample. For "pure" announcements, where the announcement was not accompanied by a simultaneous SEC registration filing, the parent equity increased by 3.047% (\(t\)-statistic = 3.576).

### 4.2 Initial returns of the carve-out IPOs

We begin our investigation by examining the predictability of initial-trading day returns of the carved-out IPOs. Our objectives are two-fold: first, we need to document whether the initial returns of the carved-out subsidiary mimic those of their IPO counter-parts. Second, we investigate whether the additional information available due to the presence of a publicly-traded parent provides important information about initial returns.

In the first panel of Table 4, we investigate the degree of anticipation of the subsidiary's IPO underpricing, where the underpricing is defined in a manner comparable to IPO studies. The estimates strongly suggest that the returns to the parent during the book-building period provide both economically and econometrically important information concerning first day performance. Specifically, the estimated intercept is positive and significant, suggesting that, if the parent company's share price did not move during the book-building period, the subsidiary's predicted initial return would be over 6%. Despite the availability of indirect investment in the subsidiary via

\textsuperscript{14} In a sample of 61 equity carve-outs from 1981 to 1988, Michaely and Shaw (1995) document a one-day announcement day excess return of -0.01% for the parent companies, not significantly different from zero. Slovin, Sushka and Ferraro (1995) find two-day announcement excess return of 1.23% for 32 carve-outs' parents from 1980 to 1991. Allen and McConnell (1998) record an average three-day excess stock return 2.12% surrounding carve-out announcement for 188 carve-outs during the period 1978 through 1993. Schipper and Smith (1986) report an average two day return of 1.2% (\(t\)=1.91) for 37 carve-outs during 1965-1983.
the parent, a portion of the subsidiary's underpricing is still left unexplained. We interpret this as evidence that the existence of an indirect investment option mitigates, but does not eliminate, the uncertainty surrounding the IPO underpricing.

The estimated coefficient associated with the return of the parent during the book-building period is highly significant both statistically and economically. For example, from Table 2, the standard deviation of the return to the parent during the book-building period is 34.754%, which suggests that a one standard deviation change in the parent book-building period return is associated with a roughly 14.4% change in the predicted first-trading day return of the subsidiary. We interpret this result as evidence of latent inefficiency in the IPO pricing market. Specifically, a publicly-observable signal -- the share price of the parent -- can be used to predict the first day return of the subsidiary. Although the existence of an efficient IPO market has not been credibly argued, we nonetheless believe that our results are at least informative that one more common- or public- signal is informative about first day underpricing.

In the next specification, we employ the partition described in the model section and examine whether the relation between first-day subsidiary return and parent pre-offer performance varies across the components of the parent company. The results, presented in the second column of Table 4, are invariant across the components of the parent company. Our estimates indicate that the relations between first-day carve-out performance and the returns to both the parent's stake in the subsidiary and their remaining divisions are equal. Indeed, the F-test for equality across the two components (0.39) is below the respective critical value at any traditional level. As mentioned in the data section, the correlation between book-building period performance and initial trading period performance of the IPO is consistent with the partial-adjustment phenomenon.

Most importantly, we demonstrate a partial correlation between first-day returns and the performance with the remaining assets of the firm. The IPO literature suggests that a portion of
first-day underpricing is compensation to potential investors for performing due diligence activities. Our results are at least consistent with the joint hypothesis that potential investors simultaneously evaluate both the carve-out and the remaining assets of the firm and that valuation gains from both processes are shared with the investors, with compensation offered through the pricing of the carved-out IPO. This result is interesting in at least two dimensions: first, since we can observe continuously traded prices of the parent, we can observe compensation analogous to transfer pricing. Second, we provide some evidence consistent with the hypothesis that accessing the capital markets enhances the valuation focus of a firm, even when that firm is publicly-traded.

In Model 3, we follow Loughran and Ritter (2002) and include the contemporaneous return to a market bundle (in our case, the S&P 500 index\textsuperscript{15}) from filing to offer date. Loughran and Ritter argue that returns to a market index (in their paper, the CRSP value weighted index) captures "public" information, which they document to be positively correlated with initial IPO returns. Our estimate is insignificant at 1%, and is insignificant for any critical level when alternative measures of underpricing are used (see the next paragraph for more detailed discussion). This suggests that any public information may already be reflected in the price of the parent during the book-building period.

In Panels B and C, we re-run the previous specifications, but with differing measures of initial day carve-out return for our dependent variable. As described above, Panel B presents regression estimates when the dependent variable is the return to the carve-out scaled by the size of the parent, while in Panel C, the return is adjusted by both the size of the parent at the pricing day and the parent's holding of the subsidiary after the carve-out ($\alpha$). The results remain robust, although the statistical fit deteriorates with these alternative measures. We do note a slight improvement in statistical fit, however, when we adjust the scaled first-day return by the percent

\textsuperscript{15} Our results do not change when we use CRSP value weighted index returns.
retained by the parent. Regardless of our choice of dependent variable, our major results remain intact. We show, as have many previous studies, a partial adjustment in the pricing of the IPO. However, we also provide evidence that the underpricing of the carved-out IPO depends upon the value revisions associated with the remaining assets of the firm. Interestingly, we document that returns to our market index during the book-building period are highly statistically related to the initial trading day return deflated by the market capitalization of the parent. However, inconsistent with the findings of Loughran and Ritter, our estimates are negative.

Our results are not due to the presence of trading in the non-rationed parent: When we regress the subsidiary's unadjusted initial return against the return to our market index, the estimated coefficient associated with the index is 18.737% but is statistically insignificant ($p = 0.503$).

Regressing the initial trading day return adjusted for the market capitalization of the parent against only the market index yields an estimated coefficient of 19.517%, again insignificant at any critical level ($p = 0.154$). This result is robust to an alternative market index return measure (CRSP value weighed index return) and to an alternative definition of the initial return ($\alpha R_{IT}$).

Throughout, we report uncentered $R^2$s. Since our null hypothesis is $\mu = 0$, this metric measures the explained variation around this unconditional mean. In Models 1 through 3, our measure approaches 60%. Econometrically, use of information concerning the returns to the parent during the book-building period provides significantly greater statistical or explanatory power for first trading-day returns than previously documented. For example, Loughran and Ritter, using only contemporaneous market returns, report $R^2$s that do not exceed 0.02. Indeed, our regressions using only market returns around book-building period similarly yield $R^2$s near or below 2%.

### 4.3 Returns during the initial trading period
In this subsection, we re-investigate the relations between initial-trading returns of the parent and the carved-out subsidiary. In Table 5, we choose to examine these relations in a regression context, with various metrics of the return to the subsidiary as the dependent variable. We choose the subsidiary's return as the dependent variable since it is consistent with our "naive" hypothesis where an investor uses the parent's stock as an indirect, yet non-rationed, avenue to capture the initial gains of the carve-out.

There is, indeed, a strong predictable relation between the first trading-day returns to the parent and the subsidiary; however, in gross contrast to our naive hypothesis, the relation is strongly negative. Regardless of the definition of subsidiary return employed, the data suggests that higher first day returns for the parent are generally associated with lower first-day returns with the subsidiary.

As above, we find a relation between the initial return of the subsidiary and the performance of a market index during the book-building period. Again, as above, the relation is positive but at most marginally significant. In terms of economical significance, the coefficient reported in Panel B (0.238), for example, multiplied by the standard deviation of the explanatory variable (the value of which is known before the first trading day) of 5% yields a product of 1.19%.

However, as mentioned throughout our study, documenting abnormal returns in the first trading day of the carved-out subsidiary may not allow for feasible trading strategies that yield abnormal returns due to the rationing of the shares of the IPO or may reflect compensation to participants in the IPO book-building process.

4.4 Arbitrage and the parent’s return during initial trading period

In the previous two sub-sections, we documented that initial returns of the subsidiary are predictable given the book-building period performance of both the parent and the subsidiary, and
that the correlation between the returns to the two on the first trading day. In this subsection, we examine whether the returns to the parent companies can be predicted. Again, since trading and ownership of the parent firm is not restricted nor rationed, any evidence of predictability cannot be explained by frictions inherent in the IPO market, but must be perceived as violations of efficient markets. In the first model displayed in Table 6, we regress the parent's initial day return against their return during the book-building period. The estimated coefficient associated with the book-building period return is negative and significant, which is consistent with an over-reaction hypothesis where valuation revisions during the book-building period are partially reversed during the first trading day. In Model 2, we decompose the book-building period return of the parent. Again, consistent with the hypothesis of over-reaction, both components are negative and significant. Further, the $F$-test of equality cannot reject a null hypothesis that the two coefficients are equal ($p = 0.153$).

In the next three models, we parse the initial return of the subsidiary into two components: an expected and an unexpected component, which we define statistically based on publicly-available information from the book-building period. Specifically, we use the fitted values and residuals from Model 5 in Table 4. In all three specifications, the estimated coefficient associated with the anticipated return to the carved-out IPO is negative and significant. Despite a high level of statistical significance, the economic significance of these results are arguable: the standard deviation of the predictable component (0.0669) multiplied by the largest of the coefficients (Model 4, Table 6 = -0.201) suggests that a one standard-deviation change in the predicted return leads to a change in expected parent company returns of -1.345%. This amount may or may not exceed transactions costs.

In contrast, the unanticipated change in the subsidiary's stock on the first trading day is uncorrelated with the return to the parent. We interpret this as evidence that revisions in the
subsidiary are not reflected in the parent's stock. This is inconsistent with the hypothesis that a parent is punished for "giving away the store" by selling a subsidiary too cheaply.

In the final model, we include the return to our market index during the pre-IPO period. As above, the coefficient is positive and significant at 5% level. The economic significance is debatable. The estimated coefficient (0.117) multiplied by the standard deviation of the index return (0.05) yields 0.585%. Again, whether this represents an arbitrage opportunity depends critically upon the assumed level of transactions costs.

4.5 Robustness tests

In this section, we investigate the robustness of our results to a variety of methodological variations. Our results remain unaltered both economically and econometrically.

Ownership stakes: pre- and post-carve-out

For the 13 firms in our sample, the entire subsidiary is carved-out ($\alpha = 0$). In these cases, arbitrage in the subsidiary via the parent is infeasible. Using a dataset that excludes these 13 observations, we re-estimated each model in Tables 4 through 6. Results were not altered but statistical fit improved marginally.

For 20% of our sample, the carved-out entity was a joint venture ($\beta < 1$). In some of these cases, it is feasible that these carve-outs--which we have interpreted to be joint-venture--are, in fact, secondary offerings. Again, to determine any impact this may have on our results, Tables 4 through 6 were re-estimated with a dataset that omits all of our joint-venture observations. Aside from a

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16 Many of these tests and their motivations were suggested by an anonymous referee, whom we thank for their insights.
relatively significant improvement of statistical fit and stronger test statistics, results are unchanged.¹⁷

**Additivity and deflating**

In our model derivation, we deflated all returns using the market value of the parent in all cases. By doing so, certain combinations of variables must, by construction, "add up." In Tables 4 and 6, we exploited this additivity constraint to test the relative importance and equality across variables. Since numerous commentators found these constraints worrisome, we re-estimated Tables 4 and 6 using own deflators: for example, using the value of the subsidiary as the denominator when calculating the return of the subsidiary. Although the magnitude of the coefficient estimates varied to reflect the new scales of the regressors, statistical significance and interpretation of the results remained unchanged.

**Offer size**

A number of studies in the IPO literature have shown that initial trading day returns (underpricing) are negatively related to the market capitalization of the offering. This suggests including the natural log of the value of the subsidiary in our specifications. However, notice that

\[
\ln(V^{S}_{EndofBB}) = \ln(V^{S}_{BegofBB}) + R^{S}_{BB}
\]

¹⁷ We compared the absolute value of t-statistics using the full sample to those using the reduced sample multiplied by \(\sqrt{\frac{n_{red}}{n_{full}}}\) and found no variances greater than 10%.
Including both $\ln(V_{EndoBB}^S)$ and $\ln(V_{BegoBB}^S)$ in the same specification would induce multicollinearity. As a result, we re-estimated Table 4 including $\ln(V_{BegoBB}^S)$ in each specification. Contrary to traditional IPO's, we find little evidence that initial return vary with the size of the offering. None of the nine specifications yield a statistically significant coefficient. Most importantly, none of the remaining results or interpretations is impacted.

5. CONCLUSIONS

In this study, we investigated the efficiency of the IPO market using a unique experimental design. Specifically, we examined the pricing performance of carve-out IPOs and their parents. The powerful dimension of our experimental design is that the shares of the IPO are not traded in the book-building period, but shares in the parent -- which owns a non-trivial fraction of the subsidiary, and for whom their stake in the subsidiary is a non-trivial fraction of their assets -- are traded in a continuous and non-rationed market environment. We find that, like traditional IPOs, the initial return of the carved-out IPOs is positive and significant: the initial return is close to 9% and is correlated with the value revision from the mid-point of the filing range to the offer price.

Our primary objective was to examine the efficiency of the IPO market for these offerings. The parent company's first-trading day return can be predicted by its book-building period value revision, but they are negatively correlated. This implies an over-reaction of the parent company's return in its book-building period. We also find a significant but negative first-trading day return correlation between parent and its carved-out subsidiary. More generally, the return to the parent on its subsidiary's first trading day is predictable given pre-IPO metrics of both the parent and the carve-out. Although trading in the parent stock is unencumbered, such significance must be interpreted as evidence of equity market inefficiency. However, the economic magnitude of the predictable returns exceeds transaction costs for only the most extreme observation.
A second dimension along which we examined the efficiency of the IPO market was to explore the relations between public or common information flows, information flows concerning the parent, and IPO-specific information flows. We found that the performance of a market index is negatively related to IPO performance, but not statistically significant in most cases.

The investigation of our secondary goal, namely our investigation concerning information revelation during the book-building process, yielded our most surprising results. As in a traditional IPO, we find that significant information revelation occurs for the carve-out and is positively related to its value revision during the book-building period. This later finding is consistent with the hypothesis that investors are compensated for their information revelation. However, we find that the initial return of the subsidiary is also related to book-building period value revisions of the remaining assets of the parent. We interpret this as evidence that potential investors are compensated through IPO underpricing for providing information on the value revisions of both the IPO and the remaining assets of the firm. Although the link between information revelation and IPO underpricing has been previously documented, we believe our evidence is the first to suggest a link between revisions in the valuation of the remaining assets of the parent and compensation via IPO underpricing of the subsidiary.

APPENDICES

APPENDIX A. Description and derivation of variables

In this Appendix, we provide greater detail on the derivation of the variables and the numerical example provided in Section 2. The unconditional mean value of the subsidiary is approximated by \( V^S_{\text{BegOfBB}} \), the value of the subsidiary at the beginning of the book-building period, or on the filing day. It is the product of the mid-point of initial indicative price range filed in the preliminary prospectus, and the number of shares filed, divided by \( \beta - \alpha \). In our example, \( \beta = 100\% \),
\(\alpha = 75.6\%\), the initial indicative price range was $6~$6, with a mid point of $6, and 1,250,000 shares were filed. Thus, \(V_{\text{BegofBB}}^S = \frac{6 \times 1,250,000}{1-75.6\%} = $30,737,704.9\).

On the other hand, the conditional mean value of the subsidiary is captured by \(V_{\text{EndofBB}}^S\), the value of the subsidiary at the end of the book-building period, or on the pricing day. This is calculated as the final IPO offer price, an approximation of conditional mean value of the subsidiary, times post-issue number of shares outstanding, which should be close to the final shares offered divided by 1-\(\alpha\).

The revision of the total value of the subsidiary in dollar amount, \(V_{\text{EndofBB}}^S - V_{\text{BegofBB}}^S\), is caused by the investment banker's and parent's reaction towards information generated during this book-building period. And \(R_{BB}^S = \frac{V_{\text{EndofBB}}^S - V_{\text{BegofBB}}^S}{V_{\text{BegofBB}}^P}\) describes the value revision in the subsidiary during this period of time in a relative manner, weighted by the size of the parent company's market capitalization at the beginning of the book-building period.

Accordingly, a parent company’s holding period return during the book-building phase can be computed and decomposed as \(^{18}\)

\[R_{BB}^P = R_{BB}^R + \beta R_{BB}^S\]

Spin-off theories such as Habib, Johnsen and Naik (1997) and Chang and Yu (2002) suggest by spinning off one business unit from the parent, information about both subsidiaries can be generated. Here, \(\frac{V_{\text{EndofBB}}^S - V_{\text{BegofBB}}^S}{V_{\text{BegofBB}}^P}\) captures the incremental informational value of the subsidiary.

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\(^{18}\) We use the market values of the parent company at the beginning and ending day of the registration period to compute \(R_{BB}^P\). This avoids possible changes of shares of the parent company during the book-building phase.
generated from book-building process, while \( R_{BB}^R = \frac{V_{EndoBB}^R - V_{BegofBB}^R}{V_{BegofBB}^P} \) captures any incremental informational value of the remaining assets generated from book-building process of the carved-out subsidiary.

In our carve-out IPO example Advanced Mammography Systems, The issue was offered on January 25th, 1993, with a final offer price of $6 and shares offered 1.29 million. The parent carved out 24.4% of its subsidiary, retained 75.6% after its subsidiary’s IPO. The post-IPO number of shares outstanding recorded in CRSP is 5.484 million. Therefore, \( R_{BB}^S = 0 \) and \( R_{BB}^R = 1.882\% \).

For the initial trading period, in addition to \( R_{IPO}^S \), which follows the most commonly used measure of underpricing, we also compute \( R_{IT}^S = \frac{V_{EndoIT}^S - V_{BegofIT}^S}{V_{BegofIT}^P} \), where \( V_{EndoIT}^R \) represents the market capitalization of the subsidiary on its first day of trading (or at the end of the initial trading period), and \( V_{BegofIT}^S \) is the market capitalization at the pricing day (which is the same as \( V_{EndoBB}^S \)). This is obtained by the product between final offer price and post-issue number of shares outstanding. Similarly, the value change of the remaining assets of the parent company was calculated as \( R_{IT}^R = \frac{V_{EndoIT}^R - V_{BegofIT}^R}{V_{BegofIT}^P} \), where \( V_{BegofIT}^P = V_{EndoBB}^P \) and \( V_{EndoBB}^R = V_{EndoBB}^R \).

The first trading day closing price is $8 in our carve-out example, so its initial return (or underpricing) \( R_{IPO}^S = \frac{8}{6} - 1 = 33.333\% \). The market capitalization of the parent on the pricing day is $54.989 million, and is $52.952 million on the first trading day. According to the above specification, we compute \( R_{IT}^S = 19.946\% \), and \( R_{IT}^R = 4.182\% \).

APPENDIX B. Constructing Figure 1
For each issue's parent company $i$, let $P^{p}_{i,F}$ denote the parent company's filing day price, and let $P^{p}_{i,t}$ denote the parent company's daily price for during the book-building phase. We define the market adjusted return for each event date as:

$$r^{p}_{i,t} = \frac{P^{p}_{i,t}}{P^{p}_{i,F}} - (1 + R^{market}_{i,t})$$

We next "time-standardize" the book-building period interval by computing the book-building period interval in unit of trading days (offer day minus file day) $L_i$ and obtain the longest period, $L_{\text{max}} = \max(L_i,s)$ as the base interval. For other issues whose period interval $L$ is less than $L_{\text{max}}$, we distributed their daily returns evenly according to the base.

To illustrate, assume there are three issues in our sample, with 20-, 10- and 6-trading-day book-building periods respectively ($L_1 = 20, L_2 = 10$, and $L_3 = 6$). Accordingly, there are 20 daily return observations $r^{p}_{1,t}$ for issue 1's 20 day period, but only 10 for $r^{p}_{2,t}$ and 6 for $r^{p}_{3,t}$. The base length of the interval is 20 days ($L_{\text{max}} = L_1$). We evenly spaced the returns for issue 2 and issue 3 along the base interval via step functions. That is, for issue 2, its 10 daily returns are allocated on day 2, 4, 6, 8, ..., 20 along $L_2$ and are treated as the jump points. The same rationale applies to issue 3 where the jump point occurs at $RND(L_{\text{max}} / L_2)$ (which is 3, so these jump points are on 3, 6, 9, ..., 18). The returns keep flat during the days between two adjacent allocations and take the value of the latter return.

The average return of parents on each day $t$ is computed as

$$r^{p}_{t,i} = \frac{\sum_{j=1}^{n_i} r^{p}_{j,t}}{n_i}$$
This methodology allows us to compute the standardized average return $r_{tr}^{P}$ for all days in the standardized book-building period. The plot is $r_{tr}^{P}$'s against book-building period base interval ($t$) whose length equals 321 in our sample.

APPENDIX C. Additional robustness tests

Hand and Skantz (1998) document a sharp rise of the parent's price on announcement day and then a decline in the price on the first trading day of its subsidiary. Since in our sample, some carve-out IPOs' announcement days are relatively close to their filing days, it is possible that our finding of a similar relationship between the price movement of the parent during its subsidiary's book-building period and the first trading day is affected by the announcement day effect studied in Hand and Skantz (1998). To separate this announcement day effect on the parent's price, we re-run our analyses based on a re-defined book-building period: between 5 days after the documented filing day, and the offer day. Our results remain unchanged economically and econometrically.

Ofek and Richardson (2001) examine 1998-2000's internet stock market mania and concentrate on the after-market trading behaviors of these internet stocks, suggesting that the internet market bubble might be caused by retail investors' over-valuing the stock and by lack of supply of shares for short when a majority of shares are subject to lockup agreement after the internet firms went public. Lamont and Thaler (2000) study several tech stock carve-outs followed by spin-offs where a subsidiary is more valuable than its parent, who controls a large fraction of this subsidiary. They find arbitrage does not eliminate these mispricing due to short sale constraints, so even subsidiary is overpriced it is expensive or impossible to sell short.

In this paper, our sample does not overlap with at least a major part of the 1998-2000 market bubble period. We also concentrate on the parent and subsidiary's performances during the subsidiary's book-building and the initial trading day periods, not the post-IPO long-term
performance of either parents or subsidiaries. However, it is still possible that our results be affected
by high tech outliers. To control this, we classify our sample firms (by SIC code) according to the
intensity of innovation, intangibles and growth opportunities within their industry. We define the
three-digit SIC codes 357 (computer manufacturing), 366-367 (communications and electronic
equipment), 737 (computer and data processing services), 381-384 (optical, medical and scientific
instruments), and 283 (drugs and genetic engineering) as representative of high tech firms.19

Based on this definition, there are 60 tech IPOs in our sample. We then re-run our analyses
based on a sub-sample containing only non tech IPOs (157 IPOs). Again our results do not change.

Some commentators suggest that carve-outs may be clustered, which could cause incorrect
standard errors and thus mislead our analysis.20 We investigate this potential problem by checking
the frequency of the offerings sorted both by the filing day and by the offer day. In our sample,
however, we do not find sufficient evidence of clustering carve-outs.21

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19 This definition is from an early version of Benveniste, Ljungqvist, Wilhelm and Yu (2003) and is very similar to the
SDC’s definition of a "High Tech" company.

20 This can be controlled, for example, by adopting a variation of the standard robust estimator of variance (Huber 1967,
White 1980), developed by Rogers (1993) to compute robust standard errors. This procedure takes into account the
possibility that observations within clusters may not be independent. The formula for the standard robust estimator of
variance is

$$ V = \hat{V} = \left( \frac{\partial \ln L}{\partial \beta} \right)^t \left( \frac{\partial \ln L}{\partial \beta} \right) $$

where \( \hat{V} = \left( \frac{\partial \ln L}{\partial \beta} \right)^t \) is the conventional estimator of variance and \( u_j \) is the
contribution from the \( j \)th observations to the score \( \frac{\partial \ln L}{\partial \beta} \). In the above formula, observations are assumed to be
independent.

If however, observations denoted by \( j \) are not independent but they can be divided into \( M \) groups \( G_1, G_2, \ldots, G_M \)
that are independent, then the robust estimator of variance is

$$ \tilde{V} = \hat{V} \left( \sum_{k=1}^{M} \hat{u}_k^{(c)} \right) $$

where \( u_k^{(c)} \) is the contribution of the \( k \)th group to the scores \( \frac{\partial \ln L}{\partial \beta} \). Hence, for the case where observations within clusters are not independent, the
application of the robust variance formula involves using a different decomposition of \( \frac{\partial \ln L}{\partial \beta} \), namely, \( u_k^{(c)}, k=1, \ldots, M \),
rather than \( u_j, j=1, \ldots, N \).

21 Out of the 217 IPOs used in our analysis, 2 issues are filed on December 19, 1985, 2 filed on April 7, 1988, 2 on
October 27, 1992, 2 on April 23, 1993, and 2 on June 26, 1996. There are 2 carve-out IPOs offered on January 24, 1986,
REFERENCES


Cornell, B., and Q. Liu, 2000, The parent company puzzle: When is the whole worth less than one of the parts? Working Paper, University of California at Los Angeles.


Figure 1 Time standardized parent companies’ mean cumulative returns during the book-building period of their subsidiaries’ IPOs.
Table 1 Summary Statistics (I)

The table provides summary statistics (mean, median, maximum, minimum and standard deviation) for the carved-out subsidiaries and their publicly traded parents. The sample consists of 217 carve-out IPOs and their parents from 1980 to 1998 that were extracted from SDC database. The stock price information is obtained from the CRSP daily stock tapes. $T$-statistics for testing the difference in the means of variables on pricing day and filing day are presented in (.). The percentage of the sample issues that are not wholly owned by their parent companies prior to the IPO is presented in [.].

<table>
<thead>
<tr>
<th></th>
<th>Mean</th>
<th>Maximum</th>
<th>Minimum</th>
<th>Median</th>
<th>Std. Dev.</th>
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<tbody>
<tr>
<td><strong>Panel A: On Filing Day</strong></td>
<td></td>
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<td></td>
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<td></td>
</tr>
<tr>
<td>Parent company's market</td>
<td>3,224.293</td>
<td>103,670.208</td>
<td>4.592</td>
<td>447.278</td>
<td>9,981.313</td>
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<td>capitalization (mil $)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Subsidiary's market</td>
<td>418.569</td>
<td>12,951.705</td>
<td>3.188</td>
<td>136.000</td>
<td>1,186.435</td>
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<td>capitalization evaluated at</td>
<td></td>
<td></td>
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<tr>
<td>the mid-point of the filing</td>
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<td>range in prospectus (mil $)</td>
<td></td>
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<tr>
<td>% of subsidiary held by</td>
<td>97.557%</td>
<td>100%</td>
<td>62.2%</td>
<td>100%</td>
<td>6.235%</td>
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<td>parent before offering ($\beta$)</td>
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<td></td>
<td>[20.737%]</td>
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<tr>
<td><strong>Panel B: On Pricing Day</strong></td>
<td></td>
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<td>Parent company's market</td>
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<td>17,189.872</td>
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<td>the offer price (mil $)</td>
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<td></td>
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<td>% of subsidiary held by</td>
<td>63.282%</td>
<td>95%</td>
<td>0%</td>
<td>70%</td>
<td>24.722%</td>
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<td>parent after offering ($\alpha$)</td>
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<td></td>
<td>(-20.212)</td>
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<tr>
<td><strong>Length of Book Building</strong></td>
<td>62.203</td>
<td>321</td>
<td>14</td>
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<td>Period (Filing Day - Pricing</td>
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<td>Day)</td>
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</table>
Table 2 Summary Statistics (II)

The table provides summary statistics for the returns of carved-out subsidiaries and their parents during the book building period and the initial trading period. The book building period (or registration period) is the time period from the day the firm files for an IPO with the SEC (filing day) to the day the issue is offered (pricing day). The initial trading period is the period from pricing day to the first day the issue is publicly traded (first trading day). The book building period returns $R_{BB}^P$, $R_{BB}^S$, and $R_{BB}^R$ and the initial trading day returns $R_{IT}^P$, $R_{IT}^S$, and $R_{IT}^R$ are defined as in the paper. $T$-statistics are shown in ( ).

<table>
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<tr>
<th>Mean</th>
<th>Max</th>
<th>Min</th>
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<th>Std. Dev</th>
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**Panel A: Book building period (from filing day to pricing day)**

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<thead>
<tr>
<th>$R_{BB}^P$</th>
<th>6.995%</th>
<th>382.963%</th>
<th>-37.803%</th>
<th>0.800%</th>
<th>34.754%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Parent company's pre-offer period return (2.965)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$R_{BB}^S$</td>
<td>-3.244%</td>
<td>85.641%</td>
<td>-301.416%</td>
<td>0.250%</td>
<td>32.704%</td>
</tr>
<tr>
<td>Subsidiary's value change scaled by parent's market cap. on filing day (-1.461)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$\beta R_{BB}^S$</td>
<td>-2.962%</td>
<td>85.641%</td>
<td>-301.416%</td>
<td>0.213%</td>
<td>32.194%</td>
</tr>
<tr>
<td>Return to parent from holding subsidiary scaled by parent's market cap. on filing day (-1.355)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$R_{BB}^R$</td>
<td>9.957%</td>
<td>359.424%</td>
<td>-70.285%</td>
<td>2.085%</td>
<td>41.638%</td>
</tr>
<tr>
<td>Remaining asset's value change scaled by parent's market cap. on filing day (3.523)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Panel B: Initial trading period (from pricing day to the first trading day)**

<table>
<thead>
<tr>
<th>$R_{IT}^P$</th>
<th>-0.778%</th>
<th>13.953%</th>
<th>-25.532%</th>
<th>0.000%</th>
<th>3.844%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Parent company's initial day return (-2.982)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$R_{IT}^S$</td>
<td>3.920%</td>
<td>81.409%</td>
<td>-11.780%</td>
<td>0.606%</td>
<td>10.044%</td>
</tr>
<tr>
<td>Subsidiary's initial return scaled by parent's market cap. on offer day (5.749)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$\alpha R_{IT}^S$</td>
<td>2.724%</td>
<td>67.000%</td>
<td>-10.719%</td>
<td>0.299%</td>
<td>7.468%</td>
</tr>
<tr>
<td>Return to parent from holding subsidiary scaled by parent's market cap. on offer day (5.374)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$R_{IT}^R$</td>
<td>11.339%</td>
<td>154.783%</td>
<td>-85.981%</td>
<td>5.642%</td>
<td>23.596%</td>
</tr>
<tr>
<td>Remaining asset's initial return scaled by parent's market cap. on offer day (7.079)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$R_{IPO}^S$</td>
<td>8.989%</td>
<td>220.000%</td>
<td>-24.167%</td>
<td>2.778%</td>
<td>20.475%</td>
</tr>
<tr>
<td>Subsidiary's initial day return (not adjusted by parent's size) (6.467)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Table 3 Summary Statistics (III)

This table presents correlation analysis for the returns parent companies and their subsidiaries during the book building period and during the initial trading period. The Pearson correlation coefficients are present in the lower triangular cells of the table while the Spearman (rank) correlation coefficients are in the upper triangular part of the table. The $p$-values associated with $t$-statistics testing the coefficients to be zero are given in (.).

<table>
<thead>
<tr>
<th></th>
<th>$R_{BB}^P$</th>
<th>$R_{BB}^S$</th>
<th>$R_{BB}^R$</th>
<th>$R_{IT}^P$</th>
<th>$R_{IT}^S$</th>
<th>$R_{IT}^R$</th>
<th>$R_{IPO}^S$</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Book Building Period</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$R_{BB}^P$ Parent company's return</td>
<td>0.324</td>
<td>0.620</td>
<td>-0.006</td>
<td>0.270</td>
<td>-0.090</td>
<td>0.294</td>
<td></td>
</tr>
<tr>
<td>$R_{BB}^S$ Subsidiary's return scaled by parent's size on filing day</td>
<td>(0.000)</td>
<td>(0.000)</td>
<td>(0.928)</td>
<td>(0.000)</td>
<td>(0.188)</td>
<td>(0.000)</td>
<td></td>
</tr>
<tr>
<td>$R_{BB}^R$ Remaining asset's return scaled by parent's size on filing day</td>
<td>0.229</td>
<td>-0.365</td>
<td>0.010</td>
<td>0.443</td>
<td>-0.102</td>
<td>0.444</td>
<td></td>
</tr>
<tr>
<td>$R_{BB}^R$ Remaining asset's return scaled by parent's size on offer day</td>
<td>(0.001)</td>
<td>(0.000)</td>
<td>(0.879)</td>
<td>(0.000)</td>
<td>(0.136)</td>
<td>(0.000)</td>
<td></td>
</tr>
<tr>
<td><strong>Initial Trading Period</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$R_{IT}^P$ Parent company's return</td>
<td>-0.334</td>
<td>0.013</td>
<td>-0.289</td>
<td>0.026</td>
<td>0.155</td>
<td>0.07</td>
<td></td>
</tr>
<tr>
<td>$R_{IT}^S$ Subsidiary's return scaled by parent's size on offer day</td>
<td>(0.000)</td>
<td>(0.847)</td>
<td>(0.000)</td>
<td>(0.707)</td>
<td>(0.023)</td>
<td>(0.275)</td>
<td></td>
</tr>
<tr>
<td>$R_{IT}^R$ Remaining asset's return scaled by parent's size on offer day</td>
<td>0.660</td>
<td>0.241</td>
<td>0.366</td>
<td>-0.252</td>
<td>-0.166</td>
<td>0.898</td>
<td></td>
</tr>
<tr>
<td>$R_{IT}^R$ Remaining asset's return scaled by parent's size on offer day</td>
<td>(0.000)</td>
<td>(0.000)</td>
<td>(0.000)</td>
<td>(0.000)</td>
<td>(0.015)</td>
<td>(0.000)</td>
<td></td>
</tr>
<tr>
<td>$R_{IPO}^S$ Subsidiary's return (not adjusted by parent's size)</td>
<td>-0.205</td>
<td>0.054</td>
<td>-0.212</td>
<td>0.171</td>
<td>-0.220</td>
<td>-0.364</td>
<td></td>
</tr>
<tr>
<td>$R_{IPO}^S$ Subsidiary's return (not adjusted by parent's size)</td>
<td>(0.002)</td>
<td>(0.433)</td>
<td>(0.002)</td>
<td>(0.012)</td>
<td>(0.001)</td>
<td>(0.000)</td>
<td></td>
</tr>
</tbody>
</table>
Table 4 Initial Trading Day Return Analysis for the Carved-out Subsidiaries

In this table we investigate whether the book building period return from the publicly traded parent company can predict the initial return (underpricing) of the subsidiary during the first trading day. The dependent variable is the subsidiary’s initial return, where three variations are used: \( R_{IPO}^S \) (subsidiary’s initial return scaled by the size of the subsidiary on the offer day), \( R_{IT}^S \) (subsidiary’s initial return adjusted by the size of the parent on the offer day), and \( \alpha R_{IT}^S \) which is scaled by \( \alpha \), the parent of the subsidiaries shares retained by the parent. The independent variables are in the first column of the table. As defined in the paper, the parent company’s book building period return \( R_{BB}^P \) is also partitioned into the book building period return to the subsidiary, the book building period return to the remaining assets and wealth transfer, all adjusted by the size of the parent (market capitalization) on the filing day. \( R_{BB}^m \) is the S&P 500 return during the book building period. \( p \) values associated with \( t \)-statistics and \( F \) statistics testing the equivalence between the coefficients of \( \beta R_{BB}^S \) and \( R_{BB}^R \) are also reported.

<table>
<thead>
<tr>
<th></th>
<th>PANEL A ( (R_{IPO}^S) )</th>
<th>PANEL B ( (R_{IT}^S) )</th>
<th>PANEL C ( (\alpha R_{IT}^S) )</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Model 1</td>
<td>Model 2</td>
<td>Model 3</td>
</tr>
<tr>
<td>Intercept</td>
<td>0.061</td>
<td>0.062</td>
<td>0.069</td>
</tr>
<tr>
<td></td>
<td>(0.000)</td>
<td>(0.000)</td>
<td>(0.000)</td>
</tr>
<tr>
<td>( R_{BB}^P )</td>
<td>0.415</td>
<td>0.429</td>
<td>0.191</td>
</tr>
<tr>
<td></td>
<td>(0.000)</td>
<td>(0.000)</td>
<td>(0.000)</td>
</tr>
<tr>
<td>( \beta R_{BB}^S )</td>
<td>0.431</td>
<td>0.214</td>
<td>0.160</td>
</tr>
<tr>
<td></td>
<td>(0.000)</td>
<td>(0.000)</td>
<td>(0.000)</td>
</tr>
<tr>
<td>( R_{BB}^R )</td>
<td>0.411</td>
<td>0.185</td>
<td>0.146</td>
</tr>
<tr>
<td></td>
<td>(0.000)</td>
<td>(0.000)</td>
<td>(0.000)</td>
</tr>
<tr>
<td>( R_{BB}^m )</td>
<td>-0.447</td>
<td>-0.091</td>
<td>-0.092</td>
</tr>
<tr>
<td></td>
<td>(0.027)</td>
<td>(0.386)</td>
<td>(0.222)</td>
</tr>
<tr>
<td>Uncentered ( R^2 )</td>
<td>0.578</td>
<td>0.579</td>
<td>0.587</td>
</tr>
<tr>
<td>( F )-test</td>
<td>0.39</td>
<td>3.17</td>
<td>1.40</td>
</tr>
</tbody>
</table>
Table 5 Initial Trading Day Returns Analysis

In this table we investigate whether initial returns to the subsidiaries are related to returns to their parents over the first trading days of the subsidiaries. *p* value of t-statistics are given in (.)

<table>
<thead>
<tr>
<th></th>
<th>PANEL A (R_{IPO}^{S})</th>
<th>PANEL B (R_{IT}^{S})</th>
<th>PANEL C (\alpha R_{IT}^{S})</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
<td>0.078</td>
<td>0.072</td>
<td>0.034</td>
</tr>
<tr>
<td></td>
<td>(0.000)</td>
<td>(0.000)</td>
<td>(0.000)</td>
</tr>
<tr>
<td></td>
<td>-1.502</td>
<td>-1.532</td>
<td>-0.659</td>
</tr>
<tr>
<td></td>
<td>(0.000)</td>
<td>(0.000)</td>
<td>(0.000)</td>
</tr>
<tr>
<td></td>
<td>0.283</td>
<td>0.238</td>
<td>0.167</td>
</tr>
<tr>
<td></td>
<td>(0.294)</td>
<td>(0.074)</td>
<td>(0.090)</td>
</tr>
<tr>
<td>Uncentered (R^2)</td>
<td>0.229</td>
<td>0.233</td>
<td>0.188</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>0.200</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>0.180</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>0.191</td>
</tr>
</tbody>
</table>
Table 6 Analysis of Potential Arbitrage for the Parent's First Day Return

In this table we investigate whether the returns of the parent companies for the first trading day of their carved-out subsidiaries, can be predicted by the information generated during the book building period. The dependent variable is $R_{IT}^P$. The independent variables include anticipated $R_{IT}^S$, which is the predicted underpricing of the subsidiary by using information available during the book building period (the fitted values from model 5, Panel B, Table 4), and unanticipated $R_{IT}^S$, which is the residual from the same regression model. $p$ values associated with $t$-statistics and $F$-statistics testing the equivalence of coefficients of $\beta R_{BB}^S$ and $R_{BB}^R$ are also reported.

<table>
<thead>
<tr>
<th>Dependent variable: $R_{IT}^P$</th>
<th>Model 1</th>
<th>Model 2</th>
<th>Model 3</th>
<th>Model 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept (%)</td>
<td>-0.005</td>
<td>-0.005</td>
<td>-0.001</td>
<td>-0.002</td>
</tr>
<tr>
<td></td>
<td>(0.040)</td>
<td>(0.065)</td>
<td>(0.831)</td>
<td>(0.442)</td>
</tr>
<tr>
<td>$R_{BB}^P$</td>
<td>-0.037</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.000)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$\beta R_{BB}^S$</td>
<td>-0.028</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.003)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$R_{BB}^R$</td>
<td>-0.039</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.000)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Anticipated $R_{IT}^S$</td>
<td>-0.183</td>
<td>-0.201</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.000)</td>
<td>(0.000)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Unanticipated $R_{IT}^S$</td>
<td>-0.028</td>
<td>-0.023</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.407)</td>
<td>(0.487)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$R_{BB}^m$</td>
<td></td>
<td></td>
<td></td>
<td>0.117</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>(0.021)</td>
</tr>
<tr>
<td>Uncentered $R^2$</td>
<td>0.147</td>
<td>0.155</td>
<td>0.140</td>
<td>0.161</td>
</tr>
<tr>
<td>F-test</td>
<td></td>
<td></td>
<td></td>
<td>2.06</td>
</tr>
</tbody>
</table>