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On the anticipation of IPO underpricing: Evidence from equity carve-outs ☆

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ABSTRACT

We investigate IPO market efficiency using a sample of equity carve-outs offered during the period of 1985–2005. 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, in equity carve-outs, investors can trade in the non-rationed market for shares of the parent, which holds a significant fraction of the subsidiary. We find that the subsidiary's initial day return is significantly related to its parent's return over the book-building period, but unrelated to its parent's contemporaneous return. Neither the pre-IPO price revision of the subsidiary nor the return to the parent on the initial trading day can be predicted. While the portion of the subsidiary's initial return unpredictable from information available during the book-building period is significantly related to its parent's contemporaneous return, the predictable component of the initial return is not. We interpret these results as evidence consistent with market efficiency.

1. Introduction

In both the empirical and theoretic paradigms, one of the most examined phenomena in the finance literature is the pricing of Initial Public Offerings (IPOs). Arguably, the primary attraction of this subject to researchers is the empirically identified first trading day return (underpricing) which on average exceeds 18% (Ibbotson, Sindelar and Ritter, 1994). Under the standard financial theory of efficient markets, such a predictable one day return should not exist.

Numerous theoretical models treat this observed initial return as an equilibrium return. For example, book-building theories such as Benveniste and Spindt (1989) argue that an issuer conditions its final offer price and share quantity on information acquired through its underwriter's book-building effort, and that initial returns are compensations to informed investors for revealing their private information about the value of the IPO firm.

An alternative explanation is that some portion of the initial return 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 returns are correlated with market returns before the offering, suggesting that public information is not fully incorporated into the offer price.[1]

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[1] For a survey of theories on IPO underpricing, see Jenkinson and Ljungqvist (1996) and Ritter and Welch (2002). For discussions of IPO discretionary allocation and other characteristics of book-building process, see Ljungqvist and Wilhelm (2003) and Busaba (2006).

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In this paper we re-examine the efficiency of the IPO market by studying the pricing of equity carve-outs during both the pre- and post-offer periods. In an equity carve-out IPO, the parent firm sells a fraction of its privately owned subsidiary to the public. Unlike a typical IPO whose value discovery process during the book-building period is not observable,[2] the parent in an equity carve-out owns a significant fraction of the subsidiary both before and after the IPO, and its post-carve-out equity stake in the subsidiary represents a non-trivial fraction of its assets.

As a result, value revisions in the subsidiary should be reflected in the price of the publicly- and unrationed-traded parent. The existence of such an unencumbered, indirect avenue for participation in the subsidiary's equity offering even in the pre-IPO market allows us to track changes in the valuation of the non-traded subsidiary during its book-building stage, indirectly through the value of its parent.

Since shares of the parent are freely traded throughout the pre-IPO process, arguments concerning rationing are not pertinent. Our experimental design thus also allows us to evaluate the degree of anticipation on the subsidiary's underpricing and to investigate whether any inefficiency, if it exists, can be arbitraged away. For example, if initial returns to the carved-out subsidiary were, on average, unbiasedly forecasted, then such returns would be incorporated in the parent's returns during the subsidiary's book-building period. We should then expect the subsidiary's initial return to be significantly and positively correlated with the parent's return during the book-building period, but uncorrelated with the parent's contemporaneous performance.

Further, the existence of a continuously traded parent yields a unique proxy for public information. The prospect theory from Loughran and Ritter (2002) argues that the entrepreneur does not bargain hard for a higher IPO offer price because he integrates the good news of becoming richer than expected with the bad news of money left on the table due to underpricing. Underwriters take advantage of this mental accounting and severely underprice these deals. Both public and private information will then be only partially incorporated into the offer price. In the presence of a continuously-traded parent, however, the positive relation between the market return during the book-building period and the IPO initial return should be subsumed by the firm-specific information contained in the parent's book-building period returns. In addition, our research design implies that this positive relation is less likely to be driven by the prospect theory because parent companies in carve-out IPOs are publicly traded and have relatively large market capitalizations. They do not face the same wealth constraints that entrepreneurs usually confront and are less likely to be subject to the underwriters' monopoly power.

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 initial day return for our sample of carve-outs. Similar to Hanley (1993) and Ljungqvist and Wilhelm (2002) and consistent with Benveniste and Spindt's (1989) "partial adjustment" hypothesis, we find a positive and significant correlation between the book-building period return and first trading day return for the subsidiaries.

To explore how the existence of a non-rationed and continuously-traded equity vehicle affects the pricing efficiency of the subsidiary, we start by examining whether the performance of the parent during the pre-IPO period provides any explanatory power for predicting initial returns. We find that the pre-IPO returns to the parent are both econometrically and economically valuable for predicting the subsidiary's initial returns. We then parse parent company returns into both returns to their holding in the subsidiary, and returns to the remaining assets of the parent firms. We find that each of the components has predictive power. Next, we take into account the impact of the subsidiary's file range amendment activity, which, if it occurs, reveals additional firm-specific information during the pre-IPO stage and subsequently, could alter investors' incentives to participate in the shares of the parent. We find returns to the parent company from the original file date to the amendment date and from the amendment date to the final offer date predict the subsidiary's initial returns. Finally, our results indicate that, after including parent company return information in the specification, the partial correlation between initial return and market performance during the book-building period is no longer significant. This suggests that market-wide information is subsumed by firm-specific information.

We then investigate the efficiency of the IPO market using two separate tests. First, if investors recognize the pre-IPO value discovery process and anticipate the carved-out subsidiary's underpricing, then such anticipation should be incorporated into the parent's book-building period returns. Consistent with this, we find that while the subsidiary's initial day return is significantly positively correlated with the parent's return during the book-building period, it is uncorrelated with the parent's contemporaneous performance.

Second, we examine whether the return to the parent on its subsidiary's IPO day, as well as the subsidiary's price revision during its book-building period, can be predicted. Given that shares of the parent are not subject to rationing, any predictability cannot be attributed to market frictions, but must be interpreted as violations of market efficiency. We find that the return to the parent on the IPO day can neither be predicted by the return to the parent over its subsidiary's book-building period, nor by the return to the parent upon observing its subsidiary's file range amendment. More importantly, the part of the subsidiary's underpricing which is unpredictable given the information during its pre-IPO period is positively and significantly related to the parent's first day return. Conversely, the predictable component of the subsidiary's underpricing is not related to the parent's contemporaneous return. In addition, we find that the price revision of the subsidiary during its book-building period cannot be predicted by the public information – such as returns to the market, returns to the parent, and offering characteristics – at the time the issue is filed. We interpret these results as evidence consistent with market efficiency.

[2] Although a "when-issued" market can mitigate this unobservability, "when-issued" trading is prohibited for all IPOs (including equity carve-outs) in the United States and is mainly available in selected European countries whose IPO markets are subject to different institutional features. For a detailed discussion of "when-issued" markets, see Löffler, Panther and Theissen (2005) and Aussenegg, Pichler and Stomper (2006).

Our paper is related to the literature studying how public versus private information during the pre-IPO period affects IPO underpricing. For example, Loughran and Ritter (2002) and Lowry and Schwert (2004) investigate the impact of market-wide information.[3] Bradley and Jordan (2002) examine the impact of firm-specific information captured by issuing firms' file range amendments. By concentrating on a proxy for firm-specific information that is continuously observable throughout the book-building period, we show that the effect of market-wide information diminishes in the presence of firm-specific information. Furthermore, unlike file range amendments, which do not occur constantly for every IPO, the continuously traded parent allows us to disentangle the effect of share rationing from that of pricing efficiency.

Lamont and Thaler (2003) focus on six cases of tech stock carve-outs followed by spin-offs where a subsidiary is more valuable than its parent during the 1998–2000 period. They find arbitrage fails to eliminate these mispricings due to short sale constraints, so even though the subsidiary is overpriced it is expensive or impossible to sell short. Instead of examining the pricing efficiency in the secondary market for certain carved-out subsidiaries after their IPOs, we concentrate on the efficiency in the primary market using a sample containing all available carve-outs. Our finding suggests that arbitrage is not feasible given that both the subsidiary's pre-IPO price revision and the return to the parent on its subsidiary's initial trading day cannot be predicted by public information. In this respect, our paper is related to Lowry and Schwert (2004) who document a statistically – but not economically – significant relation between issuing firm's price revision and public information leading up to the filing, as well as between initial returns and market returns before the offering. They interpret these results as the IPO pricing process being almost efficient. We show that the evidence consistent with IPO market efficiency appears to be stronger in the presence of a continuously traded parent, as neither market-wide nor firm-specific public information is statistically significantly related to the subsequent price revision of the subsidiary and the return to the parent on the initial trading day.

There is also a large literature focusing on announcement day effects of equity carve-outs (e.g., Schipper and Smith, 1986; Slovin, Sushka and Ferraro, 1995; Allen and McConnell, 1998). However, previous studies have not considered whether the impact of the announcement of a carve-out captures the complete valuation effects on the parent. In this paper, 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.

The rest of the paper is organized as follows. In Section 2, we describe our empirical framework and define the return metrics employed in this study. Section 3 describes the construction of our data sample. Sections 4 through 7 present the results. Section 8 provides additional robustness results. Section 9 concludes. Mathematical derivations and figure construction are in the 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 parent's non-S assets and businesses. We value the parent and its two components first during the subsidiary's pre-IPO book-building period – defined as the time between the filing date (when a company files a preliminary prospectus with the SEC) and the offer date (when the final offer price is set), then during the initial trading period between the offer date and the day when the subsidiary is first traded publicly. A parent company holds a fraction β of shares of its subsidiary – typically 100% – before the offering, and retains a fraction α of its subsidiary after the IPO.

2.1. Constructing returns over the book-building period and initial trading period

Book-building theories such as that of 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 efforts, where potential investors are compensated for revealing valuable information through underpricing. To capture the reactions from the underwriter and the parent towards information about the value of the subsidiary, we calculate the return to the subsidiary during its book-building stage ($RET\_SUB_{-1,0}$) as the value revision of the subsidiary scaled by its parent's market capitalization at the beginning of this period.

Spin-off theories including those of Habib, Johnson and Naik (1997) and Chang and Yu (2004) suggest that spinning off a business unit from the parent generates information about both the subsidiary and the remaining units. Value revision in the remaining assets of the firm, though not directly observable, can be inferred from the difference in value revision between the parent and the subsidiary. Similarly to $RET\_SUB_{-1,0}$, we compute the return to the remaining assets of the parent ($RET\_REM_{-1,0}$) as 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 – $RET\_PAR_{-1,0}$ – is therefore the sum of $RET\_REM_{-1,0}$ and $\beta \times RET\_SUB_{-1,0}$.

The commonly adopted measure of initial return is calculated as the percentage change in the first day close price relative to the offer price. The dollar value of the underpricing is defined as the difference between the market capitalization of the subsidiary on the initial trading day, and the value of the subsidiary on the offer date. Since both the values of the parent and carved-out subsidiary are observable during the initial trading period, the implied value change in the remaining assets of the parent can be easily calculated. The parent company's return on the first trading day hence contains two components: (1) the post-IPO α fraction

[3] While Loughran and Ritter (2002) interpret the results of partial adjustment to public information from a behavioral perspective, Lowry and Schwert (2004) question the economic significance of the relation between initial returns and pre-IPO public information. Leite (2007) provides a rational model for this partial adjustment.

of holdings of the subsidiary S, ($\alpha \times RET\_SUB_{0,1}$), where the initial day return of the subsidiary ($RET\_SUB_{0,1}$) is calculated as the dollar value of subsidiary's underpricing scaled by the size of the parent company at the offer date, and (2) the implied return to the remaining business units during the subsidiary's initial trading period ($RET\_REM_{0,1}$), calculated as the value change of remaining business units weighted by the size of the parent company on the offer date. Details of variable derivations and an illustrative example are provided in Appendix A.

2.2. Pre-IPO file range amendment activities

Our research design so far considers the price adjustment of the parent company to be the proxy for firm-specific information and the value discovery of the subsidiary to occur throughout its book-building period. We now take into account the potential arrival of additional firm-specific information — namely, that an issuing firm can adjust its initial indicative price range any time before the offer date by filing an amended S-1 form with the SEC.

Unlike the price of the parent company, which is continuously available in the non-rationed market for each subsidiary throughout its entire book-building period, a file range amendment does not occur for every issuing firm. Nevertheless, if an issuer amends its original file range, it usually does so closer to the offer date. As pointed out by Bradley and Jordan (2002), part of this is related to the SEC's rule that the final offer price is limited to within 20% of the final file range; hence, an amendment becomes mandatory if the issuer believes the offer price will reach beyond the allowed range – which, if it occurs, normally happens at the end of the road show.

In the context of our research framework, however, return to the parent is no longer the only firm-specific information publicly available during the pre-IPO stage once a file range amendment takes place. In addition, information about the subsidiary's value revision revealed through amendments tends to be less noisy than the price of the parent because the latter also reflects the information of the remaining assets within the parent firm. The arrival of this additional firm-specific information thus affects the price of the parent, not only through its ownership of the subsidiary, but also by augmenting the incentives of the investors who participate in the shares of the parent as an indirect venue of investing in the going-public subsidiary.

To take into account the impact of file range amendment activities, we break our book-building period into the file range amendment sub-period (from the original filing date to the date of file range amendment) and the final offer sub-period (from the date of file range amendment to the final offer date). These two sub-periods, along with the book-building period and initial trading period, are illustrated in Fig. 1. Following an approach similar to Section 2.1, we use the amended price of the subsidiary and the value of the parent at the time of the amendment to compute the returns to the subsidiary, to the parent, and to the remaining assets over the file range amendment sub-period, $RET\_PAR_{-1,A}$, $RET\_SUB_{-1,A}$, and $RET\_REM_{-1,A}$, and then the returns over the final offer sub-period, $RET\_PAR_{A,0}$, $RET\_SUB_{A,0}$ and $RET\_REM_{A,0}$. Specifically, while $RET\_PAR_{-1,A}$, $RET\_SUB_{-1,A}$ and $RET\_REM_{-1,A}$ are scaled by the value of the parent on the original filing date, $RET\_PAR_{A,0}$, $RET\_SUB_{A,0}$ and $RET\_REM_{A,0}$ are scaled by the value of the parent on the amendment date. Our return metrics therefore reflect the effect of additional firm-specific information on investors' anticipation of the pre-IPO value discovery process and on the value revision of the parent firm.

In case an issuer does not make any file range amendment during its book-building period, we follow Bradley and Jordan (2002) and re-define the amendment date as the original filing date. In this respect, $RET\_PAR_{A,0}$, $RET\_SUB_{A,0}$ and $RET\_REM_{A,0}$ become identical to $RET\_PAR_{-1,0}$, $RET\_REM_{-1,0}$ and $RET\_SUB_{-1,0}$.

3. Sample selection and data description

3.1. Sample selection

We follow Hand and Skantz (1999, fn. 3) in extracting equity carve-outs from Thomson Financial's Security Data Company (SDC) database. After excluding unit offers, rights issues, closed-end funds (including REITs), partnerships, foreign issuers, ADRs, and financial institutions (SIC code 6000-6999), our search of SDC yielded 424 completed carve-out IPOs offered between 1985 and 2005. We then exclude 198 firms whose parents are not publicly traded or not traded on the US stock markets, 18 misclassifications

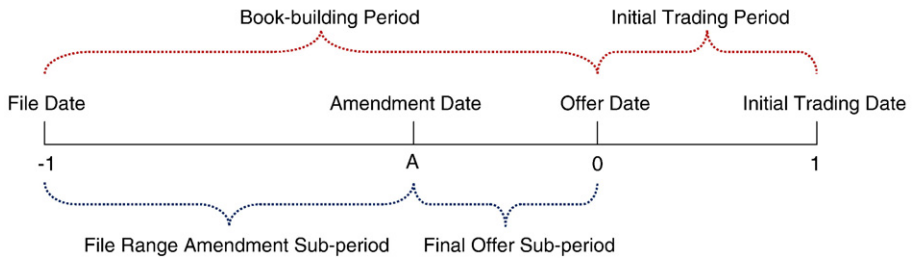

Fig. 1. Timing of the events. Fig. 1 illustrates both the pre- and post-IPO periods during an issuing firm's going public process as discussed in Section 2. In case an issuing firm does not amend its indicative file range during the pre-IPO book-building period, its final offer sub-period is the same as the book-building period.

where parents sold 100% of their holdings in the subsidiaries, six issues where the parent and the subsidiary are identical, two issues qualified as simultaneous spin-offs from the same parent, and one tracking stock offer.[4]

We cross-check the number of shares outstanding reported in SDC with CRSP and remove 10 issues where we cannot verify the inconsistencies between SDC and CRSP from other sources.[5] Since our analysis requires the parent to have a significantly large stake in its subsidiary, we also exclude 13 offers in which the parents own less than 80% prior to the public offerings of their subsidiaries. Alternative cutoff points at 85%, 90%, and 100% do not change our results. Our final sample consists of 176 carve-out IPOs.

Offer characteristics such as offer size, filing date, offer date, the fraction of the subsidiary owned by its parent prior to and after the IPO, and file range amendment information, are from SDC. Underwriter's reputation ranking is from Loughran and Ritter's (2004) update of the Carter and Manster (1990) tombstone measure. Stock prices and shares outstanding are from the Center for Research in Securities Prices (CRSP) daily stock data tape. In case the offer date is the same as the first trading day of the subsidiary, we follow Ellis, Michaely and O'Hara (2000) and re-define the offer day as one business day prior to the original offer day.

3.2. Summary statistics

Panel A of Table 1 reports summary statistics of offering characteristics obtained for the carve-out IPOs. On average, it takes 72 days for the subsidiaries in our sample to go public. The average gross proceeds that the subsidiary files with the SEC are $244.51 million, with a median of over $38 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 large issues in particular. Relatedly, the carve-out IPOs average a 14% first day return during our sample period, slightly lower than the 18% documented in Ibbotson, Sindelar and Ritter (1994).

Valued at the final offer price, the average fraction of the subsidiary offered for sale represents 21% of the parent's value, suggesting that the parent carves out a non-trivial portion of its assets. We also observe that the parent retains a significant and controlling portion – on average 68% – of the subsidiary after the offering. Although untabulated, the parents' post-IPO equity stake retained in their subsidiaries averages around 41% of the assets of the parent. There is variation in the percent of the subsidiary held by the parent — α varies from 8.2% (Kentucky Electric Steel) to 94.5% (Newmont Gold Co.).

In our sample, 29% of the subsidiaries and their parents are in the same industry defined by the first two-digit SIC codes. About 29% of the subsidiaries come from the "high-tech" industries (three-digit SIC codes 283, 357, 366, 367, 381, 382, 383, 384, 737, 873, and 874).[6] 60% of the offerings raise funds for future investments such as acquisitions and product developments, while the remaining 40% are for financing purposes such as debt reduction and refinancing.

Panel B of Table 1 provides summary statistics on various return metrics. We observe a significant 9% share price increase for the parent (7% if adjusted for contemporaneous S&P 500 returns, $p=0.02$) during its subsidiary's pre-IPO book-building stage. When dichotomizing this return into the (weighted) returns to the subsidiary and the remaining firm, there is an average fall in the subsidiary's value, though it is not statistically significant. When weighted by the fraction of the subsidiary held by the parent (β), the mean subsidiary return becomes less negative, suggesting some positive correlation between β and the parent's book-building period return. On its subsidiary's first trading day, we observe a slightly negative, though significant, return to the parent. However, the seemingly small reaction based on this aggregate measure belies the magnitude of the underlying determinants. We also note that consistent with underpricing, a subsidiary's value change (scaled by the size of its parent) during its initial trading period, is significantly positive.

Panel C reports the summary statistics with respect to file range amendment activities for our sample firms. 37 out of the 176 sample firms amended their prices.[7] Among the 37 issues who amended their file ranges, 11 revised their prices above the original filing range, 11 revised within the original filing range, and 15 revised below the original filing range. There is no significant difference in initial returns for issues revising below the original filing range and those revising within the original range ($p=0.571$). In contrast, the initial return for issues revising above their file range averages 68.75% — which is both economically and statistically significantly different from the other two groups of firms. Similar to Bradley and Jordan (2002), we also find that file range amendments more likely occur towards the end of the book-building stage (not reported). These results suggest that if investors rely on the arrival of file range amendments to participate indirectly in the underpriced subsidiaries through investing in the shares of their parents, then they are not only limited to those that revise their file range upwards, but are also limited to a much shorter time horizon.

We plot the time-series process of the market-adjusted return in a scaled event space in Fig. 2. Details on the construction of this figure are provided in Appendix B. In Fig. 2, the blue solid line reflects the time-standardized cumulative abnormal returns for the parent firms in our sample. We observe that value revisions in the parent companies occur towards the end of the book-building period, suggesting that the positive market-adjusted return to the parent firm over the book-building period is less likely

[4] Equity carve-outs differ from spin-offs, which are *pro rata* stock dividends – usually tax-free – and where the entire control rights to the new entity are apportioned to the shareholders of the parent firm (Schipper and Smith, 1986; Allen and McConnell, 1998). Equity carve-outs also differ from tracking stocks. "Holders of tracking stock do not have a special right to the tracked assets and share in all of the issuer's assets." For a detailed discussion of tracking stocks, see Chemmanur and Paeglis (2001) and Clayton and Qian (2004). Including or excluding this tracking stock in our sample does not change our results.

[5] Ljungqvist and Wilhelm (2003) document significant inconsistencies between the number of shares outstanding reported in SDC and those reported in CRSP or other sources. A detailed discussion of the errors they found is available at http://pages.stern.nyu.edu/~aljungqv/research.htm. We thank Alexandar Ljungqvist for sharing their 1996–2000 data with us.

[6] This definition follows Benveniste, Ljungqvist, Wilhelm and Yu (2003) and "Hi Tech Industry Group" defined by SDC, and covers industries such as pharmaceuticals, computing, computer equipment, electronics, medical and measurement equipment, software and biotech industries.

[7] In our analyses, we use the first available file range amendment to both capture the impact of the initial entry of additional firm-specific information into the market during the pre-IPO stage, and to mitigate the effect from amendments due to the SEC mandatory rules. Using the last file range amendment does not change our results.

Table 1
Summary statistics

Panel A: Firm and offering characteristics	Mean	*p*-value	Median	Standard deviation	*N*
Initial return	13.81%	(0.000)	3.96%	34.47%	176
Price revision	0.21%	(0.901)	0.00%	22.70%	176
Gross proceeds (in $mm)	244.51		38.40	875.31	172
Underwriter ranking	7.7		8.1	2.0	175
Length of the book-building period (in days)	72		56	51	176
Fraction of the parent being carved out	20.80%		7.83%	48.73%	176
Fraction of the subsidiary owned by parent before carve-out (β)	98.21%		100.00%	4.61%	176
Fraction of the subsidiary owned by parent after carve-out (α)	67.99%		71.85%	18.10%	176
Fraction of high-tech issues	28.98%				176
Same Industry	28.98%				176
Use of Proceeds	59.65%				171
Panel B: Returns to the carved-out subsidiaries and their parents					
Book-building period (from filing to offer date)					
$RET\_PAR_{-1,0}$	8.99%	(0.006)	2.03%	42.59%	176
$RET\_SUB_{-1,0}$	−11.69%	(0.125)	−0.01%	99.44%	172
$\beta \times RET\_SUB_{-1,0}$	−10.21%	(0.120)	−0.01%	85.69%	172
$RET\_REM_{-1,0}$	22.84%	(0.004)	3.95%	103.37%	172
Initial Trading Period (from offer to initial trading date)					
$RET\_PAR_{0,1}$	−1.74%	(0.002)	−0.40%	7.44%	176
$RET\_SUB_{0,1}$	6.97%	(0.006)	0.77%	33.14%	176
$\alpha \times RET\_SUB_{0,1}$	4.64%	(0.001)	0.53%	18.19%	176
$RET\_REM_{0,1}$	−8.14%	(0.001)	−1.70%	33.37%	176

Panel C: File range amendment activities

	Above	Within	Below	*p*-value	*p*-value	*p*-value
	(1)	(2)	(3)	(1)=(2)	(1)=(3)	(2)=(3)
Price revision	45.26%	4.26%	−27.36%	(0.020)	(0.000)	(0.061)
	(0.004)	(0.726)	(0.000)			
Initial return	68.75%	19.21%	0.52%	(0.043)	(0.002)	(0.571)
	(0.014)	(0.030)	(0.674)			
$RET\_PAR_{-1,0}$	72.59%	7.38%	−6.61%	(0.125)	(0.033)	(0.889)
	(0.088)	(0.517)	(0.147)			
$RET\_PAR_{0,1}$	−4.16%	−3.23%	0.09%	(0.965)	(0.429)	(0.593)
	(0.302)	(0.070)	(0.947)			
No. of observations	11	11	15			

Panel A provides summary statistics for the sample of 176 carve-out IPOs and their parents between 1985 and 2005. *Initial return* is the first day close price over the offer price, minus one. *Price revision* is the percentage change between the expected and final offer prices over the pre-IPO book-building period. Gross proceeds do not include the over-allotment option. *Length of the book-building period* is the number of days in the book-building period. Underwriter rankings are investment banker rankings based on the Loughran and Ritter (2004) update of the Carter and Manaster (1990) tombstone measure. "High-tech" industries are classified by the first three-digit SIC codes 283, 357, 366, 367, 381, 382, 383, 384, 737, 873, and 874. Same Industry is a dummy variable equal to 1 if the parent and the subsidiary share the same first two-digit SIC code and 0 otherwise. Use of Proceeds is a dummy variable equal to 1 if the proceeds from carving out the subsidiary are used for investment and operation improvements and 0 otherwise. Panel B provides summary statistics for the returns of carved-out subsidiaries and their parents during the book-building period (from $t=-1$, to $t=0$) and the initial trading period (from $t=0$ to $t=1$). $RET\_PAR_{-1,0}$ is the parent company's book-building period return. $RET\_SUB_{-1,0}$ and $RET\_REM_{-1,0}$ are the value change in the subsidiary and the remaining assets during the book-building period, scaled by their parent's market capitalization on the filing date, respectively. $RET\_PAR_{0,1}$ is the parent company's return during its subsidiary's initial trading period. $RET\_SUB_{0,1}$ and $RET\_REM_{0,1}$ are the value change in the subsidiary and the remaining assets during the initial trading period, scaled by their parent's market capitalization on the offer date, respectively. The details of variable calculations are given in Appendix A. Panel C reports summary statistics for these sample firms who amend above, within, or below their initial file ranges. *p*-values associated with *t*-statistics testing the mean value to be zero are reported in parentheses.

to be associated with the announcement effect due to the carve-out (perhaps due to increased focus). This result remains unchanged when we use raw returns instead of market-adjusted returns.

Furthermore, Fig. 2 suggests that the rise of the time-standardized cumulative abnormal returns of the parent firms (blue-solid line) towards the end of the book-building period is affected by those whose subsidiaries amend their file range above their initial indicative file range (purple-dashed line).[8] To analyze whether investors can achieve abnormal returns from investing in the parents upon observing their subsidiaries' upward price amendments, we compute the abnormal return for each of these parent firms on a given day by subtracting the S&P500 return from the return to the parent on that day. We accumulate these abnormal returns from the amendment date to the offer date. The mean cumulative return for these parents firms is −4.85% ($p=0.34$) and the median is −2.30% ($p=0.15$). These test statistics thus complement the results of Table 1 and indicate that returns from investing in the shares of the parent upon observing its subsidiary's price amendment above the original file range are, on average, not statistically different from zero.[9]

[8] The time-series processes of the market-adjusted returns of the parent firms whose subsidiaries do not amend their file range or amend within their file range fall between those of the parent firms whose subsidiaries amend above and amend below their file range. Therefore, these returns are not included in Fig. 2.

[9] In an alternative specification we consider subsidiaries whose mid-point of the amended file range is higher than the mid-point of the original file range. The mean and median cumulative abnormal returns of their parent firms from the amendment date to the offer date are -0.137% ($p=0.978$) and -2.164% ($p=0.376$), respectively.

4. Initial returns of the carve-out IPOs

We now present the results of our empirical strategy outlined in Section 2. In the current section, we examine the predictability of the first day performance of the carved-out subsidiary by focusing on whether the additional information from having a publicly-traded parent provides economically important predictive powers beyond those measures previously identified in the literature. In Section 5 we focus on the cross-market correlations between the first trading day performance of the carved-out subsidiary and the parent. Finally, in Sections 6 and 7, we turn our attention to the predictability of returns to the parent on the subsidiary's initial trading day, and the predictability of returns to the subsidiary (price update) during its book-building period. 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. Returns to the parent over the book-building period

We begin our analysis by analyzing the correlations between our various return metrics (not tabulated). Consistent with the partial adjustment evidence documented by Hanley (1993), the initial return of the subsidiary is positively and significantly related to the value revision of the issue during its book-building period — the Pearson correlation between the pre-IPO value revision and initial return is 0.492 ($p=0.00$), and becomes 0.244 ($p=0.00$) if both are scaled by the market values of the parent. Spearman (rank) correlation analysis yields similar results. We observe a negative correlation between the book-building period return and the initial day return of the parent. This may represent some evidence consistent with over-reaction in the revaluation of the parent stock during the book-building period.

While the value revision of the subsidiary during the book-building period is not significantly related to the parent's first day return, the return to the parent during the book-building period is significantly and positively correlated with the subsidiary's first trading day return. This result is consistent with the hypothesis that the subsidiary's first trading day return is partially anticipated by traders in the parent's stock.

We now explore this result formally by examining whether the parent's book-building period return affects its subsidiary's first trading day return. Our objectives are two-fold: first, we need to document whether the initial returns of the carved-out subsidiaries mimic those of their IPO counter-parts. Second, we need to investigate whether the additional information available due to the presence of a publicly-traded parent provides important information about initial returns.

Panel A of Table 2 reports the results of the degree of anticipation of the subsidiary's IPO underpricing, where underpricing is defined in a manner comparable to previous IPO studies. *p*-values are based on robust standard errors.

Column (1) of Panel A indicates that the return to the parent during the pre-IPO book-building period is positively and significantly related to the subsidiary's underpricing. One standard deviation change in the parent's book-building period return is associated with a 15.8% (=0.371×42.59% of Table 1) change in the predicted first trading day return of the subsidiary. This suggests that a publicly-observable signal – the share price of the parent – can be used to predict the first day return of the subsidiary. Although so far the existence of an efficient IPO market has not yet been credibly argued, our result at least reveals that one more common or public signal is informative about first day underpricing.

We then employ the partition described in Section 2 and examine whether the relation between subsidiary's initial return and parent's pre-offer performance varies across the components of the parent company. The results are presented in Column (2) of Panel A.

We find that value revision of the subsidiary during its book-building period is positively and significantly associated with its first day performance. This is consistent with the partial-adjustment argument and previous empirical findings. In addition, the

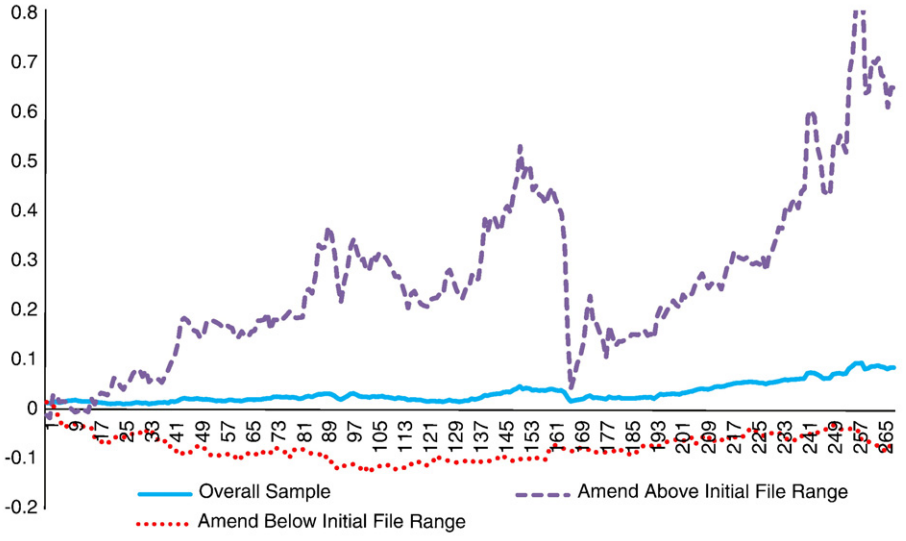

Fig. 2. Time standardized parent companies' mean cumulative returns during the book-building period of their subsidiaries' IPOs.

performance of the remaining assets of the parent is positively related to the subsidiary's first day return. The *F*-test for equality across the two components indicates that the two coefficients are not equal ($p=0.00$).

Our results thus 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 Columns (3) and (4) we control for the contemporaneous market return (the S&P 500 index) during the subsidiary's book-building period. Hanley (1993), Loughran and Ritter (2002) and Lowry and Schwert (2004) find that market index return – a proxy for public information during the book-building period – is positively related to IPO underpricing. Interestingly, we find this effect is not significant in the presence of the parent company's return. This suggests that any market-wide public information may already be reflected in the return of the publicly traded parent during the book-building period and may no longer predict the subsidiary's initial day return.[10] Our results do not change when we use CRSP value-weighted index returns.

We then re-estimate our regression by including other firm-specific control variables that could affect initial returns. These are underwriter's reputation and market power (*UWRANK*), the purpose of going public (Use of Proceeds, a dummy variable equal to 1 if the proceeds raised are used for investment and development, and 0 otherwise), the similarity between the parent and the subsidiary (Same Industry, a dummy variable equal to 1 if both the parent and the subsidiary share the same first 2-digit SIC code, and 0 otherwise), and whether the issuer belongs to high-tech industries (Hi-Tech). We add a control for size, where SIZE is the log value of the gross proceeds filed with SEC. To control for IPO waves over time, we also include year fixed-effect in our analysis.[11]

The results are reported in Columns (5) and (6) of Panel A, Table 2. We find that our results in Columns (1) and (2) are robust to year fixed-effects and controlling for additional firm-specific characteristics. The parent company's pre-IPO period return continues to be positively and significantly associated with the subsidiary's initial day return (Column (5)). Our results are consistent with the hypotheses that the market recognizes information acquisition and value discovery process during the subsidiary's book-building period and anticipates that the issue will be underpriced.[12]

To summarize, we document that the parent's return during its subsidiary's pre-IPO book-building period is positively related to the subsidiary's underpricing. We also find that the underpricing of the carved-out IPO depends upon the value revisions associated with the subsidiary and the remaining assets of the firm. Our results suggest that investors recognize the information discovery process and anticipate the underpricing of the IPO. In addition, market returns during the book-building period are no longer significantly related to the subsidiary's underpricing in the presence of a parent company's returns. This suggests market-wide information is subsumed by firm-specific information.

Note that our research design makes our results unlikely to be driven by the prospect theory hypothesis discussed in Loughran and Ritter (2002). This is because the parent companies in our samples are relatively large and are publicly traded firms. They are unlikely to be subjected to wealth constraints faced by small entrepreneurs. They also tend to have more bargaining power against underwriters.

4.2. Availability of additional firm-specific information: file range amendment

Bradley and Jordan (2002) document that issuing firms' file range amendments are significantly related to their IPO underpricing. As discussed in Section 2.2, in the context of our research framework, a file range amendment – if it occurs – captures the arrival of an additional and also potentially more precise piece of information about the subsidiary. This affects the price of the parent not only through its ownership of the subsidiary, but also by augmenting the incentives of the investors who participate in the parent company's stocks as an indirect venue of investing in its subsidiary. To take into account the impact of file range amendment during the book-building period, we run the same regressions as those in Panel A, but with returns over the pre-IPO file range amendment sub-period and final offer sub-period defined as in Section 2.2. Panel B of Table 2 reports the regression results.

Columns (1), (3) and (5) of Panel B reveal that returns to the parent from initial filing date to the amendment date and from the amendment date to the final offer date both have predictive power. *F*-tests reveal that there is no difference between the two coefficients, indicating that returns over the two sub-periods generate similar effect on initial returns. In terms of economic significance, Column (1) of Panel B suggests that one standard deviation change in the parent's return between the filing date and the amendment date leads to a change of 14.30% in initial returns. In contrast, one standard deviation change in the parent's return between the amendment and the offer dates leads to a change of 4.30% in initial returns.[13]

[10] For example, the *F*-test cannot reject the null hypothesis that 0.383 − 0.301 = 0 (Column (3)). This suggests that market-wide information is subsumed by firm-specific information proxied by the parent's return during the book-building period.

[11] Lamont and Thaler (2003) study several tech stock carve-outs where a subsidiary is more valuable than its parent and find that arbitrage does not eliminate these mispricings due to short sale constraints. Ofek and Richardson (2003) examine 1998–2000's internet stock market mania and find that the internet market bubble might be caused by retail investors' over-valuing the stock and by lack of supply of shares for short. We therefore control for the high-tech dummy and year fixed-effect.

[12] In untabulated results, we re-run the previous specifications, but with differing measures of initial day carve-out returns for our dependent variable. The first dependent variable is the return to the carve-out subsidiary scaled by the size of the parent, and the second dependent variable is the return adjusted by both the size of the parent at the offer date and the parent's holding of the subsidiary after the carve-out (α). Our results are robust, regardless of the choice of the dependent variable.

[13] We multiply the coefficient of 0.217 from Column (1) of Panel B, Table 2, with the standard deviation of $RET\_PAR_{-1,A}$, 65.90% (not reported), to arrive at the change in initial return of 14.30%. We then multiply the coefficient of 0.184 from Column (1) of Panel B, Table 2, with the standard deviation of $RET\_PAR_{A,0}$, 23.36% (not reported), to arrive at the change in initial return of 4.30%.

Columns (2), (4) and (6) indicate that the value-revisions of the subsidiary during both the file range amendment sub-period and the final offer sub-period are positively associated with the subsidiary's initial returns. This is consistent with the findings of Bradley and Jordan (2002).

In addition, we observe that returns to the remaining assets over the two sub-periods do not statistically predict the initial return of the subsidiary separately.

5. Returns during the subsidiary's initial trading period

In this section, we investigate the relationships between initial trading day returns of the parent and its carved-out subsidiary. We examine these relations in a regression context, with various metrics of the return to the subsidiary as the dependent variable. If an investor uses the parent's stock as an indirect, yet non-rationed, avenue to capture the initial gain of the carve-out, and if the market is efficient, then we should expect the parent company's book-building period return to be associated with the initial return of its carved out subsidiary, but we should not observe any significant correlation between the parent company's return and its subsidiary's return on the initial trading day.

Table 3 reports the results. In contrast to the results from Table 2, where the parent company's book-building period return is significantly related to the first day return of the subsidiary, there is no contemporaneous relationship between the parent company's return and its subsidiary's underpricing. Regardless of the definition of the subsidiary's initial return employed, and whether the contemporaneous market return is included, first day returns to the subsidiary are not significantly associated with the contemporaneous returns to the parent.

6. Predictability of the parent's return during initial trading period

In the previous two sections, we documented that the initial returns of the subsidiary are predictable given the book-building period performance of both the parent and the subsidiary, but the correlation between the returns to the two on the first trading day is not significant. In this section, we investigate the efficiency of IPO market by examining whether the returns to the parent companies can be predicted on the first day when their subsidiaries become publicly traded. Since trading and ownership of the parent firm are neither 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.

Column (1) of Panel A, Table 4 reports the results from regressing the parent's initial day return against its return during the book-building period. We note that the coefficient associated with the parent company's book-building period return is negative (−0.028) and insignificant. It becomes marginally significant after controlling for market return during the same period (Column (2)). This suggests that the effect of a possible over-reaction – where valuation revisions during the book-building period are partially reversed on the first trading day – is at most marginal.

Next, we decompose the book-building period return of the parent into the return to the subsidiary and to the remaining assets in the parent company. The results are reported in Columns (3) and (4) of Panel A, Table 4. Also consistent with the hypothesis of over-reaction, the coefficients associated with the two components are negative. However, both remain insignificant regardless whether the market return is controlled.

Finally, we parse the initial return of the subsidiary into an expected component ($PRED\_RET\_SUB_{0,1}$) and an unexpected component ($RESI\_RET\_SUB_{0,1}$), which we define statistically based on publicly available information from the book-building period. Specifically, for Columns (5) and (6) we obtain the fitted values and residuals of initial returns by regressing $RET\_SUB_{0,1}$ against the variables as in Column (5) of Panel A, Table 2. In this case, the expected component of initial return ($PRED\_RET\_SUB_{0,1}$) reflects both firm-specific and market-wide information proxied by the returns to the parent and to the market during the book-building period.

From Columns (5) and (6) we observe that the coefficients associated with the *anticipated* return to the carved-out IPO ($PRED\_RET\_SUB_{0,1}$) are insignificant. This suggests that the part of the subsidiary's initial return that is predictable using public information available during its book-building period is unrelated to the parent company's return on the first trading day. In contrast, the coefficients associated with the *unanticipated* component of the subsidiary's initial return ($RESI\_RET\_SUB_{0,1}$) are significantly and positively related to the parent's first day return. This suggests that the part of the subsidiary's initial return unpredictable by the information revealed during its book-building period is related to the parent company's contemporaneous return. Our results are robust to controlling for the market return during the subsidiary's pre-IPO period and year fixed-effect.

Notes to Table 2:

This table describes the relationship between the book-building period return of the publicly traded parent company and the initial return of the subsidiary. The dependent variable is the subsidiary's initial return. In Panel A, the parent company's book-building period return $RET\_PAR_{-1,0}$ is also partitioned into the book-building period returns to the subsidiary ($RET\_SUB_{-1,0}$) and to the remaining assets ($RET\_REM_{-1,0}$), all adjusted by the size of the parent (market capitalization) on the filing date. $RET\_MKT_{-1,0}$ is the S&P 500 return during the book-building period. In Panel B, various pre-IPO returns are further partitioned into returns to the parent, the subsidiary and the remaining assets over the file range amendment sub-period ($RET\_PAR_{-1,A}$, $RET\_SUB_{1,A}$, $RET\_REM_{1,A}$ and $RET\_MKT_{1,A}$), and over the final offer sub-period ($RET\_PAR_{A,0}$, $RET\_SUB_{A,0}$, $RET\_REM_{A,0}$ and $RET\_MKT_{A,0}$). SIZE is the log value of the subsidiary at the filing day. Underwriter rankings (UWRANK) are investment banker rankings based on the Loughran and Ritter (2004) update of the Carter and Manaster (1990) tombstone measure. Hi-Tech is a dummy variable equal to 1 if the subsidiary's first three-digit SIC code belongs to 283, 357, 366, 367, 381, 382, 383, 384, 737, 873, and 874 and 0 otherwise. Same Industry is a dummy variable equal to 1 if the parent and the subsidiary share the same first two-digit SIC code and 0 otherwise. Use of Proceeds is a dummy variable equal to 1 if the proceeds from carving out the subsidiary are used for investment, operation improvements and 0 otherwise. *p*-values based on robust standard errors are in parentheses below coefficients.

In Panel B of Table 4, we explicitly examine whether the arbitrage is possible upon observing file range amendment by investigating whether the return to the parent over the final offer sub-period can predict the return to the parent on the initial trading day. We find that the coefficient associated with the return to parent from its subsidiary's file range amendment date to the

Table 2
Initial trading day return analysis for the carve-out subsidiaries

Panel A	Dependent variable: initial return					
	(1)	(2)	(3)	(4)	(5)	(6)
Intercept	0.105	0.105	0.110	0.110	0.188	0.201
	(0.000)	(0.000)	(0.000)	(0.000)	(0.101)	(0.087)
Variables of interest						
$RET\_PAR_{-1,0}$	0.371		0.383		0.383	
	(0.000)		(0.001)		(0.001)	
$\beta \times RET\_SUB_{-1,0}$		0.418		0.431		0.422
		(0.000)		(0.000)		(0.000)
$RET\_REM_{-1,0}$		0.342		0.353		0.349
		(0.000)		(0.000)		(0.001)
Control variables						
$RET\_MKT_{-1,0}$			−0.301	−0.317	−0.681	−0.688
			(0.533)	(0.496)	(0.187)	(0.201)
UWRANK					0.002	−0.002
					(0.882)	(0.883)
Use of Proceeds					0.060	0.069
					(0.174)	(0.126)
Same Industry					−0.003	−0.014
					(0.959)	(0.821)
Hi-Tech					0.020	0.012
					(0.730)	(0.840)
SIZE					−0.023	−0.019
					(0.355)	(0.388)
Year Fixed-Effect					Yes	Yes
No. of obs.	176	172	176	172	167	167
Panel B						
Intercept	0.073	0.127	0.072	0.129	0.171	0.275
	(0.009)	(0.000)	(0.009)	(0.000)	(0.149)	(0.020)
Variables of interest						
$RET\_PAR_{-1,A}$	0.217		0.218		0.178	
	(0.005)		(0.016)		(0.101)	
$RET\_PAR_{A,0}$	0.184		0.180		0.235	
	(0.028)		(0.060)		(0.008)	
$\beta \times RET\_SUB_{-1,A}$		0.540		0.646		0.606
		(0.048)		(0.006)		(0.023)
$\beta \times RET\_SUB_{A,0}$		0.727		0.743		0.686
		(0.003)		(0.003)		(0.008)
$RET\_REM_{-1,A}$		0.235		0.255		0.193
		(0.176)		(0.144)		(0.328)
$RET\_REM_{A,0}$		−0.006		−0.006		0.001
		(0.420)		(0.391)		(0.913)
Control variables						
$RET\_MKT_{-1,A}$			−0.050	−1.351	−0.582	−1.899
			(0.965)	(0.123)	(0.662)	(0.106)
$RET\_MKT_{A,0}$			0.079	−0.005	−0.269	−0.315
			(0.895)	(0.993)	(0.732)	(0.655)
UWRANK					0.004	0.006
					(0.759)	(0.639)
Use of Proceeds					0.028	0.005
					(0.571)	(0.900)
Same Industry					0.035	0.012
					(0.614)	(0.858)
Hi-Tech					0.027	0.016
					(0.644)	(0.770)
SIZE					−0.028	−0.036
					(0.285)	(0.130)
Year Fixed-Effect					Yes	Yes
No. of obs.	176	172	176	172	167	167

Table 3
Return analysis during the initial trading period

	Initial Return		$RET\_SUB_{0,1}$		$\alpha \times RET\_SUB_{0,1}$	
	(1)	(2)	(3)	(4)	(5)	(6)
Intercept	0.125	0.125	0.073	0.073	0.046	0.046
	(0.000)	(0.000)	(0.020)	(0.020)	(0.004)	(0.005)
$RET\_PAR_{0,1}$	−0.765	−0.835	0.183	0.173	−0.034	−0.054
	(0.251)	(0.245)	(0.714)	(0.751)	(0.914)	(0.775)
$RET\_MKT_{0,1}$		3.325		0.500		0.953
		(0.441)		(0.831)		(0.520)
No. of obs.	176	176	176	176	176	176

In this table we investigate whether initial returns to the subsidiaries are related to the returns to their parents during the initial trading periods. The dependent variable is the subsidiary's initial return, where three variations are used: the value revision of the subsidiary during the initial trading period scaled by the size of the subsidiary on the offer date, *Initial Return*, scaled by the size of the parent on the offer date, $RET\_SUB_{0,1}$, and $\alpha \times RET\_SUB_{0,1}$, which is $RET\_SUB_{0,1}$ multiplied by α, the fraction of the subsidiary's shares retained by the parent. $RET\_PAR_{0,1}$ is the parent company's return on its subsidiary's initial trading day. $RET\_MKT_{0,1}$ is the S&P 500 index return on the subsidiary's initial trading day. *p*-values based on robust standard errors are in parentheses.

final offer date is not significantly related to the parent's initial day return (Columns (1) through (2)). This suggests that arbitrage profit on average is not accessible upon observing file range amendments.

For Column (5) and (6) of Panel B, Table 4, we obtain the fitted values and residuals by regressing initial returns against the returns to the parent and to the subsidiary during both the file range amendment sub-period and the final offer sub-period in

Table 4
Analysis of predictability of the parent's first day return

Panel A	(1)	(2)	(3)	(4)	(5)	(6)
Intercept	−0.014	−0.018	−0.015	−0.018	−0.015	−0.016
	(0.014)	(0.008)	(0.018)	(0.013)	(0.023)	(0.024)
$RET\_PAR_{-1,0}$	−0.028	−0.033				
	(0.143)	(0.066)				
$\beta \times RET\_SUB_{-1,0}$			−0.025	−0.030		
			(0.227)	(0.150)		
$RET\_REM_{-1,0}$			−0.023	−0.028		
			(0.189)	(0.113)		
$PRED\_RET\_SUB_{0,1}$					−0.047	−0.047
					(0.217)	(0.214)
$RESI\_RET\_SUB_{0,1}$					0.046	0.046
					(0.002)	(0.002)
$RET\_MKT_{-1,0}$		0.159		0.150		0.071
		(0.163)		(0.217)		(0.518)
Year Fixed-Effect	Yes	Yes	Yes	Yes	Yes	Yes
No. of obs.	176	176	172	172	167	167
Panel B						
Intercept	−0.019	−0.019	−0.019	−0.019	−0.018	−0.010
	(0.002)	(0.007)	(0.002)	(0.008)	(0.285)	(0.317)
$RET\_PAR_{A,0}$	0.027	0.027				
	(0.214)	(0.184)				
$\beta \times RET\_SUB_{A,0}$			0.032	0.032		
			(0.113)	(0.097)		
$RET\_REM_{A,0}$			0.027	0.027		
			(0.121)	(0.102)		
$PRED\_RET\_SUB_{0,1}$					0.002	0.000
					(0.938)	(0.988)
$RESI\_RET\_SUB_{0,1}$					0.024	0.024
					(0.087)	(0.097)
$RET\_MKT_{-1,A}$						0.156
						(0.394)
$RET\_MKT_{A,0}$		−0.002		−0.009		0.030
		(0.985)		(0.947)		(0.828)
Year Fixed-Effect	Yes	Yes	Yes	Yes	Yes	Yes
No. of obs.	176	176	172	172	167	167

In this table we investigate whether the returns to the parent companies on 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 the parent company's return on its subsidiary's initial trading day. Return variables over the entire book-building period and over the final offer sub-period are defined in Table 1. $PRED\_RET\_SUB_{0,1}$ is the predicted initial return of the subsidiary using the information available during the book-building period. For Columns (5) and (6) of Panel A, it is obtained by regressing $RET\_SUB_{0,1}$ against $RET\_PAR_{-1,0}$ and control variables of $RET\_MKT_{-1,0}$, UWRANK, Use of Proceeds, Same Industry, Hi-Tech, SIZE and year fixed effects. For Columns (5) and (6) of Panel B, it is obtained by regressing $RET\_SUB_{0,1}$ against $RET\_PAR_{-1,A}$, $RET\_PAR_{A,0}$, $RET\_SUB_{-1,A}$ and $RET\_SUB_{A,0}$, controlling for $RET\_MKT_{-1,A}$, $RET\_MKT_{A,0}$, UWRANK, Use of Proceeds, Same Industry, Hi-Tech, SIZE and year fixed effects. The unanticipated component of the subsidiary's initial return ($RESI\_RET\_SUB_{0,1}$) is the residual from the corresponding regression model, respectively. *p*-values based on robust standard errors are in parentheses below coefficients.

addition to the control variables as in Column (5) of Panel B, Table 2. The expected component of initial return ($PRED\_RET\_SUB_{0,1}$) thus takes into account the impact of potential arrival of another piece of firm-specific information – the subsidiary's price amendment during the book-building period — in addition to that of other control variables.

The results from Columns (5) and (6) are consistent with those in Panel A of Table 4. The predictable component of the subsidiary's initial return continues to be unrelated to the return to the parent on the initial trading day, after taking into account the availability of additional firm-specific information with respect to the value revision of the subsidiary. The coefficient associated with the unpredictable component remains positive, albeit only marginally significant.

Its magnitude also appears to be smaller compared to those in Panel A. Since file range amendment tends to be a less noisy proxy than the price of the parent concerning the value of the subsidiary, and tends to occur at the end of the book-building period, the uncertainty surrounding the subsidiary's underpricing is further reduced upon the arrival of this additional firm-specific information. Consequently, the unexpected component of initial return becomes less related to the returns to the parent on the initial trading day.

To summarize, we document that the returns to the parent companies on the first day when the subsidiaries become publicly traded cannot be predicted by the returns to the parents or to the subsidiaries during the book-building period, nor by the returns to the parents upon observing their subsidiaries' file range amendments. It is the unanticipated component, rather than the anticipated component, of a subsidiary's initial return that is correlated with the parent's contemporaneous return. We interpret these results as evidence consistent with market efficiency.

7. Predictability of the subsidiary's price revision during book-building period

Lowry and Schwert (2004) find that price revision during the book-building period is statistically predictable given the information known at the time when an issuing firm files for public offering. While this empirical evidence suggests that public information is not fully incorporated into the initial filing range, they point out that the economic significance of this relationship is marginal, suggesting that underwriters incorporate majority of public information when setting the initial filing range. In addition, the statistical significance of predicting price revision cannot be materialized into an arbitrage profit as the shares of the issuing firms are not publicly traded during the book-building period.

In the context of our research framework, however, the presence of continuously traded parents in the non-rationed market offers a unique venue to analyze the effects of public information on the pricing of IPOs at the time the issues are filed. Again, since trading and ownership of the parent firm are neither restricted nor rationed, any evidence of predictability of the issuing firm's subsequent price revision leads to a potential arbitrage profit by trading the shares of the parent company when its subsidiary files for public offering, and therefore, must be perceived as violations of efficient markets.

In this section, we investigate the efficiency of IPO market by examining whether the subsidiary's price revision during the book-building period can be predicted. In a framework similar to that of Lowry and Schwert (2004), we analyze the relation between price revision and both firm-specific characteristics and various measures of market returns at the time the issue is filed.

In addition to information indicated in the preliminary prospectus (UWRANK, Use of Proceeds, Same Industry, Hi-Tech and SIZE), we include other proxies for pre-filing firm-specific information: $RET\_PAR_{\_WK1}$, $RET\_PAR_{\_WK2}$, …, and $RET\_PAR_{\_WK8}$, where $RET\_PAR_{\_WK1}$ through $RET\_PAR_{\_WK8}$ are the parent company's returns for the eight weeks (trading days 1–5, 6–10, …, and 36–40) immediately before the subsidiary's filing date. In terms of market-wide public information, we include variables $RET\_MKT_{\_WK1}$, $RET\_MKT_{\_WK2}$, …, and $RET\_MKT_{\_WK8}$, where $RET\_MKT_{\_WK1}$ through $RET\_MKT_{\_WK8}$ are the S&P 500 returns for the eight weeks (trading days 1–5, 6–10, …, and 36–40) immediately before the filing date. Since in Lowry and Schwert (2004) market returns for the most recent four weeks usually have more predictive power, we conduct the regression analyses based on returns up to four weeks and up to eight weeks prior to the filing date, respectively.

Table 5 reports the regression results. Columns (1) through (3) indicate that the returns to the parent up to the time when the subsidiary files for public offering cannot predict the price revision of the subsidiary in its subsequent book-building period. Furthermore, in the presence of a continuously traded parent, offering characteristics are not statistically significantly related to price revision. Columns (4) through (6) reveal that the subsequent price revision is also unrelated to the pre-filing returns to the market. These results suggest that underwriters incorporate all public information when setting the initial price range for the carve-out subsidiaries.

8. Robustness

8.1. Non-stationarities in the IPO market

Ritter and Welch (2002) caution the interpretation of the results from IPO research because they are sensitive to "…the exact time period chosen". In particular, they point out that the sub-sample period including 1999, 2000, and 2001 can lead to different conclusions.

To examine how our results are affected by the non-stationarities in the IPO market identified in Ritter and Welch (2002), we split our sample into pre- and post-1996 sub-samples. We run the regressions for Tables 2 and 4 for each of the two sub-samples. Our main results are robust for the pre-1996 period. For the post-1996 period, however, our results in Table 4 weakened a little – the relation between the unpredicted component of underpricing and the parent's initial day return becomes insignificant. This

Table 5
Analysis of predictability of the subsidiary's price revision

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Intercept	0.000	0.000	−0.198	0.004	0.010	−0.177	−0.183	−0.179
	(0.982)	(0.988)	(0.036)	(0.851)	(0.638)	(0.096)	(0.060)	(0.065)
RET_PAR_{-WK1}	0.061	0.104	0.085				−0.051	−0.094
	(0.873)	(0.788)	(0.830)				(0.897)	(0.825)
RET_PAR_{-WK2}	−0.061	−0.049	0.022				−0.013	0.040
	(0.853)	(0.880)	(0.945)				(0.970)	(0.906)
RET_PAR_{-WK3}	−0.148	−0.159	−0.225				−0.236	−0.262
	(0.704)	(0.712)	(0.617)				(0.570)	(0.577)
RET_PAR_{-WK4}	−0.158	−0.151	−0.188				−0.355	−0.301
	(0.457)	(0.575)	(0.539)				(0.238)	(0.380)
RET_PAR_{-WK5}		−0.114	−0.077					−0.086
		(0.719)	(0.806)					(0.763)
RET_PAR_{-WK6}		−0.114	−0.123					−0.170
		(0.725)	(0.717)					(0.633)
RET_PAR_{-WK7}		0.146	0.146					−0.003
		(0.422)	(0.476)					(0.988)
RET_PAR_{-WK8}		−0.012	0.007					−0.082
		(0.952)	(0.973)					(0.707)
RET_MKT_{-WK1}				0.422	0.306	0.098	0.348	0.134
				(0.598)	(0.709)	(0.910)	(0.726)	(0.896)
RET_MKT_{-WK2}				0.265	0.273	0.350	0.249	0.093
				(0.802)	(0.806)	(0.764)	(0.822)	(0.930)
RET_MKT_{-WK3}				0.031	0.025	−0.094	0.049	0.188
				(0.978)	(0.982)	(0.933)	(0.965)	(0.869)
RET_MKT_{-WK4}				1.272	1.192	0.997	1.456	1.393
				(0.100)	(0.121)	(0.221)	(0.108)	(0.160)
RET_MKT_{-WK5}					0.466	0.626		0.702
					(0.727)	(0.648)		(0.565)
RET_MKT_{-WK6}					−0.076	0.208		0.521
					(0.929)	(0.819)		(0.616)
RET_MKT_{-WK7}					0.940	1.176		1.255
					(0.350)	(0.262)		(0.299)
RET_MKT_{-WK8}					0.359	0.561		0.522
					(0.657)	(0.474)		(0.554)
UWRANK			0.019			0.018		0.020
			(0.064)			(0.058)		(0.058)
Use of Proceeds			0.021			0.022		0.020
			(0.452)			(0.479)		(0.498)
Same Industry			0.040			0.041		0.043
			(0.355)			(0.345)		(0.319)
Hi-Tech			0.054			0.062		0.062
			(0.311)			(0.214)		(0.247)
SIZE			0.002			0.002		−0.002
			(0.922)			(0.936)		(0.914)
No. of obs.	176	176	167	176	176	167	167	167

This table reports the regression results using pre-filing public information to predict the price revision of the subsidiary during its book-building period in a framework similar to that of Lowry and Schwert (2004). The dependent variable is the subsidiary's price revision during its book-building period. RET_PAR_{-WK1} through RET_PAR_{-WK8} are the parent companies' returns for the eight weeks (trading days 1–5, 6–10, …, and 36–40) immediately before the subsidiaries' filing dates. RET_MKT_{-WK1} through RET_MKT_{-WK8} are the S&P 500 returns for the eight weeks (trading days 1–5, 6–10, …, and 36–40) immediately before the filing date. UWRANK, Use of Proceeds, Same Industry, Hi-Tech, and SIZE are defined as in Table 1. *p*-values based on robust standard errors are in parentheses below coefficients.

may be due to the smaller sample size for this sub-period (130 observations for the pre-1996 period and 46 observations for the post-1996 period). It is also possible that the uncertainties surrounding underpricing are significantly reduced due to more frequent file range amendment activities in the late 1990s.

8.2. Other robustness checks

In our sample, some carve-out IPOs' announcement dates are relatively close to their filing dates. Hand and Skantz (1998) document a sharp rise in the parent's price on the announcement day and then a decline in the price on the first trading day of its subsidiary. To separate this potential 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 date and the offer date. Our results remain unchanged economically and econometrically.[14]

[14] Although not reported, the distribution of carve-out IPOs in our sample indicates that there appears to be no obvious clustering of carve-out IPOs over our sample period. Relatedly, the fraction of carve-out IPOs with respect to the total IPOs offered in a particular year appears relatively stable over time.

Our main results are robust if we deflate the return variables by their own deflators (e.g., using the value of the subsidiary instead of the value of the parent as the denominator when calculating the return of the subsidiary). In another robustness check, we include an additional control variable RELSIZE to mitigate the potential impact of the noise in the remaining assets within the parent company on the information content of the subsidiary during the book-building period. RELSIZE is defined as the value of the subsidiary divided by the value of the parent on offer date, scaled by the fraction change of the parent holding in the subsidiary ($\beta-\alpha$). We find similar results.

9. Conclusions

In this study we investigate the efficiency of the IPO market by examining the pricing performance of carve-out IPOs and their parents. The powerful dimension of our experimental design is that shares of the IPO are not traded in the book-building period, but shares of the parent – who owns a non-trivial fraction of the subsidiary, and for whom its stake in the subsidiary is a non-trivial fraction of its assets – are traded in a continuous and non-rationed market environment. We find that, like traditional IPOs, the initial return of the carve-out IPOs is positive and significant – on average 14% – and is correlated with the value revision during the subsidiary's pre-IPO book-building period. When exploring the relations between market-wide information flows and information flows concerning the parent and the subsidiary IPO, our result suggests that market-wide information is subsumed by firm-specific information, as the performance of a market index is no longer significantly related to IPO performance in the presence of a publicly traded parent firm. Complementing the results of Bradley and Jordan (2002), we find that the returns to the parent from the file range amendment sub-period and the final offer sub-period prior to the subsidiary's IPO predict its underpricing.

We find that the pre-IPO price revision of the carve-out subsidiary cannot be predicted by market-wide and firm-specific public information available at the time the initial filing range is set. Nor can the return to the parent on its subsidiary's first trading day be predicted given pre-IPO metrics of both the parent and the carve-out. It is the unanticipated component, rather than the anticipated component, of the subsidiary's initial day return that is correlated with the parent's contemporaneous return. We interpret these results as evidence consistent with market efficiency.

Appendix A. Description and derivation of variables

In this Appendix, we provide a detailed derivation of the variables and the numerical example discussed in Section 2.1. Variables discussed in Section 2.2 can be constructed analogously.

Let $t=-1$, A, 0, and 1 denote the filing date, file range amendment date (if it occurs), offer date and the first day the firm is publicly traded. So for any IPO firm, the pre-IPO book-building period is from $t=-1$ to $t=0$, and the first trading day period is from $t=0$ to $t=1$. As illustrated in Fig. 1, if an issuing firm amends its filing price range prior to its IPO, then the book-building period consists of two sub-periods: the file range amendment sub-period (from $t=-1$ to $t=$A), and the final offer sub-period (from $t=$A to $t=0$).

The value of the parent, V^P_{-1}, V^P_0 and V^P_1, is its market capitalization on the filing date, the offer date and the first day the subsidiary is publicly traded, respectively. The value of the subsidiary on the filing date, V^S_{-1}, is the product of the mid-point of the initial price range filed in the preliminary prospectus, and the number of shares filed, divided by $\beta-\alpha$. The value of the subsidiary on the offer date, V^S_0, is the product of the final IPO offer price and the post-issue number of shares outstanding. The value of the subsidiary on the first trading day, V^S_1, is its market capitalization. Note that V^S_{-1} captures the unconditional mean value of the subsidiary at the beginning of the book-building period, and that V^S_0 captures the conditional mean value of the subsidiary at the end of the book-building period.

The implied value of the remaining assets within the parent on the filing date, the offer date and the first day the subsidiary is publicly traded, V^R_{-1}, V^R_0 and V^R_1, is derived from $V^P_{-1}=V^R_{-1}+\beta V^S_{-1}$, $V^P_0=V^R_0+\beta V^S_0$, and $V^P_1=V^R_1+\alpha V^S_0$, respectively, where β – usually 100% – is the fraction of the subsidiary held by the parent prior to its IPO, and α is the fraction held by the parent post IPO. This is consistent with the change in the holding of the parent being reflected after the book-building period.

During the pre-IPO book-building period, a parent company's holding period return can be decomposed as

$$\text{RET\_PAR}_{-1,0}=\frac{V^P_0-V^P_{-1}}{V^P_{-1}}=\frac{\left(V^R_0+\beta V^S_0\right)-\left(V^R_{-1}+\beta V^S_{-1}\right)}{V^P_{-1}}=\frac{V^R_0-V^R_{-1}}{V^P_{-1}}+\beta\frac{V^S_0-V^S_{-1}}{V^P_{-1}}=\text{RET\_REM}_{-1,0}+\beta\times\text{RET\_SUB}_{-1,0}$$

So $\text{RET\_SUB}_{-1,0}\equiv\frac{V^S_0-V^S_{-1}}{V^P_{-1}}$ captures the value revision of the subsidiary during its book-building period, and $\text{RET\_REM}_{-1,0}\equiv\frac{V^R_0-V^R_{-1}}{V^P_{-1}}$ captures any incremental informational value of the remaining assets generated from book-building process of the carved-out subsidiary.

During the initial trading period, the parent's return can be decomposed as:

$$\text{RET\_PAR}_{0,1}=\frac{V^P_1-V^P_0}{V^P_0}=\frac{\left(V^R_1+\alpha V^S_1\right)-\left(V^R_0+\beta V^S_0\right)}{V^P_0}=\alpha\frac{V^S_1-V^S_0}{V^P_0}+\frac{V^R_1-V^R_0}{V^P_0}-(\beta-\alpha)\frac{V^S_0}{V^P_0}=\alpha\text{RET\_SUB}_{0,1}+\text{RET\_REM}_{0,1}-(\beta-\alpha)\frac{V^S_0}{V^P_0}.$$

Therefore, $\text{RET\_SUB}_{0,1}\equiv\frac{V^S_1-V^S_0}{V^P_0}$ captures the value change of the subsidiary while $\text{RET\_REM}_{0,1}\equiv\frac{V^R_1-V^R_0}{V^P_0}$ captures the change in the value of remaining assets of the parent company.

To illustrate, consider the alphabetically first observation in our dataset: the carve-out of Advanced Mammography Systems, a wholly-owned (β=100%) subsidiary of Advanced NMR Systems. The prospectus was filed with the SEC on November 6th, 1992, with an initial indicative price of $6 and 1.25 million shares. The final offer price of $6 was set on January 25th, 1993. The initial trading day was identical to the offer date, with a closing price of $8. Therefore, the initial return is 33.33%. Post-IPO, the number of shares outstanding is 5.48 million. Thus, V^S_{-1}=$30.74 (million), V^S_0=$32.88 (million) and V^S_1=$43.84 (million).

The market capitalization of the parent was $53.01 (million) on the filing date (V^P_{-1}), $54.99 (million) on the offer date of January 22, 1993 (V^P_0), and $52.95 (million) on the first trading day of January 25, 1993 (V^P_1). The parent carved out 24.4% of its wholly-owned subsidiary, retained 75.6% after the IPO (α=75.6%). The implied value of the remaining assets was $22.27 (million) on the filing date (V^R_{-1}), $22.11 (million) on the offer date (V^R_0), and $9.11 million on the first trading day. So $\text{RET\_PAR}_{-1,0}$=3.74%, $\text{RET\_SUB}_{-1,0}$=4.04%, $\text{RET\_REM}_{-1,0}$=−0.29%, $\text{RET\_PAR}_{0,1}$=−3.71%, $\text{RET\_SUB}_{0,1}$=19.93%, and $\text{RET\_REM}_{0,1}$=−4.19%.

Appendix B. Constructing Fig. 2

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

$$r^P_{i,t} = \frac{P^P_{i,t}}{P^P_{i,-1}} - \left(1 + R^{\text{MKT}}_t\right)$$

where R^{MKT}_t is the day t S&P 500 index return.

We next "time-standardize" the book-building period interval by computing the book-building period interval in units of trading days (offer date minus file date) L_i and obtain the longest period, $L_{\max}=\max(L_i\ s)$ as the base interval. For other issues whose period interval L is less than $L_{\max}$, 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 for issue 1's 20 day period, but only 10 for r^P_2 and 6 for r^P_3. The base length of the interval is 20 days ($L_{\max}=L_1$). 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_1 and are treated as the jump points. The same rationale applies to issue 3 where the jump point occurs at $\text{RND}(L_{\max}/L_1)$ (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

$$r^P_t = \frac{\sum_{j=1}^{n_t} r^P_{j,t}}{n_t}.$$

This methodology allows us to compute the standardized average return r^P_t for all days in the standardized book-building period. The plot (Fig. 2) is r^P_t s against book-building period base interval (t) in our sample.

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