PRELIMINARY AND INCOMPLETE

Can the market add and subtract? Mispricing in tech stock carve-outs

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Abstract

Recent equity carve-outs in US technology stocks appear to violate a basic premise of financial theory: identical assets have identical prices. In our sample, holders of a share of company A are expected to receive x shares of company B, but $P_A < xP_B$. A prominent example involves 3Com and Palm. Arbitrage does not eliminate these blatant mispricing due to short sale constraints, so that B is overpriced but expensive or impossible to sell short. Evidence from options prices shows that shorting costs are extremely high, eliminating exploitable arbitrage opportunities.

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There are two important implications of the efficient market hypothesis. The first is that it is not easy to earn excess returns. The second is that prices are "correct" in the sense that prices reflect fundamental value. This latter implication is, in many ways, more important than the first. Do asset markets offer rational signals to the economy about where to invest real resources? If some firms have stock prices that are far from intrinsic value, then those firms will attract too much or too little capital. While important, this aspect of the efficient market hypothesis is difficult to test because intrinsic values are unobservable. That is why tests of relative valuation, for example using closed-end funds, are important. The fact that closed-end funds often trade at substantial discounts or premia makes one wonder whether other assets may also be mispriced.

The most basic test of relative valuation is the law of one price: the same asset cannot trade simultaneously at different prices. The law of one price is usually thought to hold nearly exactly in financial markets, where transactions costs are small and competition is fierce. Indeed, the law of one price is in many ways the central precept in financial economics. Our goal in this paper is to investigate violations of the law of one price, cases where prices are almost certainly wrong in the sense that they are far from the frictionless price. Although the number of cases we examine is small, the violations of the law of one price are large.

The driver of the law of one price in financial markets is arbitrage, defined as the simultaneous buying and selling of the same security for two different prices. The profits from such arbitrage trades give arbitrageurs the incentive to eliminate any violations of the law of one price. Arbitrage is the basis of much of modern financial theory, including the Modigliani-Miller capital structure propositions, the Black-Scholes option pricing formula, and the arbitrage pricing theory and related multi-factor asset pricing models.

Do arbitrage trades actually enforce the law of one price? This empirical question is easier to answer than the more general question of whether prices reflect fundamental value. Tests of this more general implication of market efficiency force the investigator take a stance on defining fundamental value. Fama (1991) describes this difficulty as the "joint-hypothesis" problem: "market efficiency per se is not testable. It must be tested jointly with some model of equilibrium, an asset-pricing model." In contrast, one does not need an asset-pricing model to know that identical assets should have identical prices.

The same difficulty that economists face in trying to test whether asset prices generally reflect intrinsic value is also faced by real world arbitrageurs looking for mispriced securities. For example, suppose security A appears to be overpriced relative to security B. Perhaps A is a glamorous growth stock, say a technology stock, and B is a boring value stock, say an oil stock. An arbitrageur could short the technology stock and buy the oil stock. Unfortunately, this strategy is exposed to "bad model" risk, another name for the joint hypothesis problem. Perhaps the arbitrageur has neglected differences in liquidity, risk, or taxes, differences that are properly reflected in the existing prices. In this case, the trade is unlikely to earn excess returns. Researchers have not been able to settle, for example, whether value stocks are too cheap relative to growth stocks (as argued by De Bondt and Thaler (1985) and Lakonishok, Shleifer, and Vishny (1994)) or just more risky (as favored by Fama and French (1993)).

Another second risk for the arbitrageur is fundamental risk. An arbitrageur who shorts technology companies and buys oil companies runs the risk that peace breaks out in the Middle East, causing the price of oil to plummet. In this case, perhaps the original judgment that oil stocks were cheap was correct but the bet loses money ex post.

In contrast, if A and B have identical cash flows but different prices, the arbitrageur eliminates fundamental risk. If securities A and B have other similar features, for example similar liquidity, then bad model risk is minimized as well. Violations of the law of one price are easier for economists to see, and safer for arbitrageurs to correct. For example, suppose A is a portfolio of stocks, and B is a closed end fund that owns A. If B has a lower price than A, then (ignoring issues such as fund expenses), the arbitrageur can buy B, short A, and hope to make a profit if the prices converge. Unfortunately, this strategy is exposed to a third sort of risk, noise trader risk. An arbitrageur that buys the fund and shorts the underlying shares runs the risk that the discount may widen as investor sentiment shifts. This risk can be either systematic (all closed-end fund discounts widen) or idiosyncratic (De Long, Shleifer, Summers, and Waldmann (1990), Lee, Shleifer, and Thaler (1991)). Since there is no guarantee that A and B will converge in price, the strategy is risky.

Noise trader risk can be eliminated in the long run in situations where A and B are certain to converge in finite time. For example, suppose at time T the closed end fund B will liquidate, and all holders of B will receive a cash settlement equal to the net asset value of the portfolio, i.e., A. We know that the price of A and B will be identical at time T. Noise trader risk still exists in the intermediate period between now and T, but not over the long run. The terminal date eliminates other concerns as well, for example liquidity is not an issue for investors holding until time T. In this case, with no fundamental risk, bad model risk, or noise trader risk, there still is another problem that can cause the prices of A and B to be different: transactions costs.

Both market efficiency and the law of one price are affected by transactions costs. If transactions costs are not zero, then arbitrageurs are prevented from forcing price all the way to fundamental value, and the same security can have different prices. In this case, then Fama (1991) describes an efficient market as one in which "deviations from the extreme version of the efficiency hypothesis are within information and trading costs." An example is a market where it is impossible to short a stock, equivalent to infinite transactions costs for short sales. In this market, a stock could be massively overpriced, yet since there is no way for arbitrageurs to make money, the market is still efficient in the sense that there is no money left on the table. Still, this is market efficiency with very wrong prices.

In this paper we investigate apparent violations of the law of one price where there are few risk issues involved but transactions costs involved with short selling play an important role in limiting arbitrage. We study equity carve-outs in which the parent has stated its intention to spin off its remaining shares. A notable example is Palm and 3Com. Palm, which makes hand-held computers, was owned by 3Com, a profitable company selling computer network systems and services. On March 2nd, 2000, 3Com sold a fraction of its stake in Palm to the general public via an initial public offering (IPO) for Palm. In this transaction, called an equity carve-out, 3Com retained ownership of 95 percent of the shares. 3Com announced that, pending an expected IRS approval, it would eventually spin off its remaining shares of Palm to 3Com's shareholders before the end of the year. 3Com shareholders would receive about 1.5 shares of Palm for every share of 3Com that they owned.

This event put in play two ways in which an investor could buy Palm. The investor could buy (say) 150 shares of Palm directly, or he could buy 100 shares of 3Com, thereby acquiring a claim to 150 shares of Palm plus a portion of 3Com's other assets. Since the price of 3Com's shares can never be less than zero (equity values are never negative), here the law of one price establishes a simple inequality: the price of 3Com must be at least 1.5 times the price of Palm.

Since 3Com held more than $10 a share in cash and securities in addition to its other profitable business assets, one might expect 3Com's price to be well above 1.5 times the price of Palm.

The day before the Palm IPO, 3Com closed at $104.13 per share. After the first day of trading, Palm closed at $95.06 a share, implying that the price of 3Com should have jumped to no less than $142.59. Instead, 3Com fell to $81.81. The "stub value" of 3Com (the implied value of 3Com's non-Palm assets and businesses) was minus $60.78. In other words, the stock market was saying that the value of 3Com's non-Palm business was minus 23 billion dollars! The "information costs" mentioned by Fama (1991) are small in this case, since the mispricing took place in a widely publicized IPO that attracted frenzied attention. The nature of the mispricing was so simple that even the dimmest of market participants and financial journalists were able to grasp it. On the day after the issue, the mispricing was widely discussed, including in two articles in the Wall Street Journal and one in the New York Times, yet the mispricing persisted for months.

This is a gross violation of the law of one price, and one for which most of the risks identified above do not apply. An arbitrageur who buys 100 shares of 3Com and shorts 150 shares of Palm is essentially buying the 3Com stub for minus $60.78. If things go as planned, in less than a year this value must be a least zero. We do not need to agree on a model of asset pricing to agree on the proposition that one share of 3Com should be worth at least 1.5 shares of Palm. Noise trader risk is minimized because there is a terminal date at which the shares will be distributed. When the distribution occurs the 3Com stub cannot have a negative price. Fundamental risks about the value of Palm are completely hedged. The only remaining problem is costly arbitrage. Still, investors were willing to pay over $2.5 billion dollars to buy expensive shares of Palm rather than buy the cheap Palm shares embedded in 3Com and get 3Com thrown in.

We do not claim that this mispricing creates exploitable arbitrage opportunities. To the contrary, we document the precise market friction that allows prices to be wrong, namely shorting costs. These costs arise when short sales are either very expensive or simply impossible. Although shorting costs are necessary in order for mispricing to occur, they are of course not sufficient. Shorting costs can explain why a rational arbitrageur fails to short the overpriced security, but not why anyone buys the overpriced security. To explain that, one needs investors who are (in our specific case) irrational, woefully uninformed, or endowed with very strange preferences. We will refer to these conditions collectively as "irrational," but they could be anything that causes a downward sloping demand curve for specific stocks (despite the presence of cheaper and nearly identical substitutes). Thus two things, trading costs and irrational investors, are necessary for mispricing. Trading costs, by limiting arbitrage, creates an environment in which simple supply and demand intuition is useful in explaining asset prices. In our case, the demand for certain shares by irrational investors was too large relative to ability of the market to supply these shares via short sales, creating a price that was too high.

We investigate this question using all the cases we could find that share the key elements of the Palm-3Com situation, namely a carve-out with an announced intention to spin off the new issue in the near future. By limiting ourselves to these cases (as opposed to the much larger category of all carve-outs) we are able to minimize the risks that the spin-off never takes place and thus reduce the noise trader risk inherent in the arbitrage trade.

We start in section I by describing carve-outs and spin-offs, showing how we construct the sample and describing its main features. In section II we document high apparent returns that are implicit in market prices, describe relevant risks, and ask whether the high returns can plausibly be explained by risk. In section III we describe the short-sale constraints that allow mispricing to persist. We document another notable departure from the law of one price, the violation of put-call parity, and explain how this departure is consistent with short sale constraints. In section IV we ask why stubs become negative, look at IPO day returns on parents and issues, and show the characteristics of investors in parents and issues.

I. Sample of carve-outs

We examine carve-outs followed by spin-offs. An equity carve-out, also known as a partial public offering, is defined as an IPO for shares (typically a minority stake) in a subsidiary company. In an equity carve-out, a subsidiary firm raises money by selling shares to the public and then typically giving some or all of the proceeds to its parent. A spin-off occurs when the parent firm gives remaining shares in the subsidiary to the parent's shareholders; no money changes hands.

We study a sample of equity carve-outs in which the parent firm explicitly states its intention to immediately spin off its remaining ownership in the subsidiary. We study this sample of firms since in this case, negative stubs appear to present a trading opportunity with fairly clear timing. In contrast, Schill and Zhou (2000) and Cornell and Liu (2000) look at negative stub situations generally, not necessarily involving an explicit intention to spin off. Our focus on cases with a terminal date allows us to ignore some issues they discuss such as agency costs (the possibility that the parent firm may waste the cash generated by the subsidiary).

Spin-offs can be tax-free both to the parent firm and to its shareholders. In order to be tax-free, spin-offs need to comply with Internal Revenue Code Section 355, which requires that the parent (prior to the spin-off) owns at least 80 percent of the subsidiary. Thus if a firm plans a carve-out followed by a tax-free spin-off, it is necessary to carve out less than 20 percent of the subsidiary.

There are several reasons why a firm might carve out before spinning off. First, the parent firm might want to raise capital for itself (Allen and McConnell, 1998). Second, the parent might wish to raise capital for the subsidiary to use. Third, a standard explanation is that the parent might want to establish an orderly market for the new issue by selling a small piece first (see Cornell, 1998). According to this explanation, the parent avoids flooding the market with a large number of new shares in a full spin-off, and the IPO gives an incentive for investment banks to market and support the new issue. Raising capital via a carve-out of the subsidiary, rather than an equity issue for the parent stock, is especially attractive if the firm believes that the parent stock is underpriced or the subsidiary will be overpriced, as in Nanda (1991) and Slovin et al (1995).

A. The Sample

We start building our sample by obtaining from Securities Data Corporation a list of all carve-outs in which the parent retains at least 80 percent of the subsidiary. Their list contains 155 such carve-outs from April 1985 to May 2000. To their list, we added one issue (PFSWeb) that appears to have been miscoded by them, and four issues occurring after May 2000. Using the Securities and Exchange Commission's Edgar database, we then searched registration form S-1 for explicit statements by the parent firm that it intended to distribute promptly the remaining shares to the shareholders. We discarded all firms for which we were unable to find a definitive statement that the parents intended to distribute all its shares. A typical statement, from Palm's registration, is: "3Com currently plans to complete its divestiture of Palm approximately six months following this offering by distributing all of the shares of Palm common stock owned by 3Com to the holders of 3Com's common stock." The statements often mentioned IRS approval as a pre-condition of distribution; the specified time frame for the distribution was usually 6 to 12 months.

We searched registrations starting in 1995, although since Edgar's database is incomplete prior to May 6, 1996, we were unable to find all firms before then. As it happens, we find no firms in 1995 that satisfied our requirements, so the final sample contains 18 issues from April 1996 to August 2000. This sample, shown in Table 1, consists of every carve-out of less than 20 percent of subsidiary shares in which the parent declared its intention to distribute the remaining shares.

B. Constructing stubs

We define the stub value using the ratio of subsidiary shares to be given to parent shareholders at the distribution date. The ratio is the parent's holdings of the subsidiary divided by the outstanding number of shares of the parent on the record date of the distribution. Unfortunately, this ratio is not known with certainty on the issue date, because the number of parent shares outstanding can fluctuate, e.g. due to the conversion of convertible debt or the exercise of options owned by insiders.

Let the parent stock have date 0 price per share of P_0^P and the subsidiary stock P_0^S. Let x be the ratio of subsidiary shares that are given to parent shareholders at the distribution date. A negative stub means $S_0 = P_0^P - xP_0^S < 0$. We can also express the stub as a fraction of the parent, which we do with a lower case s, $s_0 = \frac{P_0^P - xP_0^S}{P_0^P} = \frac{S_0}{P_0^P}$.

Thus to calculate stub values, we have to estimate the expected ratio at each point in time. We did this in two stages. First, we simply used the naïve ratio of the parent holdings in the subsidiary divided by the current parent shares outstanding. Since the various contingencies generally raise the number of shares of the parent, this naïve ratio likely overstates the actual ratio and thus makes the calculated stub more negative. Second, after examining the pattern of stubs in the 18 cases, we more carefully studied the cases of potential negative stubs.

We concentrate on negative stubs in order to consider only cases of clear violations of the law of one price. Of course, there may be mispricing in other situations, but in such cases there is no uncontroversial proof of mispricing. So negative stubs should be considered the extreme cases of unambiguous mispricing. For the potential negative stubs, we gathered information that was available in real-time to construct the estimated ratio. The appendix gives more information on the specific cases; our sources included a company web page, SEC filings, brokerage reports, and estimates produced by Spinoff Advisors, a private firm. In most cases the uncertainty about the final ratio appears to be small, especially for parent firms with little convertible debt or outstanding options. [1]

Of our 18 firms, nine clearly had positive stubs. We classify three stubs as marginally negative (ATL Products, Orient Express Hotels, and TransAct Technologies). These were cases where we observed a small negative stubs on one or two days only, or where the correct ratio is sometimes unclear due to changing numbers of shares. For these cases we think that a reasonable person would not be convinced that the stub was negative given all available information. None of the three marginal cases involves a negative stub at or near the IPO date.

We identify six cases of unambiguously negative stubs: UBID, Retek, PFSWeb, Xpedior, Palm, and Stratos Lightwave. All six are technology stocks. UBID is an on-line auction firm. Retek produces B2B inventory software. PFSWeb provides transactions management services for e-commerce. Xpedior is an e-business consulting firm. Stratos Lightwave is an optical networking firm. Both the six parents and the six subsidiaries trade on NASDAQ.

As shown in Table 2, for the six cases with negative stubs, four were negative at closing prices on the first day of trading, and the other two were negative by two days after. For five of the cases, the stub was negative for at least two months, with a maximum of more than five months for UBID. For one case, Xpedior, the stub was negative for only three days before turning positive again. Xpedior's minimum stub also had a fairly small magnitude of only -19 percent of the parent company's value, unlike the other five that had minimum stubs of -39 to -77 percent of parent value. Thus Xpedior is a weaker case in terms of the persistence and magnitude of the mispricing.

Table 2 shows the magnitude of the mispricing in a variety of ways. Perhaps the most relevant is the market value of the shares trading in the subsidiary. This number (which uses the number of publicly trading shares, not the number of outstanding shares) is at its peak $2.5 billion for Palm, meaning that investors worth $2.5 billion thought it was better to own Palm than to own 3Com.

C. Time pattern of negative stubs

Figures 1 through 6 show the time series of stub values for the six cases of negative stubs. Several patterns are apparent. First, stubs start negative and gradually get closer to zero, eventually becoming positive.[2] Second, the announcement of IRS approval and the consequent announcement of a distribution date (occurring on the same day) cause the stub to go from negative to positive in two cases, UBID and Palm. Thus in these cases the market is acting as if there is significant news on these days.

In one case, Xpedior, the distribution never occurred. On March 22, 2000, the parent company announced another firm was acquiring it. Xpedior's stub rises markedly on this day. However, one could argue that on and after this date, Xpedior's stub has little meaning, since the distribution is presumably cancelled. On the announcement day, although not explicitly canceling the spin-off, the acquirer failed to confirm the spin-off and instead announced it had gained control of Xpedior and was investing additional money in it.

Finally, in Figure 7 we plot all the stub values on the same time line. Figure 7 shows that our sample is mostly concentrated in the year 2000. Despite this time clustering, however, the picture is one of predictable idiosyncratic movement in stubs. Stubs start off negative, and then get positive. This pattern is repeated over time, and does not appear to reflect systematic exposure to some common factor, but rather idiosyncratic developments.

We draw two conclusions from the analysis so far. First, we are able to identify six cases of clearly negative stubs. We do not think that the proportion of negative stubs, one third of the cases we study, is particularly significant. As we stressed above, a negative stub indicates a gross case of mispricing. Even a single case would raise important questions about market efficiency. The fact that we find six such cases indicates that the highly publicized Palm example was not unique.[3]

Second, all the cases we study show a similar time pattern of returns whereby the stub becomes less negative over time and eventually becomes positive. This suggests that market forces act to mitigate the mispricing, but slowly. We return to this slow adjustment, which reflects the sluggish functioning of the market for lending stocks, in section III.

II. Risk and return on stubs

In this section, we investigate the returns to an investment strategy of buying the parent and shorting the subsidiary. We find that this strategy produces high returns with low (and largely idiosyncratic) risk. However, we caution readers not to rush out to form hedge funds to exploit this phenomenon; as we show in the next section, the high returns we find on paper are probably not achievable in practice, due to the difficulty of shorting the subsidiary (although we are aware of individual investors who did make small amounts of money on certain of these situations). Thus the question we ask is whether the investment strategy would have produced profits if it could have been implemented.

This investment strategy is related to several controversies in finance: value, IPO's, and the diversification discount. First, it is a value strategy of buying cheap stocks and shorting expensive stocks. Second, it is a strategy that shorts IPO's. Ritter (1991) documents that IPO's tend to have low subsequent returns, but the statistical soundness of this finding has been the subject of a vigorous debate summarized in Fama (1998) and Loughran and Ritter (2000). As a subset of the IPO debate, Vijh (1999) finds that carve-outs stocks do not have low subsequently returns. Third, it is a strategy of that buys firms with a large diversification discount. Lamont and Polk (2001) show the diversification discount partly reflects subsequent returns on diversified firms, so that the diversification discount does not only reflect agency concerns such as wasteful managers. In the case of our firms, it seems unambiguous that the subsequent pattern of returns is driven by mispricing, so that we have a clear example where the value/IPO/diversification effect is due to mispricing.

A. Returns on stub positions

The following analysis ignores dividends and assumes the distribution takes place with fixed distribution ratio at time T. First, since the stub must go from negative to positive by date T, it must be the case that $R_T^P > R_T^S$, where R_T^P and R_T^S are the return on the parent and subsidiary between date zero and date T. Thus if an investor buys the parent and shorts an equal dollar amount of the subsidiary, she gets a positive return of $R_T^P - R_T^S$. In a frictionless market in which the investor gets access to short sale proceeds, this strategy is a zero-cost or self-financing strategy. For this strategy, the exact distribution ratio x is not important, as long as one knows that the stub is negative initially. On paper, this strategy is an arbitrage opportunity, since it has zero cost and generates strictly positive cash flow in the future.

Assuming the distribution takes place with known ratio x, one can construct a position that is a pure bet on the stub. This second strategy eliminates the effect of fluctuations in subsidiary value, and again guarantees strictly positive returns. It buys one share of the parent, shorts x shares on the subsidiary, and (again assuming access to the short sale proceeds) invests the resulting -S_0 dollars of cash in the initial period at the risk free rate of R_F. Again, this strategy is theoretically self-financing, and puts equal amounts into the long portfolio (consisting of riskless assets and the parent) and the short portfolio (consisting of the subsidiary). One can express the returns on this strategy as $\frac{1}{1-s_0}R_T^P + \frac{-s_0}{1-s_0}R_T^F - R_T^S$.

Table 3 shows returns from the strategy of buying the parent and shorting the subsidiary at the closing price on the first day that the stub is negative. We examine two holding periods: holding until one day after the announcement date, or holding until the distribution date. For the purposes of Table 3, we use the takeover announcement for Xpedior's announcement date, and the takeover consummation as Xpedior's distribution date. Stratos is left blank since the distribution day has not yet occurred. Table 3 shows that parents had returns that were 33 percent higher than subsidiaries holding until after the announcement date, and 35 percent higher holding until the distribution date. This difference was statistically significant. From this evidence alone, one cannot say whether the subsidiary is overvalued or the parent is undervalued. Later, we show evidence from options markets implying that it is the subsidiary that is mispriced.

B. Traditional measures of risk

Table 3's T-statistics do not adjust for the substantial clustering of the observations. Table 4 addresses this concern by using monthly data on portfolio returns reflecting a strategy of buying parents and shorting subsidiaries. On the last trading day of the month, if the subsidiary has a negative stub on that day, we buy the parent and short the subsidiary. We maintain this position until the last day of the month in which the distribution announcement is made. We calculate equal weighted returns on the portfolio holdings on this strategy. The strategy holds one to four paired positions each month, for the 14 months of returns from January 1999 to May 1999 (UBID) and December 1999 to August 2000 (the other four subsidiaries; the strategy does not take a position in Xpedior).

Over this period, the simple strategy of buying parents and shorting subsidiaries in equal dollar amounts has a monthly return that averages 13 percent per *month* (significantly different from zero) with a standard deviation of 16 percent per month, producing a monthly Sharpe ratio of 0.80 per month. The hedged strategy that takes a pure bet on the stub has a slightly higher Sharpe ratio of 0.90 a month. Over the same period, the aggregate monthly market excess return (S&P Composite total return minus T-bill returns from Ibbotson Associates) had an average of one percent and a standard deviation of four percent, for a Sharpe ratio of 0.18. This performance is fairly typical for the aggregate market, as its Sharpe ratio is 0.16 from January 1926 to August 2000. Thus stub strategies have risk-return tradeoffs more than four times more favorable than the market's.

Table 4 shows estimates of a CAPM equation. The α for the simple strategy is a huge 11 percent per month, while the α for the hedged strategy is 12 percent per month. The t-statistic on

α formally tests the hypothesis that the stubs trading strategy can be used to produce a higher Sharpe ratio than the market. Even using these highly undiversified portfolios with only 14 monthly observations, we are able to resoundingly reject the hypothesis that α is zero.

C. Risks specific to stubs

Since our sample is so small, it is useful to discuss some events that didn't occur but might be expected to occur in a larger sample. Events that might have a negative impact on arbitrage investors include canceling the spin-off or changing the distribution ratio by lowering the number of subsidiary shares that each parent shareholder receives. If the expected ratio changes, then the stub can go from negative to positive without any change in prices. As discussed previously, this ratio changes with the number of parent shares.

Cancellation of the distribution can occur for several reasons. First, if the firm does not receive IRS approval, the spin-off is not tax-free and will probably be cancelled. Our impression from press reports is that IRS rejection is a very low probability event. Second, the firm might change its mind and cancel the spin-off even if the IRS does approve. Although the parents in our sample stated their intention to distribute their ownership, this statement is not legally binding. An example that occurred in our larger sample of 18 carve-outs is Blockbuster. The parent, Viacom, stated in an SEC filing four months after the carve-out that it would wait until Blockbuster's share price was higher before completing the separation. In this example, Viacom's decision is not much of negative event for the stub strategy of shorting the subsidiary, since the distribution only is cancelled in the state of the world where the subsidiary price remains low. Nevertheless, it is always possible for a cancelled spin-off to cause the trading strategy to reap negative returns.

Another reason a distribution can be cancelled is a takeover by a third party or shareholder pressure. We have already discussed the case of Xpedior, whose parent was acquired. As shown in Table 3, this acquisition did not prevent the stub strategy from earning high returns. Another example from our sample is PFSWeb. Prior to the carve-out the parent firm received an unsolicited takeover bid which was conditional on canceling the spin-off, and later a large shareholder in the parent publicly objected to the spin-off and threatened legal action. Despite these events, the carve-out and distribution took place as planned.

These examples highlight the fact that the trading strategy is not riskless. It is worth noting, however, that many of these unpredictable events seem likely to benefit strategies that buy parent shares and short subsidiary shares. Takeover of the parent company (with the usual takeover premia), shareholder pressure to increase value to parent shareholders, or cancellation of the distribution due to low prices of the subsidiary all are positive for the strategy.

Since returns are high, and the risks seem both quite low and almost entirely idiosyncratic, it appears that these subsidiaries are overpriced relative to the parent shares. However, with only six pairs of firms, and only 14 months of returns, this evidence is not conclusive. It is possible that there was some negative event capable of generating large losses to the arbitrage strategy that just did not come up during the period we studied. To address these concerns we will turn to the options market for additional evidence on mispricing.

III. Short sale constraints and the persistence of mispricing

The previous section argued that the negative stub situations created very attractive investment opportunities. Why, then, didn't rational arbitrageurs step in to correct the mispricing, by buying the parent and shorting the subsidiary? There are many types of reasons that in general might prevent rational investors from correcting mispricing. These reasons include fundamental risk, noise trader risk, liquidity risk, institutional or regulatory restrictions, and tax concerns. Shleifer and Vishny (1997) discuss idiosyncratic risk and agency problems in delegated portfolio management (see also Pontiff (1996)). In the cases we study, the principle idiosyncratic risk is the possibility that the distribution will not take place, and consistent with this, when the distribution date is announced, the stub values sometimes go from negative to positive. This pattern is consistent with arbitrageurs who are reluctant to take on substantial idiosyncratic risk.

In many situations, noise trader risk, institutional restrictions, etc. might cause assets to be mispriced. In our specific case, however, these issues appear to be minimal, and the chief impediment to arbitrage is short sale constraints. Short sales constraints come in two ways. First shorting can be simply impossible. Second, when shorting is possible, it can have large costs.

A. Description of shorting process

The market for shorting stock is not simply the mirror image of buying stocks long, for various legal and institutional reasons. To be able to sell a stock short, one must borrow it, and because the market for borrowing shares is not a centralized market, borrowing can be difficult or impossible for many equities. In order to borrow shares, an investor needs to find an institution or individual willing to lend shares. Financial institutions, such as mutual funds, trusts, or asset managers, typically do much of this lending. These lenders receive a fee in the form of interest payments generated by the short-sale proceeds, minus any interest rebate that the lenders return to the borrowers. Stocks that are held primarily by retail investors, stocks with low market capitalization, and illiquid stocks can be more difficult to short.

Being simply unable to short is particularly likely for individual retail investors, although there is extensive anecdotal evidence of institutional investors unable to short the overpriced subsidiaries. In some cases, firms ask their stockholders not to lend their stock, to prevent short-sellers from driving down the price. In the specific case of Palm, the *Wall Street Journal* reported that "It may be possible to short sometime next week…The brokerage firms and institutional investors that control much of Palm's stock generally agree not to immediately lend the stock to short sellers until sometime after the IPO date" (WSJ 3/6/00).

For institutions that are able to find shares to borrow, the cost of shorting is reflected in the interest rate rebate they receive on the short sale proceeds. This rebate acts as a price that equilibrates supply and demand in the securities lending market. The rebate can be negative, meaning institutions that sell short have to make a daily payment to the lender for the right to borrow the stock (instead of receiving a daily payment from the lender as interest payments on the short sale proceeds). This rebate apparently only partially equilibrates supply and demand, because the securities lending market is not a centralized market with a "market-clearing" price. Instead, rebates reflect individual deals struck among security owners and those wishing to short, and these actors must find each other. This search may be costly and time-consuming (Duffie (1996) suggests that the securities lending market could be described by a search model).

B. Shorting costs and overpricing

Short sale constraints have long been recognized as crucial to the workings of efficient markets. Diamond and Verrechia (1987) describe a model with some informed traders, other uninformed but rational traders, and possible restrictions on shorting. In their model, although short sale constraints impede the transmission of private information, short sale constraints do not cause any stocks to be overpriced. Uninformed agents rationally take into account short sale constraints, and set prices realizing that negative opinion may not be reflected in trading.

With irrational traders, however, short sale constraints can cause some stocks to become overpriced. With short sale constraints, rational arbitrageurs can only refrain from buying overpriced stocks, and if there are enough irrational traders, stocks can be overpriced (see, for example, Miller (1977), Russell and Thaler (1985), and Chen, Hong, and Stein (2000)). A variety of evidence is consistent with such overpricing. Figlewski and Webb (1993) and Dechow et al (2001) show that stocks with high short interest have low subsequent returns.

One potentially confusing aspect of short sales is that the cost for those borrowing the stock is income for those lending the stock. Thus it is not quite accurate to say that only an irrational investor would buy an overpriced stock. A rational investor might be willing to buy an overpriced stock if he can derive sufficient income from lending it to short sellers. Based on this fact, one might be tempted to conclude that the situation we observe is therefore "rational," since rational investors are willing to buy the subsidiaries. Along these lines, one could argue that the observed returns for Palm, for example, are not a "real" return since the true return should include the income from lending (reflecting the convenience yield or dividend from securities lending), and that the "marginal" investor sets the traded price to embody all income generated by the shares.

Such an interpretation would be a mistake. It is important to recognize that irrationality, or at least some unexplained phenomena causing downward sloping demand curves for stocks, is a crucial element. Consider the following example. A firm, consisting of $100 in cash, issues 100 shares. The firm will liquidate tomorrow, and each share will pay a liquidating dividend of $1. These shares are issued and sold by auction to investor *I* who buys all 100 shares directly from the firm. Investor *I* mistakenly believes the shares will pay out $2.01 tomorrow, and "wins" the auction with a bid of $2.00 per share. It is clear in this example that investor *I* has overpayed for the shares, and that $2 is a "real price." We label this overpayer investor *I* because he is either irrational, ignorant (perhaps because he is illiterate or innumerate), institutionally constrained in some way, or endowed with insane preferences.

Now suppose two other investors, *Y* and *Z*, enter the market. *Y* buys all 100 shares from the firm for $2, and lends them to *Z*. *Z* pays *Y* a fee of $1 for each share lent, and sells the shares to *I* for $2. Now in this example, *Y* and *Z* are both acting rationally. However, there is no sense in which *Y* and *Z* are the "marginal" investors that set prices. *Y* and *Z* would be just as happy with a price of $200 per share (and a corresponding loan fee of $199). It is the willingness of investor *I* to overpay that sets the price of the shares. The price of $2 is a real price, and the firm should rationally respond to the mispricing by issuing more shares. The fact that *Y* and *Z* are intervening actors between the firm and the owner are irrelevant in this example.

It is always true that *someone* has to own the shares issued by the firm; not all buyers can lend their shares. If the firm issues 100 shares, exactly 100 shares have to be owned by someone who is not lending them out. Thus it is not an empirical issue whether the owners of Palm lend out their shares or not, but rather a simple identity: $2.5 billion worth of shares were owned by investors who were not receiving any lending income from their shares.

More generally, in any situation where the shorting market is imperfect and some investors have a downward sloping demand curve for a particular security, equilibrium prices depend on supply and demand. For example, Duffie (1996) and Krishnamurthy (2001) study the market for Treasury bonds. At some times, the price of on-the-run Treasury bonds is particularly high relative to off-the-run bonds, perhaps reflecting liquidity concerns. At these times, the cost of shorting reflects these prices differences, so that it is not necessarily profitable to short the expensive bond and buy the cheap one, and it might well be rational to buy the expensive bond in order to reap the lending income. These price movements reflect the existence of a demand curve for on-the-run securities. In a frictionless market, arbitrageurs would be able to supply bonds to meet this demand for on-the-run securities. Similarly, in our example, if investor *Z* was able to manufacture new shares, he might be able to satiate investor *I*.

C. Evidence on short sales

Given the obvious nature of the mispricing in the cases of negative stubs, and the publicity associated with some of the cases such as Palm, it is not surprising that many investors were interested in selling the subsidiaries short. Table 5 shows the level of short interest for parents and subsidiaries. Short interest is much higher in subsidiaries than in parents, consistent with the idea that the subsidiaries are overpriced. Short interest is reported on or about the 15th of the month. For parents, we report short interest divided by total shares outstanding. For subsidiaries, we report short interest divided by total shares sold to the public in the IPO, since these shares are the only ones trading in the market.

Table 5 shows that on the first reporting date after the IPO, the parents had an average of 3.7 percent of their shares shorted. The subsidiaries had a significantly larger level of 19.1 percent. A month later, on the second reporting date, 43.8 percent of subsidiary shares were shorted. This dramatic increase over time could be produced by some combination of two factors. First, it may take a while for investors to become aware of the mispricing and decide to try to exploit it. Second, and more plausibly, the short sale market works sluggishly. Only shares that are held by institutions willing to lend them are available for interested short sellers, and it takes time for lendable shares to find their way to the market for shorting.

Table 5 also shows the peak level of short interest for subsidiaries, for the time between the IPO and the distribution date. At the peak, short sales are 71.4 percent of total shares trading, and for Palm the level is an amazing 147.6 percent. More than all the floating shares had been sold short. This is possible if shares are borrowed, then sold short to an investor who then permits the shares to be borrowed again. Again, the multiplier-type process takes time to operate, due to frictions in the securities lending market. This peak level of short interest for Palm was reached on 7/14/00, two weeks before the announced distribution, at a time when the stub was positive but rising.

Figure 8 shows short interest (expressed as a percent of total shares issued) and stub value (expressed as a percent of parent company stock price) for Palm over the relevant period. The figure shows that as the supply of shares available grows via short sales, the stub value gets more positive. In other words, the observed trend in the stub value traces out the demand curve for the overpriced subsidiary. As supply grows, we move down the demand curve of irrational investors and the subsidiary price falls relative to the parent. As a statistical test of the hypothesis that the growth in supply drives down the price, we run a regression with stub values on the left hand side and short interest on the right hand side (expressed in the same units as in Figure 8). This regression contains individual intercepts for each of the six stubs, and included 34 monthly observations (the standard errors reflect time clustering). The results are a coefficient of 0.35 on the short interest ratio with a t-statistic of 2.09, meaning that for every 10 percent increase in short interest as a percent of shares trading, the stub as percent of parent price rises 3.5 percent.

Although quantity data in the shorting market is readily available, price data is not. We do not know precisely what was the cost of shorting the overpriced subsidiaries. We do have a shred of evidence for two of the subsidiaries. D'Avolio (2000) reports that at one point borrowers paid up to 40 percent (in annual terms) to short Palm, while Reed (2001) reports a rate of 45 percent for Stratos Lightwave in late August 2000. We next look at options markets to get more complete quantitative evidence on just how expensive it is to sell short.

D. Short selling constraints: evidence from options

Options can facilitate shorting, both because options can be a cheaper way of obtaining a short position and because options allow short-sale constrained investors to trade with other investors who have better access to shorting. Figlewski and Webb (1993) show that optionable stocks have higher short interest. Sorescu (2000) finds that in the period 1981-95, the introduction of options for a specific stock cause its price to fall, consistent with the idea that options allow negative information to become impounded into the stock price.[5]

In a frictionless market one expects to observe put-call parity. It should hold exactly (within trading costs) for European options, and approximately for American options. One way of expressing put-call parity is to say that synthetic shares (constructed using options plus borrowing and lending) should have the same price as actual shares, plus or minus trading costs such as the bid/ask spread. This equality is just another application of the law of one price. A weaker condition than put-call parity, which should always hold for non-dividend-paying American options, is the following inequality: the call price minus the put price is greater than the stock price minus the exercise price. For options that are at-the-money (so that the option's exercise price is equal to the current price of the stock), this inequality says that call prices should be greater than put prices.

For our six cases with negative stubs, three had exchange-traded American options within the relevant time frame: Xpedior, Palm, and Stratos. Obtaining time-stamped option prices proved to be surprisingly difficult, and required that we physically visit the Chicago Board of Exchange to hand collect data from their equipment. Due to the labor-intensive nature of the data collection, we used weekly share prices and weekly options prices, as of 4 PM Eastern Time on Friday.

Table 6 shows an example from the first week of trading in Palm's options (occurring more than two weeks after the IPO) using options that are closest to being at-the-money. Options on Palm display massive violations of put-call parity, and violate the weaker inequality as well. Instead of observing at-the-money call prices that are greater than put prices, we find puts were about twice as expensive as calls. We also calculate the implied price of synthetic securities. For example, on March 17th one can create a synthetic short position in Palm by buying a November put, selling a November call, and borrowing dollars. The payoff from holding the synthetic short until November is identical to the payoff from shorting the stock and holding until November (ignoring shorting costs). These calculations are done assuming that one can borrow from March to November at the 6-month LIBOR rate. Buying a November put (at the ask price), writing a November call (at the bid price), and borrowing, on March 16th the price of synthetic short was about $39.15, far below the actual trading price of Palm, $55.25 at that time. This constellation of prices is a significant violation of the law of one price, since the synthetic security is worth 29 percent less than the actual security. May and August options also showed substantial, though smaller violations of put-call parity.

The synthetic shorts at different horizons in Table 6 can be used to calculate the implied holding cost of borrowing Palm's shares. For an investor who is indifferent to shorting actual Palm shares from March until May, and creating a synthetic short, the holding costs must be 14 percent over two months or about 119 percent at an annual rate. For an investor planning to short for 8 months, until November, the holding costs must be 29 percent or 147 percent at an annual rate. Thus the options prices suggest that shorting Palm was either incredibly expensive, or that there was a large excess demand for borrowing Palm shares, a demand that the market could not meet for some institutional reasons. Since the evidence we have from D'Avolio (2000) indicates a much lower 40 percent shorting cost for Palm, it may be that the cost of actually finding shares to borrow was significant.

We now have three different market estimates of Palm's value: the embedded value reflected in 3Com's share price, the value reflected in options prices, and the actual share price. The options market and the shareholders in 3Com seemed to agree: Palm was worth far less than its market price. The direction of the deviation from the law of one price is consistent with the difficulty of shorting Palm. To profit from the difference between the synthetic security and the underlying security, one would need to short Palm and buy the synthetic long.

Again, although the prices here are consistent with very high shorting costs, one can turn the inequality around and ask why anyone would ever buy Palm (without lending it). On March 17^{th} one can create a synthetic long Palm by buying a call and selling a put, and this synthetic long is 23 percent cheaper than buying an actual share of Palm and holding until November. Arguments that buying the parent is a more risky substitute than buying the subsidiary (because the planned spin-off may not occur) are irrelevant to the synthetic long constructed using options. Why are investors who buy Palm shares directly willing to pay much more than they could pay using the options market?

One can also use the synthetic short price of Palm to create a synthetic stub value. On March 17, 2000, the actual stub value for Palm was -$15.98 per share. The synthetic stub for Palm, constructed using the synthetic short price implied in six-month at-the-money options, was positive at $1.75. Although this value seems low (i.e., less than the cash 3Com held) it is at least positive and thus no longer so close to a pure arbitrage opportunity.

We have earlier seen that the actual stubs became less negative over time and eventually turned positive. In Figure 8 we display the time series of the actual stubs along with the synthetic stubs for the time period up to the distribution date (constructing synthetic stubs using options that are closest to six months and at-the-money). The solid line, the actual stub, goes from strongly negative at the beginning to positive $10 a share. The dotted line, the synthetic stub, is positive in all but one week. The line with triangles shows the difference between the actual and synthetic stub. By the distribution date, this difference is close to zero, roughly consistent with put-call parity. The pattern shows that options prices adjust to virtually eliminate profitable trading opportunities. Put differently, the implied cost of shorting falls as the desirability of shorting falls.

In Table 7, we regress the violation of put-call parity (the deviation of the synthetic stub) on the actual stub. The synthetic stub deviation moves strongly with actual stub, and even with just 19 weekly observations, we can reject the hypothesis that the two do not move together. The R-square is a whopping 98 percent, suggesting that violations of put-call parity are strongly related to apparent near-arbitrage opportunities. Putting in a time trend does not change this conclusion.

Figure 10 shows the case for Stratos. Here, the actual stub is persistently negative, and the synthetic stub is (except for one week) strongly positive. Thus Stratos also supports the idea that the high cost of shorting allows the new subsidiary to be overpriced. The announcement and distribution days for Stratos have not yet occurred, so we do not have much variation in the actual stub. We expect that in coming months, we will be able to update this figure so that it looks more like Palm's figure, and will be able to run another regression.

Our third case with exchange-traded options is Xpedior. Unfortunately, Xpedior is a marginal case; as shown in Figure 4, Xpedior produces a stub that is only strongly negative for one week when options are trading. When we examine the difference between actual and synthetic prices (not shown in a figure), Xpedior does not seem to display a high cost of shorting, although we have little power since the actual stub is so marginally negative.

Are these violations of put-call parity unusual? Most empirical studies of options prices have found that put-call parity basically holds, with small or fleeting violations due perhaps to trading costs or asynchronous price data (Klemkosky and Resnick (1979), Bodurtha and Courtadon (1986)). One might wonder whether put-call parity generally holds using data from our sample period and using our sources and methods. Although a thorough investigation of put-call parity for all equity options is beyond the scope of this paper, we did do a brief check as follows. We picked a random date, 10/10/00, and compared the synthetic short on Stratos with those of other options. Stratos options started trading on the CBOE on 7/12/00. We looked at 28 other firms where options were initially listed on the CBOE between 6/11/00 and 7/12/00. Most of these firms were, like Stratos, recent technology IPO's. We omitted firms paying dividends or firms with a stock price below $10 a share. On 10/10/00, the stub value for Stratos was -$1.66 a share, and the synthetic short price constructed using six-month options was 24 percent below the actual price of Stratos (similar to the deviation seen for Palm in Table 6), or $5.89 below the actual price per share. For the 28 other firms, the average synthetic short price was only three percent below the actual price, or 87 cents in per share, easily explainable with bid/ask spreads on options. The maximum deviation was eight percent below the actual price, only a third of the deviation observed for Palm and Stratos. Based on this evidence, the Palm and Stratos cases appear to present unusually large violations of put-call parity.

To conclude, in the case of Palm and Stratos, we have strong evidence from options markets confirming that the new issues are overpriced, and no one should buy them (at least without lending them out, which not everyone can do in equilibrium) because cheaper alternatives are available. Although shares in the parent are not perfect substitutes for shares in the subsidiary (due to the risk of spin-off cancellation), the synthetic shares are virtually identical. Although not an exploitable arbitrage opportunity, this is a case of blatant mispricing.

IV. What causes mispricing?

We hope to have convinced even the most jaded reader that the cases we are studying are clear violations of the law of one price. Given that arbitrage cannot correct the mispricing, why would anyone buy the overpriced security? Why are some investors willing to buy shares in Palm when there are cheaper alternatives available in the market, either by buying the parent or by buying Palm synthetically in the options market? In this section we investigate this question, first by asking a simple question: who buys the expensive subsidiary shares, and how long do they hold them? We then look at IPO day returns for evidence on how these investors affect prices of the parent.

A. Investor characteristics

The left-hand side of Table 9 displays volume data for both parents and subsidiaries in our six cases with negative stubs. We show turnover for the first month of trading, defined as average daily volume divided by shares outstanding (for parents) or by total shares sold to the public (for the IPO). The turnover measure does not include the first day of trading itself. All twelve stocks trade on NASDAQ. Since NASDAQ is a dealer market, reported volume includes dealer trades, and the turnover caused by trades between actual investors is approximately half the turnover reported in Table 9.

The first thing to note is that subsidiaries have turnover that is more than five times that of parent turnover, with 37.7 percent of all tradable shares turning over *per day*. Higher turnover means that subsidiary shareholders have lower holding periods and thus shorter horizons, compared to parent shareholders. UBID shareholders, for example, had an average investment horizon of one trading day, since turnover was more than 100 percent (excluding dealer trades, UBID has turnover of more than 50 percent and investor horizons of about two days).

Table 9 also shows institutional ownership for parents and subsidiaries using data from quarterly 13F filings, reflecting holdings by institutional investment managers having equity assets under management of $100 million or more. In the first quarter after the IPO, institutional ownership is 15 percent higher for parents than subsidiaries (this difference is understated due to the heavy short interest in subsidiaries).[6]

One potential explanation for the mispricing involves restrictions on what institutions are allowed to hold. For example, Froot and Dabora (1999) show that Royal Dutch and Shell (two stocks representing the same firm) seem mispriced relative to each other. In recent years, the stock which is part of the S&P 500 trades at a premium to a stock which is not, possibly reflecting the fact that index funds are forced to buy the more expensive stock and cannot substitute the cheaper one. Similarly, one money manager told us (discussing stub situations in general) that although he was well aware that a particular subsidiary was overpriced relative to the parent, he could not buy the cheaper parent instead of the subsidiary because he ran a growth fund, and the cheaper stock was by definition value. However, Table 9 suggests that such institutional explanations are unlikely to explain the overpricing, since most owners are individuals.

The information in Table 9 also helps explain why the supply of lendable shares to short was so sluggish. First, high turnover impedes securities lending because when a share lender sells his shares, the share borrower is obliged to return the shares and must find a new lender.

Second, shares held be individual investors are less likely to be lent than shares held by institutions.

Table 9 is perfectly consistent with irrational or ignorant investors. We next turn to evidence from IPO day returns for additional evidence.

B. IPO day returns

Hand and Skantz (1998), looking at carve-outs generally, provide evidence that irrational investors can affect carve-out pricing. As documented in Schipper and Smith (1986) and Allen and McConnell (1998), when announcing the carve-out, parents earn excess announcement returns of around 2 percent. Hand and Skantz (1998) show that on the IPO date itself, parents have excess returns of -2 percent. One explanation is that optimistic investors who desire to hold the subsidiary drive up the price of the parent on the announcement days, and then dump the parent in favor of the subsidiary on the IPO day.

Table 8 looks at evidence for segmentation in our sample from IPO day returns. It compares IPO day returns for the 14 subsidiaries that had positive stubs on the IPO date and the 4 subsidiaries with negative stubs (for Xpedior and Retek the stubs only became negative after a few days of trading). Table 8 shows that subsidiaries resulting in negative stubs had much higher IPO returns than other subsidiaries, where the returns are offer price to closing price for the new subsidiary. This difference is unsurprising since one way to get negative stubs is to have a high price of the subsidiary.

Another way to get a negative stub is to have a low price of the parent. Table 8 also shows that the prices of parents in negative stub situations fell 14 percent from the day before the IPO to the close on the IPO day. For the 14 cases with positive stubs on the IPO date, the parents fell an average of one percent. The differences between the positive stub and negative stub IPO's are large and statistically significant for both parent returns and subsidiary returns (the statistical significance does not change if one categorizes Xpedior and Retek, which had negative stubs in the next few days, in the second group).

The large decline in parent prices in negative stub situations is surprising, since the parents own so much of the new issue. One might think that when the subsidiary does unexpectedly well on the issue date, the parent would benefit as the value of its holdings increase. For example, prior to the issue, Palm's underwriters had originally estimated the offering price to be $14 to $16 per share. After gauging investor demand, they increased the estimated offering price to $30 to $32. Finally, the night before the offer, they chose $38 as the final issuing price. On the first day of trading, Palm immediately went to $145, and later rose as high as $165, before ending the day at $95.06 a share. Thus, the very high subsidiary return seems likely to have been a surprise, making the drop in the price of 3Com that day mystifying.[7]

These patterns are all consistent with irrational investors. Prior to the IPO, irrational optimists who desire to own Palm have to hold 3Com instead. 3Com trades in the optimistic segment of the market. Once the IPO occurs, these optimists buy Palm directly (ignoring the cheaper alternative of holding 3Com). 3Com now trades in the more rational segment of the market, and its price falls to the rational price, as in Hand and Skantz (1998).

V. Conclusion

One of us used to have a colleague who, when teaching the basic finance course to impressionable young first year MBA students would shout the name of a well-known game show as a key conclusion of efficient markets: The Price is Right! He would offer little empirical support for this claim, but could rest assured that it was a claim that was hard to disprove. The trick to testing the "price is right" hypothesis is to find unambiguous relative price comparisons, such as closed-end funds.

The negative stubs in this paper are in a similar category, though the mispricing appears to be even more blatant. Unlike closed-end funds where arguments about agency costs by the fund managers, tax liabilities, and bad estimates of net asset value can cloud the picture, in this case any investor who can multiply by 1.5 should be able to tell that Palm is overpriced relative to 3Com. The evidence from options markets shows that these stocks were unambiguously overpriced, and is difficult to explain why in equilibrium anyone would own these shares. The mispricing persisted because of the sluggish functioning of the shorting market

There are two key findings of this paper that need to be understood as a package. First, we observe gross violations of the law of price. Second, these do not present exploitable arbitrage opportunities because of the costs of shorting the subsidiary. In other words, the no free lunch component of the efficient market hypothesis is intact, but the price equals intrinsic value component takes another beating.

Still, it possible to argue that we have only six cases here that collectively represent a tiny portion of the US equity market. Maybe everything else is just fine. Why should we be concerned? Put another way, are these cases of blatant mispricing the tip of a much bigger iceberg, or the entire iceberg? In one respect, our overpriced stocks are clearly different than most stocks. They were difficult or expensive to borrow because the supply of lendable shares did not quickly respond to the mispricing. In contrast, most stocks and particularly large cap stocks are easy to borrow. D'Avolio (2000) and Reed (2001) show that few stocks are expensive to short, and Dechow et al (2001) report that few stocks have significant short interest. So, perhaps it is only the rare cases in which shorting is very expensive that lead to mispricing. That is the rosy interpretation of our findings.

We do not share this rosy view. Rather, we think that our evidence should cast doubt on the claim that market prices reflect rational valuations because the cases we have studied should be ones that are particularly easy for the market to get right. Suppose we consider the possibility that Internet stocks were priced much too high around 1998-2000. The standard efficient markets reaction to such claims is to say that this cannot happen. If irrational investors bid up prices too high, arbitrageurs will step in to sell the shares short, and in so doing will drive the prices back down to rational valuations. The lesson to be learned from this paper is that arbitrage doesn't always enforce rational pricing. In the case of Palm, arbitrageurs faced little risk, but could not find enough shares of Palm to satiate the demands of irrational investors. We have identified cases in which arbitrageurs are *unable* to arbitrage relative mispricing. In the more general case there might be cases of mispricing in which arbitrageurs are *unwilling* to arbitrage mispricing because of fundamental risk or noise trader risk. Perhaps many investors thought that internet stocks were overpriced during the mania, but only a small minority were willing to take a short position, and these short sellers were not enough of those to drive the prices down to rational valuations. Further, many institutions are either not permitted to sell short or simply choose not to do so for various reasons. Almazan et al (2000) find that only about thirty percent of mutual funds are allowed to sell short, and only two percent actually do sell short.

The conclusion we draw is that there is one law of economics that does still hold: the law of supply and demand. Prices are set where the number of shares demanded equals the number of shares supplied. In the case of Palm, the supply of shares could not rise to meet demand because of the sluggish response of lendable shares to short. Similarly, if optimists are willing to bid up the shares of some faddish stocks, and not enough courageous investors are willing to meet that demand by selling short, then optimists will set the price.

APPENDIX

	Initial Ratio	Final Ratio	Source For Initial	Notes
UBID	0.72	0.71	CRSP	
Retek	1.63	1.24	CRSP	Ratio is unclear at times, used various sources
PFSWeb	0.81	0.81	Spinoff Advisors	
Xpedior	1.01	NA	Company web page	Assumes convertible debt converted
Palm	1.52	1.48	Spinoff Advisors	
Stratos	1.52	NA	Spinoff Advisors	

For Retek, the number of shares in the parent changes over time. We update them using company filings in 2000, using CRSP's algorithm for assigning daily values for shares outstanding. For 7/28/00, we updated the Retek ratio using an estimate from an analyst report.

Prices and dividends come from CRSP for pre-2000, and from Dreyfus and Yahoo in 2000.

ENDNOTES

[1] In one case, Retek, there appears to have been substantial uncertainty about the final ratio since the parent's number of shares was somewhat volatile. Retek's parent ultimately decided to accelerate the vesting of the options held by insiders.

[2] In one case, Retek, the stub has less of trend. Due to the uncertainty about the ultimate distribution ratio, Retek's true stub is not totally clear in July 2000.

[3] It is hard to say whether the ratio of one third overestimates or underestimates the prevalence of mispricing. On the one hand, perhaps firms tend to do carve-outs when they think their subsidiaries are overpriced, in which case the 18 firms are not a representative sample (firms should issue equity when that equity is overpriced, as argued by Stein, 1996). Further, it could be that 1998-2000 was a time when mispricing was prevalent, but in most years mispricing is rare (Ritter (2000) shows that this period was one with extraordinary IPO first day returns). On the other hand, mispricing could occur more than one third of the time. We only show that six of the eighteen have negative stubs. Perhaps the other 12 have stubs that are too low or too high. So in that sense, perhaps one third is a lower bound for relative mispricing.

[5] This effect was present in our sample, since in the three cases with negative stubs, when exchange-traded options were introduced, all three had sizable increases in the stub value (as seen in Figures 4-6). In all three cases, the subsidiary fell on the day that options started trading.

[6] We report institutional ownership as a percent of parent shares outstanding or subsidiary shares trading. For example, Palm sold 26.5 million shares in the IPO on 3/2/00, had 5.1 million shares in short interest as of 3/15/00, and institution ownership of 12.1 million shares at the end of March. Although 26.5 million shares were issued, 31.6 million shares were owned by

somebody, thanks to short-sellers who borrowed shares and sold them. Thus institutions held 46 percent of the shares issued, but only 38 percent of all the ownable shares.

[7] More generally, Bergstresser and Karlan (2000) examine cross-corporate equity holdings similar to the ones considered here (but without the terminal date), and find that parent firm stock prices under-react to changes in the value of their holdings. Similarly, closed end funds trading in the US but holding foreign securities have prices that do not always react properly to foreign market movements (see Klibanoff, Lamont, and Wizman (1998)).

References

Almazan, Andres, Keith C. Brown, Murray Carlson, and David A Chapman, 2000, Why constrain you mutual fund manager?, University of Texas at Austin working paper.

Allen, Jeffrey W. and John J. McConnell, 1998, Equity carve-outs and managerial discretion, *Journal of Finance* 53, 163-186.

Bergstresser, Daniel and Dean Karlan, 2000, The market valuation of cross-corporate equity holdings, MIT working paper.

Bodurtha, James N. Jr., and Georges R. Courtadon, 1986, Efficiency tests of the foreign currency options market, *Journal of Finance* 41, 151-162.

Chen, Joseph, Harrison Hong, and Jeremy C. Stein, 2000, Breadth of ownership and stock returns, http://post.economics.harvard.edu/faculty/stein/papers.html

Cornell, Bradford and Qiao Liu, 2000, The parent company puzzle: When is the whole worth less than one of the parts, UCLA working paper.

Cornell, Joseph W., 1998. *Spin-off to pay-off: analytical guide to investing in corporate divestitures* (McGraw-Hill, New York, NY).

D'Avolio, Gene, 2000, The market for borrowing stock, Harvard University working paper

De Bondt, Werner F. M., and Richard M. Thaler, 1985, Does the stock market overreact?, *Journal of Finance* 40, 793-805.

De Long, J. Bradford, Andrei Shleifer, Lawrence H. Summers, and Robert J. Waldmann, 1990, Noise trader risk in financial markets, *Journal of Political Economy* 98, 703-738

Dechow, Patricia M., Amy P. Hutton, Lisa Meulbroek, and Richard G. Sloan, 2001, Short-sellers, fundamental analysis and stock returns, *Journal of Financial Economics* forthcoming.

Diamond, Douglas W. and Robert E. Verrechia, 1987, Constraints on short-selling and asset price adjustment to private information, *Journal of Financial Economics* 18, 277-311.

Duffie, Darrell, 1996, Special Repo Rates, *Journal of Finance* 51, 493-526.

Fama, Eugene F., 1991, Efficient Capital Markets: II, Journal of Finance, Vol. 46, No. 5. (Dec., 1991), pp. 1575-1617.

Fama, Eugene F., 1998, Market efficiency, long-term returns, and behavioral finance, *Journal of Financial Economics* 49, 283-306.

Fama, Eugene F. and Kenneth R. French, 1993, Common risk factors in the returns on stocks and bonds, *Journal of Financial Economics* 33, 3-56.

Figlewski, Stephen, and Gwendolyn P. Webb, 1993, Options, short sales, and market completeness, *Journal of Finance* 48, 761-777.

Hand, John R.M. and Terrance R. Skantz, 1998, Noise traders in event studies? The case of equity carve-outs, http://itr.bschool.unc.edu/faculty/hand/

Klemkosky, Robert C. and Bruce G. Resnick, Put-Call Parity and Market Efficiency, Journal of Finance, Vol. 34, No. 5. (Dec., 1979), pp. 1141-1155.

Klibanoff, Peter, Owen Lamont, and Thierry A. Wizman, 1997, Investor reaction to salient news in closed-end country funds, Journal of Finance 53, 673-699.

Krishnamurthy, Arvind, 2001, The Bond/Old-Bond Spread, Northwestern University working paper.

Lakonishok, Josef, Andrei Shleifer, and Robert W. Vishny, 1994, Contrarian Investment, Extrapolation, and Risk, *Journal of Finance* 49, 1541-1578

Lamont, Owen A., and Christopher Polk, 2001. The diversification discount: cash flows vs. returns. Journal of Finance, forthcoming.

Lee, Charles M.C., Andrei Shleifer, and Richard Thaler, 1991, Investor sentiment and the closed-end fund puzzle, Journal of Finance 46, 75-109.

Loughran, Tim and Jay R. Ritter, 2000, Uniformly least powerful tests of market efficiency, *Journal of Financial Economics* 55, 361-389.

Miller, Edward M., 1977, Risk, uncertainty, and divergence of opinion, *Journal of Finance* 32, 1151-1168.

Nanda, Vikram, 1991, On the good news about equity carve-outs, *Journal of Finance* 46, 1717-1737.

Pontiff, Jeffrey, 1996, Costly arbitrage: Evidence from closed-end funds, *Quarterly Journal of Economics* 111, 1135-1151.

Reed, Adam, 2001, Costly short-selling and stock price adjustment to earnings announcements, Wharton working paper

Ritter, Jay R., 1991, The Long-Run Performance Of Initial Public Offerings, *Journal of Finance* 46, 3-27.

Ritter, Jay R., 2000, Big IPO Runups of 1975-2000, http://bear.cba.ufl.edu/ritter

Russell, Thomas, and Richard Thaler, 1985, The Relevance of Quasi Rationality in Competitive Markets, *The American Economic Review* 75, 1071-1082.

Schill, Michael J. and Chungsheng Zhou, 1999, Pricing an Emerging Industry: Evidence from Internet Subsidiary Carve-Outs, University of California at Riverside working paper (October 1999)

Schipper, Katherine, and Abbie Smith, 1986, A comparison of equity carve-outs and seasoned equity offerings: Share price effects and corporate restructuring, *Journal of Financial Economics* 15, 153-186.

Shleifer, Andrei, and Robert W. Vishny, 1997, The limits of arbitrage, *Journal of Finance* 52, 35-55.

Slovin, Myron B., Marie E. Sushka, and Steven R. Ferraro, 1995, A comparison of the information conveyed by equity carve-outs, spin-offs, and asset sell-offs, *Journal of Financial Economics* 37, 89-104.

Sorescu, Sorin M., 2000, The effect of options on stock prices: 1973 to 1995, *Journal of Finance* 55, 487-514.

Stein, Jeremy C., 1996, Rational capital budgeting in an irrational world, *Journal of Business* 69, 429-455

Summers, Lawrence H. 1985. "On Economics and Finance." Journal of Finance. July, 40:3, pp. 633-35.

Vijh, Arnand M., 1999, Long-term returns from equity carveouts, *Journal of Financial Economics* 51, 273-308.

Table 1
Distribution status and stubs as of 9/00

Issue Date	Parent	Subsidiary	Distribution Date	Negative stub?
4/3/96	AT&T	Lucent Technologies	09/30/96	No
8/21/96	Tridex	TransAct Technologies	03/31/97	Marginal
11/13/96	Santa Fe Energy Resources	Monterey Resources	07/25/97	No
3/6/97	Odetics	ATL Products	10/31/97	Marginal
8/12/98	Cincinnati Bell	Convergys	12/31/98	No
12/3/98	Creative Computers	UBID	06/07/99	Yes
2/4/99	General Motors	Delphi Automotive Systems	05/28/99	No
8/10/99	Viacom	Blockbuster		No
11/17/99	Hewlett-Packard	Agilent Technologies	06/02/00	No
11/17/99	HNC Software	Retek	09/29/00	Yes
12/1/99	Daisytek	PFSWeb	07/06/00	Yes
12/15/99	Metamor Worldwide	Xpedior		Yes
3/1/00	3Com	Palm	07/27/00	Yes
4/3/00	Cabot Corporation	Cabot Microelectronics	09/29/00	No
6/26/00	Methode Electronics	Stratos Lightwave		Yes
6/26/00	Deluxe	Efunds		No
7/10/00	Eaton	Axcelis Technologies		No
8/9/00	Sea Containers	Orient Express Hotels		Marginal

List of 18 equity carve-outs , 1995-2000, in which the parent stated its intention to distribute to its shareholders its remaining shares in the subsidiary.

Table 2
Stub values and market values between IPO and distribution

	Min stub, S_t, $ per parent share	Min stub, s_t, fraction of parent	Max market value of issue ($ mil)	First neg.	Next first pos.	Last neg.	Distribution announcement
				------------- Trading days -------------			
Creative/UBID	-74.81	-1.40	342	1	114	113	113
HNC/Retek	-49.01	-0.56	594	2	50	177	181
Daisytek/PFSWeb	-13.72	-0.63	157	1	82	81	131
Metamor/Xpedior	-5.26	-0.19	320	3	5	40	67
3Com/Palm	-62.68	-0.77	2514	1	48	47	47
Methode/Stratos	-20.86	-0.39	499	1	133		

$S_t = P_t^P - x_t P_t^S$ is stub value in dollars per share. $s_t = \frac{P_t^P - x_t P_t^S}{P_t^P} = \frac{S_t}{P_t^P}$ is stub value as a percent of parent value. First day of trading is day 1. Minimum and maximum between IPO and distribution. "Max market value of issue" is the maximum price times number of shares issued (not outstanding) during the interval. "First neg." is the first trading day with a negative stub. "Next first pos." is the subsequent day on which prices imply a positive stub. "Last neg." is the last day on which a negative stub occurs. All calculations are based on closing prices. For Metamor/Xpedior, day 67 is the day that the takeover of parent Metamor is announced. For Methode/Stratos, distribution announcement and positive stub have not yet occurred.

Table 3
Total returns from first negative stub to announcement/distribution days

	First neg.	-- Announcement day plus one--				------Distribution day------			
	Stub	Stub	R_T^P	R_T^S	R_T^P - R_T^S	Stub	R_T^P	R_T^S	R_T^P - R_T^S
Creative/UBID	-8.09	4.74	0.49	0.00	0.49	8.30	0.24	-0.29	0.53
HNC/Retek	-8.04	14.94	-0.19	-0.34	0.15	15.93	0.32	0.23	0.09
Daisytek/PFSWeb	-13.72	5.64	-0.48	-0.84	0.36	5.75	-0.58	-0.90	0.32
Metamor/Xpedior	-3.65	7.75	0.15	-0.22	0.37	9.76	-0.05	-0.46	0.41
3Com/Palm	-62.68	3.98	-0.41	-0.69	0.28	10.51	-0.21	-0.63	0.42
Methode/Stratos	-10.00								
Average	-17.69	7.41	-0.09	-0.42	0.33	10.05	-0.06	-0.41	0.35
T-stat	1.95	3.73	0.49	2.72	5.87	5.98	0.34	2.16	4.73
Average Excluding Xpedior	-20.50	7.33	-0.15	-0.47	0.32	10.12	-0.06	-0.40	0.34
T-stat	1.94	2.86	0.67	2.49	4.48	4.67	0.27	1.63	3.59

Returns are total simple returns from the day of the first negative stub to either the day after the announcement day, or the distribution day. The only stock paying a dividend is Methode Electronics, the parent of Stratos Lightwave, which paid a dividend of five cents a share on 7/12/00. For Xpedior, we count the announcement day as the day that Xpedior's parent announces that it is being acquired, and the distribution day as the day Xpedior's parent ceases trading.

Table 4
CAPM regression for monthly trading strategies

R_t^P - R_T^S = α + β (R_t^M - R_t^F) + ε

	Coefficients	Standard Error	t Stat
α	0.11	0.04	2.78
β	1.35	0.94	1.44
R Square	0.15		

$\frac{1}{1-s_0} R_t^P + \frac{-s_0}{1-s_0} R_t^F - R_t^S$ = α + β (R_t^M - R_t^F) + ε

	Coefficients	Standard Error	t Stat
α	0.12	0.04	3.10
β	0.59	0.86	0.68
R Square	0.04		

R_t^P is the monthly return from parent stock, R_T^S is monthly return from the subsidiary stock, and R_t^M - R_t^F is S&P Composite total returns minus T-bill return, both from Ibbotson Associates. Calculations use monthly closing prices. The strategy takes a position on the last day of the month if the stub is negative on that day, and holds until the last day of the month in which the distribution announcement is made. In all five cases, the position is initiated at the end of the first month of trading. Since Metamor/Xpedior does not have a negative stub at the end of the month, it is not included in this strategy. $s_0 = \frac{P_0^P - xP_0^S}{P_0^P}$ is the stub value as a percent of parent stock price, as of the last day of the first month of trading. Equal weighted returns on from one to four paired positions per month. Number of observations is 14 months.

Table 5
Short Interest

	First Month Parent	First Month Subsidiary	2nd Month Subsidiary	Peak Subsidiary
Creative/UBID	4.2%	8.5%	54.7%	70.9%
HNC/Retek	7.5%	19.8%	37.4%	53.4%
Daisytek/PFSWeb	1.6%	17.7%	48.6%	63.7%
Metamor/Xpedior	5.0%	17.2%	24.6%	26.8%
3Com/Palm	2.6%	19.4%	47.3%	147.6%
Methode/Stratos	1.4%	31.8%	50.3%	65.8%
Average	3.7%	19.1%	43.8%	71.4%
Difference from previous column		15.3%	24.7%	27.6%
T-stat		4.37	4.51	1.87

Short interest calculated as percent of parent shares outstanding or subsidiary shares trading. The level of short interest comes from NASD, and is on or around the 15th calendar day of the month. The shares outstanding of the parent and the shares issued in the IPO are from company SEC filings. "First month" is the first observed short interest after the IPO, and "2nd month" is one month later. "Peak" is the highest level between the IPO date and the distribution date. Stratos peak as of 9/00.

Table 6
Palm options on 3/17/00

LIBOR

3-month	6.125
6-month	6.3125

Stock prices

Palm	55.25
3Com	68

Options Prices

	Call		Put		Synthetic	Percent	Synthetic	Percent
	Bid	Ask	Bid	Ask	Short	Deviation	Long	Deviation
May 55	5.75	7.25	10.625	12.625	47.55	-14%	51.05	-8%
August 55	9.25	10.75	17.25	19.25	43.59	-21%	47.09	-15%
November 55	10	11.5	21.625	23.625	39.15	-29%	42.65	-23%

May options expire 5/20/00. August options expire 08/19/00, November options expire 11/18/00. A synthetic short position buys a put (at the ask price), sells a call (at the bid price), and borrows the present value of the strike price. A synthetic long position sells a put (at the bid price), buys a call (at the ask price), and lends the present value of the strike price. Source of options price data: CBOE. Source of LIBOR: Datastream

Table 7
Regression of Palm 6-month synthetic stub deviation on actual Palm stub

No trend			
R Square	0.98		
	Coefficients	*Standard Error*	*t Stat*
Constant	-7.85	0.20	40.08
S_t	0.56	0.02	26.20

With trend			
R Square	0.98		
	Coefficients	*Standard Error*	*t Stat*
Constant	-9.34	0.87	10.76
S_t	0.48	0.05	9.46
Trend	0.15	0.08	1.76

The dependent variable is $S_t - \hat{S}_t$, the deviation between the actual stub and the synthetic stub. The actual stub, $S_t = P_t^P - x_t P_t^S$, uses actual prices of Palm and 3Com shares. The synthetic stub, $\hat{S}_t = P_t^P - x_t \hat{P}_t^S$, uses the actual price of 3Com shares and the synthetic short price of Palm shares. The synthetic short price of Palm, $-\hat{P}_t^S$, is constructed by selling a six-month at-the-money call at the bid prices, buying a six-month at-the-money put at the ask prices, and borrowing the present value of the exercise price at the 6-month LIBOR rate. The regression uses 19 weekly observations as of Friday, 3/17/00 to 7/21/00.

Table 8
IPO day returns

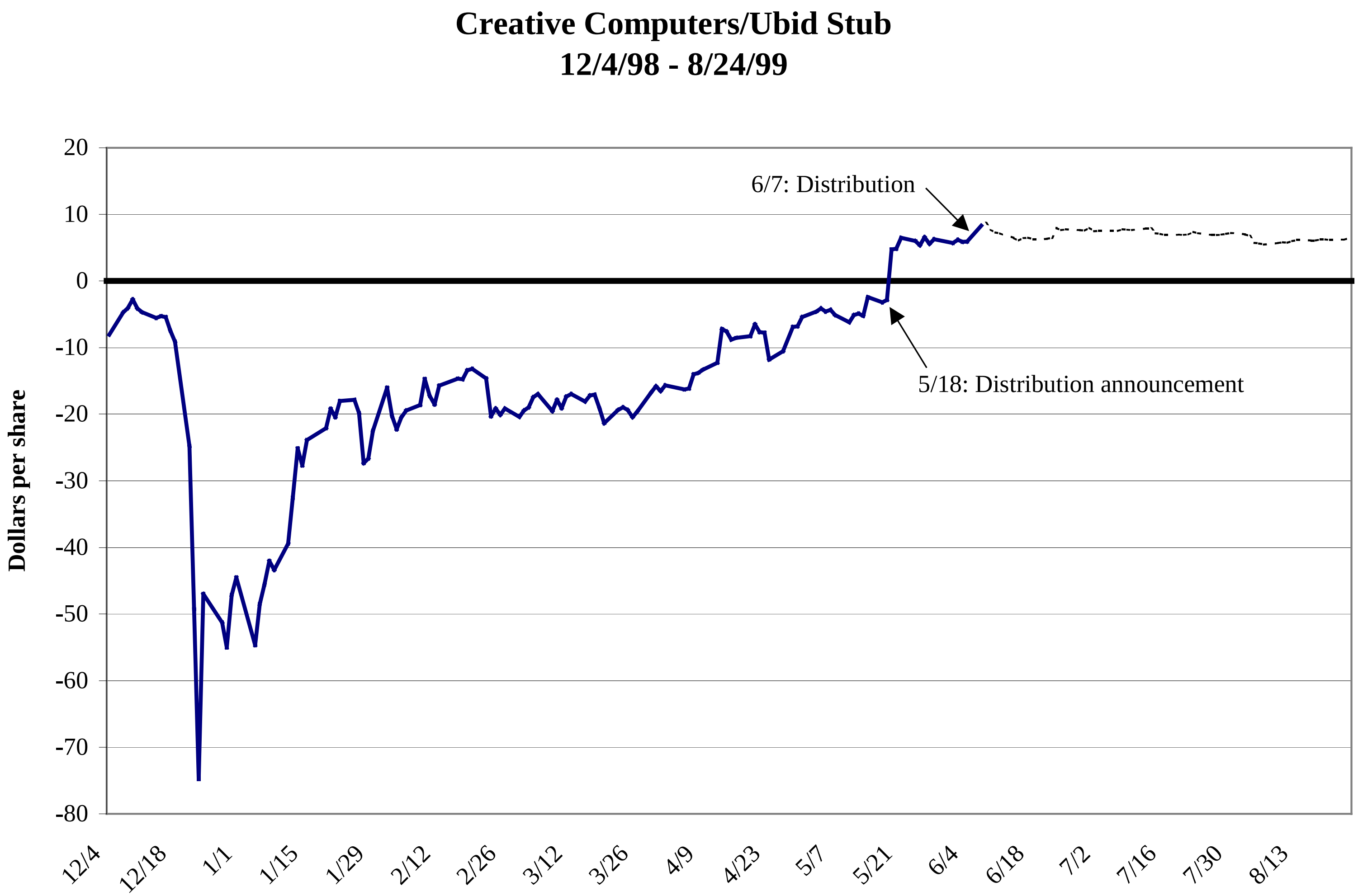
	-----Subsidiary-----			--------Parent--------		
	Offer Price	Closing Price	Change	Pre-IPO Price	Closing Price	Change
HP/Agilent	30.00	42.75	43%	78.00	94.31	21%
Odetics/ATL	11.00	11.88	8%	19.63	18.25	-7%
Eaton/Axcelis	22.00	23.94	9%	69.50	69.50	0%
Viacom/Blockbuster	15.00	15.00	0%	40.56	39.94	-2%
Cabot Corp/Cabot Micro	20.00	24.88	24%	29.50	28.00	-5%
Cincinnati Bell/Convergys	15.00	16.63	11%	29.75	28.69	-4%
GM/Delphi	17.00	18.63	10%	87.06	85.94	-1%
Deluxe/Efunds	13.00	12.00	-8%	23.88	23.31	-2%
AT&T/Lucent	27.00	30.63	13%	64.13	62.88	-2%
Santa Fe/Monterey	14.50	16.50	14%	14.75	15.00	2%
Sea Containers/Orient Express	19.00	19.75	4%	28.13	26.25	-7%
HNC/Retek	15.00	32.56	117%	61.00	60.88	0%
Tridex/TransAct	8.50	8.75	3%	10.44	10.63	2%
Metamor/Xpedior	19.00	26.00	37%	33.19	29.00	-13%
Average for 14 subsidiaries with positive stub on issue date			20%			-1%
3Com/Palm	38.00	95.06	150%	104.13	81.81	-21%
Daisytek/PFSWeb	17.00	44.13	160%	22.63	21.94	-3%
Methode/Stratos	21.00	34.13	63%	43.94	41.88	-5%
Creative/UBID	15.00	48.00	220%	35.25	26.25	-26%
Average for 4 subsidiaries with negative stub on issue date			148%			-14%
T-statistic for difference in means			5.69			2.61

Table 9
Volume and institutional ownership

	Turnover		Institutional ownership	
	Parent	Subsidiary	Parent	Subsidiary
Creative/UBID	23.7%	106.5%	18%	10%
HNC/Retek	3.7%	22.2%	98%	72%
Daisytek/PFSWeb	2.4%	25.5%	72%	70%
Metamor/Xpedior	2.1%	11.7%	53%	36%
3Com/Palm	4.5%	18.9%	54%	46%
Methode/Stratos	2.5%	41.2%	70%	37%
Average	6.5%	37.7%	60.7%	45.2%
Difference, parent vs. subsidiary		31.2%		15.5%
T-stat		2.81		3.17

Turnover is daily volume as percent of parent shares outstanding or subsidiary shares trading. Subsidiary shares trading are shares sold to the public in the IPO. Volume is average daily volume from the first 20 trading days after the IPO date (not including the first day of trading). The shares outstanding of the parent and the shares issued in the IPO are from company SEC filings. Institutional ownership is from 13F filings to the SEC (via Securities Data Corporation) and is for the first quarterly filing after the IPO. Institutional ownership as a percent of parent shares outstanding or subsidiary shares trading.

Figure 1



Creative Computers/Ubid Stub
12/4/98 - 8/24/99
Dollars per share
20
10
0
-10
-20
-30
-40
-50
-60
-70
-80
12/4
12/18
1/1
1/15
1/29
2/12
2/26
3/12
3/26
4/9
4/23
5/7
5/21
6/4
6/18
7/2
7/16
7/30
8/13
6/7: Distribution
5/18: Distribution announcement

Figure 2

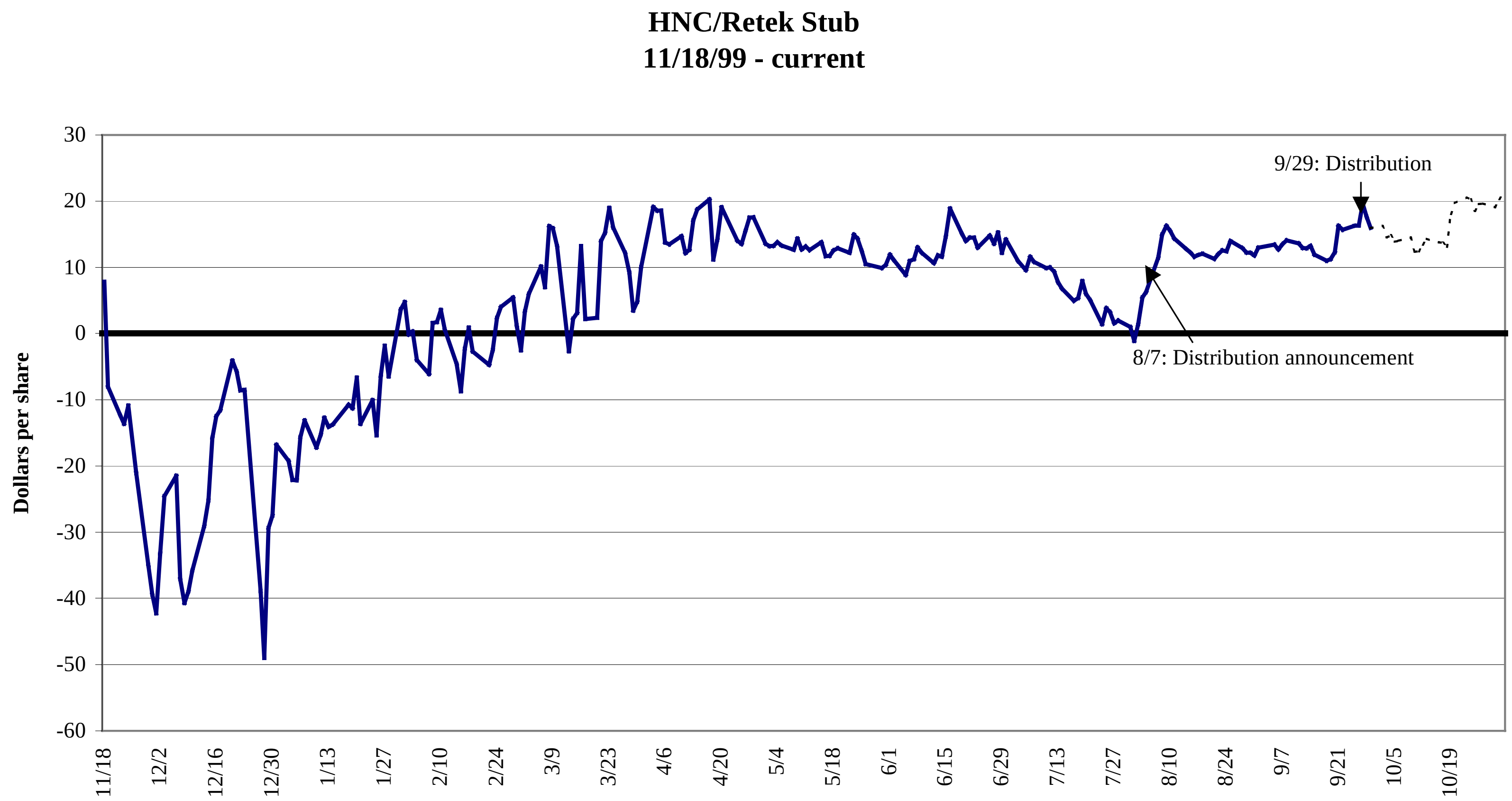
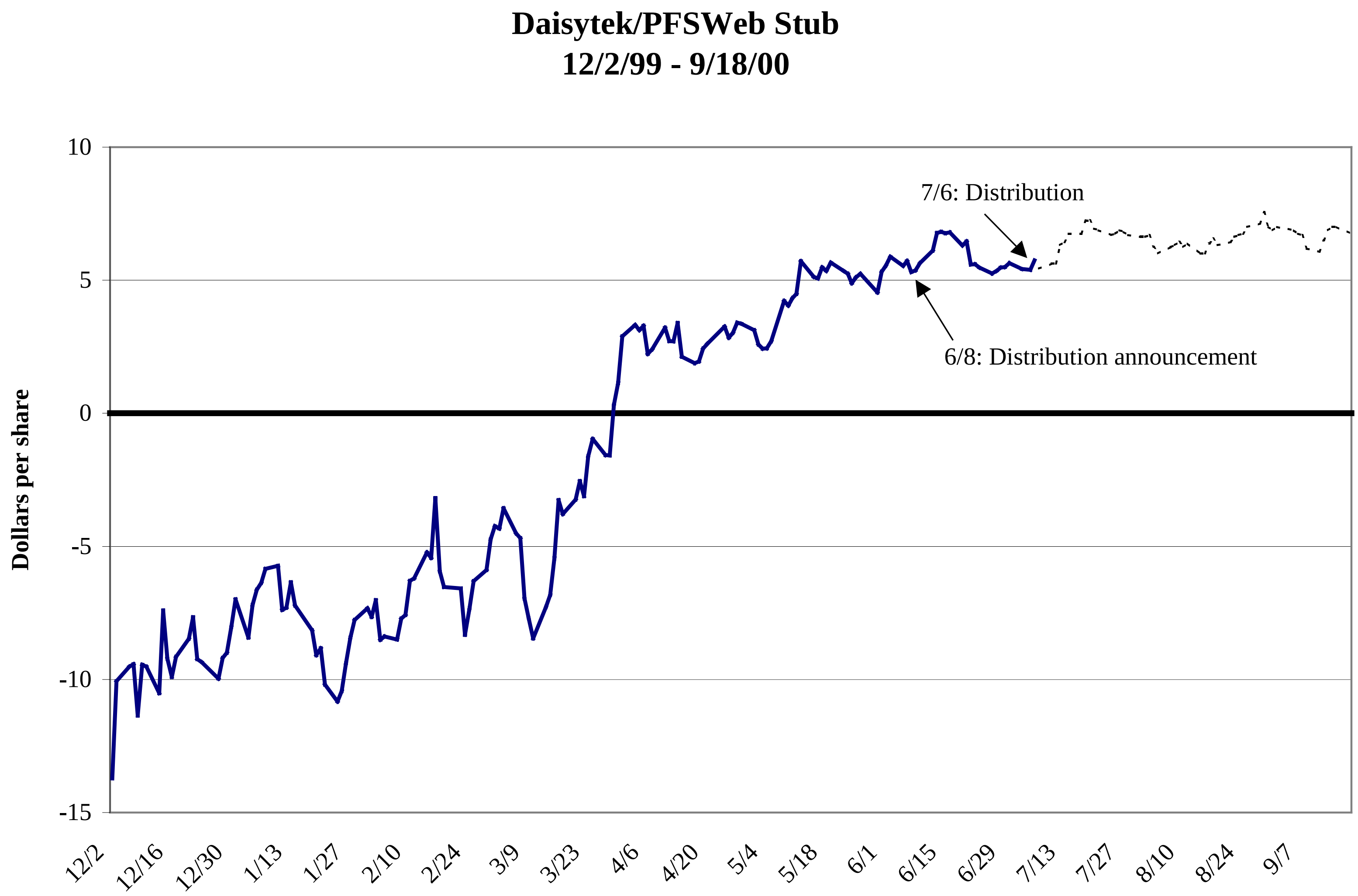
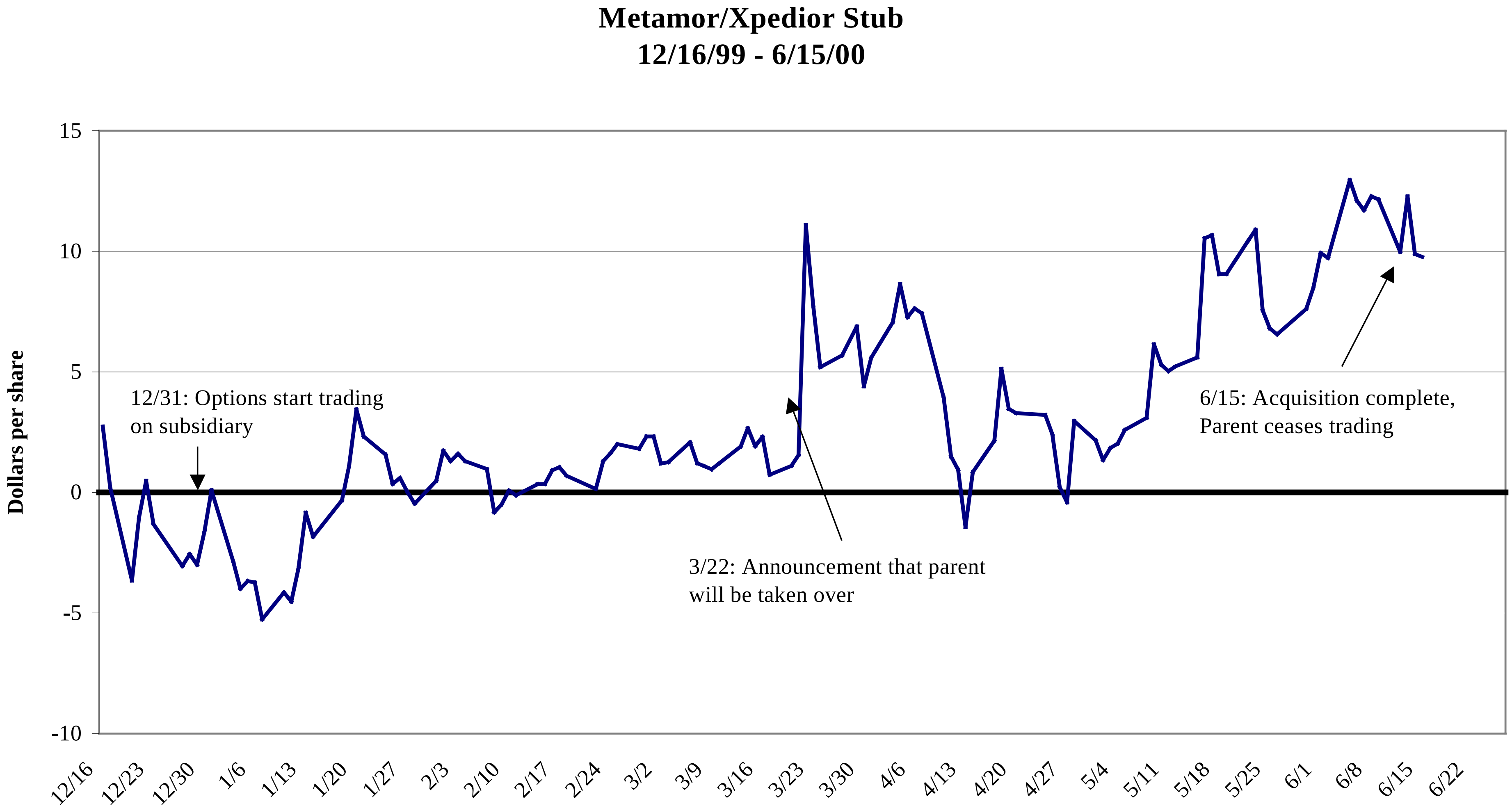

HNC/Retek Stub
11/18/99 - current
Dollars per share
30
20
10
0
-10
-20
-30
-40
-50
-60
11/18
12/2
12/16
12/30
1/13
1/27
2/10
2/24
3/9
3/23
4/6
4/20
5/4
5/18
6/1
6/15
6/29
7/13
7/27
8/10
8/24
9/7
9/21
10/5
10/19
9/29: Distribution
8/7: Distribution announcement

Figure 3



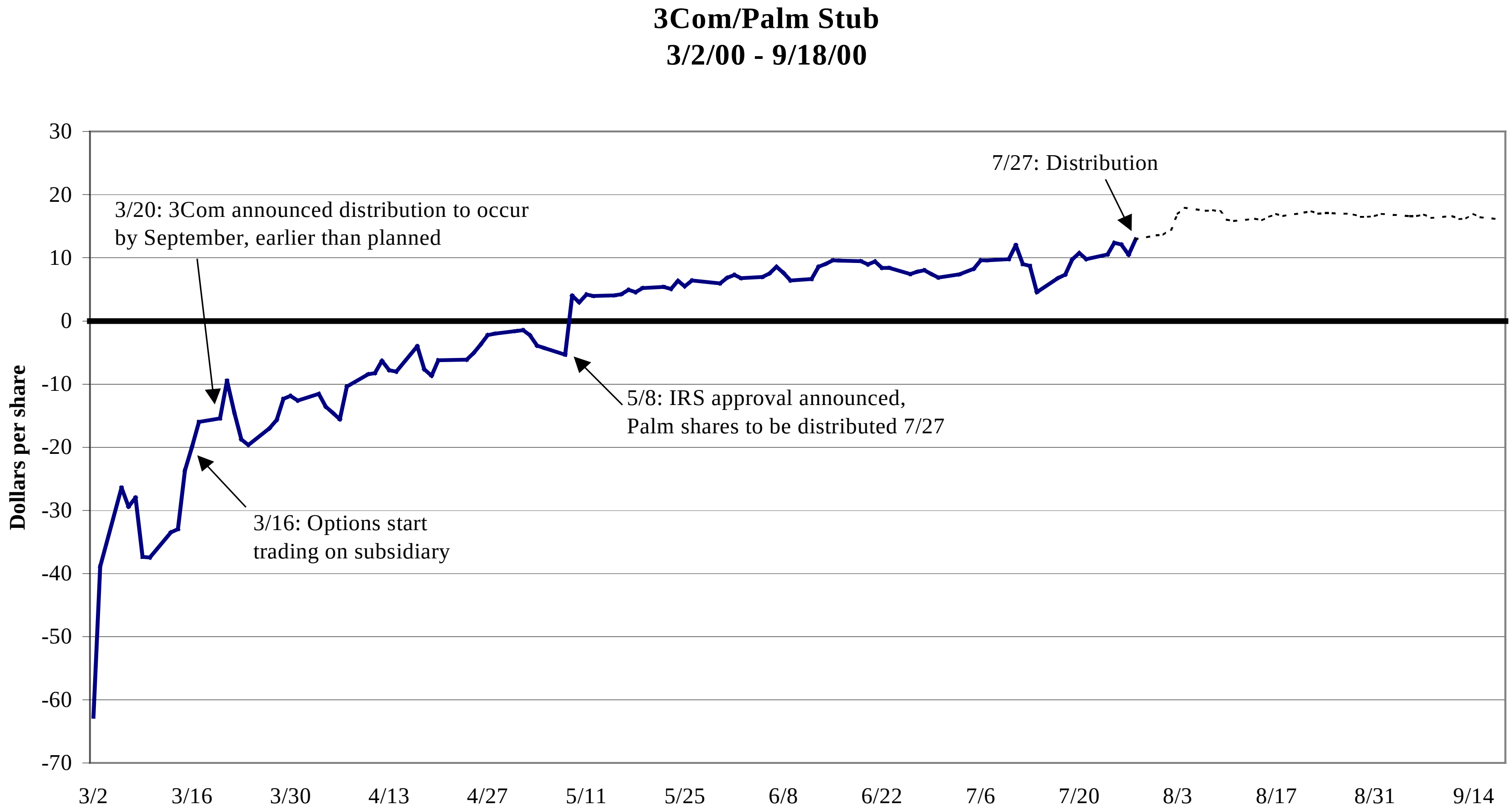
Daisytek/PFSWeb Stub
12/2/99 - 9/18/00
10
5
0
-5
-10
-15
Dollars per share
7/6: Distribution
6/8: Distribution announcement
12/2
12/16
12/30
1/13
1/27
2/10
2/24
3/9
3/23
4/6
4/20
5/4
5/18
6/1
6/15
6/29
7/13
7/27
8/10
8/24
9/7

Figure 4



Metamor/Xpedior Stub
12/16/99 - 6/15/00
Dollars per share
15
10
5
0
-5
-10
12/31: Options start trading
on subsidiary
3/22: Announcement that parent
will be taken over
6/15: Acquisition complete,
Parent ceases trading
12/16
12/23
12/30
1/6
1/13
1/20
1/27
2/3
2/10
2/17
2/24
3/2
3/9
3/16
3/23
3/30
4/6
4/13
4/20
4/27
5/4
5/11
5/18
5/25
6/1
6/8
6/15
6/22

Figure 5



3Com/Palm Stub
3/2/00 - 9/18/00
Dollars per share
30
20
10
0
-10
-20
-30
-40
-50
-60
-70
3/2
3/16
3/30
4/13
4/27
5/11
5/25
6/8
6/22
7/6
7/20
8/3
8/17
8/31
9/14
7/27: Distribution
3/20: 3Com announced distribution to occur by September, earlier than planned
5/8: IRS approval announced, Palm shares to be distributed 7/27
3/16: Options start trading on subsidiary

Figure 6

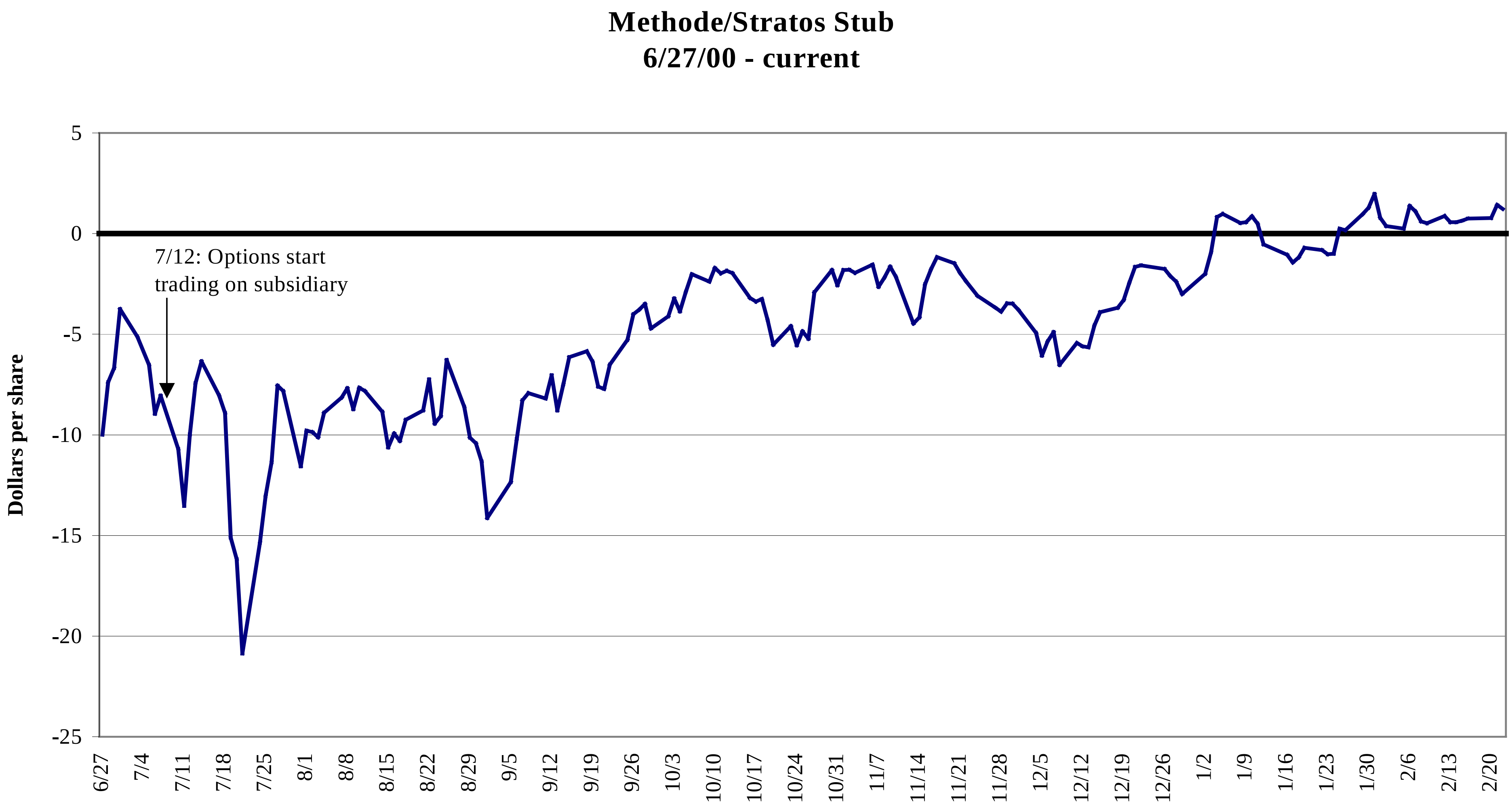

Methode/Stratos Stub
6/27/00 - current
Dollars per share
5
0
-5
-10
-15
-20
-25
7/12: Options start
trading on subsidiary
6/27
7/4
7/11
7/18
7/25
8/1
8/8
8/15
8/22
8/29
9/5
9/12
9/19
9/26
10/3
10/10
10/17
10/24
10/31
11/7
11/14
11/21
11/28
12/5
12/12
12/19
12/26
1/2
1/9
1/16
1/23
1/30
2/6
2/13
2/20

Figure 7

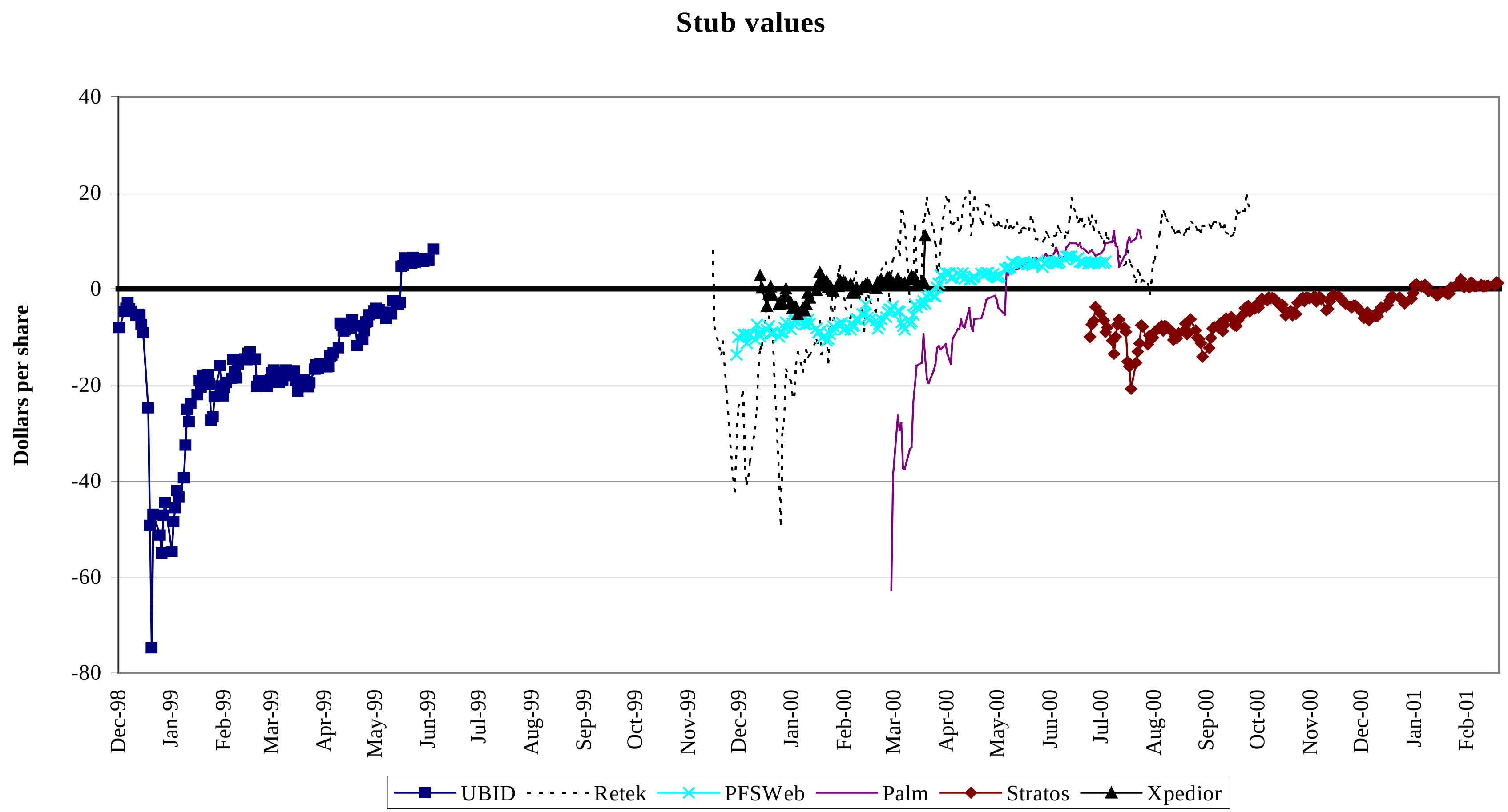

Stub values
Dollars per share
40
20
0
-20
-40
-60
-80
Dec-98
Jan-99
Feb-99
Mar-99
Apr-99
May-99
Jun-99
Jul-99
Aug-99
Sep-99
Oct-99
Nov-99
Dec-99
Jan-00
Feb-00
Mar-00
Apr-00
May-00
Jun-00
Jul-00
Aug-00
Sep-00
Oct-00
Nov-00
Dec-00
Jan-01
Feb-01
UBID
Retek
PFSWeb
Palm
Stratos
Xpedior

Figure 8

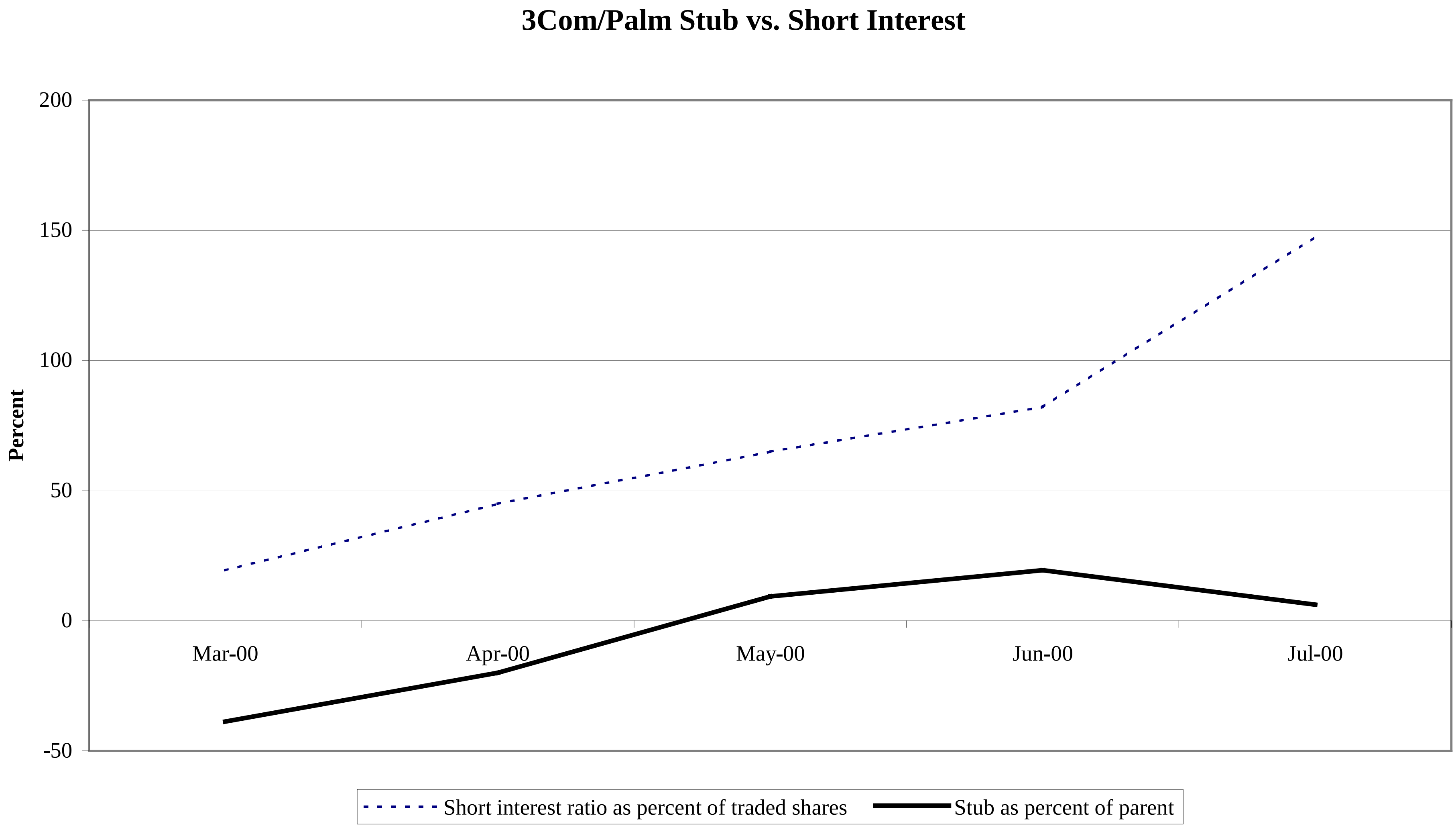

3Com/Palm Stub vs. Short Interest
200
150
100
50
0
-50
Percent
Mar-00
Apr-00
May-00
Jun-00
Jul-00
Short interest ratio as percent of traded shares
Stub as percent of parent

Figure 9

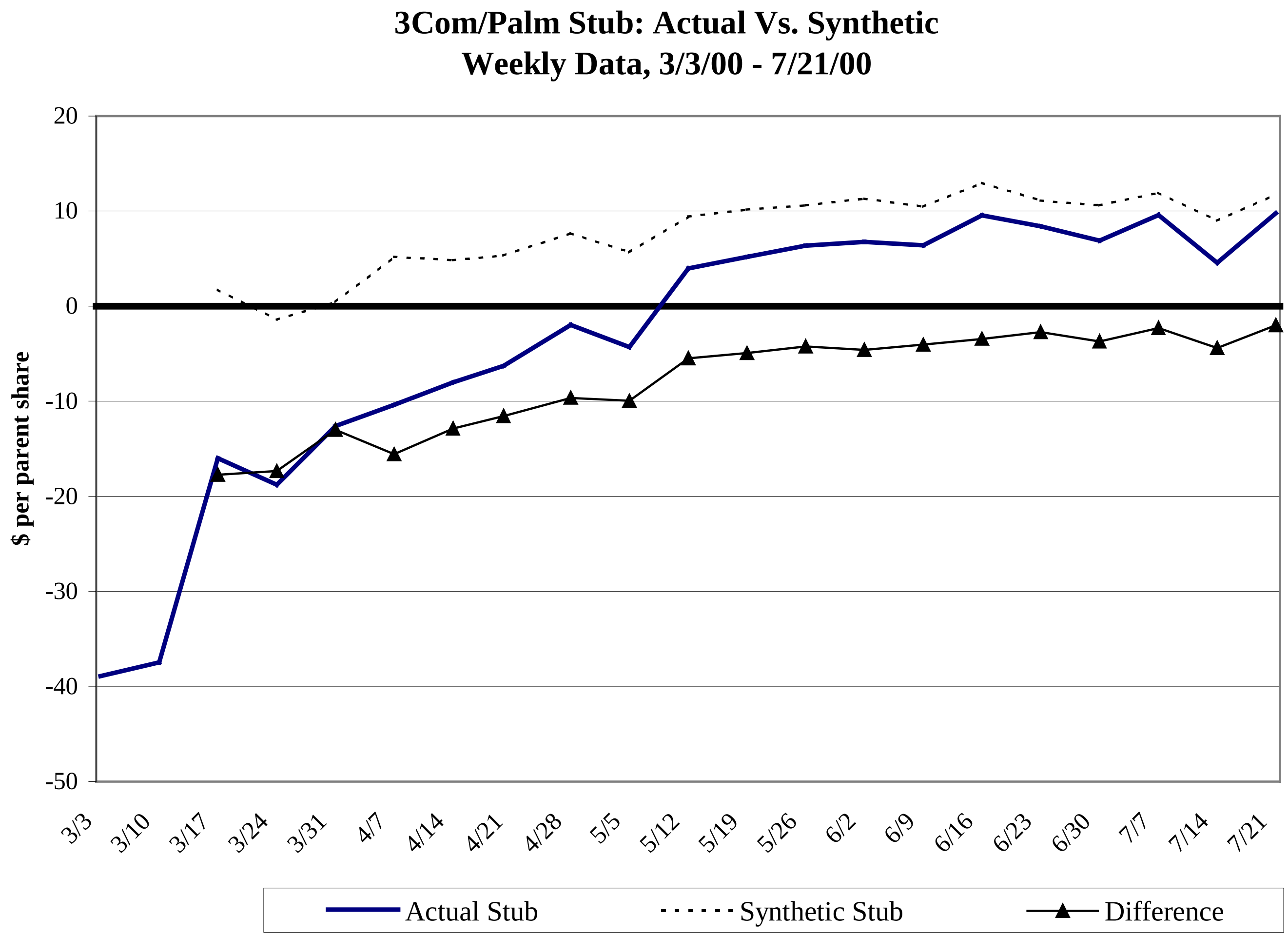
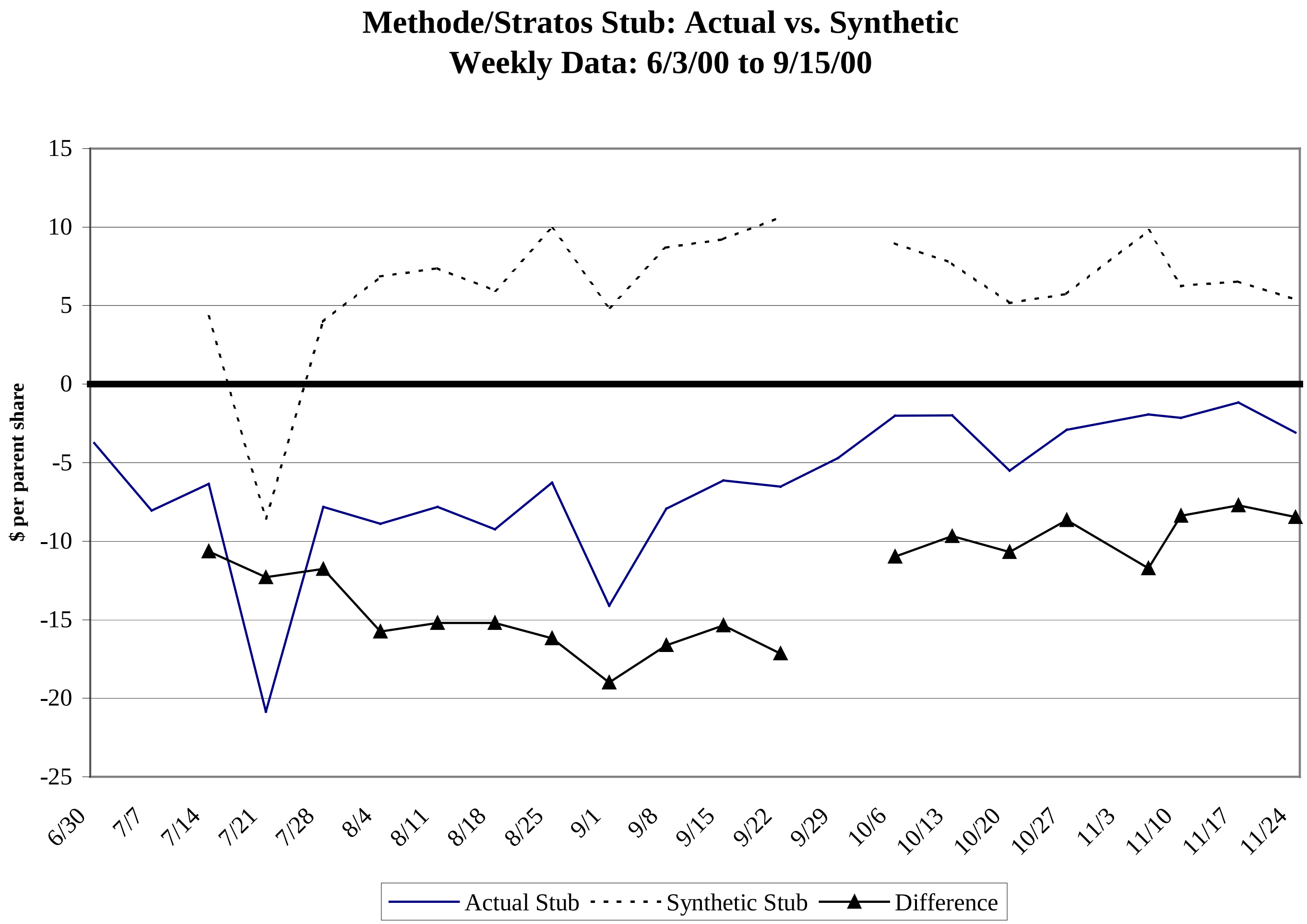

3Com/Palm Stub: Actual Vs. Synthetic
Weekly Data, 3/3/00 - 7/21/00
$ per parent share
20
10
0
-10
-20
-30
-40
-50
3/3
3/10
3/17
3/24
3/31
4/7
4/14
4/21
4/28
5/5
5/12
5/19
5/26
6/2
6/9
6/16
6/23
6/30
7/7
7/14
7/21
Actual Stub
Synthetic Stub
Difference

Figure 10


Methode/Stratos Stub: Actual vs. Synthetic
Weekly Data: 6/3/00 to 9/15/00
$ per parent share
15
10
5
0
-5
-10
-15
-20
-25
6/30
7/7
7/14
7/21
7/28
8/4
8/11
8/18
8/25
9/1
9/8
9/15
9/22
9/29
10/6
10/13
10/20
10/27
11/3
11/10
11/17
11/24
Actual Stub
Synthetic Stub
Difference