“A solution to the Palm—3Com spin-off puzzles”

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Abstract

This paper revisits the relative pricing of Palm and 3Com at the peak of Internet pricing. We offer a simple rational explanation of the pricing during the Palm--3Com spin-off episode (when it was suggested that the market valued the common stock portion of Palm owned by 3Com at more than the whole of 3Com) based on the observation that Palm shares issued in the IPO had higher valuation than shares still held by 3Com due to the lending fees that Palm shares could have earned. In valuing 3Com we use Palm’s post-spin-off forward prices, which can be calculated from the market prices of calls and puts. Considering forward pricing resolves various pricing puzzles. We also re-interpret empirical evidence about the relative pricing movements between Palm and 3Com in light of the resolution of uncertainty about the spin-off.
Introduction

A fundamental paradigm and bedrock principle in modern financial economics is the efficiency of market pricing, the absence of arbitrage and the existence of a linear pricing operator.\(^5\) An important challenge to this paradigm comes from the perspective that asset prices are driven by behavioral biases. An especially celebrated example is the spin-off of Palm from 3Com near the peak of Internet pricing in early 2000. After the carve-out of Palm and IPO of 5% of its shares, 3Com still owned the remaining 95% of Palm; when extrapolating the market valuation of the 5% of the Palm shares to the remaining 95% of Palm, the value of Palm was much larger than the total stock market value of 3Com. This example raises the broader question of how can the pricing of a parent company be less than the pricing of a subsidiary potentially being spun out of it? At its most general level, Palm—3Com has been interpreted as suggesting that its market pricing represents an apparent violation of the law of one price and even questioning the ability of the marketplace to undertake basic relative valuation arithmetic (for example, Lamont and Thaler (2003b) entitle their well-known paper, “Can the Market Add and Subtract? Mispricing in Tech Stock Carve-outs”).\(^6\) In light of the striking nature of the Palm—3Com example and the wide attention paid to it,\(^7\) it is implausible on its face that there would be extreme violations of basic market pricing principles per se. How then can we interpret the much studied Palm—3Com context and associated pricing puzzles? Certainly, one cannot deny that this example is intriguing.

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\(^{5}\)See, for example, Ross (1976, 1978, and 2004).

\(^{6}\)The 3Com-Palm example is one of a large number of situations in which the value of the parent is nominally less than the value of the subsidiary (e.g., Lamont and Thaler (2003b), Cornell and Liu (2001), Schill and Zhou (2001) and Mitchell, Pulvino and Stafford (2002)).

\(^{7}\)This situation was discussed extensively contemporaneously in such outlets as the *New York Times* and *Wall Street Journal* and received attention by many investors, in addition to being subject to considerable academic study.
3Com carved out its subsidiary Palm in September 1999 and IPOed about 5% of it (leading to a 23,000,000 share float) on March 2, 2000 with the intention to spin-off the remaining 95% in December 2000 by distributing 1.5 shares of Palm for each 3Com share. Lamont and Thaler (2003b) utilize March 2nd market price data to value 3Com’s non-Palm assets at -$66 per share, which would imply a negative $22 billion market capitalization for all of 3Com’s non-Palm assets. But this raises important measurement issues as 3Com had positive net value before acquiring Palm and a $5 billion capitalization the day after Palm’s spin-off (which suggest that the financial market recognized that there was considerable residual value in 3Com). One possible conclusion is that the market valuation of the 23,000,000 freely trading Palm shares is too high (as compared to the 532,000,000 shares still held by 3Com) - leaving open resolving the question as to why?

We point to the scarcity of Palm shares prior to the spin-off plus heterogeneity of investors’ opinions about Palm causing a large volume of option trading and the emergence of enormous lending fees earned by the owners of currently floating Palm shares; the scarcity will disappear after the spin-off. While the pre-spin-off valuation of Palm shares includes the capitalized value of the lending fees, the post-spin-off valuation does not. Every investor in 3Com will receive its Palm shares only after the spin-off, when there are no fees earned. This causes a wedge between the valuation of Palm shares still held within 3Com and the freely –trading Palm

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8 3Com did not lend out its unissued Palm shares.
shares. To make a correct valuation of 3Com’s stub [=value of 3Com’s non-Palm assets] we must use the value of a Palm share net of the capitalized value of lending fees.10

A simple example may be instructive. Suppose that the Palm share trades at $100 and that the spin-off occurs in exactly one year. We suppose that the lending fees are 34% with continuous compounding (and risk-free rate =6%), then the valuation of Palm reflects the capitalized value11 of lending fees of $28 and a value of each Palm share retained by 3Com equal to $72 (so that 28+72=100). A $1 change in Palm’s market price would translate into a 1.5*.72=$1.08 change in the price of 3Com (as each share of 3Com “contains” 1.5 shares of Palm).

Now, if the time to spin-off were shortened unexpectedly by one-half year (as actually happened in the Palm-3Com case on May 8, 2000), but suppose hypothetically that Palm’s share price stays at $100, then the capitalized value of lending fees would be $15 and the value of Palm shares still held by 3Com would be $85. 3Com’s price would increase (instantaneously upon announcement of an earlier spin-off date) by $19.5=1.5*($85-$72) and a subsequent $1 change in Palm’s market price would translate into a 1.5*.85=$1.28 change in the price of 3Com.

But Palm share value should drop as the share will earn the lending fees for one-half year only. We can show that should Palm’s shares fall in value but stay above $85, the value of

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10 The size of fees is substantial: “the evidence from D’Avolio (2000) indicates a[n up to]…35 percent… shorting cost for Palm during this period…” [Lamont and Thaler (2003b, p. 256)]. D’Avolio (p. 273) states that “less than 1% of stocks (roughly seven per month) on loan become extremely special, demanding negative rebate rates (i.e., loan fees in excess of the risk-free rate). Krispy Kreme Doughnuts and Palm Inc. are examples of such stocks, exhibiting loan fees as high as 50% and 35%, respectively.” A rebate of 35% means a lending fee of 35%+6.3%=41.3%!

11 The capitalized value of the lending fees is equal to \[\int_0^T [(\delta S_0 * e^{-\delta t}) * e^{-RT}] dt = \frac{\delta}{\delta + R} S_0 * (1 - e^{-(\delta + R)T}),\] where \(\delta\) is the continuous rate of lending fees, \(R\) is the risk-free rate and \(T\) is time to the spin-off. For \(\delta=0.34, R=0.06\) and \(T=1\) the lending fees are $28. We disregard any considerations of compounding and describe the example in a somewhat imprecise fashion.
3Com must go up! For example, should the new price of Palm be $90, the capitalized value of fees should be $14 and the value of Palm shares still held by 3Com should be $76 (so that 
14+76=90) and the price of 3Com should raise by $6=1.5*(76-$72). Now a subsequent change in $1 Palm’s value will translate into a 1.5*(76/90) = $1.27 change in the price of 3Com.

This is exactly what happened on May 9, 2000: after 3Com declared that it will spin-off Palm’s shares in July rather than in December 2000, the May 9th closing price for 3Com was 48.25, up from 43.69, while Palm’s share fell from 32.25 to 29.13. As our heuristic example would suggest, our empirical analyses shows that a $1 change in Palm’s price forecast a $.7 change in 3Com price prior to May 9, but a $1.33 change after May 9 (in both cases the adjusted $R^2$ exceeded 90%).

The above numerical example shows that the timing of the spin-off date and the uncertainty about the spin-off date are crucial in the valuation of Palm’s impact on 3Com. To study this issue further, we examine the co-movement in pricing between 3Com and Palm. When we try to explain movements in the stock price of 3Com against the stock price of Palm we see some striking patterns. Central to this regression analysis, we split our sample at May 8, 2000 when 3Com announced that it would move ahead with the spin-off on July 27, 2000, thus shorting the time to spin-off by 4 months at least and removing the uncertainty about spin-off. Because the information was announced after the market close on May 8th, the pre-resolution sample runs through the close on May 8th and the post-resolution sample begins on May 9th. This resolved the uncertainty as to whether the spin-off would occur and dramatically shortened the interval over which lending fees would be earned by the holders of Palm relative to 3Com.
Various researchers have undertaken regressions to examine the relative pricing movements between Palm and 3Com. An important broad theme to emerge from such analyses is that the linkage between the price movements on these two stocks is far from perfect, which many interpret as indicating that the arbitrage mechanism did not perform well and even that the market is unsure how to undertake basic valuation arithmetic. Our analysis suggests that it is crucial to incorporate the uncertainty of spin-off data in the specification of our regressions. If we regress the stock price of 3Com on the stock price of Palm, the R-square would be determined by the proportion of variation in 3Com that reflects variation in Palm. To the extent that the remainder of the 3Com business model is distinct, one would expect the R-square to be substantially less than 100%. Greater certainty about the completion of the spin-off would increase potentially the R-square as well as the coefficient on Palm in the underlying regression. Indeed, with complete certainty we would expect the regression coefficient to be near 1.5 (since each share of 3Com would include 1.5 shares of Palm). When we split the data at May 8\textsuperscript{th}, we find that in the post-May 8\textsuperscript{th} daily dataset that the slope coefficient was much larger than in the pre-May 9\textsuperscript{th} data (1.69 vs. .78) and the adjusted R-square was higher as well (.95 vs. .91). Interestingly, when we pool the sample, ignoring the regime shift due to the resolution of uncertainty on May 8\textsuperscript{th}, we estimate that the slope coefficient is only .635 and the adjusted R-square also is substantially lower, .638. This highlights the dramatic importance of the timing of spin-off. Without splitting the sample, the regressions are not specified as precisely and produce much more ambivalent findings. This could have contributed to previous authors not identifying a resolution to the puzzle. Complementing the daily regressions described above, we also computed similar minute-by-minute transaction level regressions using May 8\textsuperscript{th} (before
the regime shift) and May 9th (after the regime shift) pricing. The slope coefficient on May 8th was .7 (adjusted R-square = .38) and the slope coefficient on May 9th was 1.33 (adjusted R-square = .72). This evidence from before and after the resolution of uncertainty tells a similar story to the daily regressions summarized above.\textsuperscript{12}

Our numerical example above illustrates that a natural way to adjust the stub value for these lending fees would be to use the forward price for Palm (based upon assumptions about the date of the spin-off instead of the current spot price). Analogously, in commodity valuation analyses the forward price of a commodity does not reflect its use value prior to the expiration of the forward contract, while the spot price of a commodity reflects the value of the option to “use” the commodity in “stock-out” states prior to the expiration of the forward contract.\textsuperscript{13} We also can get the Palm’s value net of lending fees by utilizing forward contracts on Palm with a post-spin-off delivery date. We calculate the forward prices from calls and puts with post-spin-off maturity dates.

\textsuperscript{12} Cochrane (2003) offers an interesting and somewhat critical analysis of aspects of the conclusions in Lamont and Thaler (2003b), but without offering a resolution of the central puzzle. Using regression evidence he points out that 3Com appears to be a less favorable way to own Palm over time, but this focuses upon the spot price dynamics of the two assets without adjusting for the lending fees available to investing by owning Palm outright.

\textsuperscript{13} The use value of a commodity can be interpreted as “convenience yield,” as illustrated by the equilibrium analysis in Routledge, Seppi and Spatt (2000). The lending fees for Palm reflect the overall “use” values for direct ownership of a share of Palm even prior to the date of spin-off, but these are not reflected in the implicit ownership of Palm through ownership of 3Com. Absent storage costs, this results in a downward sloping forward curve for commodities.
When the capitalized values of fees are removed, the various paradoxes disappear. The correctly-calculated stub value is always positive and Palm’s synthetic forward price behavior is consistent with a large lending fee that disappears after spin-off. Lastly, the perceived violations of put-call parity and of LOOP are absent. We conclude that all laws and relationships prescribed by classical finance theory were satisfied during the Palm-3Com episode.

Despite the considerable frictions and impediments to short-selling, our empirical analyses suggest that the market approached the relative valuation of 3Com and Palm in a highly sophisticated manner. Indeed, given the considerable contemporaneous spotlight on this relative valuation, this is not at all surprising, even if behavioral biases were to play a huge role in market pricing. It is certainly difficult to discern the importance of behavioral biases for market pricing from this context.

1. Modeling the spin-off time uncertainty.

1.1 Uncertainty about the spin-off date and its resolution on May 8

The Palm’s spin-off was regulated by the December 12, 1999 “Master Separation and Distribution Agreement - 3Com Corp. and Palm Computing Inc.”; the agreement stated that 3Com’s board (in its sole discretion) could expedite or delay the spin-off date; the board could also cancel the spin-off if it deems (in its sole discretion) that “… result [of Palm’s spin-off and]
the Distribution [of shares could have]… a material adverse effect on 3Com”.  The spin-off was conditioned on a favorable IRS ruling [the ruling whether the company could distribute the remaining 532 million shares without any tax penalties was expected in mid–September] and other conditions; but the 3Com board could cancel the spin-off even if all conditions were met. For example, an offer from another firm for a merger with 3Com or an offer for acquisition of 3Com could be treated as having a “material adverse effect” against the Distribution. Consequently, the spin-off and its timing were uncertain.

The uncertainty was resolved in the after-hours of May 8 when 3COM unexpectedly announced that a positive Internal Revenue Service ruling occurred earlier than expected and that 3Com “will distribute on July 27th … months earlier than scheduled -- about 1.5 Palm shares for each 3Com share.”

1.2 Modeling the uncertainty of the spin-off timing

We start with modeling the extra layer of complexity that comes from uncertainty of the spin-off’s timing.

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14 “3Com currently intends, following the consummation of the IPO, to complete the Distribution by December 1, 2000. 3Com shall, in its sole and absolute discretion, determine the date of the consummation of the Distribution and all terms of the Distribution. …3Com may … modify or change the terms of the Distribution, including, without limitation, by accelerating or delaying the timing of the consummation of all or part of the Distribution”. (see Section 4.3)

“The following are conditions that must take place prior to the consummation of the Distribution. The conditions are for the sole benefit of 3Com and shall not give rise to or create any duty on the part of 3Com or the 3Com Board of Directors to waive or not waive any such condition.

(a) IRS Ruling. 3Com shall have obtained a private letter ruling from the Internal Revenue Service in form and substance satisfactory to 3Com (in its sole discretion) … [that] the transfer by the 3Com Group to the Palm Group of the property … will qualify as a reorganization under Sections368(a)(1)(D) and 355 of the Code;

(d) No Material Adverse Effect. No other events or developments shall have occurred subsequent to the IPO Closing Date that, in the judgment of the Board of Directors of 3Com, would result in the Distribution having a material adverse effect on 3Com or on the stockholders of 3Com.” (see Section 4.4)

15 See “Stock Watch: Buyback, Palm Spinoff Plans Drive 3Com” by Nora Macaluso in E-Commerce Times on 05/09/00
Let $F_{T,t}$ denotes the time $t$ forward price\textsuperscript{16} of PALM share with delivery date $T$ and $S_t$ denotes the time $t$ price of Palm. Lamont and Thaler (2003b) define the stub value of a 3Com share as the value of 3Com’s non-Palm assets and calculate it from

$$S_{3COM,t} = STUB_t + 1.5 * S_t \quad (*)$$

as $STUB_t = S_{3COM,t} - 1.5 * S_t$

But the buyer of a 3Com share gets the 3Com “stub value” and a prepaid forward on 1.5 Palm shares (with a delivery date or spin-off date $T^*$), not 1.5 shares today.

$$S_{3COM,t} = STUB_t + 1.5 \ PV[F_{T^*,t}] \quad (1)$$

If possession of Palm shares yields a stream of continuous constant “lending fees” $\delta$ for all $t < T^*$, then the capitalized value of fees for interval $[t, T^*]$ should be accrued in the spot price of Palm (as an individual owner of Palm would earn those fees for lending his shares), but not in the valuation of 3Com. This places a wedge between the valuation of a freely-trading Palm share and those Palm shares still held by 3Com.

The relationship of $F_{T^*,t}$ with $S_t$ is complex. If we assume a constant continuous risk-free rate\textsuperscript{17} $R$ and lending fees earned for all $t < T^*$, then

$$F_{T^*,t} = S_t * e^{(R-\delta) * (T^* - t)} \quad (2) \text{ and}$$

$$PV[F_{T^*,t}] = * e^{(-\delta) * (T^* - t)} S_t \quad (2a)$$

\textsuperscript{16}Unless specified otherwise, $t$ is assumed to be equal to zero, $t = 0$, and Sub-index $t$ is sometimes omitted.

\textsuperscript{17}In this article we use $R=6.3\%$ as the risk–free rate- for reasons explained below.
Therefore, Palm’s contribution to price of 3Com is not $1.5 S_t$ as (*) would have it, but rather from (1)

$$S_{3COM,t} = STUB_t + 1.5 \cdot e^{(-\delta) \cdot (T^* - t)} S_t$$

which we rewrite as

$$S_{3COM,t} = STUB_t + G(T^*, t, \delta) \cdot S_t \quad (**\)$$

where $G(T^*) = 1.5 e^{-\delta \cdot (T^* - t)}$ is a complex function of the lending fee $\delta$, time to spin-off $T^*$, etc.

Above we have derived $G(T^*, \delta, t)$ for the case when the spin-off date $T^*$ is certain. The graph below shows that this $G(T^*)$ depends crucially on the value of $T^*$.

![Graph of $G(T, t, \delta)$ for $\delta=.15$](image)

**Figure 1: Value of $G(T^*, \delta, t)$ for Delta=0.15 and different spin-off dates**
We next derive $G(T^*, \delta, t)$ for the case when the spin-off date $T^*$ is uncertain. To model the uncertainty about the spin-off time, we assume that $T^*$ is uniformly distributed between two dates, $(a, a+z)$, with $a$ denoting the first expected date of spin-off and $a+z$ denoting the latest expected date of spin-off with $z \geq 0$.

Under uncertainty (2) morphs into $S_{3COM} = STUB + 1.5EV(PV[F_{\hat{T}^*,t}])$

with $\hat{T}^*$ uniformly distributed at $[a, a + z]$. Considering that

$$EV(PV[F_{\hat{T}^*,t}]) = EV(S_t \cdot e^{-\delta*(T^*-t)}) = \int_a^b \frac{1}{z} \cdot S_0 e^{-\delta*(x-t)} dx,$$

we get

$$S_{3COM,t} = STUB + 1.5EV(PV[F_{T^*,t}]) = STUB + S_t \frac{1.5}{z} \int_a^{a+z} [e^{-\delta*(x-t)}] dx =$$

$$=STUB + S_t \frac{1.5}{\delta z} [e^{-\delta*(a-t)} - e^{-\delta*(a+z-t)}]$$

Thus, in case of uncertainty equation (***) morphs into (***)

$$S_{3COM,t} = STUB + \frac{1.5}{\delta z} [e^{-\delta*(a-t)} - e^{-\delta*(a+z-t)}] \cdot S_t \ (***).$$

And for $t=0$

$$G(T^*, \delta, t = 0) = \frac{1.5}{\delta z} [e^{-\delta*a} - e^{-\delta*(a+z)}] \quad (3a)$$

It can be easily shown that $\frac{\partial G(T^*)}{\partial a} < 0$ and $\frac{\partial G(T^*)}{\partial z} < 0$ and $\frac{\partial G(T^*)}{\partial t} > 0 \quad$ i.e., increase (decrease) in the time to the earliest reasonable distribution date $a$ and an increase (decrease) in the length of

\[18\] The tilde sign will be drop whenever it does not cause ambiguity.
the interval measured by \( z \) decreases (increases) the impact of \( S \) on \( S_{3COM} \), whereas \( G(T^*) \) increases with time \( t \).

In the next four sections we empirically estimate \( G(T^*, t, \delta) \) for the case when the spin-off date \( T^* \) is uncertain (Section 2), then we calculate \( F_{T^*, t} \) from option prices, then estimate directly \( 1.5EV(PV[F_{T^*, t}]) \) – to use it for a direct calculation of 3Com’s stub value (Section 3). We then verify that the synthetic forward prices behave as our theory would predict (Section 4). Lastly, we utilize the synthetic forwards and spot Palm prices to estimate the implied lending fees (Section 5).

2. Empirical estimation of \( G(T^*, \delta, t) \)

2.1 Empirical estimation of \( G(T^*, \delta, t) \) from March 2 data

Palm shares started trading at 11:30 a.m. on March 2; the graph below shows the minute-by-minute Palm and 3Com prices between 11:30 a.m. and 4:30 p.m. One can see that the markets for Palm and 3Com were in continuous minute-by-minute coordination, that the valuation process was orderly and that a $1 change in Palm price was matched by a change of about $0.52 in price of 3Com. It is striking that the adjusted R-square from the regression (86%) and correlation in the movement of the pair of stock prices (illustrated by the graph below) is so high—emphasizing that there is a close connection between the markets for Palm and 3Com.

March 2, 11:30 AM – 16:30 PM - Minute by-minute data[ t-values in brackets]

\[
S_{3COM,t} = \frac{33.57}{(26.82)} + \frac{0.52}{(43.13)} S_{PALM,t}
\]

Adj \( R^2 = 0.86 \); 300 observation
, i.e., \( G(T^*, \delta, t) = .52 \), not $1.5$, in spite that on March 2 one 3Com share “contained” 1.5 shares of Palm.

![Figure 2: March 2, 2000 minute-by-minute prices of Palm and 3Com](image)

The May 8 resolution of uncertainty and its impact on \( G(T^*, \delta, t) \).

During March 2-May 8 period [henceforth period 1] the earliest spin-off date was \( a = \) Dec 2000 and delay in spin-off date was possible, i.e., \( z > 0 \).

But during May 9-July 27 period [henceforth period 2] \( a = \) July 27 and \( z = 0 \), i.e., as a result of May 8 announcement both \( a \) and \( z \) got much smaller instantaneously. These changes to \( a \) and \( z \) should cause \( G(T^*) \) to increase instantaneously (see equation (3a)). To test this we ran 4 regressions of \( S_{3COM, t} \) on \( S_{PALM, t} \) using the minute-by-minute prices for May 8 vs. May 9 and separately, using daily closing prices for period 1 and period 2 data.

Results are below with t-values in the brackets.
May 8 regression: 9:30 a.m.- 4 p.m. min-by-min price data. Result: \( G(T^*, \delta, t) = .7 \)

\[
S_{3COM,t} = 21.49 + 0.7 * S_{PALM,t} \quad \text{Adj. R Square} = 0.38; \text{Observations} = 389
\]

(14.91) (15.30)

May 9 regression: 10 a.m.- 4 p.m. min-by-min price data. Result: \( G(T^*, \delta, t) = 1.33 \)

\[
S_{3COM,t} = 9.67 + 1.33 * S_{PALM,t} \quad \text{Adjusted R Square} = 0.72; \text{Observations} = 361
\]

(7.8) (30.71)

Results for period 1 and period 2 are below (with t-values in the brackets) show distinct patterns\(^{19}\) of \( S_{PALM,t} \) coefficient: 0.78 in the first period and 1.69 in the second, with very high \( R^2 \) for both sub-periods.

March 2 – May 8: $S_{3COM,t} = 18.7 + 0.78 S_{PALM,t}$

\[
\begin{align*}
(10.5) & \quad (21.0) \quad \text{Adj } R^2 = 0.91; 47 \text{ observation}
\end{align*}
\]

Interestingly, there is no relationship between prices after July 27.

July 28 – Oct 11: $S_{3COM,t} = 16.35 + 0.0087 S_{PALM,t}$

\[
\begin{align*}
(10.47) & \quad (.24) \quad \text{Adj } R^2 = 0.01; 53 \text{ observation}
\end{align*}
\]

Once the spin-off is complete there is no remaining correlation in the pricing between Palm and 3Com.
2.3 The May 8 resolution of uncertainty and its impact on prices

The May 8 announcement shortened the period for which Palm’s freely-trading shares collect lending fees- so (ceteris paribus) we should expect a drop in price of Palm and from $S_{SCOM,0} = STUB + G(T) * S_0$ we should expect (ceteris paribus) an increase/decrease in price of 3Com on May 9 when

$$\frac{\Delta G(T)}{G(T)} \text{ larger/smaller than } \frac{\Delta S_0}{S_0}. \text{ As } \frac{\Delta S_0}{S_0} \approx .1 \text{ and } \frac{\Delta G(T)}{G(T)} \approx 1 , \text{ value of 3Com has to increase.}$$

Indeed, May 9 closing price for 3Com was 48.25, up from 43.69 while Palm’s share fell from 32.25 to 29.13.

While these diverse price movements are not explained in other frameworks, the decline in Palm reflects the elimination of lending fees from late July until the prior anticipated range of spin-off dates. It is especially striking that the 3Com prices rose by about 10% from May 8th to May 9th, despite the decline in Palm’s stock price because the access of the 3Com stockholders to Palm is now clearer and much more immediate. This emphasizes the substantial importance of the prior uncertainty about whether the spin-off would be brought to fruition.

Indeed, the strong price reaction of 3Com provides a substantial market assessment that there had been considerable uncertainty about whether the Palm spin-off would occur at all, consistent with many of these potential spin-offs not coming to fruition. In contrast, a framework that abstracts from lending fees would have considerable difficulty in accounting
simultaneously for the decrease in Palm’s stock and increase in the value of 3Com’s stock price, where the claim to Palm reflects a substantial portion of the value of 3Com.

Summarizing the findings of Section 2.2 and 2.3

- The uncertainty in the spin-off date’s parameters, \( a \) and \( z \), plays an important role in the Palm/3Com price relationship; the empirical data shows that \( G(T) \) was about 0.8 before the announcement\(^{22} \) and around 1.5 after the announcement.
- The 3Com share price incorporates expectations about the spin-off date; a change in spin-off date caused a large change in 3Com’s price.

The Palm share price incorporates expectations about the length of the interval when Palm shares receive lending fees; a substantial reduction in the interval caused a large decline in Palm’s price.

1. **Calculating the stub value from synthetic forward prices**

To estimate \( G(T^*, t, \delta) \) in (***) we have run regressions of the type \( S_{3COM, t} = \alpha + \beta \times S_t \)

Observe though, that we have an alternative and direct route as \( F_{T^*, t} \) from Palm options prices; we then can calculate \( G(T^*, t, \delta) \times S_t \) as \( G(T^*, t, \delta) \times S_t = 1.5 \times PV[F_{T^*, t}] \).

Once \( 1.5 \times PV[F_{T^*, t}] \) is known, the STUB value can be calculated as \( STUB_t = S_{3COM, t} - 1.5 \times PV[F_{T^*, t}] \) We start by calculating \( F_{T^*, t} \) from option prices.

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\(^{22}\) The May 8 announcement shortened the value of \( T \) and thus increased the value of \( PV[F_T] \).
3.1 Calculating the synthetic forward

Let \( C_t(X,T)[P_t(X,T)] \) be the time \( t \) value of a European call[put] with strike \( X \) and maturity \( T \) [Unless specified otherwise, \( t \) is assumed to be equal to zero, \( t = 0 \), and Sub-index \( t \) is sometimes omitted]. From the put-call parity for forwards

\[
C(X,T) - P(X,T) = PV(F_T - X) \tag{4}
\]

As noted in an earlier footnote, we assume \( R=0.063 \); then solving for \( F_T \)

\[
F_T = [C(X,T) - P(X,T)] * e^{(0.063*T)} + X \tag{5}
\]

To build a long position in synthetic forward requires buying the call at ask and selling put at bid, therefore the synthetic long forward equals to

\[
F_T^A = [C^A(X,T) - P^B(X,T)] * e^{(0.063*T)} + X \tag{6}
\]

Analogously, the synthetic short forward equals to

\[
F_T^B = [C^B(X,T) - P^A(X,T)] * e^{(0.063*T)} + X \tag{7}
\]

and

\[
F_T^{MID} = \frac{F_T^B + F_T^A}{2} \tag{8}
\]

3.2 Calculating the March 16 stub value of 3COM: the “part is (not) larger than the whole”
Lamont and Thaler (2003b) use the March 16, 2000 option price data\textsuperscript{23} to draw a number of conclusions about Palm’s pricing. We contrast their conclusions by using the same dataset – see Table 1 below.

The values of $F_{T}^{A}$, $F_{T}^{B}$ and $F_{T}^{MID}$ for different values of $T$ are the last 3 columns of Table 1.

**Table 1**\textsuperscript{24}

<table>
<thead>
<tr>
<th>Panel A</th>
<th>Call</th>
<th>Call</th>
<th>Put</th>
<th>Put</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>years</td>
<td>Bid</td>
<td>Ask</td>
<td>Bid</td>
</tr>
<tr>
<td>May 55</td>
<td>0.17</td>
<td>5.75</td>
<td>7.25</td>
<td>10.63</td>
</tr>
<tr>
<td>August 55</td>
<td>0.42</td>
<td>9.25</td>
<td>10.75</td>
<td>17.25</td>
</tr>
<tr>
<td>November 55</td>
<td>0.67</td>
<td>10.00</td>
<td>11.50</td>
<td>21.63</td>
</tr>
</tbody>
</table>

**Panel B. Other Prices and Rates**

<table>
<thead>
<tr>
<th>Time</th>
<th>LIBOR</th>
<th>Stock prices:</th>
</tr>
</thead>
<tbody>
<tr>
<td>3-month</td>
<td>6.21</td>
<td>Palm 55.25</td>
</tr>
<tr>
<td>6-month</td>
<td>6.41</td>
<td>3Com 69</td>
</tr>
</tbody>
</table>

From (2) $STUB = S_{3 \text{COM}} - 1.5 \text{PV}[F_{T}^{MID}]$ and the last column of data in Table 1 we calculate stub values for 3 future spin-off dates: May 2000, August 2000 and November 2000; see Table 2.

The table stops at November 2000 because November 17th is the latest date for which one can calculate synthetic forward prices. We observe that longer-date forwards are declining with increases in the forwards’ delivery date, as one would expect from the formula $F_{T^*,t} = S_{t} \times e^{(R-\delta)\times(T^*-t)}$. If the spin-off is expected later than Nov 2000 (as it was the case in March 2000, when spin-off date was expected to be in Dec 2000), the estimated stub value would be higher, i.e., the value of the STUB depends crucially on spin-off date $T^*$. For $T^* = November 17th$ the

\textsuperscript{23} March 16 was the first date when options on Palm traded.

\textsuperscript{24} For simplicity of comparison we utilize data from Lamont and Thaler (2003b): our Table 1 is based on March 16, 2000 data as reported in Lamont and Thaler’s (2003b) Table 6 with the last 3 columns calculated. [We used LIBOR of 6.3% for all dates.]
value of the stub was $7.35. The “negative $22B stub” is an optical illusion: both Lamont and Thaler (2003b) and the financial press mistakenly value the stub by using PALM’s spot rather than post-spin-off forward price.

### Table 2

<table>
<thead>
<tr>
<th>T=Time in years</th>
<th>Value of Stub using MID forward</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.17</td>
<td>-5.32</td>
</tr>
<tr>
<td>0.42</td>
<td>0.65</td>
</tr>
<tr>
<td>0.67</td>
<td>7.35</td>
</tr>
</tbody>
</table>

3.3 Calculating the stub value for all dates: The “part is (not) larger than the whole”

To estimate 3Com’s stub value for all dates between March 16 and July 27, we calculate $F_{T^*,t}$ for all $t < T^*$ with $T^* =$Nov 2000 during period 1 and $T^* =$Aug 2000 during period 2; we then calculate $PV(F_{T^*,t})$, what we define as the “true contribution” of Palm at time $t$ to the share price of 3Com. [Remember that $T^* =$Nov 2000 overestimates the “true contribution” of Palm for period 1 and underestimates it for period 2; we do correct the period 2 bias – but cannot correct the period 1 bias.]

Figure 2 provides the present value of a prepaid forward on Palm share with a delivery date of November 2000 [for period 1] and for August 2000 [for period 2]; it also presents Palm’s stock price.

We then evaluate the stub defined as the price of 3Com minus 1.5 times prepaid Palm forward (see Figure 3)

$$STUB = S_{3COM} - 1.5 \times PV[F_{T^*,t}]$$
With few exceptions (all of them before April 13, 2000) the value of the stub is positive and above\(^{25}\) $3.75- see Figure 3. So results attained for March 16 data hold for all other dates:

[Aside: these regressions use the Palm price net of lending fees, denoted as \( S_{TV-PALM,t} \) with t-values given in the brackets.]

March 16-July 27;

\[
S_{3COM,t} = 13.81 + 1.31 * S_{TV-PALM,t} \quad \text{Adjusted R Square} = 0.86; \quad \text{Observations} = 93
\]

\[
(8.4) \quad (23.4)
\]

March 16-May 8

\[
S_{3COM,t} = 10.16 + 1.31 * S_{TV-PALM,t} \quad \text{Adjusted R Square} = 0.95; \quad \text{Observations} = 37;
\]

\[
(6.47) \quad (26.35)
\]

May 9-July 27

\[
S_{3COM,t} = 8.84 + 1.59 * S_{TV-PALM,t} \quad \text{Adjusted R Square} = 0.98; \quad \text{Observations} = 56
\]

\[
(11.46) \quad (56.96)
\]

\[^{25}\text{Remember that our valuation of the post-spin-off forward is overvalued during period 1- thus the stub is undervalued.}\]
Figure 2: The PV of the forward contract vs. Market value of Palm shares

Figure 3: "true stub" defined as price of 3Com minus 1.5 shares of "true contribution" of Palm
2. **Relationship between August and November synthetic forwards**

We have assumed that possession of Palm shares yields a stream of continuous constant “lending fees” $\delta$ for all $t \leq T^*$ but this stream stops after spin-off.

The expected spin-off date $T^*$ was Dec 2000 in period 1 [prior to May 8] and became July 27 after May 8 [period 2]. If our assumptions about lending fees are correct, there should be a change in relative values corresponding to November 17th and August 16th forwards--both before and after May 8.

During period 1 $\mathcal{F}_{T,t} = S_t \cdot e^{(0.063-\delta)(T-t)}$ for all values of $T < \text{Dec 2000}$,

so that $\mathcal{F}_{Nov,t} = S_t \cdot e^{(0.063-\delta)(Nov-t)} =

S_t \cdot (e^{(0.063-\delta)(Aug-t)}) \cdot (e^{(0.063-\delta)(Nov-Aug)}) = F_{Aug,t} \cdot (e^{(0.063-\delta)(Nov-Aug)})

i.e.

$\mathcal{F}_{Nov,t} = F_{Aug,t} \cdot (e^{(0.063-\delta)(Nov-Aug)})$  (#)

and $\mathcal{F}_{Nov,t} < \mathcal{F}_{Aug,t}$ if $\delta > 0.063$

During period 2 the spin-off date is July 27th and owners of a Palm share earn the fee only till July 27th, so for $t \in [\text{May 9, July 27}]$ equation (#) morphs into

$\mathcal{F}_{Nov,t} = F_{Aug,t} \cdot (e^{(0.063)(Nov-Aug)})$

i.e., $\mathcal{F}_{Nov,t} > F_{Aug,t}$  (##)
Figure 4 graphs the daily difference between August and November forward prices during the March 16-July 27 period; the change of sign on May 8/May 9 is obvious.

3. **Implied lending fees.**

After the forward prices are derived from market prices of calls and puts, we can estimate the implied lending fee $\delta$ from Palm share’s price $S_0$

$$F_T = S_0 \times e^{(0.063 - \delta) \cdot T}$$

Figure 5 graphs the implied lending fees. The graph was built using November and August forwards.

The average implied lending fee being 41.3% for March 16- May 8 period [using November forward proxies $T^*$] , and 44% in May 9- July 27 period [when August forward proxies $T^*$]

![Diff between Aug and Nov forwards](image)

Figure 4: The Aug forward minus Nov forwards difference: it diff was about $2 on 4/13/00 but close to zero on 7/20/00
5.1 Implied lending fee for Aug 16 – Nov17 period.

From $F_{Aug,t} \times e^{(0.063-\delta)(Nov-Aug)} = F_{Nov,t}$ we can estimate the implied August 16 – November17 implied lending fee, denoted by $\delta$. Our theory predicts that during period 1 [March 16 till May 8] markets predict positive lending fee for the period of Aug 16 – Nov17 (as the markets expect spin-off only after end of November), but zero lending fee during period 2 [May 9 till July 27, 2000] .

Results are reported in Fig 4 – it shows the implied fee averaging about 28 % before May 9, but becoming (on average) zero after May 9, as the theory would predict!
Figure 6: implied δ for the Aug 16 to Nov 17. It was about 20% on 4/13, but close to zero on 6/8

4. No violation of Put-Call Parity and no violations of LOOP

Put-Call parity. Lamont and Thaler (2003b relate to March 16 market data [quoted here in table 1] when they observe, that “[o]ptions on Palm display massive violations of put-call parity [for European options] and violate the weaker inequality [for American options] as well. Instead of observing at-the-money call prices that are greater than put prices, we find that puts were about twice as expensive as calls.[Also]…[o]n March 16 the price of the synthetic short was about $39.12 [= PV of synthetic forward], far below the actual trading price of Palm of $55.25. 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.” (Lamont and Thaler (2003b, pp 255).

But above discussion disregards the fact ownership of a Palm share entitles you to earn the lending fee δ.

The call-put parity for dividend-paying stock is
Values of lending fee $\delta$ are much larger than 6.3% LIBOR [see Table XX], i.e.

$\delta \gg \text{LIBOR}$ which implies $S_0 * e^{-\delta T} - PV(S_0) \ll 0$

And from (14) $C(S_0, T) \ll P(S_0, T)$ i.e., there was no violation of put-call parity.

**Law of one price (LOOP).** Lamont and Thaler (2003b) suggest that the Law of One Price [LOOP] was violated by the 3Com-Palm data. To recapitulate, LOOP requires that assets be deliverable in lieu of the other for the law to be observed within the limits of transaction costs. As 3Com could not be delivered in lieu of a shorted Palm share [until the spin-off had occurred], LOOP is not violated. As the time of spin-off was uncertain, the Pam-3Com case offers at most a “risk arbitrage” opportunity.

A striking example of this point is the case of silver that traded contemporaneously in two different markets at different prices; the silver example does not violate LOOP although it exhibits the “whole being less valuable that its parts” phenomenon. The example is built around data concerning 1965 - 1970 Silver Kennedy Half Dollar coin, which weighs 11.5 grams and contains 40% silver and 60% copper [by weight]. These coins are sold in bags of $1000 face value; each bag has 2,000 Kennedy half-dollars, which contain approximately 295 ounces of pure silver.

On April 25 the cash Price\(^{26}\) for the $1,000 face value bag was $8,985.70(Ask) - $8,425.20(bid). On that day the silver spot price was $30.56 per ounce\(^{27}\) making the silver content of $1000

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\(^{27}\) May 17-2012 ; Silver trades at $28.09 , so the Silver value in the bag is $8286.55 , while the bag’s bid-ask prices were $7,770.30- $8,257.05
bag worth\(^{28}\) $9015.20 (=\$30.56 \times 295) \), higher than $8,985.70, the ask price for the whole bag. Here the part is more valuable than the whole. But it does not mean that these two markets break the LOOP: these are two separate markets, that serve different clienteles and there is no way to arbitrage between them as it takes $400-$600 to refine the coins into silver and copper.

The parallel with Palm and 3Com is straightforward: only 3Com management can “refine” the 3Com cum Palm share into two separate stocks. This “refinement” was in doubt on March 2, so $95 price for Palm and 3Com cum 1.5 Share of Palm at $81 did not violate LOOP. Lamont and Thaler focus upon notions of “fundamental value” or “intrinsic value,” but the “fundamental value” or “intrinsic value” of 3Com or Palm are unobservable. Our analysis offers more precise implications than the broader perspective that there is huge latitude within limits of arbitrage.

**Case of Rational Investors that have access to two segmented markets**

Lamont and Thaler (2003b) ponder who buys the expensive Palm shares when a much cheaper 1.5 shares of Palm [plus the stub] can be acquired cheaper by buying a share of 3Com. They rely on a different version of LOOP: two identical assets should trade at same price in different markets when a buyer has costless access to both markets.

But this version of LOOP requires careful calibration: While two similar in size apartments should sell for the same price if their view, exposure to sun, level of noise etc. are identical- i.e., many parameters have to be matched precisely to get the LOOP result. Matching physical

\(^{28}\) In addition a bag contains copper that was worth about $80 on April 25
attributes is not enough: two identical in every physical dimension apartments that are located in opposite wings of a building, may trade at a 30% difference if one wing is organized as a co-op and the other as a condo\textsuperscript{29}! Matching of cash-flows is not enough -- as we learn from the "on-the-run"—"off-the-run" treasury bond markets or in case of closed-end fund trading at a discount.

Assets have a number of parameters that define their valuation [e.g., Cash Flows, Bid-Ask Spread (Amihud –Mendelson), ownership structure (closed-end funds) and agency issues]. Price in the two markets will be identical if all parameters are carefully matched. This was not the case in the Palm-3Com story: Outright ownership of Palm shares vs indirect ownership of Palm shares via ownership of 3Com may be the crucial difference that drives these prices apart. A possible clientele for Palm shares are investors with very high valuation of Palm and investors that expect that the spin-off to be postponed indefinitely.

5. **Conclusions**

The Palm—3Com episode is a memorable one; everyone who lived at that time and/or teaches a number of topics such as the practice of financial markets, no-arbitrage in financial markets, informativity and rationality of market pricing, usually needs to explain the episode to students by using excuses like “limits to arbitrage” or ”market frictions.” This paper offers an alternative interpretation of the market pricing mechanism. Under this interpretation we do not obtain apparent failure of the absence of arbitrage or rational pricing.

\textsuperscript{29} Co-ops are trading at a 12% discount to identical condo apartments [Goodman & Goodman]
References


