REGULATION AND THE COST OF CAPITAL IN JAPAN:

A CASE STUDY

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ABSTRACT

Over the last several years, a combination of loan losses and regulatory barriers to equity issuance have left Japanese banks starved for capital. In September 1995, the Mitsubishi Bank was permitted to issue a complicated convertible security in a foreign market. We value the security using standard option pricing methods, including a technique to handle the path-dependency of the security's payoff. We find that the security was valued by investors at more than 20 percent below its theoretical value. We estimate the loss to Mitsubishi Bank's shareholders from this difference at $420 million. Consistent with this analysis, an event study shows a statistically significant negative abnormal return to Mitsubishi Bank's stockholders on the day after the first report of the security appeared in the Japanese financial press. We attribute the gap between market price and theoretical value to the security's design, which offers investors a combination of payoffs they find unattractive. We argue the security's design was heavily influenced by regulatory constraints. The loss suffered by Mitsubishi Bank's shareholders represents a measurable private cost of regulation, against which the regulation's social benefits, if any, should be weighed.

Keywords: convertible bond, Japanese banks, financial regulation, underpricing

JEL codes: G32, G38, G12

1. Introduction

On September 22, 1995, a subsidiary of the Mitsubishi Bank issued $2 billion of a complicated exchangeable note through a New York underwriter. If all goes well, the issue of this instrument, which is essentially a convertible subordinated debenture, will eventually raise the bank's ratio of Tier I capital to risk-weighted assets by 0.4 percentage points.[1] Nevertheless, it would have been simpler for Mitsubishi Bank to have made a public offering of additional shares of common stock to investors in Tokyo (and, perhaps, in other financial centers). In comparison, the exchangeable note issue will raise capital in a manner that is less direct, delayed (because conversion of the note to equity is not immediate), uncertain (because conversion to equity occurs only under certain conditions), and, as we show, more costly. We contend that Mitsubishi Bank's financing choice was almost certainly motivated by outside constraints, rather than the unfettered solution to a private sector optimization problem.

In the next section of the paper, we discuss the Japanese government's regulation of the primary market for equity in the 1990s, and we argue that the performance of loan portfolios over the past several years has made particularly acute the need of Japanese banks for access to capital markets. In the following section, we describe the terms of the exchangeable note. In the fourth section, we describe our methodology for valuing the exchangeable note as a derivative security. Results we present in the fifth section suggest that the value placed on the exchangeable note by investors falls well short of its theoretical value. This conclusion is robust to variations in the assumptions we make to implement our methodology. The sixth section describes the stock price reaction to the note issue, which may provide a market reading on the perceived prudence of the note issue, from the point of

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[1]The calculation uses the combined risk-weighted assets of Mitsubishi Bank and Bank of Tokyo as of September 1995. The ratio of Tier I capital to risk-weighted assets at the (pro forma) combined bank was 5.1 percent before the note issue, compared with a regulatory minimum of 4 percent. Mitsubishi Bank merged with the Bank of Tokyo on April 1, 1996 to create the Bank of Tokyo-Mitsubishi, the world's largest commercial bank. The date and terms of the merger had already been established at the time of Mitsubishi Bank's note issue.

view of an existing stockholder. In the seventh section, we further explore the robustness of our pricing model. In the final section, we present our conclusions.

2. Historical and Institutional Background

Two factors combine to make Mitsubishi Bank's issue of exchangeable notes an interesting topic for detailed study. First, Japanese regulators maintain a tight watch on the Japanese stock market. Regulatory intrusion was certainly one reason, if not the only reason, why the Mitsubishi Bank issue was so complicated. Second, Japanese banks have amassed huge losses on loans made during the "bubble economy" of the late 1980s and early 1990s. Mitsubishi Bank was one of the first Japanese banks to go to the market for new capital to replace what has been depleted by loan losses; its experience likely served as a guide to other Japanese banks seeking new capital. In fact, in the first two years after the Mitsubishi Bank note issue, 5 of the other 9 major "city banks" raised capital by issuing similar securities. The results that we present in sections 5 and 6 suggest that this imitation occurred only because the Mitsubishi Bank prototype had won regulatory approval -- Mitsubishi Bank's experience does not suggest that this type of instrument is an efficient vehicle for bank finance.

The Ministry of Finance (MoF) estimated that Japanese banks held ¥31 trillion of problem loans as of September 1995, 5.4 percent of total bank loans. Most of the problem loans were collateralized by real estate that had plummeted in value since the late 1980s. Banks held loan loss reserves equal to 20 percent of problem loans, but likely losses on problem loans were estimated at around 70 percent of face value. To make up the difference, the banks needed to raise capital, either from outside sources or internally via retained earnings. Although bank earnings from current operations were at record levels in the 1995-96 fiscal year, for most banks, retained earnings would be too slow or too small a source of funds to allow loan losses to be written off without depleting the

banks' capital, as measured for regulatory and accounting purposes. Accordingly, most banks have since tapped external capital sources.

Although they have loosened their grip in some areas in recent years, Japanese regulators still largely control access to capital markets by Japanese firms. From 1990 to 1993, regulators prohibited new share offerings by listed firms in an effort to prop up the stock market. The prohibition was gradually relaxed to allow firms with sufficiently high earnings and dividends to issue stock, and initial public offerings have been permitted. Still, most Japanese firms were effectively prohibited from issuing new equity at the time Mitsubishi Bank issued its exchangeable notes.[2] In addition, it appears that government discretion has been retained to block securities issues that it deems for some reason to be contrary to the public interest.[3]

Because of the prohibition on new equity issues, Japanese banks that have recently raised Tier I capital have been forced to do so with debt instruments that convert into equity after several years. Delayed conversion seems to placate Japanese regulators who appear to believe that ordinary equity issues would at least depress a bank's stock price, if not the level of Japanese stock prices, in general.[4] These debt instruments also contain provisions resetting the conversion price down following

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[2]In March 1996, the MoF announced that the ban on seasoned equity issues would be lifted in April.

[3]For example, on March 6, 1996 the Nihon Keizai Shimbun newspaper reported that the Ministry of Finance was drawing up guidelines to limit bank issuance of preferred stock to one or two per month.

[4]According to a report in International Financing Review 1127, April 6, 1996, p. 73, the complexity of a Tokai Bank convertible preferred stock issued in April 1996 was largely due to constraints imposed by MoF. Standard financial theory does not predict any effect from an individual firm's equity issuance on the stock prices of other firms. However, approaches to corporate finance that emphasize asymmetric information usually characterize a decision to issue equity as signalling bad news about the firm's prospects, because, with an equity issue, insiders are choosing to transfer part of the firm's risk to new investors. For U.S. companies, support for this type of theory has been found in stock price reactions to issue announcements. However, Kang and Stulz (1996) did not find concurring evidence in Japanese data. In any case, given regulatory capital standards and the current condition of Japanese banks, their need for equity capital was likely obvious enough so that equity

a decline in the bank's stock price. If banks are paying a premium to raise capital with these convertible instruments, the cost of requiring banks to include such provisions in their capital-raising efforts may outweigh whatever benefits the government perceives in minimizing stock market "disruption."[5]

3. Terms of Exchangeable Note Issue

Mitsubishi Bank's exchangeable notes were issued in September 1995 and mature on November 30, 2002.[6] They carry a 3 percent annual coupon, are denominated in dollars, and are listed on the New York Stock Exchange. The notes are exchangeable into either Mitsubishi Bank's stock or American Depositary Receipts (ADRs), which represent the stock, at the noteholder's option at any time between April 2, 1996 and November 25, 2002, at the Exchange Price (X), defined below. The Exchange Price is initially set at $22 per share, an 8.6 percent premium to the $20.25 market price of the ADRs when the notes were issued. The Exchange Price can be reset downward (but never upward) on November 30 of each year if the stock price has fallen below the Exchange Price, but it cannot fall below $14.30 per share. The Exchange Price evolves according to

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issuance by these banks would not reveal any private information.

[5]Brennan and Schwartz (1988) argue that raising capital with a convertible security is especially appropriate in a situation where managers/existing shareholders and prospective new investors cannot agree on a firm's future prospects. This situation may accurately describe Japanese banks' circumstances in September 1995. If so, absent regulation Mitsubishi Bank may have chosen to raise capital with a convertible bond issue rather than straight equity. We argue below that the terms of the convertible security that Mitsubishi Bank chose to issue made it unattractive to investors, not that investors would have preferred straight equity to any convertible security issued by Mitsubishi Bank.

[6]Our source for the terms of the note is the note's prospectus, issued by Morgan Stanley.

$$X_t = \text{Max}\left[\$14.30,\ \text{Min}\left(X_{t-1},\ P_t^*\right)\right]$$

where P^* is the Average Price measured over the period between 34 and 15 business days before November 30. Mitsubishi Bank has the right to force the exchange in five stages, from 1998 to 2002, on November 30 of the respective year, as long as its stock price is not "too low", as defined below. The fraction of the original issue that can be redeemed at each forced exchange rises from 20 percent in 1998 to 100 percent in 2002. Figure 1 depicts the terms under which forced exchanges can occur between 1998 and 2001. The bank may issue a notice of redemption 36 business days before November 30 if the ADR price was at least $16.50 on one of the two previous days. If the P_t^* that is subsequently determined is at least $14.30, then the notes are exchanged at X_t. As is clear from Figure 2, the rules for forced exchanges are different in 2002. In particular, the exchange ratio is P_t^*, provided it is at least $11. Accordingly, if X_{2001} is less than P^*_{2002}, note holders can voluntarily exchange their notes on November 25 for more shares than they would get if they waited for the forced exchange to be completed on November 30.

Informal analysis of the terms of the note suggests that it is a more attractive investment than Mitsubishi Bank ADRs. The noteholders receive all of the appreciation of Mitsubishi Bank's stock, except for the initial 8.6 percent premium of the Exchange Price over the stock price. In return, they accept none of the downside risk of the stock, and they get a 3 percent annual coupon. At the time of the note issue, Mitsubishi Bank's dividend yield was 0.42 percent. With the yield advantage roughly balancing the conversion premium, the note appears to be roughly as attractive as buying Mitsubishi Bank's stock and receiving a free at-the-money put option.

4. Valuation Methodology

Mitsubishi Bank's exchangeable note is essentially a callable convertible bond, a type of security that is neither uncommon nor particularly hard to value. We treat the exchangeable note as a derivative security, following Brennan and Schwartz (1977), and price it using a binomial tree, a method introduced for derivatives by Cox, Ross and Rubinstein (1979). However, the Mitsubishi Bank exchangeable note has two unusual features that require special treatment. First, the Exchange Price can change over time in a way that depends on Mitsubishi Bank's ADR price. This makes the exchangeable note a path-dependent derivative, and we modify our pricing methodology to handle this. Second, if Mitsubishi Bank chooses to force an exchange, the notes to be exchanged are chosen randomly. We price the exchangeable note assuming that notes to be exchanged are chosen according to a deterministic, pro rata rule. A more detailed description of our pricing methodology can be found in the Appendix.

We must make a number of assumptions to implement our pricing methodology. The future volatility of the underlying stock price is an important variable affecting the value of the note's embedded call option. Other assumptions include future levels of U.S. dollar interest rates (both risky and risk-free) and future dividend yields on Mitsubishi Bank's common stock. Our baseline assumptions will be:

1. Daily stock price volatility is equal to the standard deviation of daily percentage changes in the stock price over the preceding 250 business days (approximately one year).

2. Future levels of interest rates are determined by the forward rates implicit in the current term structure of interest rates.

3. The dividend yield on Mitsubishi Bank's stock will remain constant at its September 1995 level.

We will examine the sensitivity of our results to these assumptions.[7]

5. Valuation results and sensitivity analysis

The baseline assumptions we use to value the exchangeable note at issue are shown in Figure 3. According to our valuation model with these baseline assumptions, when issued on September 22, 1995 the Mitsubishi Bank exchangeable note had a theoretical value of 127. The note's face value and issue price were 100. The note's market price rose by 5 percent in the week after issue, to 105, while the theoretical value remained at 127, a gap of 21 percent.[8]

Over time, the gap between the theoretical value and the market price of the exchangeable note has declined but has not vanished. Table 1 shows the market price and theoretical value for the exchangeable note on the last day of each month for which a note price appeared in the Wall Street Journal or on Bloomberg.[9] Figure 4 shows a graph of these prices. Over the last six months, the gap has ranged between 10 percent and 14 percent. Evidently the gap has fallen over time but shows no signs of disappearing.

The literature on underpricing of first-time offerings of common stock and convertible bonds suggests that the typical initial security offering is somewhat underpriced. For 91 convertible bonds issued in 1988-92, Kang and Lee (1996) found a mean excess return from issue to the close of the

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[7]Our data sources are as follows. Stock price data is taken from Bloomberg. The risk-free zero-coupon term structure for U.S. government securities is taken from JP Morgan's RiskMetrics™ (from two to ten years) and from Bloomberg's Fair Market Yield Curves (from zero to one year). For the risky term structure, we combine JP Morgan RiskMetrics' term structure of swap rates (from two to ten years) and U.S. dollar LIBOR from Bloomberg (from zero to one years). The current dividend yield is taken from Bloomberg.

[8]To save space, we do not show the volatility and term structure assumptions for each day. This data is available on request from the authors.

[9]The market price is the midpoint of the bid and ask prices.

first trading day of 1.11 percent, statistically significantly greater than zero.[10] Studies of initial public offerings of common stock also find significant excess returns in the first day of trading and none thereafter, indicating that for both types of securities it takes only one day for the underpricing to dissipate.

The magnitude of the underpricing of the Mitsubishi Bank exchangeable note appears much larger than the convertible bond underpricing measured by Kang and Lee (1996), and the underpricing seems to have endured over time. If the increase in the market price from 100 to 105 in the first week after issue can be attributed to initial underpricing of the sort found by Kang and Lee (1996), and not to any factor associated with this particular security, we are left with a gap of 21 percent between the theoretical and market prices of the exchangeable note.

This gap implies a loss to Mitsubishi Bank's shareholders of around $420 million, 21 percent of the $2 billion face value of the notes, or 8.5 cents per share. Given Mitsubishi Bank's ADR price at issue of $20.25, the loss equals 0.4 percent of Mitsubishi Bank's market value. It seems likely that Mitsubishi Bank and its underwriter (Morgan Stanley) were aware of the likely magnitude of the gap between the theoretical and market prices of the exchangeable note, and were thus aware of the loss that Mitsubishi Bank shareholders would incur.[11] We conclude that Mitsubishi Bank's management must have considered $420 million an acceptable cost to pay to get $2 billion of capital into the bank.[12] The magnitude of the $420 million loss may be small compared to the potentially higher

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[10]In computing excess returns on convertible bonds, Kang and Lee (1996) do not control for the change in the issuer's stock price between the issue date and the first day of trading, a time period which averages six days in their sample.

[11]The issue price of 100 was sufficiently close to the market price after one week of 105 that the gap between market price and theoretical price could not have been unanticipated.

[12]The event study we conduct in section 6 below does not necessarily support this conclusion.

earnings on Mitsubishi Bank's approximately $100 billion of equity if the additional $2 billion of capital sufficiently relaxes operating or regulatory constraints on the bank.

5.1 Alternative volatility assumptions

Because it contains an embedded option on Mitsubishi Bank's ADR, the exchangeable note's value depends positively on the volatility of the underlying equity. The gap between the theoretical and market prices of the exchangeable note could be caused by assuming excessively high volatility for the price of Mitsubishi Bank's ADR. Our baseline assumption that future volatility can be estimated by taking the standard deviation of daily percentage changes in the stock price over the preceding 250 business days led us to use a volatility of 30.93 percent to price the exchangeable note at issue.[13] We examine three ways to determine a range of volatilities to use in a sensitivity analysis.

One way to estimate future volatility would have been available to investors when the note was issued: look at historical volatility measured over different time periods to determine a range of likely future volatilities. In the following computations, the historical periods we look at go back as far as possible using Bloomberg as the data source for Mitsubishi Bank's stock price. Over the seven 250-day periods ending on September 22 in the years 1989-1995, the mean volatility of Mitsubishi Bank's stock was 31.19 percent. Over the eleven 52-week periods ending on or near September 22 in the years 1985-1995, the mean volatility was 31.01 percent.[14] Over the overlapping 84-month periods ending in September 1991-1995, whose length roughly approximates the 7+-year life of the exchangeable note, the mean volatility was 32.82 percent, with a range from 30.20 percent to 35.66 percent. These data do not suggest that our baseline assumption for volatility of 30.93 percent is unreasonable.

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[13]All volatilities are expressed in annualized terms.

[14]Bloomberg's weekly data on Mitsubishi Bank's stock price goes back several years farther than its daily data.

Two estimates of future volatility were not available to market participants at the time of the note's issue. Volatility measured over the year after the note's issue was 21.71 percent, substantially lower than our baseline assumption had forecast. We use this "ex post" estimate of future volatility as a lower bound in our sensitivity analysis.

Implied volatility from options prices are perhaps the best estimate of volatility for our purposes. However, options on individual stocks were prohibited by Japanese financial regulators until July 1997, so implied volatility was not available to investors who were evaluating the exchangeable note at issue. As of this writing (August 1997), we have two weeks of data on exchange-traded options on Bank of Tokyo-Mitsubishi's stock to work with. Over those two weeks, implied volatility has averaged 30.89 percent using call option prices and 27.40 percent using put option prices. Over the same two week period, historical (250-day) volatility on the stock has averaged 26.65 percent. These data give no reason to think that historical volatility is an upwardly biased estimate of implied volatility for this stock.[15]

Although exchange-traded options on Mitsubishi Bank's stock have only been traded since July 1997, options on the Nikkei 225 stock market index were traded in September 1995. Investors valuing the exchangeable note at issue could have compared the index implied volatility with index historical volatility. Knowing whether future volatility of the Nikkei 225 index was likely to be greater or less than historical volatility could have guided investors in the Mitsubishi Bank exchangeable note in their choice of a future volatility estimate for Mitsubishi Bank's stock. On September 22, 1995, implied volatility on the Nikkei 225 was 25.58 percent, compared to historical (250-day) volatility of 21.57

[15]At the time of the last observation in Table 1 (July 31, 1997), implied volatility from traded options was available to market participants, yet the gap between theoretical and actual note prices persists.

percent.[16] Comparing index implied volatility with index historical volatility would have led investors to increase, not reduce, their estimate of future volatility on Mitsubishi Bank's stock.

Based on the above discussion, we take 21.71 percent as a lower bound of the range of reasonable volatility estimates. We run our valuation model for each day listed in Table 1 with the future volatility assumed to be equal to 21.71 percent. Table 2 shows the results. The difference between the two rightmost columns reflects how much greater than 21.71 percent the 250-day historical volatility was on each day. According to Table 2, making a lower-bound assumption on volatility does not cause the gap between the market price and the theoretical price to disappear.

5.2 Alternative dividend assumptions

We have assumed that Mitsubishi Bank would maintain its dividend yield at its initial level of 0.42 percent through November 2002. Our results are somewhat sensitive to this assumption since, holding the stock return fixed, greater dividends imply lower capital gains. Prior to conversion, noteholders benefit from capital gains but not from dividends. To see how sensitive our results are to the assumption of a constant dividend yield of 0.42 percent, we examine an alternative assumption on the dividends on Mitsubishi Bank's stock: that the dividend yield doubles to 0.85 percent before the March 1996 ex-dividend date and remains at the higher level throughout the life of the note.[17]

Table 3 shows how the theoretical note price changes with the alternative dividend assumption. The alternative dividend assumption does reduce the value of the note, as expected, but by a small amount, around one percent. The sensitivity of the theoretical note price to the dividend assumption is small enough that any reasonable assumption on expected future dividend increases is unlikely to

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[16]Implied volatility is calculated using the most actively traded, closest-to-the-money Nikkei 225 call option listed on the Osaka Stock Exchange (the call option expiring October 1995 with a strike price of 17,500).

[17]From end-September 1995 to end-July 1997, the average dividend yield on Mitsubishi Bank's stock was 0.39 percent, computed using month-end stock prices and 12-month ahead dividends or expected dividends.

significantly reduce the theoretical note value. The gap between theoretical and market prices remains unexplained.

5.3 Alternative interest rate assumptions

We use various interbank rates (swap rates and LIBOR) to construct a risky term structure, which in our valuation methodology is used to discount the note's future cash flows when conversion into stock is unlikely to occur.[18] Interbank rates should give an appropriate risky term structure for a large, globally-active bank like Mitsubishi Bank. However, at the time of the note issue Japanese banks were facing increased borrowing costs in interbank markets (the so-called "Japan premium"). The premium reported by Mitsubishi Bank has averaged 11 basis points for 3-month maturity and 7 basis points for 12-month maturity since September 22, 1995.[19] Among the dates for which the note was valued in Table 1, the premium peaked on October 31, 1995 at 31 basis points for 3-month maturity and 25 basis points for 12-month maturity. We examine an alternative assumption on the risky term structure: shift it up relative to our baseline assumption by the amount of the Japan premium on that day.[20]

The alternative assumption on the risky term structure rates reduces the estimated theoretical value of the exchangeable note by less than one-quarter of a percentage point on each of the days listed in Table 1. The reasons are twofold: the Japan premium is too small to make much difference, and the risky interest rate is only used to discount those future values when the note is not converted into stock. Since the probability of conversion has fluctuated between 80 percent and 97 percent,

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[18]See the Appendix for a fuller explanation of how risky and risk-free interest rates are used in the valuation methodology.

[19]Computed using end-of-week data for the BBA LIBOR fixing.

[20]We use the 3-month premium for maturities less than one year and the 12-month premium for maturities of one year and longer

according to our valuation model, the risky interest rates are not used often enough for the Japan premium to affect the note's value.

6. Stock Price Reaction to Note Issue

Our results suggest that Mitsubishi Bank paid a high price for the capital it raised with its exchangeable note issue. One implication of this finding is that Mitsubishi Bank's shareholders suffered a loss at the time of the exchangeable note issue. Of course, Mitsubishi Bank's shareholders may have gained from the note issue as well, if the additional Tier I capital from the note issue reduces operating or regulatory constraints. To see if existing shareholders suffered a loss when the terms of the exchangeable note were announced, we examine the behavior of Mitsubishi Bank's stock price around the announcement of the exchangeable note issue.

We use event study methodology to study the effect of the announcement of the exchangeable note issue on the stock price of Mitsubishi Bank. First, we subtract daily expected stock returns, conditioned on the daily Japanese stock market return, from actual returns to yield "abnormal" returns. We then examine abnormal returns on the days when new "news" about the terms of the note issue was announced, and test for statistical significance. This methodology assumes that capital markets are efficient, that is, market prices incorporate all available information. This allows us to identify the change in market prices as a result of the new information. We also examine cumulative abnormal returns over the month during which the note was announced, sold, and priced.

Expected stock returns are computed using the market model

$$r_{it}=\alpha_i+\beta_i r_{mt}+e_{it} \;;\; e_{it}\sim N(0,\sigma_i^2)$$

where each day's stock return r_{it} is assumed to depend on the market return r_{mt}, with sensitivity β_i, a constant term α_i and a random error term e_{it}. The parameters α_i, β_i, and σ_i^2 are estimated over the period from mid-April 1995 to February 1996, excluding August and September 1995, with daily stock

returns computed as the percent change in the Tokyo Stock Exchange closing price of Mitsubishi Bank stock and the Topix index representing the market return.[21] During the event period (August 21 - September 25, 1995), each day's market return is used to computed the expected return, which is subtracted from the actual return to yield an abnormal return.

We determined the dates on which new information about the exchangeable note was released by doing a computer database search of Reuters Business Briefing, which indexes the full text of many major news services. Our event dates are:

August 21 — an article reporting the planned note issue appeared in the previous day's (Sunday) Nihon Keizai Shimbun newspaper.

August 31 — Mitsubishi Bank announced the decision of its board of directors to issue the exchangeable notes. All the terms of the notes were disclosed, including the maturity, exchange price reset mechanism, and conversion options of noteholders and Mitsubishi Bank. The payment dates, initial exchange price, and coupon were not specified.

September 22 — Mitsubishi Bank announced the terms of the note, including the initial conversion price, the coupon, and the issue date. We were unable to determine if this announcement was made before or after the Tokyo market's close, so we also examine abnormal returns on the following trading day, September 25.

Between August 31 and September 22, the note was being marketed by Morgan Stanley and the other investment banking firms doing the selling. During this period, the preliminary coupon was reduced

[21] We begin our estimation period in mid-April to avoid picking up effects of the announcement in late March of the merger of Mitsubishi Bank with Bank of Tokyo. The parameter estimates were α_i = .00044, β_i = 1.36, σ_i^2 = .011.

twice. Because we cannot identify any specific event dates during this period, we examine the cumulative abnormal returns over the entire event period.[22]

Abnormal returns and cumulative abnormal returns are shown in Table 4, along with their t-statistics. The initial report in the Nihon Keizai Shimbun was associated with a significantly negative abnormal stock return of –2.6 percent; none of the other event days had a statistically significant abnormal return.[23] The cumulative abnormal return over the event period was not statistically significant, either.

In describing the negative stock price reaction to the announcement of the exchangeable note issue as statistically significant, we compared it to a null hypothesis of no stock price reaction. This may not be the appropriate null hypothesis, since some studies have found that stock prices do react to convertible securities issues. Previous research suggests that convertible debt issues by Japanese firms have not been associated with significantly negative stock price reactions, unlike convertible debt issues by American firms.[24] Thus, a null hypothesis of no stock price reaction is probably appropriate

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[22] Mitsubishi Bank's merger agreement with Bank of Tokyo, announced in March 1995 and finalized in May, included language permitting Mitsubishi Bank to issue up to ¥200 billion of new capital prior to the merger. For the purposes of our analysis, we do not treat this as an event related to the exchangeable note issue.

[23] The results are qualitatively unchanged if we look at two-day abnormal returns, although the August 21 event is no longer statistically significant at the 5 percent level.

[24] Kang, Kim, Park and Stulz (1995) found a negative but statistically insignificant average abnormal return around the announcements of offshore convertible bond issues by Japanese non-financial firms over 1977-1987. They also show that offshore convertible issues by American firms over the same period had significantly negative abnormal returns. Dann and Mikkelson (1984) found a statistically significantly negative stock price reaction of -2.3 percent to announcements of convertible debt offerings by U.S. firms.

It would not be implausible to prefer the results of Dann and Mikkelson (1984) for U.S. firms as a benchmark for Mitsubishi Bank, since Mitsubishi Bank is listed on the New York Stock Exchange and the exchangeable note was issued in dollars. In this case, the difference of -0.3 percent between the -2.6 percent abnormal return on Mitsubishi Bank's stock and the -2.3 percent average abnormal return found by Dann and Mikkelson would be the proper measure of the additional loss suffered by Mitsubishi Bank shareholders due to the complicated design of the exchangeable note. We note that the discussion in section 5 suggested a loss on the order of 0.4 percent of the bank's value.

for Mitsubishi Bank. Accordingly, we interpret the negative abnormal return of –2.6 percent at the announcement of the exchangeable note issue as reflecting the realization that Mitsubishi Bank was paying a high price to raise capital.

7. Robustness of the valuation methodology

A potential explanation for the gap we find between the theoretical and market prices of the exchangeable note is that the gap is spurious, caused by either a flaw in our methodology or a programming error in implementing the methodology. A flaw in the binomial tree methodology, as we have implemented it, is its assumption of a lognormal distribution for the returns on Mitsubishi Bank's ADR. As Campbell, Lo, and MacKinlay (1997, p. 15) put it, "the lognormal model has become the workhorse of the financial asset pricing literature" while, at the same time, "it is not consistent with all the properties of historical stock returns." One particularly unattractive feature of our binomial tree methodology is that it assumes volatility is constant over time.

As a check on the ability of our binomial tree methodology to accurately value convertible bonds and as a check of our programming, we took the computer program we wrote to value the Mitsubishi Bank exchangeable note and used it to value another convertible bond, issued at about the same time as the Mitsubishi Bank exchangeable note (and thus in similar market conditions), but without the complicated features that, we argue below, make the Mitsubishi Bank security unattractive to investors. A search on Bloomberg for convertible bonds issued in the U.S., in dollars, with maturity between five and nine years, issued within one month of the Mitsubishi Bank exchangeable note turned up 51 candidates, most of which appeared to be small and not very liquid. We chose the Starbucks Corporation 4.25% convertible subordinated notes due 2002 for our comparison, which were issued on October 19, 1995, are listed on NASDAQ, and appear to be fairly actively traded.

We used our program, modified slightly to allow a call for cash rather than a forced exchange into stock, to price the Starbucks convertible note.[25] The baseline assumptions are as described in section 4 above and are shown in Figure 5.[26] We estimate a theoretical price for the Starbucks convertible note of 100. This compares with its issue price of 100 and market prices on the first and second days of trading after issue of 99.5 and 100.625, respectively. Evidently our methodology and our program can accurately price a convertible security that lacks the complicated features of the Mitsubishi Bank exchangeable note.

8. Concluding Remarks

In this paper, we have provided robust evidence that the September 1995 Mitsubishi Bank exchangeable note issue was substantially underpriced relative to standard financial models. The bank could almost certainly have sold common stock or a convertible bond with more standard features instead, on terms that it would have regarded as more favorable. The bank's extra (risk-adjusted) cost of capital can be interpreted as a measurable private cost of the Japanese government policy of limiting equity issuance, against which the social benefits, if any, must be weighed.

The pricing of this security also provides insight into the functioning of U.S. securities markets -- both primary and secondary. One could easily believe that it is too complicated, risky, or expensive for an arbitrageur to hedge a long position in the note with a short position in the stock to merit a

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[25]Since convertible bond holders typically voluntarily convert into stock after the announcement of a call (if the issuer is following an optimal call strategy), these two provisions have a similar effect. The programming logic is slightly different, so the program was modified to handle calls or forced exchanges.

[26]The historical 250-day volatility on Starbucks common stock was 39.31 percent. The Starbucks convertible notes were rated B- by Standard and Poor's. For the risky term structure, we used the Bloomberg Fair Market Yield Curve for industrial bonds rated B-. Starbucks common stock has never paid a dividend.

payoff of about 21 percent over 7 years.[27] Yet at first blush, for a well-informed investor with a horizon of at least 7 years who was considering taking on long-term exposure to the fortunes of the Bank of Tokyo-Mitsubishi anytime after September 1995, the exchangeable note should have appeared to be a clearly more attractive vehicle at the going prices. Apparently, not enough such investors exist to close the gap between the theoretical value of the note and its actual price, although the gap has narrowed over time.

One possible explanation is that there are not enough portfolio managers willing or able to conduct the analysis necessary to accurately value the note. We consider this explanation to be implausible given the competitive nature of the investment management industry.

Alternatively, it may be that most investors do not find the particular combination of payoffs offered by the note to be attractive except when it is underpriced. We see two reasons why this might be the case. The addition of complex, path-dependent derivatives to a generic convertible bond could discourage traditional investors in convertible securities, who might require a discount to hold an unfamiliar instrument.[28] Or, the particular structure of the Mitsubishi Bank exchangeable note, rather than the mere combination of two dissimilar financial instruments, could be unattractive to investors. Regardless of which explanation is correct, the underpricing of this sort of security implies an economic dead weight loss whenever one is issued.

One feature of the Mitsubishi Bank exchangeable note that may be unattractive to investors is illustrated in Figure 6. An investor looking to hedge a long position in the exchangeable note with a

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[27]Lee, Shleifer, and Thaler (1991, p. 83) use a similar argument to explain why the discount on closed-end funds is not eliminated by arbitrage -- in their case, an infinite-horizon arbitrageur may be necessary.

[28]Discussing a new structured financing tool consisting of a bond sold with a detachable put option, one market participant stated, “the corporate [bond] market undervalues the worth of a put bond, while the derivatives market fully values it.” Craig Karmin, “Innovative Use of 'Puts' Wins Avid Following,” The Wall Street Journal, January 26, 1998, p. C1.

short position in Mitsubishi Bank's ADR would maintain a short position proportional to the “delta” of the exchangeable note, shown as a function of the ADR price in Figure 6. Over a range of prices, the delta increases when the stock price falls. This would force a hedger to sell short additional shares when the price of Mitsubishi Bank's ADR is falling. Investors may demand a risk premium for committing themselves to a hedging strategy that requires them to sell into a falling market.[29]

[29]According to a report in the Economist, Union Bank of Switzerland lost large amounts of money when it was unable to hedge its investments in convertible securities issued by Japanese banks during a sharp market downturn. “Blind Faith,” The Economist, January 31, 1998, p. 76.

Table 1. Prices of the exchangeable note over time

Date	Market price(a)	Model price	Difference (percent)
At issue(b)	100	127	27
September 1995	105	127	21
October 1995	104.5	127	22
November 1995	111	134	21
December 1995	117.9	146	24
January 1996	115	141	23
February 1996	111.8	140	25
March 1996	111	131	18
(c)			
August 1996	109.7	123	12
September 1996	112.8	125	11
October 1996	110.7	124	12
November 1996	110.5	123	11
December 1996	106.3	118	11
January 1997	98.2	113	15
February 1997	102.8	114	11
March 1997	102.5	113	10
April 1997	101.6	116	14
May 1997	105.4	120	14
June 1997	109.6	123	12
July 1997	108.2	123	14

Notes:
(a) Market price is the average of bid and ask prices at the end of each trading day.
(b) The note was issued on 22 September 1995.
(c) Neither Bloomberg nor the Wall Street Journal contain a price for the exchangeable note for April - July 1996.

Table 2. Sensitivity of the theoretical price to volatility

Date	Market price(a)	Model price	Lower bound on price(b)
At issue(c)	100	127	120
September 1995	105	127	119
October 1995	104.5	127	120
November 1995	111	134	126
December 1995	117.9	146	136
January 1996	115	141	130
February 1996	111.8	140	129
March 1996	111	131	124
(d)			
August 1996	109.7	123	122
September 1996	112.8	125	124
October 1996	110.7	124	123
November 1996	110.5	123	123
December 1996	106.3	118	118
January 1997	98.2	113	112
February 1997	102.8	114	113
March 1997	102.5	113	112
April 1997	101.6	116	114
May 1997	105.4	120	116
June 1997	109.6	123	118
July 1997	108.2	123	117

Notes:
(a) Market price is the average of bid and ask prices at the end of each trading day.
(b) The lower bound on the theoretical price assumes a volatility of 21.71 percent on all dates.
(c) The note was issued on 22 September 1995.
(d) Neither Bloomberg nor the Wall Street Journal contain a price for the exchangeable note for April - July 1996.

Table 3. Sensitivity of the theoretical price to dividends

Date	Market price(a)	Model price (dividend yield = 0.42%)	Model price (dividend yield = 0.85%)
At issue(b)	100	127	126
September 1995	105	127	125
October 1995	104.5	127	126
November 1995	111	134	133
December 1995	117.9	146	144
January 1996	115	141	139
February 1996	111.8	140	138
March 1996	111	131	130
(c)			
August 1996	109.7	123	121
September 1996	112.8	125	124
October 1996	110.7	124	123
November 1996	110.5	123	122
December 1996	106.3	118	118
January 1997	98.2	113	112
February 1997	102.8	114	113
March 1997	102.5	113	112
April 1997	101.6	116	115
May 1997	105.4	120	119
June 1997	109.6	123	123
July 1997	108.2	123	122

Notes:
(a) Market price is the average of bid and ask prices at the end of each trading day.
(b) The note was issued on 22 September 1995.
(c) Neither Bloomberg nor the Wall Street Journal contain a price for the exchangeable note for April - July 1996.

Table 4. Stock price effect of announcements related to the exchangeable note issue.

Abnormal returns and cumulative abnormal returns on Mitsubishi Bank stock. Abnormal returns are computed as actual returns minus expected returns, which were estimated using a market model over mid-April 1995 through February 1996, excluding the event months of August and September 1995.

Event date	Abnormal return (percent)	t-statistic
August 21	-2.6	-2.3
August 31	-1.0	-.88
September 22	-.13	-.11
September 25	.26	.23
August 21- September 25 (cumulative)	-6.0	-.99

Note: the 5% critical value of the t-distribution with 192 degrees of freedom is 1.972 for a two-tailed test.

Figure 1. Mitsubishi Bank's decision to exchange notes in 1998-2001

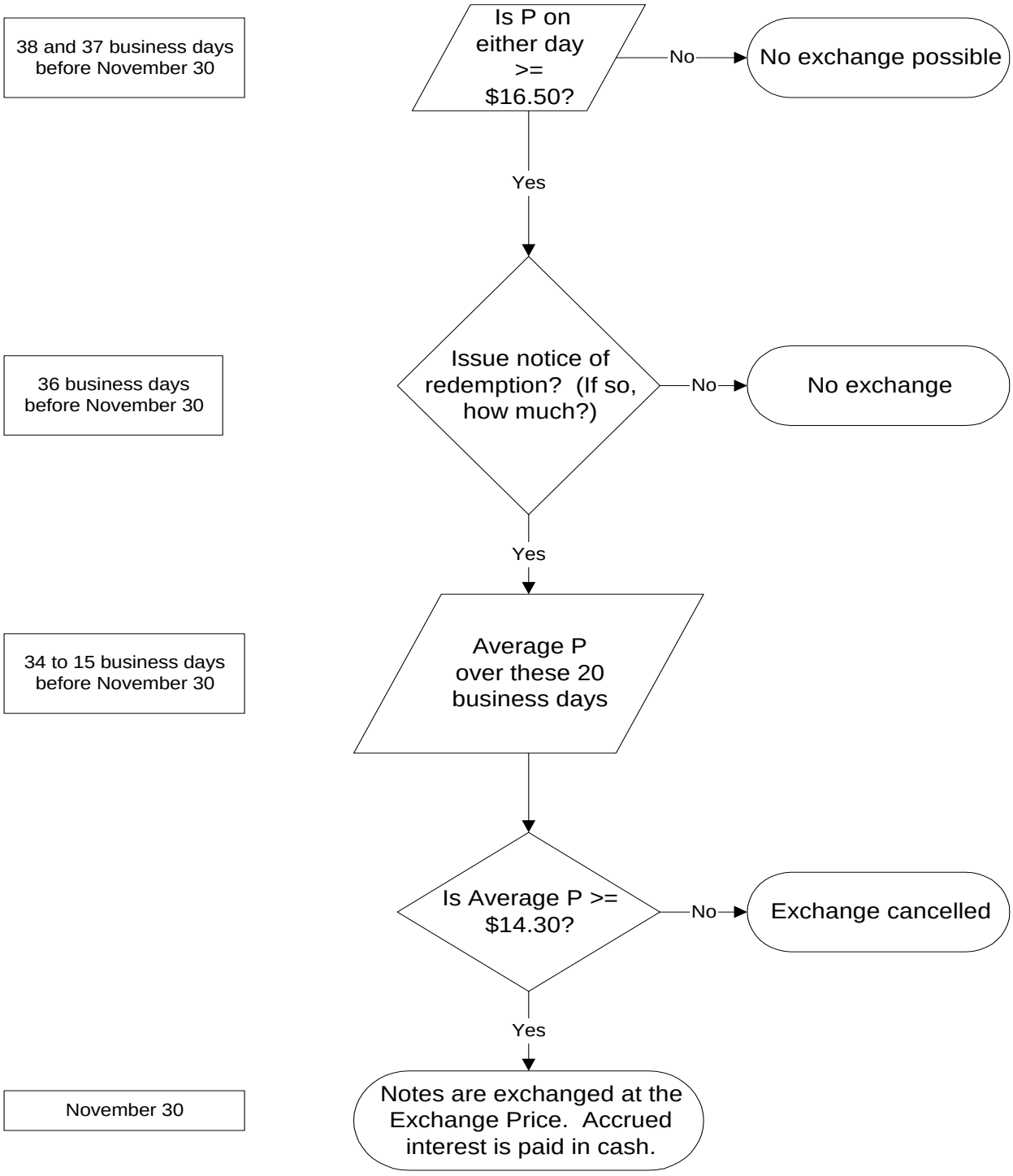


Figure 2. Mitsubishi Bank's decision to exchange notes at maturity (2002)

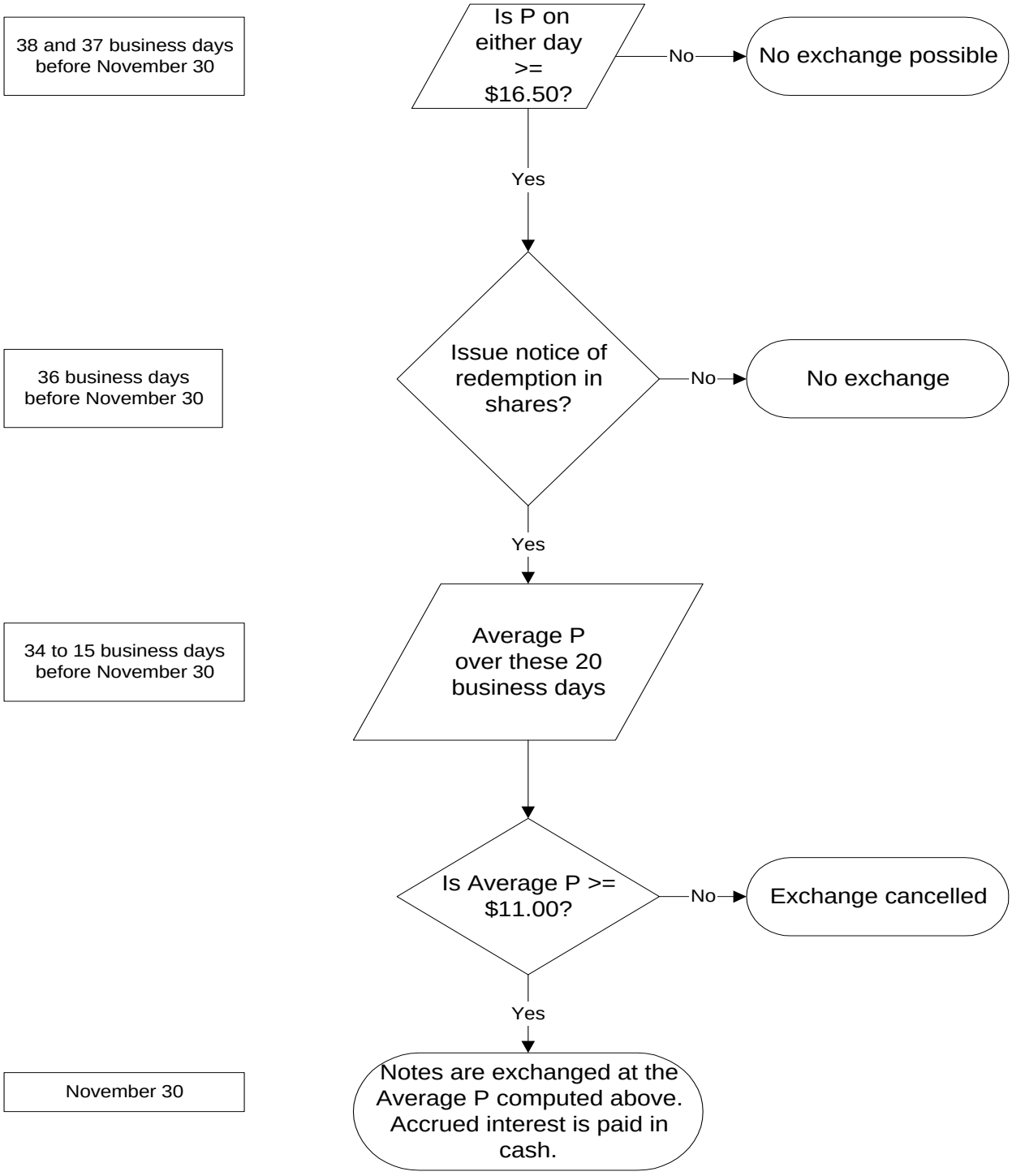
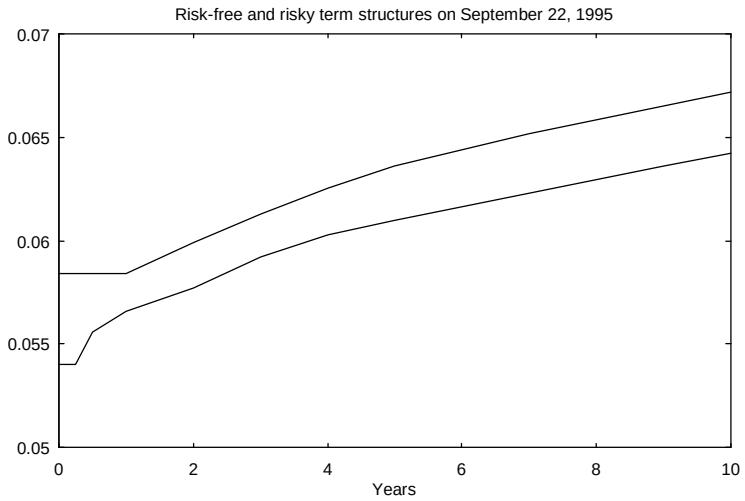


Figure 3. Baseline assumptions on the date of issue



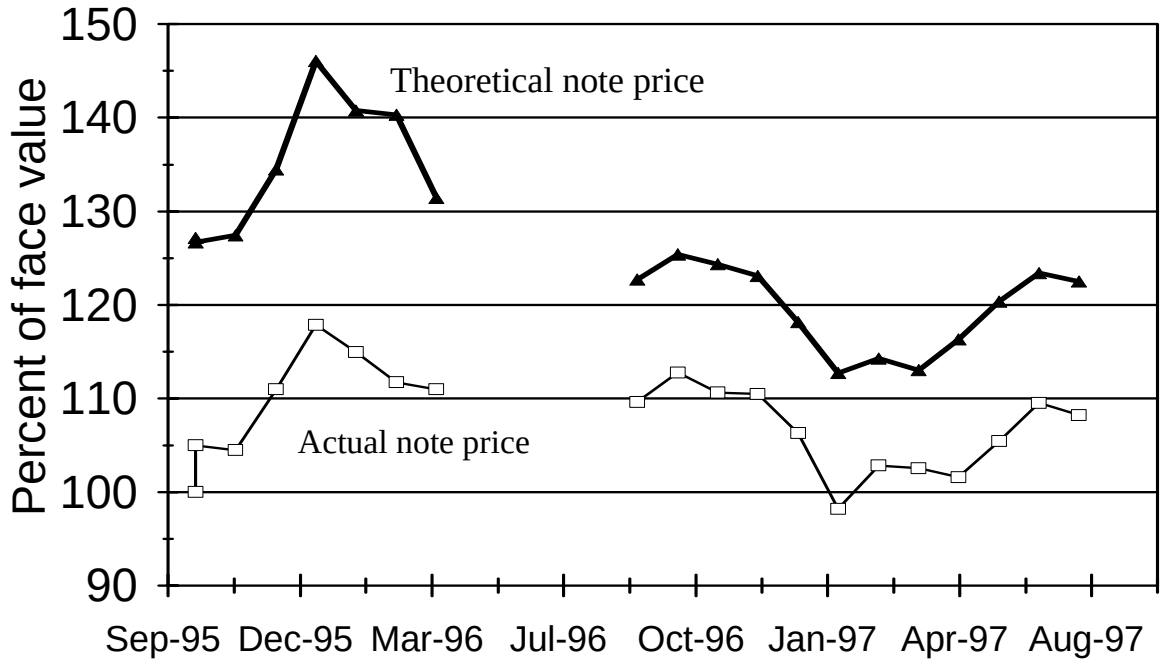
Volatility = 30.93 percent

Dividend yield = 0.42 percent

Source: Bloomberg, JP Morgan.

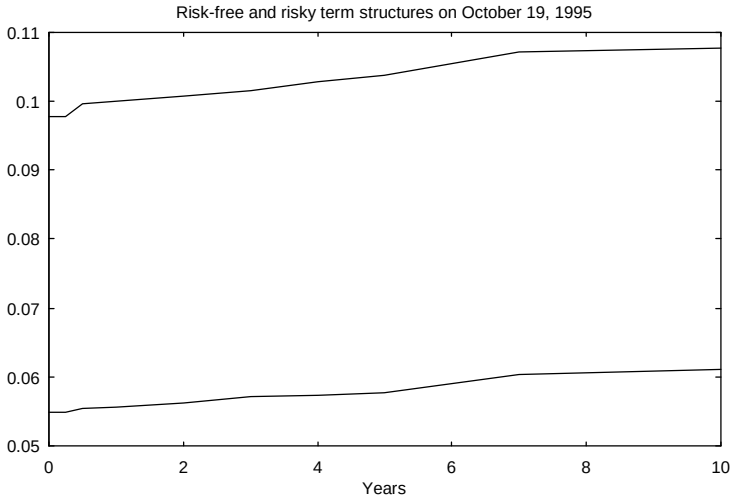
Risky term structure is a combination of U.S. dollar LIBOR (zero-one years) and JP Morgan RiskMetrics™ U.S. dollar swap curve (two-ten years). Risk-free term structure is a combination of Bloomberg Fair Market Yield Curve for U.S. Treasury Strips (zero-one years) and JP Morgan RiskMetrics™ U.S. government zero-coupon yield curve (two-ten years). Volatility is measured as the 250-day historical volatility on Mitsubishi Bank's ADR.

Figure 4. Theoretical and actual note prices.



Note: Actual note prices are the New York Stock Exchange closing price of the exchangeable note, at issue and on the last day of each month for which a trade was reported by the Wall Street Journal or Bloomberg Information Services.

Figure 5. Baseline assumptions for the Starbucks convertible note at issue



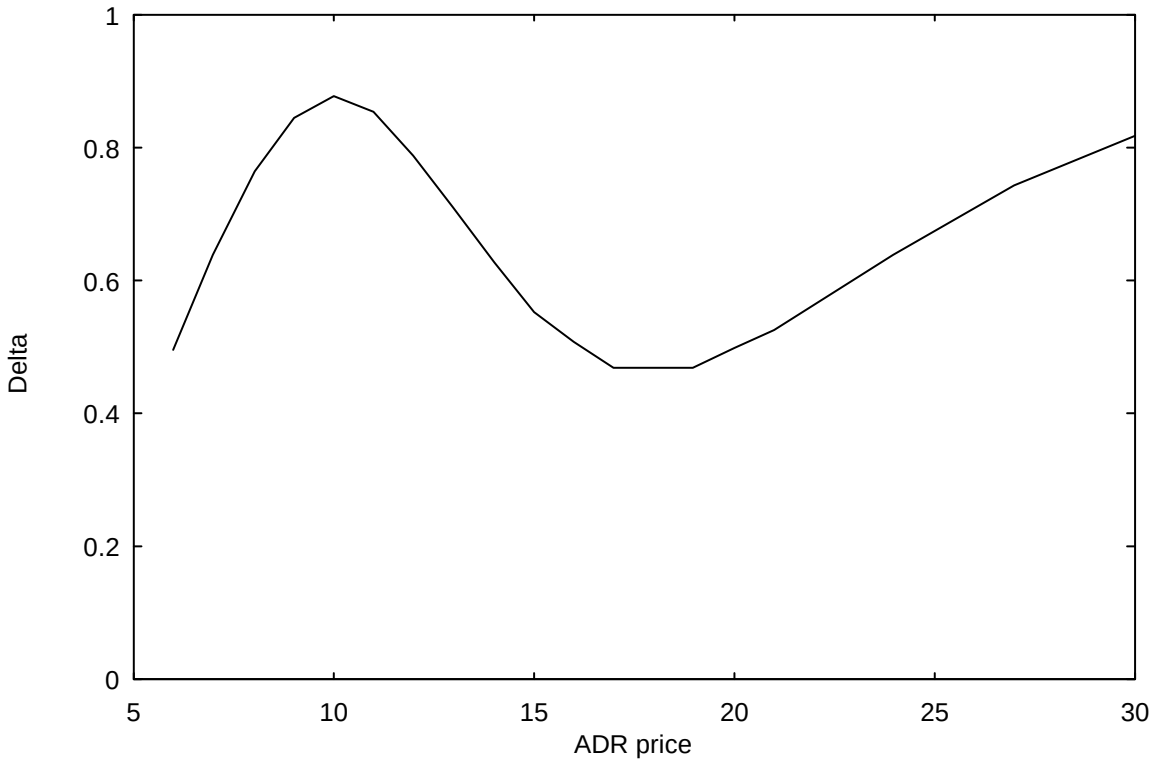
Volatility = 39.31 percent

Dividend yield = zero

Source: Bloomberg.

Risky-term structure = Bloomberg Fair Market Yield Curve for industrial bonds rated B-. Risk-free term structure = Bloomberg Fair Market Yield Curve for U.S. Treasury Strips. Volatility is measured as the historical 250-day volatility on Starbucks' common stock. Starbucks' common stock has never paid a dividend.

Figure 6. How the delta of the Mitsubishi Bank exchangeable note changes with the underlying ADR price.



Note: the delta is estimated on the binomial tree as in Hull (1997), p. 349. The delta is expressed in per-share units so it is comparable to the delta of a call option on the Mitsubishi Bank ADR. (That is, holder of an exchangeable note with face value $1000 would have to sell short Δ(1000/exchange price) shares of stock to hedge.)

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Appendix: Detailed description of the exchangeable note pricing methodology

We price the exchangeable note using the standard "textbook" methodology: a binomial tree as described in Hull (1997, chapter 20.5), augmented to account for several unusual features of the Mitsubishi Bank security. The following discussion assumes some familiarity with numerical option pricing on the part of the reader, for example at the level of Hull (1997).

The "textbook" methodology of Hull (1997, chapter 20.5) values a convertible bond as follows:

1. Assume that the stock price of the Mitsubishi Bank ADR is stochastic and model the evolution of the stock price with a binomial tree.[30] The dividend yield is assumed to be known and the stock is assumed to continue to go ex-dividend at the end of March and September. Following Hull (1997, section 15.3) we reduce the stock price at each ex-dividend node by the amount of the dividend.

2. Do not assume that interest rates are constant over the life of the note. Rather, assume that risk-free and risky interest rates change over time in a deterministic fashion so that the interest rates in future periods equal the current forward interest rate for those periods, as described in Hull (1997, chapter 15.4).

3. Vary the risk-neutral probabilities of an up or down move at each level of the tree to ensure that the expected growth rate of the stock price always equals the forward risk-free interest rate.[31]

4. At each terminal node, set the value of the note equal to the maximum of its face value or its conversion value.

5. Roll back the note's value through the tree in the usual way.

6. The conversion option, like any derivative, should be discounted at a risk-free interest rate while the bond should be discounted at a risky interest rate. To reflect this, set the discount rate for each rolled-back value equal to a weighted average of the risk-free and risky forward

[30]The tree has sixteen steps per year.

[31]The expectation is taken under the risk-neutral measure.

rates. The weights are the risk-neutral probabilities that the bond will be converted (conditional on passing through that node), and one minus that probability, respectively.[32]

7. While rolling back the value of the note through the tree, at each node an evaluation is made whether or not the noteholder should exchange the note for stock and whether Mitsubishi Bank should force an exchange (at those nodes where such exchanges are possible under the terms of the note).[33] We assume that the noteholder will exchange only when the value after an exchange exceeds the value if the note were not exchanged. We assume that Mitsubishi Bank will force an exchange whenever doing so reduces the note's value.[34]

The value of the Mitsubishi Bank exchangeable note is path-dependent, which requires the standard convertible bond valuation methodology to be modified. The exchange price adjusts on each November 30 to the lower of the market price (averaged over the 34 to 15 business days before

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[32]This way of incorporating default risk assumes there is no correlation between default on the exchangeable note and Mitsubishi Bank's stock price. In fact, default is more likely to occur when the stock price is low, which is when the exchangeable note most closely resembles a risky bond since the conversion option will be out of the money. As a result, our methodology may overestimate the note's value.

To investigate how the correlation between default and the stock price could affect the note's theoretical value, we experimented with an alternative way of incorporating default risk. Instead of using risky forward rates to construct discount rates, we use only risk-free forward rates but we set the note's value to zero at all terminal nodes where the stock price was below a cutoff level, thereby assuming a perfect negative correlation between default and stock price. The cutoff level was set to capture 0.79 percent of the probability mass at the terminal nodes. (Moody's Investors Service's (1996) study of historical default rates found that 7-year Aa-rated instruments have a default rate of 0.79 percent.) This alternative method of incorporating default risk produced a theoretical note price at issue that was 0.2 points lower than under our original methodology. We conclude that the correlation between default risk and stock price does not significantly bias our results.

[33]The terms of the note allow Mitsubishi Bank to force conversion before maturity if the stock price 38 or 37 business days before November 30 is greater than $16.50 and the average stock price between 34 and 15 business days before November 30 is greater than $14.30. (See Figure 1.) The exact valuation would introduce a computationally infeasible (for us) amount of path dependency. We assume that Mitsubishi Bank is allowed to force conversion before maturity if the stock price on November 30 is greater than $14.30. We make a similar simplifying assumption for forced conversion at maturity, where the only difference is that the stock price floor is $11.00. (See Figure 2.) We conjecture that the error introduced by this assumption is small.

[34]This strategy will only be optimal if, at the time of the forced exchange, Mitsubishi Bank has ample equity capital or can costlessly raise equity capital. If neither of these conditions holds, Mitsubishi Bank will force an exchange into stock more often than our assumed strategy predicts, even though such an exchange strategy will not minimize the note's value to investors. As a result, our assumptions put a lower bound on the note's value to an investor.

November 30) and the prior exchange price, with a floor of $14.30. The value of the note on a given date will depend on the current stock price and on the history of the stock price since the note's issue, since that history determines the exchange price.

We use the methodology of Hull (1997, chapter 18.3) to handle the path-dependency. Working forward through the tree, we identify the maximum and minimum exchange prices possible at each node.[35] When valuing the note at the terminal nodes, we value the note for 30 different exchange prices, equally spaced between the minimum and maximum exchange prices at each node. When rolling back the note's value through the tree, we roll back a value for the note at 30 different exchange prices, equally spaced between the minimum and maximum possible exchange prices. The rolled-back value for each exchange price is computed using the usual formula:

$$(p\ V_u + (1\text{-}p)\ V_d)\ e^{-r(t)\Delta t}$$

where V_u , the value of the note following an up move, and V_d , the value of the note following a down move, are conditional on a certain exchange price at the given node.[36] (We follow a similar procedure to keep track of the probability of conversion, since the conversion probability, used in step 6 above, also depends on the exchange price.)[37]

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[35]We use the actual stock price on November 30, rather than the average of stock prices between 34 and 15 business days before November 30, to determine the evolution of the exchange price. As a result, some error is introduced into our valuation of the note. Again, the exact valuation would introduce a computationally infeasible (for us) amount of path-dependency. Again, we conjecture that the error introduced by this approximation is small.

[36]Conditional on a certain exchange price at a given node, the exchange price in the event of an up or down move along the tree is known. The value of the note after an up or down move, conditional on a certain exchange price, is interpolated from the up or down node's set of 30 exchange price-note value pairs.

[37]The estimated price of the exchangeable note did not change appreciably if the size of the tree was increased beyond sixteen steps per year or if the number of points at each node was increased beyond thirty.

We assume that forced exchanges can be treated as pro rata rather than random. For example, if Mitsubishi Bank forces an exchange of 20 percent of the notes, we assume that 20 percent of each noteholder's holding will be involuntarily exchanged into stock. Our assumption would be true if all the notes were held by a single agent but is only approximately true otherwise. To make a more accurate valuation of a noteholder's holdings, we would have to know the number of notes held by that noteholder to accurately evaluate the probability of a forced exchange affecting that noteholder's holdings.

We implement this assumption by dividing the note into five tranches: notes that will first be subject to a forced exchange in 1998, 1999, 2000, 2001, and 2002. Each tranche is priced separately, and "the note price" is the average of the prices of the five tranches.