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The Relative Pricing of High-Yield Debt: The Case of RJR Nabisco Holdings Capital Corporation

By ROBERT M. DAMMON, KENNETH B. DUNN, AND CHESTER S. SPATT*

We derive and investigate empirically arbitrage pricing restrictions among three bonds of RJR Nabisco Holdings Capital Corporation. The three RJR bonds are virtually identical in all respects, except for the form in which interest is paid. We document large and persistent errors in the market pricing of the three bonds over a two-year period. The cash-paying bond was consistently more expensive than either the pay-in-kind or deferred-coupon bonds. The magnitude of the pricing errors is too large to be explained by market imperfections. (JEL G14, G10)

In this paper we derive and investigate empirically several theoretical pricing restrictions that should be satisfied by three bonds of RJR Nabisco Holdings Capital Corporation. In particular, we consider pricing restrictions involving RJR's 13.5-percent cash-paying bonds, 15-percent payment-in-kind bonds, and 15-percent deferred-coupon (initially zero-coupon) bonds. The major difference among the three securities is the form in which interest is paid. In fact, the bonds are so similar in other respects that

they seem to have been designed specifically for a pricing experiment.¹ We document large and persistent errors in the market pricing of the three bonds.

The cash-paying bond is consistently more expensive than the other two bonds. For example, a portfolio consisting of the deferred-coupon bond and Treasury strips could be constructed that provided higher cash flows and less default risk than the 13.5-percent cash-paying bond, yet for nearly two years this portfolio cost significantly less than the cash-paying bond. The pricing error frequently exceeded \$5 per \$100 of face value. During mid-January 1991 the pricing error exceeded \$11 per \$100 of face value. In fact, from mid-November 1990 through the end of January 1991 the price of the cash-paying bond (including accrued interest) exceeded the price of the deferred-

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¹In a number of contexts, important insights in finance have emerged from particularly well-controlled market situations. A classic study along such lines is the pioneering work on dividend payment policy by John Long (1978). More recent examples include the studies of Treasury bond pricing by Bradford Cornell and Alan Shapiro (1989) and Francis Longstaff (1992), the study of the pricing of primes and scores by Robert Jarrow and Maureen O'Hara (1989), the study of dividend payment policy by James Poterba (1986), and the study of the pricing of multiple classes of stock with perfectly correlated cash flows by Leonard Rosenthal and Colin Young (1990).

TABLE 1—GENERAL TERMS AND FEATURES OF THE THREE RJR BONDS

Feature	Cash-paying bond	Pay-in-kind (PIK) bond	Deferred-coupon bond
Issue date	May 15, 1989	May 15, 1989	May 15, 1989
Issue size	\$0.5 Billion	\$1.0 Billion	\$4.1 Billion
Maturity date	May 15, 2001	May 15, 2001	May 15, 2001
Coupon rate	13.5 percent	15.0 percent	0 percent through May 15, 1994; 15.0 percent thereafter.
Payment dates	May 15 and November 15 of each year	May 15 and November 15 of each year	May 15 and November 15 of each year
Payment method	Cash	Cash or additional PIK bonds (at the option of RJR) through May 15, 1994; cash only thereafter ^a	No coupons through May 15, 1994; cash only thereafter ^b
Sinking fund	25 percent on May 15, 1999, and May 15, 2000	25 percent on May 15, 1999, and May 15, 2000	25 percent on May 15, 1999, and May 15, 2000
Call feature ^c	Callable after May 15, 1994	Callable after May 15, 1994	Callable after May 15, 1994

Notes: The three RJR bonds rank *pari passu* (i.e., have equal standing per dollar of claim) in the event of bankruptcy or default.

^aAdditional PIK bonds issued in lieu of cash interest are valued at 100 percent of their face value.

^bThe deferred-coupon bonds were originally issued at a discount to face value to yield 15.0 percent (compounded semiannually) through May 15, 1994. The accreted-value schedule for the deferred-coupon bond is provided in Table 3.

^cThe call-price schedules for the three bonds are provided in Table 2. Prior to May 15, 1994, the three bonds are not callable except in the event of a change in control (see footnote 3 for a definition of "change of control"). In the event of a change of control, all three bonds also become puttable at 101 percent of their face (or accreted) values.

coupon bond by more than the *undiscounted* difference in coupon payments between the two bonds. There were periods of time in which the price of the cash-paying bond was near par, while the payment-in-kind and deferred-coupon bonds traded at substantial discounts of more than 20 percent to their face or accreted values. Although the magnitude of the pricing errors was large and persisted for nearly two years, the mispricing largely disappeared by mid-March 1991, a period when the high-yield bond market was experiencing a strong rally.

The paper is organized as follows. In Section I we describe the contractual features of the three RJR bonds. The theoretical arbitrage and relative pricing relationships are developed in Section II. We present our empirical analysis and document large and persistent violations of the pricing restrictions in Section III. Arbitrage portfolios are constructed to establish the magnitude and time-series behavior of the pricing errors. In Section IV we investigate a number of possible explanations for the pricing errors,

including restrictions on short sales, the preference for high cash income by some investors, taxes, liquidity, and bargaining differences among the bonds. None of these explanations, however, can satisfactorily explain the magnitude of the pricing errors that we observed. Section V contains concluding comments.

I. Description of Securities

In May 1989, RJR Holdings Capital Corporation (hereafter RJR) issued three nearly identical debt securities in connection with the leveraged buyout of RJR Nabisco by Kohlberg, Kravis and Roberts (KKR): \$1.0 billion of 15-percent payment-in-kind subordinated debentures due 2001 (hereafter the pay-in-kind bond), \$4.1 billion of subordinated discount debentures due 2001 (hereafter the deferred-coupon bond), and \$525 million of 13.5-percent subordinated debentures due 2001 (hereafter the cash-paying bond). These bonds were subordinated to about \$14.5 billion of senior debt and ranked

TABLE 2—CALL SCHEDULES FOR THE THREE RJR BONDS

Call date	13.5-percent cash-paying bond	15.0-percent PIK and deferred-coupon bonds
May 15, 1989–May 14, 1990	113.50	115.00
May 15, 1990–May 14, 1991	112.15	113.50
May 15, 1991–May 14, 1992	110.80	112.00
May 15, 1992–May 14, 1993	109.45	110.50
May 15, 1993–May 14, 1994	108.10	109.00
May 15, 1994–May 14, 1995	106.75	107.50
May 15, 1995–May 14, 1996	105.40	106.00
May 15, 1996–May 14, 1997	104.05	104.50
May 15, 1997–May 14, 1998	102.70	103.00
May 15, 1998–May 14, 1999	101.35	101.50
May 15, 1999 and thereafter	100.00	100.00

Notes: Call prices are expressed as a percentage of face or accreted value. None of these bond issues is callable prior to May 15, 1994, except in the event of a change of control.

ahead of about \$6.8 billion of junior debt. A brief summary of the major contractual features of these three bonds is provided in Table 1.

All three bonds are *pari passu* (i.e., they have equal priority in the event of default or bankruptcy). Each bond matures on May 15, 2001, began trading on May 15, 1989, and has semiannual interest payment dates of May 15 and November 15 of each year commencing November 15, 1989.² The three bonds also have identical sinking-fund provisions requiring that 25 percent of the original principal amount of each issue be retired on May 15, 1999, and May 15, 2000.

Table 2 provides the call-price schedules for the three bonds. The call price is stated as a percentage of par for the cash-paying and pay-in-kind bonds, and as a percentage of accreted value (as defined below) for the deferred-coupon bond. The deferred-coupon and pay-in-kind bonds have slightly higher percentage call premiums than the

cash-paying bond. Each security may be redeemed, in whole or in part, at the option of RJR at any time on or after May 15, 1994, at the call price plus accrued and unpaid interest through the redemption date. Prior to May 15, 1994, the bonds are called *only* in the event of a change of control.³ Each bond also is puttable (i.e., can be sold back to RJR) by the holder at 101 percent of par plus accrued interest, or 101 percent of its accreted value in the case of the deferred-coupon bond, if a change in control occurs.

The major difference among the three securities is the form in which interest is paid. The 13.5-percent cash-paying bond pays interest in cash, which began accruing on May 22, 1989. Between semiannual coupon payment dates the accrued interest on the cash-paying bond is computed using

²For corporate bonds, the settlement date is five business days after the trade date. In the case of the cash-paying bond, the buyer is responsible for paying accrued interest through the settlement date. In the case of the pay-in-kind bond, no accrued interest is due upon settlement (i.e., the bonds “trade flat”). Semiannual coupons on the pay-in-kind bond are paid to the holders-of-record as of the first day of the interest-payment month. The ex-coupon date is five business days earlier.

³The definition of “change of control” from the prospectus (pp. 89–90) for the RJR deferred-coupon and pay-in-kind bonds is, in part, as follows:

“... the ownership by KKR and its affiliates, directly or indirectly, of less than 40% of the total voting power entitled to vote in the election of directors, managers or trustees of the Company; *provided, however*, that ownership by KKR and its affiliates, directly or indirectly, of 30% or greater, but less than 40% of the total voting power entitled to vote in the election of directors, managers or trustees of the Company shall not be a Change of Control if KKR... controls a majority of the Board of Directors....”

the 30/360 method.⁴ The bankruptcy claim of the cash-paying bond is par plus accrued interest. After May 15, 1994, the deferred-coupon and pay-in-kind bonds become identical 15-percent cash-paying bonds.⁵ Prior to May 16, 1994, interest on the 15-percent pay-in-kind bond may, at the option of RJR, be paid either in cash or through the issuance of additional pay-in-kind bonds valued at 100 percent of par.^{6,7} Between semiannual coupon dates, the pay-in-kind bond accrues interest using the 30/360 method. The bankruptcy claim of the pay-in-kind bond is par plus accrued interest. The deferred-coupon bond was issued on May 15, 1989, at a price of \$48.656 per \$100 of face value. Through May 15, 1994, the deferred-coupon bond pays no coupon but accretes to face value on May 15, 1994, at a rate of 15 percent per year, compounded semiannually. The accreted value sche-

⁴The 30/360 method for computing accrued interest treats each month as if it had 30 days. No incremental accrued interest is allocated for holding a bond on the last day of 31-day months, and extra interest is assigned for holding a bond on the last day in February.

⁵The indenture actually indicates that the deferred-coupon bond will pay its coupon beginning May 16, 1994, using the "actual/360" method. This appears to be a typographical error. We instead follow the standard convention of using the 30/360 accrual method for cash-paying bonds, which applies to both the deferred-coupon and pay-in-kind bonds after May 15, 1994. The bankruptcy claim of the deferred-coupon and pay-in-kind bonds after May 15, 1994, is par plus accrued interest.

⁶To mitigate the problems of discreteness, RJR distributes additional bonds in units of \$2.50 of principal per \$100 of face value. This limits the amount of interest that must be distributed in cash to less than \$25 per bondholder account and effectively eliminates the ability of investors to manipulate account sizes to force receipt of substantial cash coupons.

⁷However, under RJR's credit agreements, payment in cash was prohibited until May 16, 1994. In October 1991, following a dramatic rise in the price of its bonds, RJR renegotiated its credit agreements to allow cash payments on the pay-in-kind bonds. In fact, RJR had not renegotiated its credit agreements prior to the May 15, 1991 coupon and paid the pay-in-kind bond's coupon in additional bonds, even though the market value of the additional bonds exceeded the optional cash payment. RJR paid interest in cash on the 15-percent pay-in-kind bonds beginning with the November 15, 1991 coupon payment.

TABLE 3—ACCRETED-VALUE SCHEDULE FOR RJR'S DEFERRED-COUPON BOND

Semiannual accrual date	Accreted value per \$100 face amount
May 22, 1989	\$48.656
November 15, 1989	52.158
May 15, 1990	56.070
November 15, 1990	60.275
May 15, 1991	64.796
November 15, 1991	69.656
May 15, 1992	74.880
November 15, 1992	80.496
May 15, 1993	86.533
November 15, 1993	93.023
May 15, 1994	100.000

Note: Between two consecutive semiannual accrual dates, the accreted value of the deferred-coupon bond accrues linearly using the actual/actual method.

dule for the deferred-coupon bond at the semiannual coupon dates is presented in Table 3. Between two consecutive semiannual coupon dates the accreted value of the deferred-coupon bond increases linearly using the actual/actual method.⁸ Prior to May 15, 1994, the bankruptcy claim of the deferred-coupon bond is its accreted value. The deferred-coupon and pay-in-kind bonds trade flat (i.e., without accrued interest due upon settlement) prior to May 15, 1994, while the settlement price of these two bonds is the quoted price plus accrued interest after May 15, 1994 (since both bonds pay interest exclusively in cash subsequent to that date). The settlement price of the 13.5-percent cash-paying bond is always its quoted price plus accrued interest.

II. Theoretical Pricing Restrictions

In this section, we examine the theoretical pricing restrictions relating the prices of RJR's 13.5-percent cash-paying bond, deferred-coupon bond, and 15-percent pay-in-kind bond under the assumption that

⁸The actual/actual method for computing accrued interest allocates each semiannual coupon payment equally to each day in the semiannual period. The difference in accrued interest between the actual/actual and 30/360 methods is negligible.

there are no market imperfections. The effects of market imperfections on the pricing relationships will be discussed in Section IV. We denote the quoted price (per \$100 of face value) at time t of the cash-paying bond by p_t^c , the deferred-coupon bond by p_t^d , and the pay-in-kind bond by p_t^p . We let v_t denote the settlement price (i.e., the quoted price plus accrued interest) at time t of a bond whose quoted price is p_t . Since the deferred-coupon and pay-in-kind bonds trade flat prior to May 15, 1994, $v_t^d = p_t^d$ and $v_t^p = p_t^p$ for $t \leq T^*$, where T^* is May 15, 1994.

After May 15, 1994, both the deferred-coupon and pay-in-kind bonds become identical 15-percent cash-paying bonds. In addition to paying a lower coupon, the 13.5-percent cash-paying bond also has a lower call-price schedule (see Table 2) than either the deferred-coupon or pay-in-kind bonds. As a result, the following arbitrage restriction must hold *after* May 15, 1994:

$$(1) \quad v_t^c \leq v_t^d = v_t^p \quad \text{for } t \geq T^*$$

where the inequality assumes the absence of refinancing costs.⁹

We now focus on the pricing restrictions relating the values of the three bonds prior to May 15, 1994. We first compare the prices of the deferred-coupon and cash-paying bonds. Consider a portfolio consisting of one deferred-coupon bond and U.S. Treasury strips¹⁰ with face values of \$6.75 that mature at each of the coupon payment dates through May 15, 1994.¹¹ Beyond May 15,

⁹In the presence of refinancing costs, it is possible for a higher-coupon bond to be less valuable than a lower-coupon bond when both are selling at par or above (see Dunn and Spatt, 1986).

¹⁰A U.S. Treasury strip is a pure discount (zero-coupon) bond that makes a single cash payment at some specified future date and is backed by the full faith and credit of the U.S. government.

¹¹The first coupon on the cash-paying bond is only $\$6.75(173/180) = \6.4875 , due to the fact that the bond began trading on May 15, 1989, and first settled on May 22, 1989. This alters the arbitrage restrictions for the first coupon interval that are presented in equations (2) and (3). Our empirical analysis reflects this reduced initial coupon.

1994, the deferred-coupon bond is more valuable than the cash-paying bond due to its higher coupon and call-price schedule [see equation (1)]. Prior to May 15, 1994, the portfolio of one deferred-coupon bond plus Treasury strips has the same promised payments as the cash-paying bond, but less default risk because the payments on the Treasury strips are riskless, whereas the interest payments on the cash-paying bond are risky. Because the cash flows on the portfolio of the deferred-coupon bond and Treasury strips are less risky, and always at least as large as the cash flows on the cash-paying bond, the portfolio must cost more than the cash-paying bond to prevent arbitrage.¹² Therefore,

$$(2) \quad v_t^c < p_t^d + 6.75 \sum_{i=1}^m q_{it}$$

where q_{it} is the Treasury-strip price at time t for a dollar of payment at the i th coupon payment date, and m is the number of coupon payments remaining on the cash-paying bond through May 15, 1994. A violation of this condition implies that the cash flows on the cash-paying bond can be pur-

¹²In the event of bankruptcy or default, the cash-paying bond has claim to its face value (plus accrued interest), while the deferred-coupon bond has claim to its accreted value (see Table 3). Since the accreted value of the deferred-coupon bond is less than the face value of the cash-paying bond, it is possible, at least in principle, that the portfolio of the deferred-coupon bond and Treasury strips could be worth less than the cash-paying bond in the event of bankruptcy. However, over the entire period for which we found violations of the arbitrage restriction in equation (2), the deferred-coupon bond was selling at a larger *dollar* discount, relative to its claim in bankruptcy, than was the cash-paying bond. Consequently, in the event of bankruptcy or default, the dollar price difference between the deferred-coupon and cash-paying bonds will be reduced (since the payment per dollar of claim in bankruptcy is equal across the bonds), thus increasing the performance of the deferred-coupon bond relative to the cash-paying bond. Moreover, since the value of the Treasury strips is unaffected by bankruptcy, the overall performance of the portfolio of the deferred-coupon bond plus Treasury strips should exceed that of the cash-paying bond in bankruptcy.

chased for less than the cost of the cash-paying bond simply by purchasing the portfolio consisting of the deferred-coupon bond and Treasury strips. Under the assumption of a positive time value of money ($q_{it} < 1$), a weaker form of the arbitrage bound is derived by setting $q_{it} = 1$ in equation (2) to obtain

$$(3) \quad v_t^c < p_t^d + \$6.75m.$$

A violation of condition (3) means that the incremental cost of the cash-paying bond above the cost of the deferred-coupon bond exceeds the total *undiscounted* future coupon differential through May 15, 1994.

We next examine the pricing relationship between the pay-in-kind and deferred-coupon bonds. To gain insight into this relationship, we first consider an otherwise identical 15-percent pay-in-kind bond that requires the issuer to pay the coupons through May 15, 1994 exclusively in additional pay-in-kind bonds (i.e., without the option to pay coupons in cash). We denote the price of this hypothetical pay-in-kind bond by p_t^{pk} . This hypothetical pay-in-kind bond is identical to a deferred-coupon bond with a face value of $\$100(1.075)^n$, where n is the number of coupon payments remaining on the pay-in-kind bond through May 15, 1994. Intuitively, since the face value of the hypothetical pay-in-kind bond will grow by 7.5 percent semiannually through May 15, 1994, an investor would need to purchase $(1.075)^n$ deferred-coupon bonds to duplicate the bankruptcy claim and cash flows on the hypothetical pay-in-kind bond. Consequently, the price of the hypothetical pay-in-kind bond must satisfy¹³

$$(4) \quad p_t^{pk} = (1.075)^n p_t^d.$$

¹³The first coupon on the pay-in-kind bond is only $\$7.50(173/180) = \7.208 because it first settled on May 22, 1989, five business days after it began trading. Consequently, the arbitrage restriction in equation (4) only applies after the ex-coupon date for the first

Now consider the observed 15-percent pay-in-kind bond. Prior to May 16, 1994, this bond gives the issuer the option to pay coupons either in cash or in additional 15-percent pay-in-kind bonds. Allowing the issuer to choose the form of payment at each date is equivalent to viewing each payment as an in-kind payment, but allowing the issuer to call (separately) each payment at par. The optimal policy (absent refinancing costs) is to pay the coupon in cash provided the cum-coupon bond price at the payment date is at least par plus the coupon. Assuming that the issuer follows the optimal policy, the price of the observed pay-in-kind bond would be less than the price of the hypothetical "option-free" pay-in-kind bond. The difference, $w_t \equiv p_t^{pk} - p_t^p$, represents the dollar value of the present and future option to substitute cash for in-kind payments. Using equation (4), this implies that

$$(5) \quad w_t = (1.075)^n p_t^d - p_t^p > 0.$$

A violation of equation (5) would indicate an arbitrage opportunity between the deferred-coupon and pay-in-kind bonds. Moreover, holding all else constant, the value of the option to substitute cash for in-kind payments should be increasing in the price of the pay-in-kind bond.

Finally, consider the relative pricing of the 13.5-percent cash-paying bond and the 15-percent pay-in-kind bond. Substituting equation (5) into equation (2) yields the

coupon. Prior to this date, the arbitrage restriction is

$$p_t^{pk} = (1.075)^9 \left(1 + 0.075 \left(\frac{173}{180} \right) \right) p_t^d.$$

However, in our empirical analysis we only consider the arbitrage restriction in equation (4) after the first coupon date because our price data for the pay-in-kind bond are sparse prior to that date.

following pricing relationship:¹⁴

$$(6) \quad v_t^c < \frac{p_t^p + w_t}{(1.075)^n} + 6.75 \sum_{i=1}^m q_{it}.$$

A weak upper bound on the value of the option to substitute cash for in-kind payments, w_t , can be obtained by assuming that at each future coupon date the difference between the value of the in-kind payment and the \$7.50 cash payment is maximized. This occurs when the price of the pay-in-kind bond reaches its maximum value. Let \bar{p}_i^p represent the maximum ex-coupon price that the pay-in-kind bond could have on the i th coupon date. Then, the maximum difference between the value of the in-kind payment and the \$7.50 cash payment on the i th coupon date is $[(0.075)\bar{p}_i^p - \$7.5]$. Discounting by the Treasury strip prices and summing over all future coupon dates gives the following upper bound on the value of the option to substitute cash for in-kind payments:

$$(7) \quad w_t < \sum_{i=1}^n q_{it} [(0.075)\bar{p}_i^p - \$7.5].$$

Equation (7) involves the price \bar{p}_i^p , which is a theoretical upper bound on the ex-coupon price of the pay-in-kind bond on the i th coupon date. But what is an appropriate upper bound? We assume that at each future coupon date the pay-in-kind bond cannot sell for more than an equivalent Treasury bond that pays \$7.50 semiannually through May 15, 1994, and is redeemable

¹⁴While the 13.5-percent cash-paying bond and the 15-percent pay-in-kind bond have identical payment dates (May 15 and November 15), they have different ex-coupon dates. The ex-coupon date for the pay-in-kind bond is five business days before the first business day of the interest-payment month, while the ex-coupon date for the cash-paying bond is five business days before the payment date. Consequently, the number of coupon payments remaining on the pay-in-kind bond (n) will be one less than that for the cash-paying bond (m) for about a two-week interval between these two ex-coupon dates. At all other times n and m will be the same.

for \$107.50 on May 15, 1994.¹⁵ The value of such a Treasury bond on the i th coupon date will obviously depend upon the term structure of interest rates prevailing at that time, which is currently unobservable. However, under the expectations hypothesis of the term structure of interest rates, the current forward rates are unbiased estimates of the future spot rates. Consequently, if we use the forward rates implicit in the Treasury-strip prices, we obtain for date t the following upper bound on the value of the pay-in-kind bond on the i th coupon date:

$$(8) \quad \bar{p}_i^p = 7.5 \sum_{k=i+1}^n f_{ki} + (107.5)f_{ni}$$

where $f_{ki} \equiv q_{kt}/q_{it}$, $k = i+1, \dots, n$, are the forward rates implied by the current (date- t) Treasury-strip prices. Substituting equation (8) into equation (7) and substituting the resulting inequality into equation (6) yields the pricing restriction between the 13.5-percent cash-paying bond and the 15-percent pay-in-kind bond in equation (9), on the following page. This restriction is extremely weak, because it implicitly assumes that at each future coupon date the value of the option to substitute cash for in-kind payments is maximized, regardless of the current price of the pay-in-kind bond.¹⁶

¹⁵The pay-in-kind bond could never sell for more than the equivalent Treasury bond because (i) the payments on the Treasury bond are free of default risk and (ii) the price of the pay-in-kind bond will be less than or equal to its call price of \$107.50 on May 15, 1994.

¹⁶To illustrate, consider a situation in which there are exactly seven semiannual coupon payments remaining on the pay-in-kind bond (i.e., $n = 7$). As a convenient normalization, let the current date be $t = 0$. Suppose the term structure of interest rates is flat at 7 percent so that $q_{i0} = (1.035)^{-i}$, where i is the length of time (i.e., number of six-month intervals) until the i th coupon date. Then, our arbitrage restriction in equation (9) implicitly assumes that the pay-in-kind bond has the following (ex-coupon) prices at each of the future coupon dates: \$127.42 ($i = 1$), \$124.37 ($i = 2$), \$121.23 ($i = 3$), \$117.97 ($i = 4$), \$114.60 ($i = 5$), \$111.11 ($i = 6$), \$107.50 ($i = 7$). Given these high implicit prices for the pay-in-kind bond, the value of the option to substitute cash for in-kind payments will be grossly overestimated, especially when the pay-in-kind bond sells at a substantial discount to par.

$$(9) \quad v_i^c < \frac{p_i^p + \sum_{i=1}^n \left[(0.075) \left(7.5 \sum_{k=i+1}^n q_{kt} + 107.5q_{nt} \right) - 7.5q_{it} \right]}{(1.075)^n} + 6.75 \sum_{i=1}^m q_{it}$$

III. Empirical Analysis

To investigate these pricing relationships empirically, we obtained institutional bid-side quotes for the three RJR bonds and the Treasury strips for the period May 15, 1989, through June 28, 1991, from Goldman Sachs.¹⁷ According to equation (2), a portfolio of the RJR deferred-coupon bond and Treasury strips that pay \$6.75 on each semi-annual coupon date through May 15, 1994, should be more valuable than the 13.5-percent cash-paying bond. Figure 1 provides a graphical presentation of the empirical evidence regarding this arbitrage restriction. In particular, Figure 1 provides a time-series plot of the price of the cash-paying bond (plus accrued interest) less the price of the portfolio of the deferred-coupon bond and Treasury strips. As can be seen from the figure, during most of the period this difference was positive, indicating that the arbitrage restriction was violated. In fact, this restriction was violated within a few days of the issuance of the bonds. During much of the period the magnitude of the violation fluctuated between \$4 and \$6 per \$100 of face value, though it exceeded \$11 in mid-January 1991. Figure 1 also provides a graphical presentation of the arbitrage restriction provided in equation (3). Even this much weaker bound is violated for almost

two and one-half months during late 1990 and early 1991. This is especially surprising given the simplicity of the calculations necessary to identify violations of this arbitrage restriction.

We also examined the magnitude of the arbitrage violation using (retail) transactional data from the New York Stock Exchange's bond market for all of January 1991. For each trading day during January 1991, we analyzed the prices at which the deferred-coupon and cash-paying bond traded within five minutes of each other. Table 4 summarizes our findings. Surprisingly, the arbitrage restriction in equation (2) was violated by a substantial amount throughout this period, exceeding \$11 per \$100 of face value for several days during the month. Figure 2 provides a graphical illustration of the violations of the arbitrage restriction presented in equation (2) at half-hour intervals on January 15, 1991. These violations are quite large and confirm our earlier findings.¹⁸

Next, we examine the empirical relationship between the prices of the pay-in-kind and deferred-coupon bonds. Due to limitations in the availability of price data for the pay-in-kind bond, our empirical investigation of this relationship begins on November 8, 1989. The price difference $w_t \equiv p_t^d(1.075)^n - p_t^p$ provides a measure of the market's estimate of the value to the issuer

¹⁷The Goldman Sachs data are based upon an opening bid indication for the RJR bonds, but closing indications for the Treasury strips. This is not a serious limitation due to the limited daily movement in Treasury strip prices. Due to the importance of institutional trading in the corporate bond market, we use institutional indications for much of our pricing analysis. However, we also use retail transactional data from the New York Stock Exchange's bond market to confirm our findings.

¹⁸To confirm that this anomaly is not due to errors in the price data, we also examined the arbitrage bounds for many dates during the period from December 13, 1990, to April 15, 1991, using RJR price data obtained from Quotron at the close of trading and Treasury strip prices obtained from Bloomberg. These data confirm the basic results using the Goldman Sachs data, including the magnitude of the arbitrage violations and the convergence toward equilibrium in the first few months of 1991.

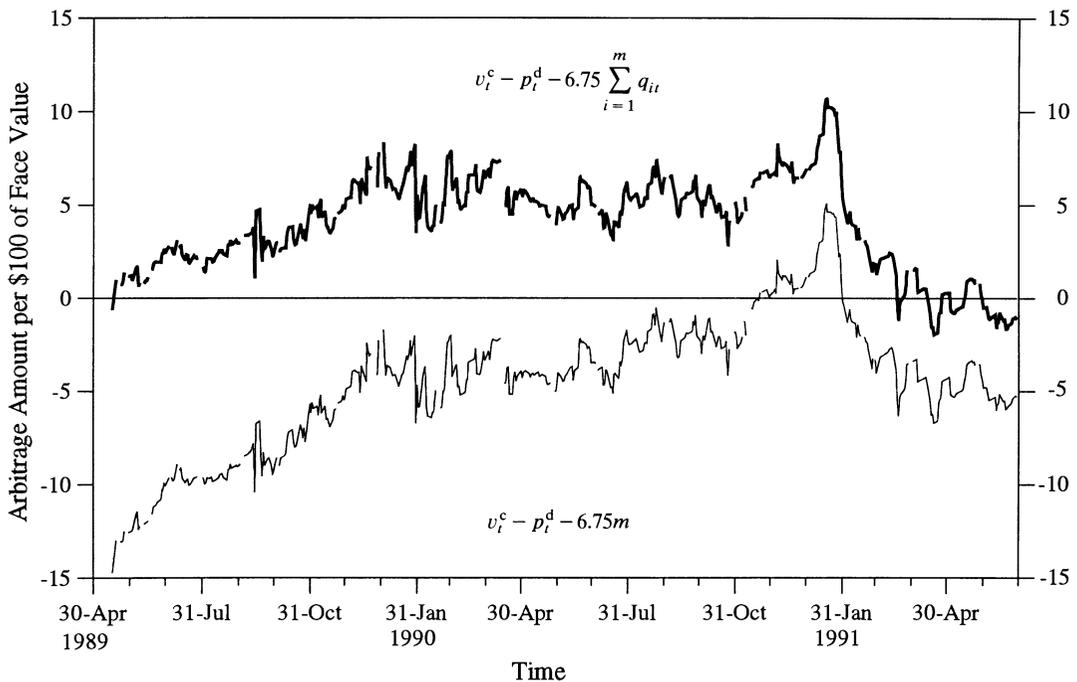


FIGURE 1. MISPRICING BETWEEN RJR'S CASH-COUPON AND DEFERRED-COUPON BONDS, MAY 1989–JUNE 1991

Note: The November 1989 coupon was actually \$6.4875 rather than \$6.75. We account for this difference in our calculations.

of the option to substitute cash for in-kind payments on the pay-in-kind bond. According to equation (5), this price difference should be strictly positive. Interestingly, on the issue date the prices of the pay-in-kind and deferred-coupon bonds were such that the implied value of the option to substitute cash for in-kind payments was zero. Both bonds were initially priced to provide investors a yield of 15 percent per annum, suggesting that the pay-in-kind bond was overpriced relative to the deferred-coupon bond at the time of issue.

Figure 3 provides time-series plots of (i) the price of the pay-in-kind bond less accrued interest and (ii) the value of the option to substitute cash for in-kind payments, w_t . The value of this option should be strictly positive and will fluctuate for two primary reasons. First, the value of the option is theoretically higher for higher bond prices

since cash payments are optimal from the issuer's standpoint whenever the pay-in-kind bond sells at a premium. Consequently, other things being equal, we would expect to find the price difference in Figure 3 to be higher when the pay-in-kind bond sells at a higher price. Second, the value of the option decreases over time as the number of remaining coupon payments declines and the maturity date of each coupon is shortened. Consequently, other things being equal, we would expect to see the price difference in Figure 3 decline gradually over time.

As can be seen from Figure 3, there were a few dates when the option value was actually negative, indicating a violation of the pricing restriction in equation (5). Note also that the option value fluctuates considerably over time and seems to be unrelated (or, perhaps, even *negatively* related) to the

TABLE 4—ARBITRAGE VIOLATIONS BETWEEN RJR'S CASH-PAYING AND DEFERRED-COUPON BONDS USING TRANSACTIONAL DATA FOR JANUARY 1991

Dates	Number of observations	Average	Minimum	Maximum
January 2, 1991	16	\$7.143	\$6.979	\$7.479
January 3, 1991	31	7.342	7.096	7.721
January 4, 1991	15	7.436	7.186	7.811
January 7, 1991	48	7.783	7.562	8.312
January 8, 1991	50	8.321	7.946	8.696
January 9, 1991	28	8.591	8.109	9.359
January 10, 1991	19	9.281	8.998	9.498
January 11, 1991	25	9.458	8.873	10.123
January 14, 1991	26	10.181	9.729	10.854
January 15, 1991	22	10.866	10.252	11.252
January 16, 1991	14	10.910	10.437	11.312
January 17, 1991	29	10.884	10.427	11.427
January 18, 1991	44	10.336	9.688	11.188
January 21, 1991	14	10.705	10.294	11.169
January 22, 1991	18	10.426	9.919	10.919
January 23, 1991	22	10.440	9.832	10.707
January 24, 1991	35	9.369	8.444	9.944
January 25, 1991	46	8.243	7.854	8.729
January 28, 1991	25	8.155	7.945	8.320
January 29, 1991	45	7.565	6.840	8.465
January 30, 1991	112	5.601	4.738	6.488
January 31, 1991	58	5.780	5.483	6.108

Notes: This table shows the magnitude of the arbitrage violations between RJR's cash-paying and deferred-coupon bonds per \$100 of face value [i.e., $v_i^c - p_i^d - (6.75)\sum_{i=1}^m q_{it}$], using the transaction prices for the two bonds whenever they traded within five minutes of each other on the NYSE bond market.

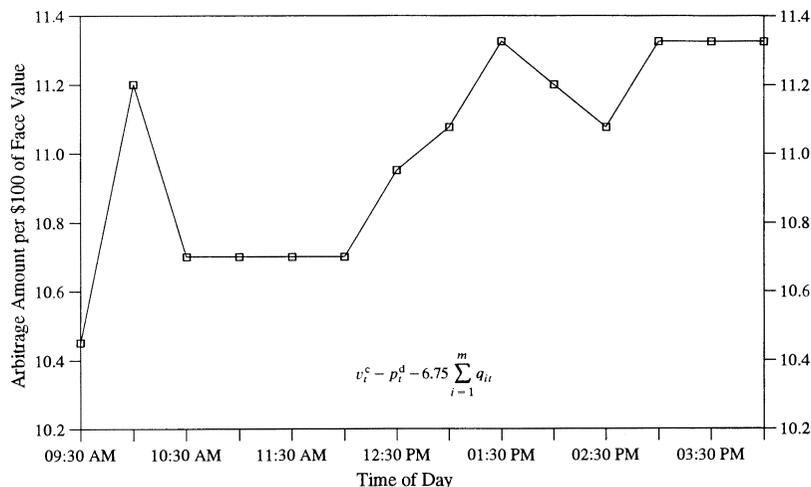


FIGURE 2. MISPRICING BETWEEN RJR'S CASH-COUPON AND DEFERRED-COUPON BONDS ON JANUARY 15, 1991

Notes: On January 15, 1991, the number of remaining coupons on the cash-paying bond through May 15, 1994, was $m = 7$. The present value of these coupons (using Treasury-strip prices to discount) was $6.75\sum_{i=1}^m q_{it} = \41.584 .

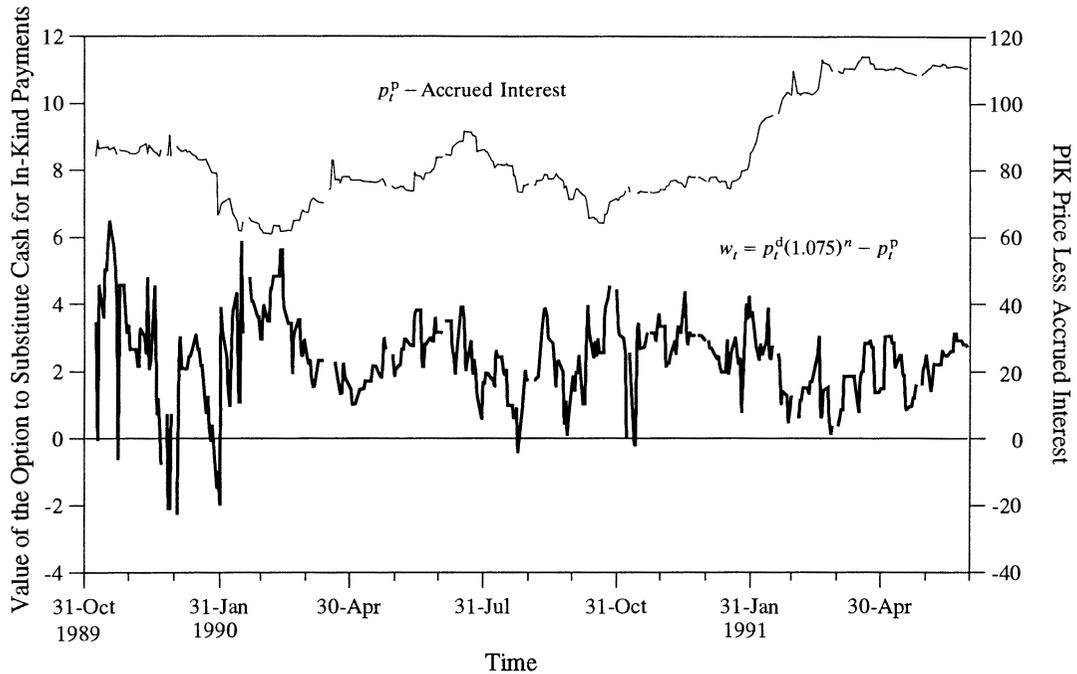


FIGURE 3. VALUE OF THE OPTION TO SUBSTITUTE CASH FOR IN-KIND PAYMENTS AND THE ADJUSTED PRICE OF THE PAY-IN-KIND (PIK) BONDS, NOVEMBER 1989–JUNE 1991

Note: Because the pay-in-kind bond trades flat (i.e., without accrued interest due upon purchase), an adjustment for accrued interest is necessary to determine whether the bond is selling at a premium or discount relative to its face value.

price level of the pay-in-kind bond. From mid-January to mid-February of 1990, for example, the pay-in-kind bond's price (less accrued interest) fell from about \$86 to about \$62 (per \$100 of face value) in response to the Moody's downgrade of RJR's debt. Surprisingly, over this same period of time, the market's estimate of the value of the option to substitute cash for in-kind payments *increased* from slightly over \$2 to almost \$6. From mid-January to mid-April of 1991, the price of the pay-in-kind bond (less accrued interest) rose from less than \$75 to more than \$114, while the value of the option to substitute cash for in-kind payments remained relatively unchanged. On January 17, 1991, for example, the pay-in-kind bond's price (less accrued interest) was \$74.50, and the value of the option to substitute cash for in-kind payments was \$2.26. Three months later, on April 17, 1991,

the price of the pay-in-kind bond (less accrued interest) had risen to \$114.25, but the market's estimate of the value of the option to substitute cash for in-kind payments was only \$2.02. While these behaviors do not necessarily indicate an arbitrage opportunity, they do indicate that the relationship between the prices of the pay-in-kind and deferred-coupon bonds is, at times, anomalous.

To investigate further the evidence in Figure 3, we examined the relationship between the price level of the pay-in-kind bond and the implied value of the option to substitute cash for in-kind payments over two subperiods: (i) November 8, 1989, through April 24, 1990 ($n = 9$), and (ii) October 29, 1990, through April 25, 1991 ($n = 7$). We chose to examine these intervals of time because they contain considerable price variability. Figure 4 illustrates that in nei-

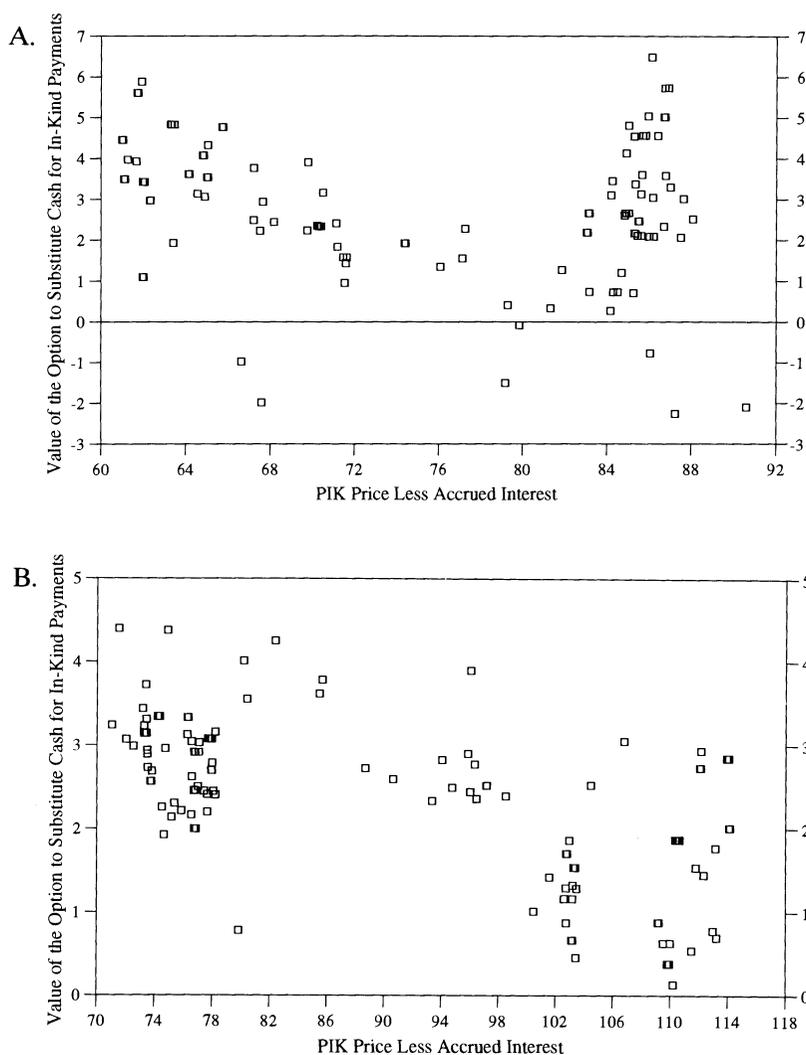


FIGURE 4. VALUE OF THE OPTION TO SUBSTITUTE CASH FOR IN-KIND PAYMENTS VERSUS THE ADJUSTED PRICE OF THE PAY-IN-KIND (PIK) BOND: A) NOVEMBER 8, 1989–APRIL 24, 1990; B) OCTOBER 29, 1990–APRIL 25, 1991

Notes: Because the PIK bond trades flat (i.e., without accrued interest due upon purchase), an adjustment for accrued interest is necessary to determine whether the bond is selling at a premium or discount relative to its face value. The option to substitute cash for in-kind payments is given by $w_t = p_t^d(1.075)^n - p_t^p$.

ther subperiod is there a strong positive relationship between the option value and the price of the pay-in-kind bond. In fact, in Figure 4B the value of the option to substitute cash for in-kind payments is highest when the pay-in-kind bond is selling at more

than a 20-percent discount to its face value and is lowest when the pay-in-kind bond is selling above par. This negative relationship is inconsistent with the theoretical prediction that the option to substitute cash for in-kind payments should be higher for

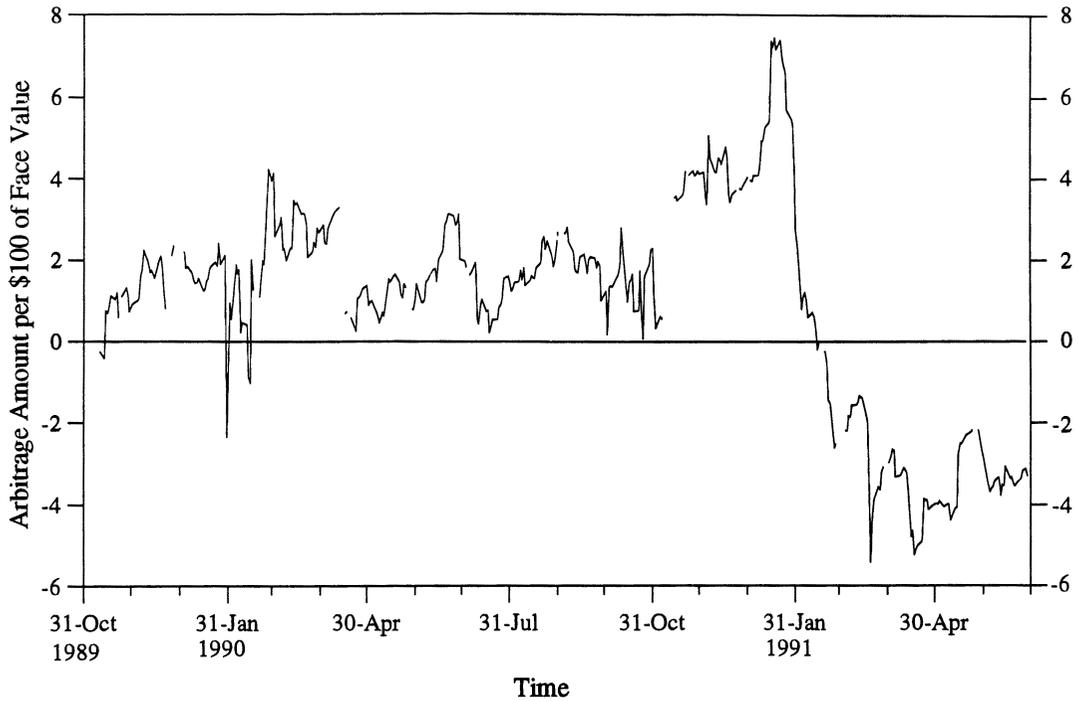


FIGURE 5. MISPRICING BETWEEN RJR'S CASH-COUPON AND PAY-IN-KIND BONDS, NOVEMBER 1989–JUNE 1991

Note: The curve depicts the arbitrage restriction in equation (9):

$$v_i^c - \frac{p_i^p + \sum_{i=1}^n \left[(0.075) \left(7.5 \sum_{k=i+1}^n q_{kt} + 107.5 q_{nt} \right) - 7.5 q_{it} \right]}{(1.075)^n} - 6.75 \sum_{i=1}^m q_{it}$$

higher pay-in-kind bond prices. Moreover, the high option values observed in Figure 4 for prices of the pay-in-kind bond below par are particularly striking in light of the fact that RJR was restricted at the time by its credit agreements from paying coupons in cash.¹⁹

¹⁹Because RJR has a strong incentive to renegotiate its credit agreements to allow for the payment of cash interest when the pay-in-kind bond is selling at a premium to par, the small option values in Figure 4B for the premium region are still somewhat puzzling. In fact, RJR did renegotiate its credit agreements to allow for the payment of cash interest prior to the November 1991 coupon payment.

The arbitrage restriction in equation (9) relating the price of the pay-in-kind bond to that of the cash-paying bond is depicted graphically in Figure 5. Despite the fact that equation (9) is an extremely weak restriction, Figure 5 indicates that there were frequent and large violations of this restriction over time. These violations indicate that an appropriately designed portfolio of the pay-in-kind bond and U.S. Treasury strips could be constructed that is guaranteed to have higher cash flows than the cash-paying bond, but has a lower cost. The arbitrage violations in Figure 5 are particularly striking in light of the fact that the pricing restriction in equation (9) assumes that the option to substitute cash for in-kind payments generates the highest possible savings for the

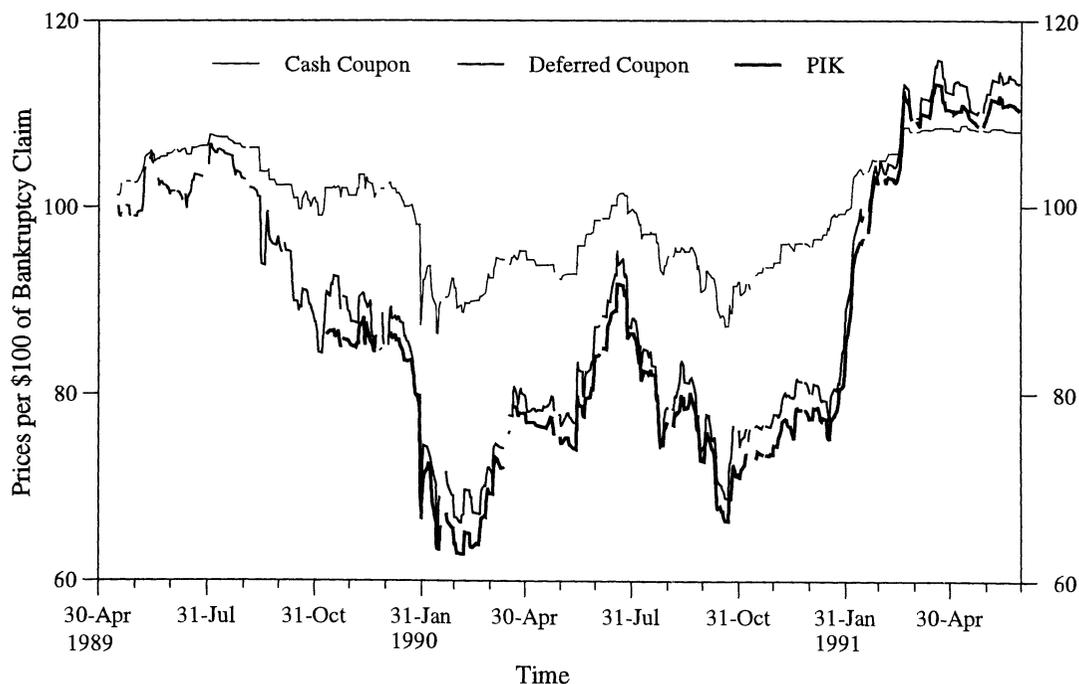


FIGURE 6. PRICES OF RJR'S CASH-COUPON, DEFERRED-COUPON, AND PAY-IN-KIND BONDS PER \$100 OF BANKRUPTCY CLAIM, MAY 1989-JUNE 1991

issuer at each future coupon date. While the arbitrage violations in Figure 5 persisted over a long period of time, they were quickly eliminated in early 1991 as the pay-in-kind bond rallied in conjunction with the overall high-yield market.

Figure 6 is a plot of the prices of the three RJR bonds, normalizing so that each represents an identical claim of \$100 in bankruptcy. This figure illustrates that, while the prices of the deferred-coupon and pay-in-kind bonds per \$100 of bankruptcy claim were similar throughout the sample period, they were consistently far below the price of the cash-paying bond. This is yet another indication that the deferred-coupon and pay-in-kind bonds were cheap relative to the cash-paying bond. For example, in mid-January 1991 the price difference exceeded \$20 per \$100 of bankruptcy claim, even though the cash-paying bond was selling near par. The worst possible scenario for the deferred-coupon and pay-in-kind bonds is if RJR remains solvent and makes the

cash coupon payments on the cash-paying bond through May 15, 1994, and then declares bankruptcy. In this case, the cash-paying bond will have received seven cash coupon payments of \$6.75 each and will have a bankruptcy claim of \$100. The deferred-coupon and pay-in-kind bonds will have received no cash coupons, but their bankruptcy claims will have grown to $\$100(1.075)^7 = \165.90 . If the claims turn out to be worthless in bankruptcy, a scenario which is strongly biased against the relative performances of the deferred-coupon and pay-in-kind bonds, then the holders of the cash-paying bond will have received a total payout of \$47.25 (ignoring discounting), while the holders of the deferred-coupon and pay-in-kind bonds will have received nothing. Thus, in this highly pathological scenario, the maximum difference in the payments would be \$47.25 (or approximately \$41.50 after discounting using Treasury strip prices). To explain a price differential of \$20, it would then be neces-

sary for the probability of bankruptcy to be in excess of 50 percent. But a high probability of default, with relatively low payoffs in bankruptcy, is inconsistent with the observation that the cash-paying bond was selling near par at the time.

IV. Consideration of Market Imperfections

The persistent empirical violations of the arbitrage restrictions documented in Section III are quite surprising. In order to understand better these pricing patterns we now examine various market imperfections as possible explanations for this behavior.²⁰

Due to inefficiencies in the short-selling mechanism, it may not have been possible to exploit the arbitrage opportunity by short-selling the cash-paying bond and using the proceeds to buy the cheaper deferred-coupon or pay-in-kind bonds.²¹ There are substantial impediments in practice to such "riskless" arbitrage. When bonds are bor-

rowed to sell short, the security lender keeps the proceeds of the sale as collateral to ensure that the borrowed bonds will be returned. In addition, the investor is required to post up to an additional 30-percent collateral beyond the short-sale proceeds, though institutional investors generally only post between 2-percent and 5-percent additional collateral. These margin requirements limit the extent to which an investor can use leverage to establish an arbitrage position. In fact, the negative correlation between the long and short positions does not reduce the margin (collateral) requirements on the short position unless the long and short assets are identical (i.e., a "short against the box"). Though the lender pays the borrower of the bonds a competitive money-market return on the cash collateral, the margin interest is typically higher, creating a wedge between the cost of borrowing to finance the long position and the return on the proceeds of the short position. When the demand to borrow the security is high, the competitive interest rate on the cash collateral can be driven below money-market returns. In fact, if the arbitrage opportunity is sufficiently valuable, it can even be difficult to locate supply of the asset one desires to short.²²

Typical short-sale arrangements do not guarantee access to the borrowed asset for a specified period of time. In the RJR context, the position is risky unless one can guarantee maintaining the short position until May 15, 1994. In practice, however, the security lender generally has the right to recall the borrowed securities with little advance notice. This subjects the borrower to the risk of a "squeeze" in which he is forced to cover his short position at a time when the security is in limited supply and relatively expensive (see Cornell and Shapiro

²⁰Some explanations can be dismissed immediately. For example, transactions costs and bid-ask spreads on corporate bonds and U.S. Treasury strips are quite small relative to the magnitude of the arbitrage violations. Though our analysis assumes uniform settlement dates for corporate bonds and Treasury strips, the Treasury strips settle in one business day, rather than the five business days for corporate bonds. The resulting understatement of the effective cost of the Treasury strips is negligible. The difference in the accrual of interest for the computation of the claim in the event of bankruptcy for the different bonds (actual/actual for the deferred-coupon bond and 30/360 for the other bonds) has a trivial valuation impact. Indeed, between coupon payment dates the pay-in-kind bond continues to have a higher dollar claim in bankruptcy than the cash-paying bond due to its higher coupon. A change in control, which makes the bonds immediately puttable (at the option of the holder) and immediately callable (at the option of the issuer), is advantageous to the issuer when the bonds are selling above their call price and disadvantageous when the bonds are selling below their put price (101 percent of their accreted value). Since the arbitrage violations we document between the deferred-coupon and cash-paying bonds arose only when the bonds were selling below the call price, it is unlikely that the possibility of a change of control could explain the observed pricing discrepancy.

²¹Jarrow and O'Hara (1989) and Charles Lee et al. (1991), among others, also discuss how inefficiencies in the short-selling mechanism can make it difficult to exploit mispricing.

²²In fact, we were unable to borrow the 13.5-percent cash-paying bond on reasonable terms through either institutional or retail brokerage channels during December 1990 and January 1991, when the arbitrage was especially large. The trading desks of several Wall Street firms had sold short the 13.5-percent cash-paying bonds.

[1989] for an example in the Treasury market). The likelihood that the borrower would be forced to cover his short position increases as the bonds become relatively more expensive, since the lender would then be more eager to sell the bonds himself. If it is not possible to guarantee access to the short position until May 15, 1994, there is a risk of having to unwind the position at a loss. However, these impediments to short-selling do not provide a satisfactory explanation for the large price discrepancies we observed, because such an explanation does not account for why investors would hold dominated assets. In particular, it does not explain why the holders of the cash-paying bond did not sell it and buy the pay-in-kind or deferred-coupon bonds.²³

Another potential explanation is related to the issue size. If the issue sizes of the securities were sufficiently small, then the anomaly could be unknown to investors or too small to exploit in practice. However, the magnitude of the yield differential between the cash-paying bond and both the deferred-coupon and pay-in-kind bonds was large, and RJR was a major component of the high-yield market. Indeed, several Wall Street firms had written reports describing the relatively high yields on the deferred-coupon and pay-in-kind bonds during 1990 (without recognizing the arbitrage violations) and recommending that investors purchase these securities.²⁴ In fact, it is possible that the large size of the RJR debt issue resulted in some institutional investors being constrained from increasing their portfolio holdings because of the fiduciary guidelines that often limit the investment in a single firm's securities to 5 percent of the

portfolio's value. However, it would be surprising if such constrained investors would be the marginal price-setters.

Our earlier analysis assumed that the marginal investor is tax-exempt. For a taxable investor, taxes must be paid on the accrued interest of the deferred-coupon (or pay-in-kind) bond and on the cash interest of the cash-paying bond. Moreover, there also is a tax on any capital gains or losses incurred over the period of time that the bonds are held. To investigate whether the differential taxes on these securities can account for the price discrepancies observed, we constructed a portfolio composed of one RJR deferred-coupon bond plus Treasury strips whose *after-tax* cash flows replicate the *after-tax* cash flows through May 15, 1994, of one RJR 13.5-percent cash-paying bond. Recall that beyond May 15, 1994, the deferred-coupon bond will be more valuable than the cash-paying bond because it has higher (cash) coupons and call-price schedule. Consequently, the absence of arbitrage for the taxable investor will require the market price of the replicating portfolio to be at least as high as the market price (plus accrued interest) of the cash-paying bond.

For convenience, we assume that the investor pays taxes on the original issue discount on the RJR deferred-coupon bond and the portfolio of Treasury strips held in the replicating portfolio on the semiannual coupon dates of May 15 and November 15.²⁵ Consequently, the face amount of Treasury strips maturing on each coupon date must be sufficient to pay these taxes and, in addition, match the *after-tax* coupon payment on the RJR 13.5-percent cash-paying bond. The taxable portion of the original issue discount on the deferred-coupon bond and Treasury strips is computed according to the rules set forth in IRS Publication 1212. For simplicity, we assume that any market discounts (or premiums) at the

²³Our arbitrage calculations ignore any incremental return that the holders of the cash-paying bond could have earned from securities lending. However, the incremental return from securities lending is typically only available to institutional investors.

²⁴The implication of this is that Wall Street firms viewed the deferred-coupon and pay-in-kind bonds as underpriced relative to the cash-paying bond. Indeed, some credit analysts felt that the cash-paying bond itself was fairly priced relative to the junk-bond market at the time.

²⁵The differential effect of our accelerating the timing of the periodic income tax payments by a few months on both portfolios is negligible.

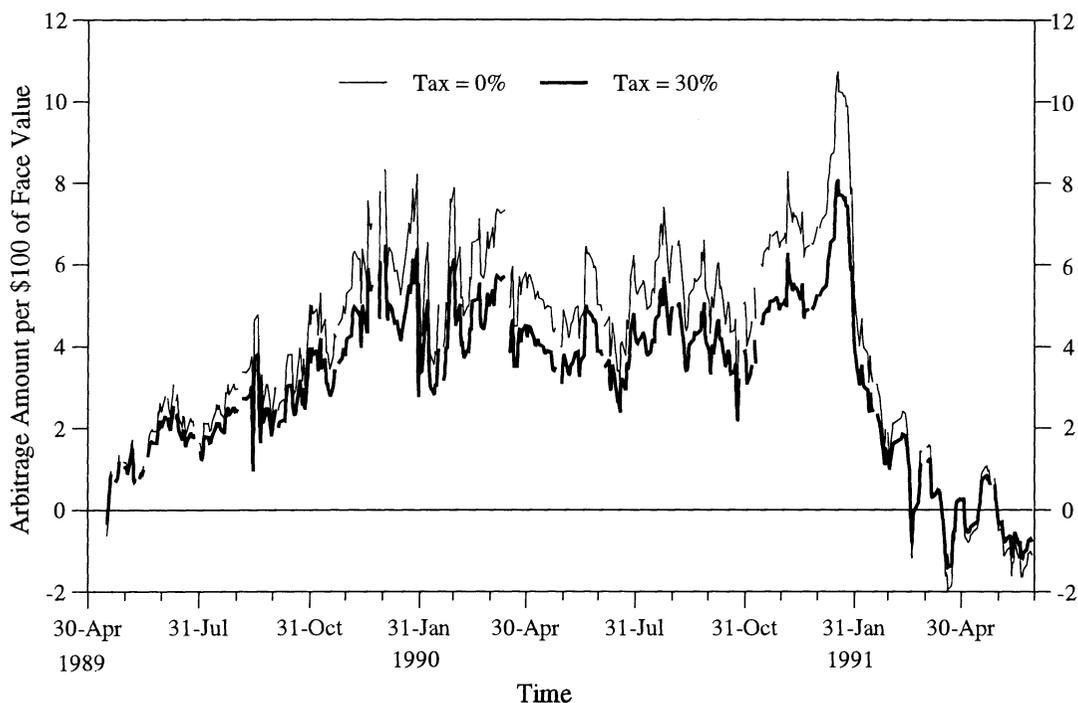


FIGURE 7. TAX-ADJUSTED MISPRICING BETWEEN RJR'S CASH-COUPON AND DEFERRED-COUPON BONDS, MAY 1989–JUNE 1991

Note: The "Tax = 0" curve is identical to the curve labeled $v_t^c - p_t^d - 6.75 \sum_{i=1}^m q_{it}$ in Figure 1.

date of purchase on the deferred-coupon and cash-paying bonds are taxed as capital gains (or losses) on May 15, 1994. Since the realization of these market discounts could be deferred until the maturity date of the bonds (May 15, 2001) or until they are called, this treatment tends to favor the cash-paying bond, because it had smaller market discounts. We also ignore the tax-timing option that the investor possesses to realize losses through time.

Figure 7 illustrates the price differential between the replicating portfolio and the 13.5-percent cash-paying bond per \$100 of face value. The bold line represents the arbitrage profit for an investor with a 30-percent tax rate on both ordinary income and capital gains and losses. For comparison, the arbitrage profit for a tax-exempt investor (the upper curve from Fig. 1) is also shown in Figure 7. Figure 7 clearly illustrates that taxes reduce the arbitrage profit but do not eliminate it. In fact, a 30-percent

tax rate tends to reduce the arbitrage profit by only about 20–25 percent. The arbitrage profit is reduced by less than the 30-percent tax rate because of the deferral of the capital-gains tax and the substantial market discount on the deferred-coupon bond over most of the sample period. Throughout the entire period of time that there existed an arbitrage opportunity for the tax-exempt investor, there also existed an arbitrage opportunity for the taxable investor.²⁶ These observations clearly indicate that taxes alone are not sufficient to explain the anomalous observed price behavior.

Many of the holders of the cash-paying bond were high-yield funds or other investors possessing a strong preference for

²⁶In fact, on two dates (May 17, 1989, and May 15, 1991), there was a small arbitrage opportunity for the taxable investor (with a tax rate of 30 percent), but not for the tax-exempt investor.

cash income. We identified several holders in such categories. Though the cash-paying bond is dominated by the deferred-coupon instrument supplemented with Treasury securities, the latter mix of assets has a zero current yield and does not meet the high-current-yield objective of many high-yield funds. While such managerial behavior is difficult to motivate on a total-return basis, many mutual funds are sold and purchased on the basis of high current yield.²⁷ Also, some fiduciaries do face "remainderman" problems in which the beneficiaries of principal and income differ.²⁸ Of course, this is not a completely satisfactory explanation, because it assumes implicitly that the *marginal investor* possesses such a preference for current income. Indeed, an arbitrageur could have formed a trust secured in part by deferred-coupon or pay-in-kind bonds in order to pay high current income. Of course, such a strategy is costly to implement and runs the risk that the realized profits can be adversely affected if the bonds decline in value after they are acquired but not yet resold to the public.

Recent work by Jacob Boudoukh and Robert Whitelaw (1991, 1993), Yakov Amihud and Haim Mendelson (1991), and Avraham Kamara (1991) examine a liquidity explanation for why securities that pay the same cash flows trade at different prices. They argue that more liquid securities can command a higher price and offer lower returns. However, this argument does not explain the observed price differences among the three RJR bonds, since the deferred-coupon and pay-in-kind bonds

were more liquid than the cash-paying bond. The 1990 trading volumes on the floor of the New York Stock Exchange bond market were \$817 million par value of deferred-coupon bonds, \$198 million par value of pay-in-kind bonds, and \$189 million par value of cash-paying bonds. During 1991, the level of trading volume for the deferred-coupon and pay-in-kind bonds increased to \$1,370 million and \$303 million, respectively, while trading volume for the cash-paying bond declined to \$135 million. Consistent with its high level of trading activity, the quotation spread for the deferred-coupon bond (usually \$0.125 per \$100 of face value) was typically narrower than for the other two bonds.

Another possible explanation of the premium for the cash-paying bond is that it has relatively more bargaining power in the event of financial distress. In our analysis, we followed the tradition in academic finance by assuming absolute priority in valuing corporate debt. In theory, the three RJR bonds are in the same tier of the capital structure and have equal priority per dollar of bankruptcy claim. Of course, in practice strategic considerations can influence the value of corporate debt (see e.g., Dunn and Spatt, 1984). In the RJR context, the ability of the holders of the cash-paying bond to force default in the event that they do not receive their cash payment can provide them with more bargaining power in negotiations with the issuer. This bargaining advantage may permit the holders of the cash-paying bond to extract a premium from the issuer in exchange for their securities prior to bankruptcy.²⁹ While such a bargaining explanation could account for a small valuation premium for the cash-paying bond, it seems strained as an explanation for the

²⁷Another recent anomaly that seems to reflect a strong preference for high current yield involved GM's preferred equity-redemption certificates (PERC's) and common stock, which was described in a November 9, 1992, *New York Times* article by Floyd Norris, entitled "A GM Issue Has Created an Anomaly." Although the GM PERC converts into at most one share of GM common on July 1, 1994, the GM PERC was selling above the GM common by more than the total (undiscounted) dividends to be paid on the GM PERC through the redemption date.

²⁸This remainderman issue also emphasizes the importance of designing optimal contracts to resolve the agency conflicts among multiple claimants in order to avoid inefficient portfolio choices.

²⁹Once the firm declares bankruptcy, any differential bargaining advantage for the cash-paying bond is greatly reduced because the firm is no longer required to continue making payments on its debt obligations. Moreover, it is doubtful whether a very asymmetric allocation of value (relative to the bankruptcy claims) would withstand legal challenge. This also limits the extent to which the holders of the cash-paying bond can extract a premium from the issuer prior to bankruptcy.

large discrepancies observed. For example, it seems implausible that the bargaining advantage would be so strong that the investor would pay a \$20–\$25 premium (per \$100 of bankruptcy claim) for the 13.5-percent cash-paying bond relative to the deferred-coupon or pay-in-kind bonds (see Fig. 6).³⁰

The differential bargaining explanation is also inconsistent with the observed price behavior of the three RJR bonds. For example, in late January 1990 Moody's announced a downgrade of RJR's debt, surprising the high-yield market.³¹ In justifying the downgrade, Moody's cited RJR's declining market share and ever-increasing debt load created by its pay-in-kind bonds. If the 13.5-percent cash-paying bond has a differential bargaining advantage over the deferred-coupon and pay-in-kind bonds that is valuable enough to explain the observed pricing differences, then we would expect to see the arbitrage violation increase following the announcement of the downgrade, which heightened concern about RJR's financial condition. On the trading day immediately preceding the public announcement of the downgrade (January 29, 1990), the cash-paying bond was selling for \$101 (including accrued interest), the deferred-coupon bond was selling for \$42.25, and the cost of the Treasury strips needed to match the coupons on the cash-paying bond through May 15, 1994, was \$50.53. Thus, the magnitude of the arbitrage violation [see equation (2)] prior to the announcement of the downgrade was \$8.22. On the trading day following the announcement of the downgrade (January 30, 1990), the prices of the RJR bonds dropped precipitously: the price of the 13.5-percent cash-paying bond (including accrued interest) fell 10.85 per-

cent to \$90.038, while the price of the deferred-coupon bond fell 14.79 percent to \$36.00. The cost of the Treasury strips needed to match the coupons on the cash-paying bond through May 15, 1994, increased slightly to \$50.56. Thus, the magnitude of the arbitrage violation immediately following the announcement of the downgrade was only \$3.48, a decline of \$4.74 from the previous day. This reduction in the arbitrage following the downgrade of RJR's debt is inconsistent with the bargaining-power explanation.

During the second half of 1990 and the first half of 1991, RJR eliminated over \$5.8 billion of the 17-percent and 17.375-percent pay-in-kind bonds through a series of recapitalizations, including several exchange offers, open-market purchases, and a final call of the 17-percent pay-in-kind bonds on June 3, 1991. These bonds were junior to the three RJR bonds that we examined. This also included the period of time in which the arbitrage violations were the largest (see Fig. 1). It is difficult to imagine that the large arbitrage violations were due to the differential bargaining power of the cash-paying bond during a period of time when RJR was using substantial amounts of cash to acquire its non-cash-paying securities (and not its cash-paying bonds). These recapitalizations indicated that RJR viewed its 17-percent and 17.375-percent pay-in-kind bonds as relatively more attractive than its cash-paying bonds. Indeed, many Wall Street firms speculated that future recapitalizations would be directed toward eliminating the 15-percent pay-in-kind and deferred-coupon bonds. This speculation contributed to a rally in the prices of the 15-percent pay-in-kind and deferred-coupon bonds in late January and February of 1991, which also coincided with the broader rally in the high-yield market. The rally in the prices of RJR's bonds eventually led to the elimination of the arbitrage (see Fig. 1).

To investigate further whether differences in bargaining power could reasonably explain the arbitrage violations that were observed, we explore the relationship between the magnitude of the arbitrage [see equation (2)] and the price level of the

³⁰Since neither the pay-in-kind bond nor the deferred-coupon bond makes mandatory cash payments prior to May 15, 1994, it is unlikely that there would be any differential bargaining advantage between these two bonds to account for the price discrepancies between them.

³¹In fact, prior to the ratings review, RJR raised expectations by publicly announcing that it hoped to receive a ratings upgrade.

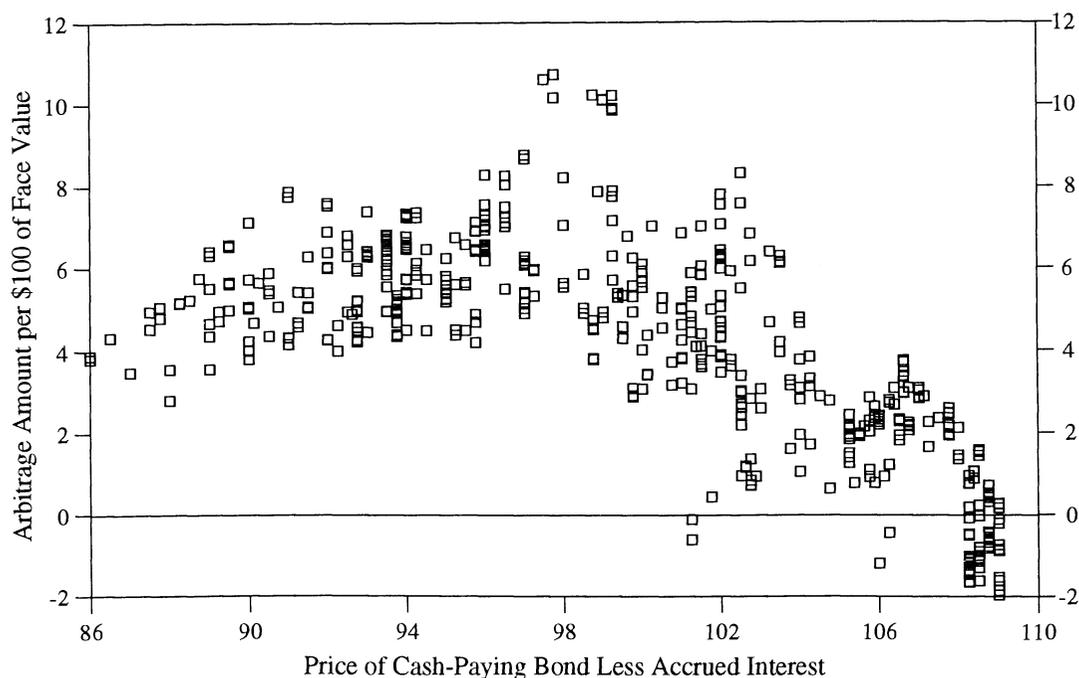


FIGURE 8. MISPRICING BETWEEN RJR'S CASH-COUPON AND DEFERRED-COUPON BONDS VERSUS THE ADJUSTED PRICE OF THE CASH-COUPON BOND, MAY 1989-JUNE 1991

Note: This figure provides a scatterplot of $v_t^c - p_t^d - 6.75 \sum_{i=1}^m q_{it}$ versus the price of the cash-paying bond, p_t^c .

cash-paying bond. If differences in bargaining power are responsible for the arbitrage violations that were observed, then the arbitrage should get larger as the price of the cash-paying bond falls below par (reflecting the higher probability of default). However, whenever the price of the cash-paying bond is above par, the arbitrage should be relatively small (reflecting the low probability of default). Figure 8 provides a graphical illustration of the relationship between the magnitude of the arbitrage violation and the price of the cash-paying bond (excluding accrued interest). For bond prices below par (i.e., below \$100), the relationship is relatively flat, or perhaps even slightly positive. This behavior is inconsistent with the existence of a strong bargaining advantage for the cash-paying bond. In contrast, for bond prices above par, the relationship is strongly negative. While this behavior is not

inconsistent with the existence of a bargaining advantage for the cash-paying bond, it may reflect the fact that the cash-paying bond was selling near par and thus had less upside potential than either the deferred-coupon or pay-in-kind bonds when the high-yield market rallied in late January and February of 1991. Moreover, the magnitude of the arbitrage violations in the premium region still seem quite large. For example, even when the cash-paying bond is selling above par, the arbitrage often exceeded \$2 per \$100 of face value. In fact, the largest arbitrage violation occurred when the cash-paying bond was selling only slightly below par. The totality of this evidence indicates that differences in bargaining power cannot reasonably account for the magnitude of the arbitrage violations we observed.

The violations of the arbitrage bounds that we have documented can be inter-

puted as either an actual arbitrage opportunity or the existence of a dominated asset due to the difficulty of selling short. In either case, this indicates market mispricing. Though we view the financial markets as broadly efficient, the price discrepancies among the RJR bonds seem to be an exception. The evidence suggests that investors are willing to pay a premium for cash-paying securities. This observation parallels that of Long (1978), who documented that investors were willing to pay a premium for cash dividends over in-kind (i.e., stock) dividends of equal value.

V. Concluding Comments

We have documented large and persistent pricing errors among three bonds issued by RJR Nabisco Holdings Capital Corporation.³² The empirical evidence indicates that, in the case of RJR, the market exhibited a strong preference for cash coupons. The preference for cash coupons was so strong that the price of the cash-paying bond exceeded the price of a portfolio of pure discount securities (i.e., the deferred-coupon bond plus Treasury strips) with higher cash flows, but less default risk, by more than \$11 per \$100 of face value.³³

This raises the question of whether the preference for cash income was a general

phenomenon in the high-yield debt market during this period. Market observers have suggested that many institutional investors were averse to non-cash-paying securities during this period, citing the "higher risk" of such securities. As we have shown here, non-cash-paying securities can be packaged with Treasury securities to form a portfolio that is less risky than securities that pay high current income. The difficulty in matching corporate bond characteristics (e.g., default risk, call and convertibility features, maturity, and seniority) and obtaining clean price data for relatively illiquid securities makes it difficult to develop persuasive evidence of the preference for cash income across the overall high-yield market. In fact, the advantage of studying the three RJR bonds is that the bonds are quite similar, and any differences are easily controlled.

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³²We identified these pricing errors in mid-1990 and thus were able to monitor closely the behavior of the prices in real time.

³³Another interesting anomaly that existed in the pricing of RJR instruments involved their warrants and equity. For the first two weeks after the RJR equity began trading on a when-issued basis (February 1, 1991), its price was below the price of the RJR warrants. Though the warrants typically traded for about $\frac{1}{8}$ above the equity, the warrants were less valuable because (a) they had an exercise price of seven cents and (b) the settlement date for paying for the equity was deferred until the securities were issued (*ex post* the equity stopped trading on a when-issued basis in late March). Both of these securities had extremely high trading volumes during this period. Although the bid-ask spreads on the equity and warrants would have eliminated much of the arbitrage opportunity, the dominance of buying the equity rather than the warrant during this interval also raises issues about the consistency of market pricing.

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