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Death and Taxes: The Market for Flower Bonds

DAVID MAYERS and CLIFFORD W. SMITH, Jr.*

ABSTRACT

Certain U.S. Government securities, known as flower bonds, can be redeemed at par plus accrued interest for the purpose of paying estate taxes, if held at the time of death. Thus, a flower bond, selling at a discount, is like a straight bond plus a life insurance policy. An equilibrium derived from a rational flower bond pricing model implies the existence of clienteles: individuals with the highest death probabilities hold the deepest discount flower bonds. The empirical implication, that bonds with the deepest discount should be redeemed at the fastest rate, is tested and the results support the proposition.

I. Introduction

CERTAIN U.S. Government securities can be redeemed at par plus accrued interest for the purpose of paying federal estate taxes. Known as flower bonds, these securities were issued prior to 1966. (The tax code did not explicitly repeal the estate tax provision for issues until March 3, 1971.) Flower bonds carry coupon rates below 4½%, thus when market interest rates are at levels experienced in the last ten years, the option of redeeming them at par plus accrued interest for the payment of estate taxes represents a valuable form of a life insurance policy.

Flower bonds are listed on the CRSP (Center for Research in Security Prices, University of Chicago) Government Bond File. The file contains monthly prices and amounts outstanding on virtually all negotiable direct obligations of the United States Treasury for the period December, 1925, to December 31, 1985. Forty-six instruments are designated on the file as being flower bonds. Table 1 contains summary statistics, by year, comparing mean flower bond coupon rates and discounts with those of a matched maturity sample of straight (non-flower) bonds.[1] For each flower bond (FB) and for each month, the straight flower bond closest in maturity is picked for the matching bond (MB). The means are calculated across bonds and months for a given year. Also included in the table are the number of flower bonds outstanding each year (N), the mean ratio of aggregate flower bond par value to the aggregate par value of all bonds on the

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[1] The single flower bond in 1941 (listed in Table 1) was issued in 1922 and was the only flower bond in existence as of 1941. Other flower bonds had been issued and called prior to 1941, but they lack data required for the table.

TABLE 1

SUMMARY STATISTICS, BY YEAR, COMPARING FLOWER BOND COUPON RATES AND DISCOUNTS WITH THOSE OF A MATCHED MATURITY SAMPLE OF NON-FLOWER BONDS. ALSO INCLUDES THE FLOWER BOND PERCENTAGE OF OUTSTANDING BOND PAR VALUE AND MEAN MATURITY DIFFERENCE FOR THE MATCHED SAMPLE*

YEAR	N	MEAN FB COUPON	MEAN MB COUPON	MEAN FB DISCOUNT	MEAN MB DISCOUNT	MEAN % OF PAR	MEAN MAT. DIFFERENCE
1941	1	4.25	2.50	-0.17	-0.08	0.01	0.3
1942	3	3.61	2.58	-0.10	-0.07	0.06	6.2
1943	5	2.95	2.55	-0.04	-0.08	0.18	32.9
1944	8	2.72	2.66	-0.02	-0.12	0.28	51.8
1945	12	2.65	2.58	-0.03	-0.12	0.32	73.3
1946	12	2.58	2.53	-0.04	-0.11	0.41	91.8
1947	12	2.54	2.55	-0.03	-0.10	0.36	93.9
1948	11	2.43	2.58	-0.01	-0.07	0.36	100.1
1949	11	2.43	2.58	-0.03	-0.08	0.35	100.1
1950	11	2.43	2.58	-0.02	-0.08	0.35	100.0
1951	11	2.43	2.48	0.01	-0.05	0.30	99.1
1952	11	2.43	2.43	0.02	-0.04	0.27	92.5
1953	12	2.48	2.47	0.04	-0.01	0.26	99.4
1954	12	2.50	2.51	-0.01	-0.03	0.26	95.4
1955	16	2.46	2.24	0.02	0.00	0.30	101.4
1956	18	2.46	2.15	0.04	0.03	0.34	98.2
1957	19	2.48	2.37	0.07	0.03	0.33	96.8
1958	17	2.80	2.59	0.04	0.01	0.27	120.0
1959	17	2.90	2.74	0.11	0.06	0.24	128.3
1960	20	2.98	3.22	0.08	0.02	0.24	129.6
1961	20	3.03	3.12	0.06	0.02	0.22	134.7
1962	21	3.08	2.87	0.06	0.02	0.21	128.0
1963	21	3.25	3.21	0.06	0.02	0.21	141.0
1964	23	3.31	3.13	0.06	0.03	0.24	131.2
1965	24	3.37	3.09	0.06	0.03	0.29	122.1
1966	24	3.38	3.10	0.09	0.05	0.29	114.2
1967	24	3.40	3.28	0.10	0.04	0.28	106.0
1968	23	3.42	3.36	0.12	0.05	0.26	98.9
1969	22	3.48	3.35	0.18	0.07	0.23	99.0
1970	19	3.58	4.58	0.21	0.07	0.18	100.7
1971	18	3.63	5.25	0.15	-0.00	0.16	96.3
1972	17	3.69	5.46	0.13	-0.01	0.16	83.4
1973	15	3.79	6.08	0.17	0.02	0.13	63.7
1974	14	3.72	6.90	0.23	0.05	0.09	54.3
1975	11	3.69	7.40	0.20	0.03	0.07	25.5
1976	11	3.69	7.57	0.15	-0.00	0.05	14.2
1977	11	3.69	7.37	0.19	-0.01	0.04	10.3
1978	11	3.69	7.44	0.20	0.05	0.04	4.2
1979	11	3.69	7.79	0.17	0.07	0.03	2.3
1980	11	3.67	8.85	0.17	0.13	0.02	1.0
1981	9	3.68	9.60	0.17	0.22	0.02	1.1
1982	9	3.68	8.89	0.13	0.17	0.01	1.1
1983	9	3.71	8.97	0.09	0.10	0.01	1.1
1984	8	3.73	9.79	0.08	0.13	0.01	0.9
1985	8	3.73	9.57	0.06	0.06	0.00	0.9

*For each flower bond (FB) and for each month the non-flower bond closest in maturity is picked for the matching bond (MB). Thus matching bonds vary for a given flower bond across months. All means are calculated across bonds and months for a given year. N is the number of flower bonds in existence during the year. MEAN % OF PAR is the average (across months of the year) of the aggregate flower bond par value to the aggregate par value of all bonds on the file. MEAN MAT. DIFFERENCE is the mean absolute maturity difference in months.

file (MEAN % OF PAR) and the mean absolute maturity difference between the flower bonds and the matching bonds (MEAN MAT. DIFFERENCE).

The mean aggregate flower bond par value to the aggregate par value of all bonds indicates the relative importance of flower bonds at various points in time. For example, in 1946 flower bonds represented 41% of the par value of all bonds outstanding, whereas more recently they represent a very small fraction of outstanding par value. The mean absolute maturity difference illustrates that flower bonds were the long term maturities for a significant number of years and thus tempers the comparability of the two samples over much of this history. Large flower bond discounts are documented as are relatively low flower bond coupon rates since the early 1970's. The more recent years (1980–1985) are interesting, where the maturity matching is reasonably close (within one month). For these years the flower bond and matching bond discounts are similar even though the coupon rates for the matching bonds are more than twice as large as the coupon rates for the flower bonds. Thus, flower bond prices appear to reflect substantial imbedded insurance premiums.[2]

In finance, the major attention received by flower bonds has been directed at their effect on estimates of the term structure of interest rates. When certain maturity ranges only included flower bonds, valuation of the estate tax feature was required to employ flower bond quotes in the derivation of a yield curve.[3]

In tax analyses of flower bonds, one frequently observes suggestions such as: "It's important that flower bonds be purchased as close to the date of death as possible, to avoid offsetting the estate tax savings with lost interest income in light of the low interest rate on flower bonds."[4] Such analysis fails to consider the obvious point that prices must adjust so that the bonds are continuously held: in other words, these discussions fail to consider from whom these bonds should be purchased.

In this paper, we treat flower bonds as a combination of a straight bond plus a life insurance contract and examine the incentives to hold flower bonds. We explicitly allow for multiple issues outstanding with differing coupon rates and maturity provisions, and thus differing discounts. In Section 2, we consider which individuals have a comparative advantage in holding the different issues, and examine the nature of the clientele effects that develop. Our analysis identifies the considerable data requirements for valuing the imbedded life insurance policy in a flower bond. This underscores the difficulty of employing these bonds in estimating the term structure of interest rates. However, our analysis yields a testable implication about the rate at which different flower bonds are redeemed. This implication is tested in Section 3 using data from the CRSP Government Bond File. We present our conclusions in Section 4.

II. The Demand for Flower Bonds

When market interest rates exceed the coupon rate ($r > c$), a flower bond is like a straight bond plus a life insurance policy. We can formalize this relationship by considering a flower bond with market value, F_j, maturity date, t_j, time to maturity, $T_j = t_j - t$, coupon rate, c_j, and par value, P_j. The market value of the

[2] Note that the conclusion of a valuable imbedded insurance policy is reinforced by the Constantinides/Ingersoll [1984] analysis which indicates a more valuable tax-timing option in bonds where coupons are near current market rates than where coupons are substantially below current rates.

[3] See McCulloch [1975] or Rovira [1983]. Flower bonds have also been mentioned in the insurance literature. See, for example, Hofflander [1969].

[4] Zaritsky [1983, p. 506].

flower bond is equal to the sum of the values of a straight government bond, with the same coupon and maturity, $B_j(r; T_j, c_j)$, plus an insurance policy premium:

$$F_j(r; T_j, c_j) = B_j(r; T_j, c_j) + \int e^{-Rt} I_j(t)\, dt, \tag{1}$$

where $R = \ln(1 + r)$ and $I_j(t)$ is an instantaneous term insurance premium. The value of the straight bond is simply the present value of the coupon stream plus the principal repayment:

$$B_j(r; T_j, c_j) = c_j P_j \int e^{-Rt}\, dt + e^{-RT_j} P_j. \tag{2}$$

To examine the value of the imbedded insurance policy we assume that instantaneous term insurance is available at actuarially fair rates. Thus, individual i who has an instantaneous death probability of $\pi_i(t)$ can purchase an insurance policy that provides coverage for the next instant in time. The policy pays an indemnity, $I_i(t)/\pi_i(t)$, in return for the payment of a premium, $I_i(t)$, if the purchaser dies during the next instant.[5]

While a flower bond can be used at par for the payment of estate taxes, it is also valued at par in calculating the estate's taxable base.[6] Therefore, the indemnity payment (the net payoff) of the imbedded insurance policy is $(P_j - F_j(r; T_j, c_j))(1 - \tau)$ where τ is the estate tax rate.[7] If individual i is to be indifferent between purchasing instantaneous term insurance and buying the imbedded insurance in the flower bond, the terms of the two contracts must be equivalent. Therefore, the imbedded insurance policy for the next instant must be priced so that

$$I_j(t) = \pi_i(t)(P_j - F_j(r; t_j, c_j))(1 - \tau).^{8} \tag{3}$$

Such pricing implies clientele effects among owners of the flower bonds.

To examine the nature of the clienteles more carefully, we order (at date t) the flower bonds by their discounts, $(P_j - F_j(r; T_j, c_j))/P_j$, from high to low, with F_1 being the date-t price of the flower bond selling at the greatest discount. We also rank all individuals in the economy by their instantaneous death probabilities, $\pi_i(t)$, from high to low, with individual 1 having the highest probability of

[5] We have assumed that instantaneous term life insurance is available at actuarially fair rates. None of our basic results would be altered if we included a loading fee, δ, on all policies so that for an insurance premium, $I_i(t)$, the individual receives an indemnity payment, $I_i(t)/(\pi_i(t) + \delta)$, in case of death.

[6] In contrast, a typical life insurance policy would make the indemnity payment directly to the beneficiary of the policy and would not be included in the deceased's taxable estate, assuming the beneficiary is the owner of the policy.

[7] Here we are assuming for simplicity that the estate tax is a constant fraction of the value of the estate. We are also ignoring the Tax Reform Act of 1976 which imposed a capital gains tax on the flower bond indemnity payment. An Internal Revenue Service procedure (Revenue Procedure 69-18, 1969-2 C.B. 300) allows initial estate tax payment in cash followed by a later substitution at par of flower bonds. Substitution after a one-year holding period results in long-term gain, even if the bonds were purchased just prior to death.

[8] We assume that individuals choose to assign policy ownership to their beneficiaries. If policy ownership is not assigned there is no differential tax and $\tau = 0$.

death in the next period. Individual 1 will displace regular term insurance with the imbedded insurance policies in the first flower bond until his holdings just pay his estate tax liability, $q_{11}P_1 = \tau W_1$; where q_{11} is the quantity of the first flower bond issue (the one with the deepest discount) held by the first individual (with the highest instantaneous death probability) and W_1 is this first individual's wealth that is subject to the estate tax at the rate τ. Similarly, individuals 2, ..., k_1 will displace explicit term insurance with the imbedded insurance policies in flower bonds until $\sum_{i=1}^{k_1} q_{i1} = Q_1$, where Q_1 is the outstanding quantity of the first issue. Since the flower bond's price will be determined by the marginal investor, the price of the imbedded insurance in the flower bond will reflect the marginal death probability of individual $k_1 + 1$, $\pi_{k_1+1}(t)$. That is, individual k_1 will bid just enough for the bond to make individual $k_1 + 1$ better off with term insurance than with bond 1. Individuals 1, ..., k_1 will be inframarginal investors in this asset. Similarly, individual $k_1 + 1$ will displace explicit insurance policies with the imbedded insurance policies in the second flower bond issue until his holding just covers his estate tax liability; that is, until $q_{k_1+12}P_2 = \tau W_{k_1+1}$. This process produces strong clientele effects: individuals with the highest death probabilities hold the deepest discount flower bonds while individuals with lower death probabilities hold bonds with lower discounts. Figure 1 illustrates the equilibrium.

To derive explicit prices for the different flower bonds one would require in addition to data on the bond's characteristics (coupon, maturity and outstanding supply), data on the distribution of the population's death probabilities and wealth, and all of the information required for forecasting future $I_j(t)$. For example, the future $\pi_i(t)$ are anticipated death probabilities of the future marginal holders not those of any individual. The inaccessibility of this data precludes direct testing of our model of the pricing of flower bonds. It also underscores the

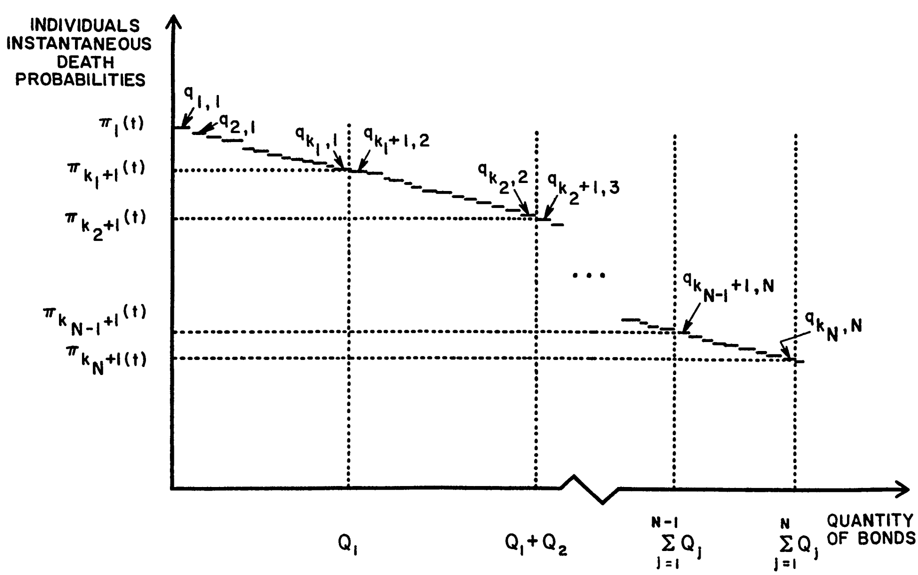

Figure 1. Illustration of Clientele Effects in the Demand for Flower Bonds.

difficulty in deriving simple adjustments to flower bond quotes in order to use them in deriving estimates of the term structure.

Our analysis also raises questions about the effective maturity of a flower bond issue and thus its placement in the term structure. From the mid-1940's to the mid-1970's Table 1 indicates that there were no straight government bonds with comparable maturities. Moreover, in the early 1970's, when yields on flower and straight bonds began to diverge significantly and the value of the imbedded insurance policy increased, the effective maturity of these bonds was reduced in the same way the effective maturity of a putable bond would be reduced. In such situations it is logically impossible to derive the "correct" adjustment to employ flower bonds in estimating the term structure—in essence, the system of equations is underidentified. There is not enough information to estimate the market price of a dollar received at those future dates.

However, we can examine the clientele implications of our analysis. Since the average death probability of the investors holding a given flower bond issue should be greater the greater the discount on the bond, the bonds with the largest discounts should be redeemed for estate tax purposes at the fastest rate.

There are several simplifying assumptions we have taken in our analysis that require discussion. First, we have assumed perfect capital markets in our analysis of the demand for flower bonds. The assumption implies that the optimal allocation of these bonds depends not on any future characteristics of the individual's distribution of death, but only on the individual's instantaneous death probability. Under this assumption, individuals generally will hold flower bonds from only one issue (unless his wealth subject to estate tax is large). However, if we admit trading costs, some of these strong results no longer obtain. If it is expensive to rebalance one's portfolio, an individual will have to worry about current as well as expected future death probabilities. As Amihud/Mendelson [1986] show, higher bid-ask spreads will induce purchases of an asset by individuals with longer expected holding periods to amortize the higher transactions costs. Thus, the expected mortality rates over the expected holding period are important. Also, as the probabilities of death are revised and/or wealth changes it may be optimal to continue to hold an existing position in one flower bond and to buy additional bonds of another issue.[9]

Second, we have ignored one aspect of the pricing of flower bonds—the flower bond provision is like an option on interest rates. Since the flower bond becomes more valuable at higher interest rates, flower bonds must sell at a premium over comparable straight bonds, even if market interest rates are below the coupon rate on the flower bond. This omission is most likely to be observable when the market interest rate is at the coupon rate on the flower bond. Consider the case where the appropriate market rate is slightly above the coupon rate; a straight bond would sell at a slight discount but the flower bond could still sell at a premium. In such a case if the holder of the bond died, his heirs would be better off selling the bond in the secondary market rather than using it to settle the estate tax liability.

[9] See Milne/Smith [1980].

Third, our derivation assumes that the tax rates are constant across individuals. When effective tax rates are not constant it is possible that effective tax-rate clienteles could offset our implication. The value of the imbedded insurance is related positively to the individual's probability of death and negatively to the individual's effective tax rate. Thus, if effective tax rates and death probabilities are positively correlated (older people are wealthier), our implication can be attenuated. Ultimately this is an empirical question and can only be resolved by looking at the data. A related problem is that in community property states the net benefit of holding flower bonds is lower.[10] The Treasury requires that, "Only one-half of each loan and issue of bonds held in trust, otherwise eligible, that constitutes community property, are eligible for the tax payment."[11] Thus, the greater the disparity of death probabilities between spouses, the less attractive are flower bonds for residents of community property states.

Fourth, flower bonds with an issue date of 1922 or earlier require that the bond be held for the entire six-month period preceeding death. If enforced, this provision would make these bonds less valuable.

Fifth, our analysis takes capital and insurance market prices as given, focusing on the optimal allocation of securities and the pricing of flower bonds by arbitrage. Thus we implicitly take some more general model of security and insurance market equilibrium as given.[12] As long as each investor continues to hold some term insurance, the addition of the flower bonds to that analysis changes none of the equilibrium first order conditions.

Sixth, our analysis of flower bonds assumes that the bonds will be held by individuals to take advantage of the imbedded life insurance contract. However, government agencies and financial institutions have at times held significant numbers of these securities when they have sold at substantial premiums over comparable non-flower bonds.[13] We have no theory of political economics rich enough to explain government agencies' holdings; however, a number of financial institutions are regulated, and the reported value of their assets has survival implications. Such regulation provides an incentive for banks and insurance companies which might have bought flower bonds at issue (when the flower bond premium was negligible) to continue to hold them rather than sell to an individual who could realize the value of the imbedded insurance policy.[14] To the extent that flower bond holdings by government agencies, regulated financial institutions, or other non-individuals vary across the bonds, our tests are biased against finding clientele effects because we measure the percentage change in terms of the entire outstanding quantity of bonds, not just those in the hands of individuals.

[10] Community property states are Arizona, California, Idaho, Louisiana, Nevada, New Mexico, Texas and Washington.

[11] See Department of the Treasury From PD 1782, SCHEDULE OF UNITED STATES TREASURY BONDS HELD IN TRUST SUBMITTED FOR REDEMPTION AT PAR IN PAYMENT OF FEDERAL ESTATE TAX.

[12] See, for example, Richard [1975].

[13] See, Buser [1977].

[14] Institutions holding flower bonds, that are not selling at a discount, will receive a normal rate of return as long as they sell when the imbedded insurance policy becomes valuable.

III. Evidence From Flower Bonds

Our analysis implies an association between flower bond discounts and the percentage change in the outstanding quantity of bonds. Not all of the 46 bonds listed in the CRSP Government Bond File have the requisite data. We require at least two consecutive monthly observations of the par value outstanding and an asking price for the first of the two months in order to calculate one percentage change in the issue's par value outstanding and a corresponding percentage discount.

In addition, we omit data where the amounts outstanding are an ascending series. The Treasury Department occasionally offered holders of outstanding bonds the option of extending the maturity of their holdings by exchanging them for bonds from a reopened bond issue.[15] Including these observations would bias our results in favor of the alternate hypothesis if the reopened bond issues tend to be those selling at lower discounts. In our sample there are 132 instances where the amount outstanding increased. These increases normally occur early in the life of the issue and typically there are few decreases in the amount outstanding between increases. The median discount at the month of an increase is 3.9%. We omit all data up to and including the last increase in the amount outstanding. Not all of the 132 increases are the result of Treasury activity; some of them appear to be data errors because following the increase the series reverts to its old level. In these cases just the errors are eliminated. In total, we eliminate 585 of the available 7424 data points.

Our final sample consists of 34 flower bonds. Table 2 contains some descriptive information. Only one bond in our sample (4.25% maturing October 15, 1952) is acceptable at par and accrued interest if owned by the decedent during the entire six months preceeding death. All of the remaining bonds are acceptable for estate tax payment if owned at the time of death. Three of the 34 instruments are tax anticipation bills (and thus have no coupons), two are notes and one is a tax anticipation certificate of deposit. The rest are all coupon paying bonds.

Our analysis implies that flower bonds selling at higher discounts are redeemed at faster rates than those selling at lower discounts. The null hypothesis is that of no association between rates of redemption and discounts. For a given bond issue we define the rate of redemption as the percentage change in the issue's par value outstanding for period t:

$$\%\Delta \mathrm{OUT}_t = \frac{\mathrm{PAR}_{t-1} - \mathrm{PAR}_t}{\mathrm{PAR}_{t-1}}, \tag{4}$$

where PAR_t is the issue's par value outstanding at t. We also define the percentage discount (or premium if $\%\mathrm{DIS}_t < 0$) as

$$\%\mathrm{DIS}_t = \frac{100 - \mathrm{ASK}_{t-1}}{100}, \tag{5}$$

[15] See, for example the October 1961 *Treasury Bulletin* concerning an "exchange in advance" where the 3.5% flower bond issue maturing November 15, 1980 was reopened.

Table 2

Instrument Type, Maturity Date, Coupon Rate and Issue Date for Flower Bond Sample*

Type	Maturity Date	Coupon Rate	Issue Date
Bond†	1952, 10/15	4.250	1922, 10/16
TA CD	1956, 03/22	1.875	1955, 07/18
TA Bill	1956, 03/23	0.000	N/A
TA Bill	1957, 03/22	0.000	N/A
TA Bill	1957, 06/24	0.000	N/A
Note	1957, 08/01	2.750	1956, 07/16
Note	1957, 08/15	2.000	1955, 02/15
Bond	1959, 09/15	2.250	1944, 02/01
Bond	1962, 06/15	2.250	1945, 06/01
Bond	1962, 12/15	2.250	1945, 11/15
Bond	1967, 06/15	2.500	1942, 05/05
Bond	1968, 12/15	2.500	1942, 12/01
Bond	1969, 06/15	2.500	1943, 04/15
Bond	1969, 10/01	4.000	1957, 10/01
Bond	1969, 12/15	2.500	1943, 09/15
Bond	1970, 03/15	2.500	1944, 02/01
Bond	1971, 03/15	2.500	1944, 12/01
Bond	1972, 06/15	2.500	1945, 06/01
Bond	1972, 12/15	2.500	1945, 11/15
Bond	1973, 11/15	4.125	1964, 07/22
Bond	1974, 02/15	4.125	1965, 01/15
Bond	1974, 05/15	4.250	1964, 05/15
Bond	1974, 11/15	3.875	1957, 12/02
Bond	1980, 02/15	4.000	1959, 01/23
Bond	1980, 11/15	3.500	1960, 10/03
Bond	1983, 06/15	3.250	1953, 05/01
Bond	1985, 05/15	3.250	1958, 06/03
Bond	1985, 05/15	4.250	1960, 04/05
Bond	1990, 02/15	3.500	1958, 02/14
Bond	1992, 08/15	4.250	1962, 08/15
Bond	1993, 02/15	4.000	1963, 01/17
Bond	1994, 05/15	4.125	1963, 04/18
Bond	1995, 02/15	3.000	1955, 02/15
Bond	1998, 11/15	3.500	1960, 10/03

* N/A = not available, TA CD = tax anticipation certificate of deposit, TA Bill = tax anticipation bill.

† This particular issue requires the decedent to have held the bond for the entire six months prior to death in order to qualify as a flower bond. All the other issues must be owned at the time of death.

where ASK_{t-1} is the beginning of period asking price of the flower bond. Our hypothesis implies a positive cross-sectional association between these two variables in any month in which at least one flower bond sells at a discount. There should be no association across flower bonds selling at premiums. We split the sample accordingly. The premium sample contains all months where at least two flower bonds sell at a premium. The discount sample includes all months where at least one flower bond sells at a discount.

Our hypothesis is ordinal, thus we calculate Spearman's rank-correlation coefficient for each month with data on at least two bonds. For the premium sample, the calculation uses all issues selling at a premium. For the discount sample, the calculation uses all issues selling at a discount plus the issue selling at the smallest premium (if one exists). Table 3 contains a frequency distribution of the available monthly sample sizes for the two samples. There are 200 months for which insufficient data are available for the minimum of two cross-sectional observations for a Spearman rank-correlation coefficient calculation. These empty months are primarily 1941 and earlier. The maximum number of cross-sectional observations is 24 (consistent with Table 1) and the most frequent number is 11. There are a total of 6698 observations available for the experiment.

We standardize each rank-correlation coefficient by dividing it by its standard error, $1/\sqrt{n-1}$, where n is the number of observations in the cross section. Under the null hypothesis, this standardized variate, Z_t, has a mean of zero and a standard error of one. We then calculate the test statistic:

$$\text{STAT} = \bar{Z}\sqrt{T}, \tag{6}$$

where

$$\bar{Z} = \sum_{t=1}^{T} Z_t/T$$

and T is the number of time-series observations. The central limit theorem implies the statistic, STAT, is approximately normal (0, 1) under the null hypothesis.

There are 145 months where at least two flower bonds sell at a premium. For this sample we predict no association and the statistic, STAT, is an insignificant 0.67. For the sample where at least one of the flower bonds has a positive discount (411 months) the statistic is a significant 21.24. Table 4 contains the reported statistics and the frequency distributions for the rank-correlation coefficients and standardized variates for these two samples. There is no evidence of outliers being important for the results. For the premium sample there are only 7 non-zero rank-correlation coefficients (six are positive and one is negative). Only one of the standardized variates is as large as 2.0. For the discount sample there are 237 positive rank-correlation coefficients and 25 that are negative. There are 117 standardized variates greater than 2.0 and none are as small as −2.0.

IV. Conclusions

Our analysis of the market for flower bonds implies the existence of significant clientele effects: it indicates individuals with the highest death probabilities hold the deepest discount flower bonds while individuals with lower death probabilities hold bonds with lower discounts. Therefore, the bonds with the deepest discounts should be redeemed at the fastest rate. Our empirical results are consistent with the proposition. We separate the observations where our theory indicates there should be no association from those where our theory indicates we should find

Table 3

Frequency Distributions of Monthly Sample Sizes for Premium Sample (At Least Two Issues Sell at Premium) and Discount Sample (At Most One Issue Sells at a Premium)

A. Frequency Distribution of Sample Sizes for Premium Sample

No. Obs.	Frequency	Percent	Cumulative Frequency	Cumulative Percent
2	30	20.7	30	20.7
3	11	7.6	41	28.3
4	6	4.1	47	32.4
5	5	3.4	52	35.9
6	1	0.7	53	36.6
7	10	6.9	63	43.4
8	12	8.3	75	51.7
9	1	0.7	76	52.4
10	10	6.9	86	59.3
11	51	35.2	137	94.5
12	8	5.5	145	100.0

B. Frequency Distribution of Sample Sizes for Discount Sample

No. Obs.	Frequency	Percent	Cumulative Frequency	Cumulative Percent
2	1	0.2	1	0.2
5	1	0.2	2	0.5
6	8	1.9	10	2.4
7	2	0.5	12	2.9
8	27	6.6	39	9.5
9	31	7.5	70	17.0
10	23	5.6	93	22.6
11	80	19.5	173	42.1
12	22	5.4	195	47.4
13	56	13.6	251	61.1
14	19	4.6	270	65.7
15	24	5.8	294	71.5
16	7	1.7	301	73.2
17	25	6.1	326	79.3
18	20	4.9	346	84.2
19	2	0.5	348	84.7
20	4	1.0	352	85.6
21	8	1.9	360	87.6
22	14	3.4	374	91.0
23	18	4.4	392	95.4
24	19	4.6	411	100.0

an association. Across issues selling at a discount, we find strong evidence that the rate of redemption is higher the larger the discount. Moreover, across issues selling at a premium, there is no statistically reliable association between the rate of redemption and the magnitude of the premium.

Table 4

Test Statistics (STAT) and Frequency Distributions of Rank-Correlation Coefficients R_t, and Standardized Variates, Z_t, for (A) Premium Sample (B) Discount Sample*

A. Premium Sample: STAT = 0.672

1. Rank-Correlation Coefficients

R_t Category**	Frequency	Percent	Cumulative Frequency	Cumulative Percent
$0.8 < R \leq 1.0$	1	0.7	1	0.7
$0.6 < R \leq 0.8$	1	0.7	2	1.4
$0.4 < R \leq 0.6$	2	1.4	4	2.8
$0.2 < R \leq 0.4$	2	1.4	6	4.1
$R = 0.0$	138	95.2	144	99.3
$-0.5 < R \leq 0.0$	1	0.7	145	100.0

2. Standardized Variates

Z_t Category**	Frequency	Percent	Cumulative Frequency	Cumulative Percent
$2.0 < Z \leq 2.5$	1	0.7	1	0.7
$1.5 < Z \leq 2.0$	1	0.7	2	1.4
$1.0 < Z \leq 1.5$	2	1.4	4	2.8
$0.5 < Z \leq 1.0$	2	1.4	6	4.1
$Z = 0.0$	138	95.2	144	99.3
$-0.5 < Z \leq 0.0$	1	0.7	145	100.0

B. Discount Sample: STAT = 21.243

1. Rank-Correlation Coefficients

R_t Category	Frequency	Percent	Cumulative Frequency	Cumulative Percent
$0.8 < R \leq 1.0$	23	5.6	23	5.6
$0.6 < R \leq 0.8$	63	15.3	86	20.9
$0.4 < R \leq 0.6$	89	21.7	175	42.6
$0.2 < R \leq 0.4$	48	11.7	223	54.3
$0.0 < R \leq 0.2$	14	3.4	237	57.7
$R = 0.0$	149	36.3	386	93.9
$-0.2 < R < 0.0$	7	1.7	393	95.6
$-0.4 < R \leq -0.2$	12	2.9	405	98.5
$-0.6 < R \leq -0.4$	6	1.5	411	100.0

2. Standardized Variates

Z_t Category	Frequency	Percent	Cumulative Frequency	Cumulative Percent
$3.5 < Z \leq 4.0$	2	0.5	2	0.5
$3.0 < Z \leq 3.5$	15	3.6	17	4.1
$2.5 < Z \leq 3.0$	40	9.7	57	13.9
$2.0 < Z \leq 2.5$	60	14.6	117	28.5
$1.5 < Z \leq 2.0$	57	13.9	174	42.3

* The test statistic, STAT = $\bar{Z}\sqrt{T}$, where $\bar{Z} = \sum^{T}_{t=1} Z_t/T$ and T is the number of observations.

** Categories are exhaustive.

Table 4—Continued

2. Standardized Variates

Z_t Category	Frequency	Percent	Cumulative Frequency	Cumulative Percent
$1.0 < Z \leq 1.5$	31	7.5	205	49.9
$0.5 < Z \leq 1.0$	21	5.1	226	55.0
$0.0 < Z \leq 0.5$	11	2.7	237	57.7
$Z = 0.0$	149	36.3	386	93.9
$-0.5 < Z < 0.0$	7	1.7	393	95.6
$-1.0 < Z \leq -0.5$	3	0.7	396	96.4
$-1.5 < Z \leq -1.0$	9	2.2	405	98.5
$-2.0 < Z \leq -1.5$	6	1.5	411	100.0

Over the past ten years, the finance profession has employed option pricing techniques to derive a deeper understanding of the pricing of imbedded options in a range of financial contracts. We believe that there are similar opportunities for valuing imbedded insurance policies. While flower bonds offer an example of a security containing an imbedded life insurance policy, there are others. For example, consider the tax-timing options discussed by Constantinides [1984] and Constantinides/Ingersoll [1984]. These papers demonstrate that the after-tax returns to a policy of strategically trading to establish capital gains and losses can substantially exceed the after-tax returns to a buy-and-hold strategy. One aspect of the tax code they do not consider in their strategies is that upon the investor's death, the cost basis for an asset is adjusted to market and capital gains and losses remain untaxed. Thus, the tax code provides, in addition to the tax-timing option, an imbedded life insurance policy. In Constantinides' analysis of trading equities, this provision reduces the benefit of establishing capital gains the higher the probability of death. In the Constantinides/Ingersoll analysis of trading debt instruments, the provision suggests that individuals with expected lifetime less than the remaining time to maturity of the debt have a comparative advantage in holding bonds trading at a discount. Thus, the explicit analysis of such imbedded insurance policies can produce a richer understanding of individual portfolio composition as well as price behavior observed in financial markets.

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DISCUSSION

ROBERT C. WITT:[1] David Mayers and Cliff Smith (MS) have developed a very interesting, theoretical and empirical analysis of the demand for flower bonds and the incentives for holding them.[2] The term "flower bond" apparently developed because these bonds blossom or mature after death.

As MS suggest, when market interest rates exceed the coupon rate, a flower bond is equivalent to a straight bond plus a term life insurance policy. Accordingly, they argue that the market value of a flower bond should be equal to the sum of the values for a straight government bond with the same coupon and maturity plus a net single premium for the imbedded term life insurance. They suggest that the amount of life insurance imbedded in the jth flower bond is the difference between its par and market values ($P_j - F_j$). In life insurance theory, this amount would be referred to as the net amount at risk for the jth bond (NAR_j). The total amount at risk (TAR_j) would be defined as the difference between the par value of the flower bond and the value of a matching straight bond ($P_j - B_j$). By not distinguishing between these two concepts, the authors inadvertently mis-specified the equilibrium pricing relationship in Equation (3) of their paper. Fortunately, this mis-specification did not affect their statistical results, but it would raise questions about the rationality of individuals who purchase and hold flower bonds.

Due to space constraints, I will only summarize a few suggestions that I made to MS for improving their very interesting and stimulating paper. First, they ignored the effect of different marginal estate taxes among individuals with different levels of taxable wealth by assuming that estate taxes were a fixed fraction of wealth for all individuals. This is not a reasonable assumption because it ignores the *effect* of progressive estate taxes in both their theoretical and empirical analysis. Accordingly, they need to redefine their hypothesis to recognize the *effect* of estate taxes on different levels of taxable wealth. Second, they need to redefine their equilibrium pricing relationship between the net single premium for the life insurance embedded in flower bonds and the equivalent

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[2] Since flower bonds are no longer being issued by the United States Treasury and outstanding issues are slowly expiring, in jest one might say that this is a morbid topic dealing with a dying issue. Joking aside, the analysis by MS provides some significant insights about the incentives to hold flower bonds and potentially about the rationality of individuals in the market for flower bonds. All references in this comment are to the paper by Mayers and Smith entitled "Death and Taxes: The Market for Flower Bonds," which was presented in December 1986 at the meeting of the American Finance Association in New Orleans. Some constructive discussions about this paper with Harry Panjer, Seha Tinic, Donghoon Kim, and David Valaer are gratefully acknowledged.