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A FARM CREDIT DEBT SELECTION MODEL

Description and Application

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FOREWORD

This Farm Credit Debt Selection Model is being made available so that Banks of the Farm Credit System may use it as a tool in making their debt selection decisions. Although the model is operational in its present state of development, most banks will find it convenient to make modifications in the model and programs to meet their individual requirements. The programs are nonproprietary and may be used or modified in any manner.

A Farm Credit Debt Selection Model: Description and Application

Introduction

The primary funding objective of a Farm Credit Bank is to obtain the necessary debt funds for its lending operations at the lowest possible cost. Fulfilling this objective entails decisions of participation in the various Farm Credit System securities. Participation decisions in present and future securities are based upon present and future debt needs and costs. Because future debt needs and costs are not known with certainty, participation decisions are necessarily complex and difficult. Complexity exists because of the numerous debt participation options that are possible. Even if future interest rates could be known with certainty, they often peak and ebb at various times. It is, therefore, a tedious job to determine the future debt participation options that would result in the lowest cost. However, because future interest rates are not known with certainty, participation decisions become very difficult.

Participation decisions are often based upon expected debt needs and costs. Unfortunately, selecting the lowest expected cost participation strategy is no guarantee that the selected strategy will in fact be the lowest cost strategy, since actual costs may deviate greatly from expected costs. This manuscript discusses a technique, called quadratic risk programming, that sorts through all participation possibilities and selects strategies that have low expected costs and low risks, such that actual costs will not deviate greatly from expected costs. The model does not forecast interest

rates or debt needs. Rather, it uses projections provided by the user to generate low expected cost and low risk debt participation strategies. The model is user oriented; it queries the operator for information and data that it needs.

The remainder of this manuscript is divided into sections discussing the details and operation of the debt selection model. The first section covers the basic concepts of the quadratic risk programming model using a simple example. Then, the characteristics of the model for selecting Farm Credit securities are specified. The third section is a user's guide for operating the model. The final section is a technical section which specifies the assumptions and equations used in the model. The Appendices include a sample application as well as a listing of the computer programs.

A Two-Period Quadratic Debt Selection Model

A simple two-period case illustrates the concepts of the debt selection model. In the first period two bonds can be issued. One bond has a duration of one period. The other bond has a duration of two periods. In the second period, there is one bond option that is a one-period duration bond. To meet the funding needs over the two periods, there are only two basic options: either fund with a long-term bond or fund with two short-term bonds. However, it is possible to use some combination of the two options in various proportions.

The selection of a bond issuance strategy depends upon interest rate movements and funding needs during the two periods. Funding needs must be met and may affect the selection of bond activities.

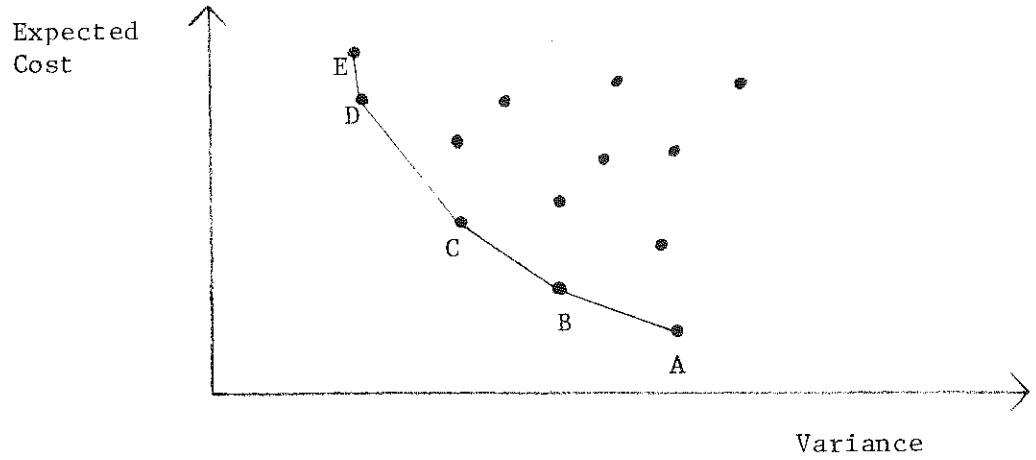
In this two period case, if funding needs increase in the second period, it is necessary to use the one-period bond of the second period to fund that increase. In contrast, if funding needs decrease in the second period, it is necessary to use the one-period bond of the first period in at least the amount of the decrease. (Short-term investment options are not included in the model, but they could be added.)

The expected costs of the three bonds and their cost risks also influence the selection of bonds. The goal is to select the minimum cost bond strategy. Because costs are not known with certainty, we must attempt to select the minimum cost bond strategy using expected bond costs, recognizing that some bond strategies have a greater risk than other bond strategies, such that the actual cost may deviate greatly from expected cost. Cost risk is measured by the variance of cost.

In the model, both expected cost and variance of cost are minimized. The minimum expected cost bond strategy, however, is rarely the minimum variance bond strategy. In fact, there is a tradeoff between expected cost and variance. The lower the expected cost of a bond strategy, the greater is the variance of cost. This relationship is depicted in Figure 1.

In Figure 1, point A is the bond strategy with the lowest expected cost, but that bond strategy has a relatively high variance level (or risk that the actual cost may deviate greatly from the expected cost). In contrast, point E is the bond strategy that has

Figure 1. Efficient Frontier of Bond Strategies



the lowest variance, but also a high expected cost. Lying between points A and E are bond strategies with various levels of expected cost and variance. What is unique about each of these strategies is that at their respective levels of expected cost, it is not possible to derive any other strategy that has a lower risk. Lying to the right of bond strategies A through E are numerous other bond strategies that could be selected, but should not be chosen because they are undesirable. Regardless of which strategy lying to the right of strategies A through E that you might select, you could always find one of the strategies A through E that has both a lower expected cost and a lower variance. Thus, strategies A through E are efficient bond strategies. Bond strategies lying to the right of strategies A through E are inefficient bond strategies.

In our simple two-period case, let us assume that there are three distinct interest rate scenarios. These three interest rate

projections and their individual probabilities of occurrence are listed in Table 1. The model first converts these interest rates into costs for the duration of each bond. In this example, costs are per $1,000 of debt for a one-year period. The expected cost of each bond is computed by summing the costs multiplied by their respective probabilities. The expected cost of bond 1 is $80(.4)+$70(.3)+$90(.3) = $80. Next, the deviations of each cost projection from the expected costs are calculated. (Cost deviations are also listed in Table 1.) The deviations and the probabilities are used to calculate the variance and covariance coefficients as follows: the deviations are multiplied by themselves (if variance) or by another bond deviation (if covariance) and by the probabilities that the deviation will occur and then summing these values. The variance of bond 1 is ($0) ($0) (.4)+(-$10)(-$10)(.3)+($10)($10)(.3) = $60. The covariance of bond 1 and bond 3 is ($0)($6)(.4)+(-$10)($6)(.3)+($10)(-$14)(.3) = -$60.

The quadratic programming solution to this simple example is listed in Table 2. There are only two unique bond strategies. In other applications there may be dozens of strategies, especially when more periods and bonds are added to the model. The quadratic programming solution technique is complex and will not be described here. However, it is easy to show how the expected cost and variance of a debt strategy can be computed. The expected cost of a debt strategy is the expected cost of each bond multiplied by the quantity of that bond to be used, summed over all the bonds. For example, in the first strategy the expected cost is 7.3($80) + 2.7($188)+17.3($94) = $2720. The variance is computed by multiply-

Table 1. Input Data for Two Period Model

Probability	Bond 1	Bond 2	Bond 3
		Interest Rate Projections	
.4	.08	.10	.10
.3	.07	.08	.10
.3	.09	.10	.08
		Cost Projections	
.4	$80	$200	$100
.3	70	160	100
.3	90	200	80
expected cost	80	188	94
		Cost Deviations	
.4	0	12	6
.3	-10	-28	6
.3	10	12	-14
		Variance - Covariance	
Bond 1	60	120	-60
Bond 2	120	336	-72
Bond 3	-60	-72	84
		Funding Requirements	
Period 1			$10,000
Period 2			$20,000

Bond 1 is a one-period, first period bond.

Bond 2 is a two-period, first period bond.

Bond 3 is a one-period, second period bond.

Table 2. Solution to Two-Period Model

Strategy 1		
	Bond 1	$ 7,300
	Bond 2	$ 2,700
	Bond 3	$17,300
	Expected Cost	$ 2,720
	Variance	$13,636
	Standard Deviation	$ 117
Strategy 2		
	Bond 1	$10,000
	Bond 2	$ 0
	Bond 3	$20,000
	Expected Cost	$ 2,680
	Variance	$15,600
	Standard Deviation	$ 125

Bond 1 is a one-period, first period bond.

Bond 2 is a two-period, first period bond.

Bond 3 is a one-period, second period bond.

ing the quantity of each bond to be used by itself (if variance) or by another bond quantity (if covariance), and by the variance or covariance value and then summing all terms. The variance of the first strategy is \$60(7.3)(7.3)+\$336(2.7)(2.7)+\$84(17.3)(17.3)+\$120(7.3)(2.7)+(-\$60)(7.3)(17.3)+(-\$72)(2.7)(17.3)+\$120(7.3)(2.7)+(-\$60)(7.3)(17.3)+(-\$72)(2.7)(17.3) = \$13,636.

The Farm Credit Debt Model

Although the concepts and the solution procedure are the same, there are differences in the above example and the Farm Credit Debt Model. The planning horizon of the Farm Credit Debt Model is one year, so interest rate and debt projections are needed for one year into the future. The model then selects optimal bond and note participations for that year. Bond options include the next 12 monthly six-month and nine-month bonds, and the quarterly long-term bonds. In addition, it is possible to specify long-term bonds for any of the 12 months. For each long-term bond issue date, up to three maturities can be specified. The model also determines the average participation in discount notes between bond dates, but does not determine the participation in specific discount note offerings.

Up to ten separate interest rate projections can be entered. The model uses these projections to compute expected costs and a variance-covariance matrix. The model discounts all interest costs to the present to adjust for differences in the timing of interest payments. This requires 12 monthly discounting rates for each in-

terest rate projection. Projected Treasury Bill rates are suggested as discounting rates.

The model has 16 periods because there are 16 separate bond entry (issue) dates. A debt requirement forecast for each of the 16 periods is required. Eight of the periods are monthly periods, four periods are two-thirds of a month, and four periods are one-third of a month. The eight fraction-month periods occur because of the mid-month quarterly long-term bond issues. A forecast of the average debt needs for each of the periods can be used for the debt requirement forecast under the criterion that any surplus during a period can be invested, and a deficit can be covered by discount notes (or other debt sources) beyond those recommended by the model. As alternatives to the average debt need for the period, it is possible to use the highest debt need, where the surplus is invested, or the lowest debt need, where the deficit is acquired elsewhere, or the debt amount necessary at the start of the period, if all debt is converted into system debt at the start of the period.

Expectation of interest rates and debt needs beyond the one year planning horizon should affect debt selection during the planning horizon. So, to indirectly incorporate interest rates beyond the one year horizon into the model, an ending yield curve is entered for each of the up to ten interest rate projections. The ending yield curve is used to price outstanding bonds at the end of the horizon. The ending prices are used to liquidate all outstanding ending bonds. The result is that only the debt costs during the

planning horizon are computed, but part of that cost is the reflection that the market believes interest rates will move up, move down, or stay constant beyond the planning horizon as reflected in the ending yield curve. The technical section of this manuscript explains the computational procedure in detail.

No adjustment is made for debt needs beyond the planning horizon. Most banks have experienced at least gradual growth in debt needs in recent years. The growth in debt needs has usually been met when needed so that increases in debt needs beyond the planning horizon are generally met by new issues beyond the horizon, even if those issues may be higher in cost. If a bank believes that interest rates will increase substantially after the end of the planning horizon, and also expects its total debt needs will increase after the end of the planning horizon, a larger debt need for the last period can be entered with the knowledge that the excess will be invested until needed. If debt needs will remain constant beyond the planning horizon, but interest rates are expected to increase, the model will adjust automatically by selecting more longer term bonds. The adjustment occurs via the ending yield curve. Declining total debt needs beyond the planning horizon can be accommodated by the user forcing the model to select sufficient short-term securities that will mature as total debt needs decline.

The user can force the model to participate in any specific bond or note issue at a minimum level, or put a maximum ceiling on that participation. The model is thus able to select participation

strategies within many types of debt policy guidelines that a bank has established.

User Instructions for the Farm Credit Debt Model

The model consists of three separate program sections. The first section is a matrix generator. This computer program queries the operator for data and constructs a data input file for the quadratic program. The second section is the quadratic program. The quadratic program uses the matrix generator data input file to compute optimal debt participation options. These options are then placed into a data file. The final section is a report writer. This computer program takes the quadratic program output and prints it in report format. The matrix generator is the only program section that requires data input from the operator. However, editing commands unique to each computer installation will be required by the operator to route output from one program to another. The editing system used at Cornell is the Conversation Monitor System (CMS).

The matrix generator program queries the user for data as the program requires it. In order to have the data when it is needed, the user should first complete data input forms 1 through 4. Each form begins with the month that a quarterly term bond is available. Thus, the first month must be January, April, July, or October. If the current month is not one of those four months it is necessary to begin at the second month (February, May, August, November), or the

third month (March, June, September, December) of the input forms. Then, when the computer asks for data for the first month (and the second month), it is necessary to enter zeros.

Input form 1 allows the user to specify what term bonds will be available in the upcoming year. Input form 2 is used to enter the interest rates of a specific forecast. One input form 2 is used for each interest rate forecast. Input form 3 is used to specify the debt needs of the bank. Input form 4 is used to specify any constraints to be placed on debt participation. Examples of completed forms are shown in Appendix A. The data on the input forms were used as the input data in the computer application that follows the input forms. The example was completed during late October. Because the next current month was November, the model begins with the second month. Zeros are entered in the first month and the first quarter term bond issue (October). Following is a description of the process.

The matrix generator first asks the user when term bonds are to be issued during the upcoming months, the number of term bonds for each month, and the term of each bond. All entries in this section are made without a decimal point except for the terms of the bonds. Terms are entered in years and part years. Thus, a four-year, six-month bond is entered as 4.50. The program also asks for the number of term bonds and their terms for each quarter.

The program then asks for the number of separate interest rate forecasts the user will enter. The user is asked for the probability of the first forecast along with the interest rate forecast.

Since the model discounts all costs to the present, 12 monthly discounting rates are first entered. These rates might be what the user expects 90-day T-bill bond equivalent rates will be for each of the next 12 months. A rate of 11 1/2 percent would be entered as 11.5. If the user wants the model to minimize nondiscounted expected cost and cost variance rather than the present values of the costs, zeros (with a decimal point) can be entered for the 12 discounting rates.

The model then asks for the 16 discount note rates for the upcoming year. Eight of these rates are the average rates for each of the eight months during which a term bond is not available in the middle of the month. The other eight rates are for the four months that a term bond is available during the month. For each of these four months, a discount note rate for the first part of the month and a discount note rate for the last part of the month are entered.

Next, the 12 six-month bond rates and the 12 nine-month bond rates are entered. Then a rate for each of the term bonds is entered. To assist the user, the model indicates the month or quarter of the bond and the term.

The model then asks if the user wants to use debt termination or salvage activities. A response of 1 for yes will activate questions concerning an ending yield curve for forecast 1. First, ending rates for one to eight-month maturity bonds will be requested. Then, rates for all of the ending term bonds will be requested. If the user states that no salvage activities are to be used, the model computes only actual debt costs that accrue for the duration of the planning horizon.

After the ending yield curve rates for the first forecast are entered, or after the user specifies no debt termination activities, the program will ask for the probability of the second forecast along with interest rates, termination activities, and rates. Then, that same information will be requested for the remaining forecasts. It is important that the probabilities of all forecasts sum to one.

After all forecasts are entered, the user enters the debt needs for each of the 16 periods in millions of dollars. These amounts are accumulated new money needs for the current period. New money needs will occur because of maturing debt issued before the start of the one year planning horizon, and growth in total debt needs since the start of the planning horizon. Two-hundred-forty-six million, fifty-four-hundred thousand dollars is entered as 246.50. In this section it is important that if the first month or the second month is not used because the current month is not the start of a quarter period, zeros with decimals be entered for the initial one to three periods.

The program next asks the user if maximum or minimum constraints should be placed on any bond, or group of bonds, or on the average discount notes outstanding between periods. The constraints are entered in millions of dollars. Extreme care must be exercised when placing constraints on any bond or discount note. It is very easy to place constraints that the model cannot fulfill. If that happens, the model breaks down and no solution is possible. The model does not contain diagnostics that the operator can use to interpret this problem.

Finally, the matrix generator states that the matrix is being generated and the Fortran file number it is placed on. Additional information that is used by the report writer, but not the quadratic program, is placed on a separate file for later use.

The operator then needs to call for the quadratic program which generates optimal debt participation strategies. Those commands are unique to each computer installation. The output from the quadratic program is stored on a file. The user can view that output if desired. However, the output format is not presented in a useful form. Therefore, the report writer should be called to take the quadratic program output and convert it into a report.

The report produced from the example data is attached. There were 31 debt issuance strategies generated in that application but only 11 of those strategies are shown here. The first strategy has the lowest standard deviation and the highest expected cost. The last strategy has the lowest expected cost and the highest standard deviation. The remaining strategies fall between these two extremes.

Each strategy shows the level of nine-month and six-month bond participation for each of the 12 months. The average discount notes outstanding are given for each period. The long-term bonds are also listed for each strategy. (The notation 7-month means the seventh month.) The reader will notice that gradual changes in bond participation occur from strategy to strategy.

Technical Descriptions

The solution procedure is comprised of three separate computer programs--a matrix generator program, a quadratic program, and a report writer program. All three are written in FORTRAN IV except that the quadratic program also uses an assembly routine. The matrix generator requires data input from the user and constructs an input matrix required by the quadratic program. The quadratic program computes an efficient frontier set of debt strategies. The report writer converts the output of the quadratic program into tables. The matrix generator program code and report writer program code are reproduced in Appendix B.

The quadratic program is listed in the publication written by, L. Cutler and D.S. Pass, "A Computer Program for Quadratic Mathematical Models to be Used for Aircraft Design and Other Applications Involving Linear Constraints," R-516-PR, June 1971, published by The Rand Corporation, Santa Monica, California. Necessary changes in the Rand program are listed in Appendix B.

Limitations to the Quadratic Debt Model

The quadratic model generates debt strategies based upon the expected costs and variance-covariance of costs. If the underlying probability of interest rates is normally distributed, then the quadratic model selects the best debt strategies. Bank management, however, must select one of the strategies after assessing its

tradeoff between risk and expected cost. If interest rate probabilities are not normally distributed, then the quadratic model may not select the best strategies. However, the strategies that it does select are better than a strategy based only upon expected cost. (Actually, the lowest expected cost quadratic program strategy is the lowest expected cost strategy. There are no lower cost options.)

The quadratic model will not adjust for interest rates that are projected to be skewed to the right or to the left of the expected interest rates. Skewness can occur, for instance, when the expected interest rate is 20 percent and there is a 50-50 chance that interest rates will be greater or less than 20 percent, but it is believed that the rate will not move above 25 percent but it could move to as low as 10 percent. This is a skewness to lower values. The model would consider that risk to be the same as if the 20 percent expected interest rate could be either 30 percent or 15 percent--a skewness to higher values. Incorporating measures of skewness is not possible with quadratic programming. Alternative solution procedures must be used, none of which are easy to use. Many are impossible to use.

Another difficulty with this debt model is that a limited number of interest rate projections are entered. A limit of ten projections was placed on the model since very few users would even approach ten projections. Many users might use only three or four projections. The small number of interest rate projections means that the normal probability function estimated by expected costs and

variance-covariance will not be based upon observations from a smooth sample surface. Three or four projections may not define the underlying probability distribution very well.

Discount Factors

At the option of the user, costs can be discounted to the present by entering non-zero discounting interest rates. A discounting interest rate is entered for each of the 12 months. Because these rates are annual rates, they are divided by 12 to obtain monthly rates. To compute the discount factor for month n, the first n month rates are multiplied together by the formula:

$$d_n = \prod_{i=1}^{n} \frac{1}{(1+r_i)}$$

where: d_n = the discount factor for month n
r_i = the monthly discounting interest rate

The twelfth month discounting interest rate is used as the monthly discounting rate for months 13 to 30 to compute any discount factor beyond month twelve.

The Computation of Interest Costs

All entered interest rates should include both the cost of issuance and interest payment costs. The cost of a discount note is computed by dividing the annual rate by 12, then multiplying by the duration between bond issues, which is either one-third, two-thirds, or one month. The cost is then discounted to the present.

The cost of the first 6, six-month bonds is calculated by converting the annual interest rate into six months' cost which is then multiplied by the discount factor of the month of payment (when the

bond matures). A six-month bond issued during the last six months of the planning horizon will not mature until after the end of the planning horizon. To calculate the interest cost of these bonds, the six months' interest cost is first calculated. Then the interest rate of a bond whose term is the months remaining on the six-month bond at the end of the planning horizon is multiplied by the months remaining, and that cost is subtracted from the six months' interest cost. The concept behind this procedure is that at the end of the planning horizon, a bond of that maturity and rate could be available as a replacement for the original six-month bond. Because the interest payments on both the six-month bond and the replacement bond would occur beyond the planning horizon, the cost difference between the six-month and replacement bond is multiplied by the discount factor of the month when payment will be made. If salvage activities are not indicated by the user, then the initial six-month bond rate is used as the interest rate of the replacement bond, which eliminates any costs beyond the planning horizon. Nine-month bonds are handled in a manner similar to six-month bonds.

Because long-term bonds have an interest payment every six months, a different technique is used to compute their costs. First, any interest payment during the planning horizon is discounted to the present. Then, the first payment beyond the planning horizon is compared to the first payment of a replacement bond to be issued at the end of the planning horizon. This cost difference is discounted to the present using the period discount factor. The re-

maining life of the original and replacement bond is treated as a six-month annuity where the payment is the difference between the interest payment on the original and replacement bond every six months. The value of the annuity is discounted to the first payment period beyond the planning horizon. Then, that value is discounted to the present. Again, if no salvage activities are elected, the initial term bond interest rate is used as the replacement interest rate, resulting in a zero cost beyond the planning horizon. Mathematically, cost is computed on a long-term bond as:

$$C = (R_o \times 6 \times D_1) - ((R_o \times 6) - (R_r \times M)) \times D_2 + (R_o - R_r) \times 6 \times (1-1/(1 + d)^n)/d \times D_2$$

where: C = discounted interest cost

R_o = monthly interest rate of original bond

R_r = monthly interest rate of replacement bond

D_1 = discount factor for the payment during the planning horizon

D_2 = discount factor for the payment beyond the planning horizon

M = months before first payment past planning horizon

d = semi-annual interest rate based upon twelve month discounting interest rate

n = number of interest payments beyond the first payment past the planning horizon

The expected cost of each bond and note activity is computed by multiplying the cost of each projection by its probability of occurrence and then summing all of these products. The variance-co-variance is computed as explained in the earlier two-period example.

APPENDIX A

An Application of the Farm Credit Debt Selection Model

Contains:
(1) Completed data input forms.
(2) Copy of data input for matrix generator
(3) Debt issuance report (partial set).

Input Form 1

FCB DEBT MODEL

Terms of Long-Term Bonds

(In years and fraction of year)

	Number of Bonds	Term 1	Term 2	Term 3
First Month				
Last Third				
Second Month				
Third Month	1	4.0		
Fourth Month	1	5.0		
Last Third	3	2.0	4.0	7.0
Fifth Month				
Sixth Month				
Seventh Month	1	5.0		
Last Third	3	3.0	6.0	10.0
Eighth Month				
Ninth Month				
Tenth Month				
Last Third	3	4.0	8.0	12.0
Eleventh Month				
Twelfth Month	1	4.5		

FCB DEBT MODEL

Interest Rate Projection # 1

Probability = .45

One of these forms must be filled out for each interest rate projection

	Discount Coefficient Rate	Discount Notes	Six-month Bonds	Nine-month Bonds	Term Bonds		
First Month	0.	0.	0.	0.			
Last Third		0.			0.		
Second Month	12.	12.1	12.05	12.			
Third Month	11.1	11.2	11.35	11.5	11.75		
Fourth Month	11.1	11.2	11.35	11.5	11.75		
Last Third		11.2			11.75	11.8	11.85
Fifth Month	11.1	11.2	11.35	11.5			
Sixth Month	11.3	11.4	11.5	11.6			
Seventh Month	11.5	11.6	11.7	11.75	12.2		
Last Third		11.75			12.4	12.75	12.5
Eighth Month	11.7	11.8	11.9	12.			
Ninth Month	11.6	11.7	11.8	11.9			
Tenth Month	11.5	11.6	11.7	11.8			
Last Third		11.55			12.25	12.3	12.35
Eleventh Month	11.4	11.5	11.6	11.65			
Twelfth Month	11.35	11.45	11.55	11.65	12.2		

Ending Rates

1-month bond	11.4	1-year bond	11.7	6-year bond	12.05
2-month bond	11.4	2-year bond	11.8	7-year bond	12.10
3-month bond	11.4	3-year bond	12.	8-year bond	12.10
4-month bond	11.45	4-year bond	12.	9-year bond	12.10
5-month bond	11.45	5-year bond	12.	10-year bond	12.10
6-month bond	11.5				
7-month bond	11.55				
8-month bond	11.6				

FCB DEBT MODEL

Interest Rate Projection # 2

Probability = .30

One of these forms must be filled out for each interest rate projection

	Discount Coefficient Rate	Discount Notes	Six-month Bonds	Nine-month Bonds	Term Bonds		
First Month	0.	0.	0.	0.			
Last Third		0.			0.		
Second Month	12.	12.1	12.05	12.			
Third Month	12.35	12.45	12.35	13.3	12.15		
Fourth Month	12.7	12.8	12.7	12.6	12.35		
Last Third		13.1			12.35	12.5	12.45
Fifth Month	13.1	13.2	13.1	12.9			
Sixth Month	13.3	13.4	13.25	13.15			
Seventh Month	13.5	13.6	13.5	13.35	12.8		
Last Third		13.75			12.95	12.9	12.85
Eighth Month	13.75	13.85	13.7	13.6			
Ninth Month	13.9	14.	13.85	13.7			
Tenth Month	14.1	14.2	13.95	13.85			
Last Third		14.35			13.25	13.3	13.3
Eleventh Month	14.3	14.4	14.1	14.			
Twelfth Month	14.25	14.35	14.1	14.	13.4		

Ending Rates

1-month bond 14.35
2-month bond 14.35
3-month bond 14.35
4-month bond 14.3
5-month bond 14.2
6-month bond 14.1
7-month bond 14.
8-month bond 13.95

1-year bond 13.95
2-year bond 13.25
3-year bond 13.35
4-year bond 13.35
5-year bond 13.35

6-year bond 13.3
7-year bond 13.3
8-year bond 13.25
9-year bond 13.25
10-year bond 13.25

Input Form 2

FCB DEBT MODEL

Interest Rate Projection # 3

Probability = .25

One of these forms must be filled out for each interest rate projection

	Discount Coefficient Rate	Discount Notes	Six-month Bonds	Nine-month Bonds	Term Bonds		
First Month	0.	0.	0.	0.			
Last Third		0.			0.		
Second Month	10.2	10.3	10.4	10.45			
Third Month	9.95	10.05	10.15	10.25	10.9		
Fourth Month	9.75	9.85	9.95	10.15	10.65		
Last Third		9.7			10.5	10.55	10.6
Fifth Month	9.55	9.65	9.75	10.05			
Sixth Month	9.65	9.75	9.85	10.15			
Seventh Month	9.8	9.9	9.95	10.25	10.45		
Last Third		10.			10.5	10.55	10.6
Eighth Month	9.95	10.05	10.05	10.35			
Ninth Month	10.	10.1	10.15	10.45			
Tenth Month	10.05	10.15	10.2	10.55			
Last Third		10.2			10.7	10.8	10.85
Eleventh Month	10.15	10.25	10.3	10.6			
Twelfth Month	10.25	10.35	10.45	10.7	10.85		

Ending Rates

1-month bond 10.5	1-year bond 10.75	6-year bond 10.9
2-month bond 10.5	2-year bond 10.8	7-year bond 10.9
3-month bond 10.5	3-year bond 10.85	8-year bond 10.9
4-month bond 10.55	4-year bond 10.85	9-year bond 10.9
5-month bond 10.6	5-year bond 10.85	10-year bond 10.9
6-month bond 10.6		
7-month bond 10.65		
8-month bond 10.75		

FCB DEBT MODEL

Debt Needs

(In Millions of Dollars)

First Month	0.
Last Third	0.
Second Month	17.
Third Month	41.
Fourth Month	52.
Last Third	76.
Fifth Month	92.
Sixth Month	103.
Seventh Month	124.
Last Third	147.
Eighth Month	180.
Ninth Month	188.
Tenth Month	196.
Last Third	209.
Eleventh Month	239.
Twelfth Month	246.540

FCB DEBT MODEL

Constraints - per debt issue (for discount notes - notes outstanding at any time)

Check: Maximum ✓ or Minimum _____

(In Millions of Dollars)

A separate form must be completed for maximum and minimum constraints

	Discount Notes	Six-month Bonds	Nine-month Bonds		Term Bonds	
First Month	50.	75.	75.			
Last Third						
Second Month						
Third Month				50.		
Fourth Month				50.		
Last Third				25.	25.	25.
Fifth Month						
Sixth Month						
Seventh Month				50.		
Last Third				25.	25.	25.
Eighth Month						
Ninth Month						
Tenth Month						
Last Third				25.	25.	25.
Eleventh Month						
Twelfth Month				50.		

```
START
EXECUTION BEGINS...
THIS IS A OPRANC MATRIX GENERATOR

WRITTEN BY

          LOREN TAUER
          DEPT. OF AG. ECON.
          CORNELL UNIVERSITY


IS THERE A TERM BOND(S) FOR MONTH  1 ? ENTER 1 FOR YES, 2 FOR NO
?
2
IS THERE A TERM BOND(S) FOR MONTH  2 ? ENTER 1 FOR YES, 2 FOR NO
?
2
IS THERE A TERM BOND(S) FOR MONTH  3 ? ENTER 1 FOR YES, 2 FOR NO
?
1
ENTER THE NUMBER OF TERM ISSUES FOR MONTH  3, THE LIMIT IS 4
?
1
ENTER THE TERM OF TERM BOND  1 FOR MONTH  3
?
4.0
IS THERE A TERM BOND(S) FOR MONTH  4 ? ENTER 1 FOR YES, 2 FOR NO
?
1
ENTER THE NUMBER OF TERM ISSUES FOR MONTH  4, THE LIMIT IS 4
?
1
ENTER THE TERM OF TERM BOND  1 FOR MONTH  4
?
5.0
IS THERE A TERM BOND(S) FOR MONTH  5 ? ENTER 1 FOR YES, 2 FOR NO
?
2
IS THERE A TERM BOND(S) FOR MONTH  6 ? ENTER 1 FOR YES, 2 FOR NO
?
2
IS THERE A TERM BOND(S) FOR MONTH  7 ? ENTER 1 FOR YES, 2 FOR NO
?
1
ENTER THE NUMBER OF TERM ISSUES FOR MONTH  7, THE LIMIT IS 4
?
1
ENTER THE TERM OF TERM BOND  1 FOR MONTH  7
?
5.0
IS THERE A TERM BOND(S) FOR MONTH  8 ? ENTER 1 FOR YES, 2 FOR NO
?
2
```

```
IS THERE A TERM BOND(S) FOR MONTH  9 ? ENTER 1 FOR YES, 2 FOR NO
?
2
IS THERE A TERM BOND(S) FOR MONTH 10 ? ENTER 1 FOR YES, 2 FOR NO
?
2
IS THERE A TERM BOND(S) FOR MONTH 11 ? ENTER 1 FOR YES, 2 FOR NO
?
2
IS THERE A TERM BOND(S) FOR MONTH 12 ? ENTER 1 FOR YES, 2 FOR NO
?
1
ENTER THE NUMBER OF TERM ISSUES FOR MONTH 12, THE LIMIT IS 4
?
1
ENTER THE TERM OF TERM BOND  1 FOR MONTH 12
?
4.5
ENTER THE NUMBER OF TERM ISSUES FOR QUARTER  1, THE LIMIT IS 4
?
0
ENTER THE TERM OF TERM BOND  1 FOR QUARTER  1
?
1.
ENTER THE NUMBER OF TERM ISSUES FOR QUARTER  2, THE LIMIT IS 4
?
3
ENTER THE TERM OF TERM BOND  1 FOR QUARTER  2
?
2.
ENTER THE TERM OF TERM BOND  2 FOR QUARTER  2
?
4.
ENTER THE TERM OF TERM BOND  3 FOR QUARTER  2
?
7.
ENTER THE NUMBER OF TERM ISSUES FOR QUARTER  3, THE LIMIT IS 4
?
3
ENTER THE TERM OF TERM BOND  1 FOR QUARTER  3
?
3.
ENTER THE TERM OF TERM BOND  2 FOR QUARTER  3
?
6.
ENTER THE TERM OF TERM BOND  3 FOR QUARTER  3
?
10.
ENTER THE NUMBER OF TERM ISSUES FOR QUARTER  4, THE LIMIT IS 4
?
3
ENTER THE TERM OF TERM BOND  1 FOR QUARTER  4
?
4.
ENTER THE TERM OF TERM BOND  2 FOR QUARTER  4
?
8.
ENTER THE TERM OF TERM BOND  3 FOR QUARTER  4
?
12.
```

```
ENTER THE NUMBER OF INTEREST RATE FORECASTS, THE LIMIT  IS 10
?
3
ENTER THE PROBABILITY OF FORECAST  1
?
.45
ENTER THE 12 MONTHLY DISCOUNTING RATES FOR FORECAST  1
?
0, 12, 11.1 11.1 11.1 11.3 11.5 11.7 11.6 11.5 11.4 11.35
ENTER THE 16 DISCOUNT NOTE RATES FOR FORECAST  1
?
0, 0, 12.1 11.2 11.2 11.2 11.2 11.4 11.6 11.75 11.8 11.7 11.6
?
11.55 11.5 11.45
ENTER THE 12 SIX-MONTH RATES FOR FORECAST  1
?
0, 12.05 11.35 11.35 11.35 11.5 11.7 11.9 11.8 11.7 11.6 11.55
ENTER THE 12 NINE-MONTH RATES FOR FORECAST  1
?
0, 12, 11.5 11.5 11.5 11.6 11.75 12, 11.9 11.8 11.65 11.65
ENTER THE RATE FOR THE  4.00 YEAR TERM BOND FOR MONTH  3 FORECAST  1
?
11.75
ENTER THE RATE FOR THE  5.00 YEAR TERM BOND FOR MONTH  4 FORECAST  1
?
11.75
ENTER THE RATE FOR THE  5.00 YEAR TERM BOND FOR MONTH  7 FORECAST  1
?
12.2
ENTER THE RATE FOR THE  4.50 YEAR TERM BOND FOR MONTH 12 FORECAST  1
?
12.2
ENTER THE RATE FOR THE  1.00 YEAR TERM BOND FOR QUARTER  1, FORECAST  1
?
99.
ENTER THE RATE FOR THE  2.00 YEAR TERM BOND FOR QUARTER  2, FORECAST  1
?
11.75
ENTER THE RATE FOR THE  4.00 YEAR TERM BOND FOR QUARTER  2, FORECAST  1
?
11.8
ENTER THE RATE FOR THE  7.00 YEAR TERM BOND FOR QUARTER  2, FORECAST  1
?
11.85
ENTER THE RATE FOR THE  3.00 YEAR TERM BOND FOR QUARTER  3, FORECAST  1
?
12.4
ENTER THE RATE FOR THE  6.00 YEAR TERM BOND FOR QUARTER  3, FORECAST  1
?
12.45
ENTER THE RATE FOR THE 10.00 YEAR TERM BOND FOR QUARTER  3, FORECAST  1
?
12.5
ENTER THE RATE FOR THE  4.00 YEAR TERM BOND FOR QUARTER  4, FORECAST  1
?
12.25
ENTER THE RATE FOR THE  8.00 YEAR TERM BOND FOR QUARTER  4, FORECAST  1
?
12.3
ENTER THE RATE FOR THE 12.00 YEAR TERM BOND FOR QUARTER  4, FORECAST  1
```

```
?
12.35
WOULD YOU LIKE TO USE DEBT TERMINATION ACTIVITIES?
 ENTER 1 FOR YES, 2 FOR NO
?
1
ENTER THE 8 ENDING RATES FOR 1- TO 8-MONTH BONDS, FORECAST  1
?
11.4 11.4 11.4 11.45 11.45 11.5 11.55 11.6
ENTER THE ENDING RATE FOR A  3.17 YEAR TERM BOND, FORECAST  1
?
12.
ENTER THE ENDING RATE FOR A  4.25 YEAR TERM BOND, FORECAST  1
?
12.
ENTER THE ENDING RATE FOR A  4.50 YEAR TERM BOND, FORECAST  1
?
12.
ENTER THE ENDING RATE FOR A  4.42 YEAR TERM BOND, FORECAST  1
?
12.
ENTER THE ENDING RATE FOR A  0.06 YEAR TERM BOND, FORECAST  1
?
99.
ENTER THE ENDING RATE FOR A  1.31 YEAR TERM BOND, FORECAST  1
?
11.7
ENTER THE ENDING RATE FOR A  3.31 YEAR TERM BOND, FORECAST  1
?
12.
ENTER THE ENDING RATE FOR A  6.31 YEAR TERM BOND, FORECAST  1
?
12.05
ENTER THE ENDING RATE FOR A  2.56 YEAR TERM BOND, FORECAST  1
?
12.
ENTER THE ENDING RATE FOR A  5.56 YEAR TERM BOND, FORECAST  1
?
12.05
ENTER THE ENDING RATE FOR A  9.56 YEAR TERM BOND, FORECAST  1
?
12.1
ENTER THE ENDING RATE FOR A  3.81 YEAR TERM BOND, FORECAST  1
?
12.
ENTER THE ENDING RATE FOR A  7.81 YEAR TERM BOND, FORECAST  1
?
12.1
ENTER THE ENDING RATE FOR A 11.81 YEAR TERM BOND, FORECAST  1
?
12.1
ENTER THE PROBABILITY OF FORECAST  2
?
.30
ENTER THE 12 MONTHLY DISCOUNTING RATES FOR FORECAST  2
?
0. 12. 12.35 12.7 13.1 13.3 13.5 13.75 13.9 14.1 14.3 14.25
ENTER THE 16 DISCOUNT NOTE RATES FOR FORECAST  2
?
0. 0. 12.1 12.45 12.8 13.1 13.2 13.4 13.6 13.75 13.85 14. 14.2
```

```
?
14.35 14.4 14.35
ENTER THE 12 SIX-MONTH RATES FOR FORECAST  2
?
0. 12.05 12.35 12.7 13.1 13.25 13.5 13.7 13.85 13.95 14.1 14.1
ENTER THE 12 NINE-MONTH RATES FOR FORECAST  2
?
0. 12. 13.3 12.6 12.9 13.15 13.35 13.6 13.7 13.85 14. 14.
ENTER THE RATE FOR THE  4.00 YEAR TERM BOND FOR MONTH  3 FORECAST  2
?
12.15
ENTER THE RATE FOR THE  5.00 YEAR TERM BOND FOR MONTH  4 FORECAST  2
?
12.35
ENTER THE RATE FOR THE  5.00 YEAR TERM BOND FOR MONTH  7 FORECAST  2
?
12.8
ENTER THE RATE FOR THE  4.50 YEAR TERM BOND FOR MONTH 12 FORECAST  2
?
13.4
ENTER THE RATE FOR THE  1.00 YEAR TERM BOND FOR QUARTER  1, FORECAST  2
?
99.
ENTER THE RATE FOR THE  2.00 YEAR TERM BOND FOR QUARTER  2, FORECAST  2
?
12.55
ENTER THE RATE FOR THE  4.00 YEAR TERM BOND FOR QUARTER  2, FORECAST  2
?
12.5
ENTER THE RATE FOR THE  7.00 YEAR TERM BOND FOR QUARTER  2, FORECAST  2
?
12.45
ENTER THE RATE FOR THE  3.00 YEAR TERM BOND FOR QUARTER  3, FORECAST  2
?
12.95
ENTER THE RATE FOR THE  6.00 YEAR TERM BOND FOR QUARTER  3, FORECAST  2
?
12.9
ENTER THE RATE FOR THE 10.00 YEAR TERM BOND FOR QUARTER  3, FORECAST  2
?
12.85
ENTER THE RATE FOR THE  4.00 YEAR TERM BOND FOR QUARTER  4, FORECAST  2
?
13.25
ENTER THE RATE FOR THE  8.00 YEAR TERM BOND FOR QUARTER  4, FORECAST  2
?
13.3
ENTER THE RATE FOR THE 12.00 YEAR TERM BOND FOR QUARTER  4, FORECAST  2
?
13.3
WOULD YOU LIKE TO USE DEBT TERMINATION ACTIVITIES?
 ENTER 1 FOR YES, 2 FOR NO
?
1
ENTER THE 8 ENDING RATES FOR 1- TO 8-MONTH BONDS, FORECAST  2
?
14.35 14.35 14.35 14.3 14.2 14.1 14. 13.95
ENTER THE ENDING RATE FOR A  3.17 YEAR TERM BOND, FORECAST  2
?
13.35
```

```
ENTER THE ENDING RATE FOR A  4.25 YEAR TERM BOND, FORECAST  2
?
13.35
ENTER THE ENDING RATE FOR A  4.50 YEAR TERM BOND, FORECAST  2
?
13.35
ENTER THE ENDING RATE FOR A  4.42 YEAR TERM BOND, FORECAST  2
?
13.35
ENTER THE ENDING RATE FOR A  0.06 YEAR TERM BOND, FORECAST  2
?
99.
ENTER THE ENDING RATE FOR A  1.31 YEAR TERM BOND, FORECAST  2
?
13.95
ENTER THE ENDING RATE FOR A  3.31 YEAR TERM BOND, FORECAST  2
?
13.35
ENTER THE ENDING RATE FOR A  6.31 YEAR TERM BOND, FORECAST  2
?
13.3
ENTER THE ENDING RATE FOR A  2.56 YEAR TERM BOND, FORECAST  2
?
13.35
ENTER THE ENDING RATE FOR A  5.56 YEAR TERM BOND, FORECAST  2
?
13.35
ENTER THE ENDING RATE FOR A  9.56 YEAR TERM BOND, FORECAST  2
?
13.25
ENTER THE ENDING RATE FOR A  3.81 YEAR TERM BOND, FORECAST  2
?
13.35
ENTER THE ENDING RATE FOR A  7.81 YEAR TERM BOND, FORECAST  2
?
13.25
ENTER THE ENDING RATE FOR A 11.81 YEAR TERM BOND, FORECAST  2
?
13.25
ENTER THE PROBABILITY OF FORECAST  3
?
.25
ENTER THE 12 MONTHLY DISCOUNTING RATES FOR FORECAST  3
?
0. 10.2 9.95 9.75 9.55 9.65 9.8 9.95 10. 10.05 10.15 10.25
ENTER THE 16 DISCOUNT NOTE RATES FOR FORECAST  3
?
0. 0. 10.3 10.05 9.85 9.7 9.65 9.75 9.9 10. 10.05 10.1 10.15
?
10.2 10.25 10.35
ENTER THE 12 SIX-MONTH RATES FOR FORECAST  3
?
0. 10.4 10.15 9.95 9.75 9.85 9.95 10.05 10.15 10.2 10.3 10.45
ENTER THE 12 NINE-MONTH RATES FOR FORECAST  3
?
0. 10.45 10.25 10.15 10.05 10.15 10.25 10.35 10.45 10.55 10.6 10.7
ENTER THE RATE FOR THE  4.00 YEAR TERM BOND FOR MONTH  3 FORECAST  3
?
10.9
ENTER THE RATE FOR THE  5.00 YEAR TERM BOND FOR MONTH  4 FORECAST  3
```

```
?
10.65
ENTER THE RATE FOR THE  5.00 YEAR TERM BOND FOR MONTH  7 FORECAST  3
?
10.45
ENTER THE RATE FOR THE  4.50 YEAR TERM BOND FOR MONTH 12 FORECAST  3
?
10.85
ENTER THE RATE FOR THE  1.00 YEAR TERM BOND FOR QUARTER  1, FORECAST  3
?
99.
ENTER THE RATE FOR THE  2.00 YEAR TERM BOND FOR QUARTER  2, FORECAST  3
?
10.5
ENTER THE RATE FOR THE  4.00 YEAR TERM BOND FOR QUARTER  2, FORECAST  3
?
10.55
ENTER THE RATE FOR THE  7.00 YEAR TERM BOND FOR QUARTER  2, FORECAST  3
?
10.6
ENTER THE RATE FOR THE  3.00 YEAR TERM BOND FOR QUARTER  3, FORECAST  3
?
10.5
ENTER THE RATE FOR THE  6.00 YEAR TERM BOND FOR QUARTER  3, FORECAST  3
?
10.55
ENTER THE RATE FOR THE 10.00 YEAR TERM BOND FOR QUARTER  3, FORECAST  3
?
10.6
ENTER THE RATE FOR THE  4.00 YEAR TERM BOND FOR QUARTER  4, FORECAST  3
?
10.7
ENTER THE RATE FOR THE  8.00 YEAR TERM BOND FOR QUARTER  4, FORECAST  3
?
10.8
ENTER THE RATE FOR THE 12.00 YEAR TERM BOND FOR QUARTER  4, FORECAST  3
?
10.85
WOULD YOU LIKE TO USE DEBT TERMINATION ACTIVITIES?
 ENTER 1 FOR YES, 2 FOR NO
?
1
ENTER THE 8 ENDING RATES FOR 1- TO 8-MONTH BONDS, FORECAST  3
?
10.5 10.5 10.5 10.55 10.6 10.6 10.65 10.75
ENTER THE ENDING RATE FOR A  3.17 YEAR TERM BOND, FORECAST  3
?
10.85
ENTER THE ENDING RATE FOR A  4.25 YEAR TERM BOND, FORECAST  3
?
10.85
ENTER THE ENDING RATE FOR A  4.50 YEAR TERM BOND, FORECAST  3
?
10.85
ENTER THE ENDING RATE FOR A  4.42 YEAR TERM BOND, FORECAST  3
?
10.85
ENTER THE ENDING RATE FOR A  0.06 YEAR TERM BOND, FORECAST  3
?
99.
```

```
ENTER THE ENDING RATE FOR A  1.31 YEAR TERM BOND, FORECAST  3
?
10.75
ENTER THE ENDING RATE FOR A  3.31 YEAR TERM BOND, FORECAST  3
?
10.85
ENTER THE ENDING RATE FOR A  6.31 YEAR TERM BOND, FORECAST  3
?
10.9
ENTER THE ENDING RATE FOR A  2.56 YEAR TERM BOND, FORECAST  3
?
10.85
ENTER THE ENDING RATE FOR A  5.56 YEAR TERM BOND, FORECAST  3
?
10.9
ENTER THE ENDING RATE FOR A  9.56 YEAR TERM BOND, FORECAST  3
?
10.9
ENTER THE ENDING RATE FOR A  3.81 YEAR TERM BOND, FORECAST  3
?
10.85
ENTER THE ENDING RATE FOR A  7.81 YEAR TERM BOND, FORECAST  3
?
10.9
ENTER THE ENDING RATE FOR A 11.81 YEAR TERM BOND, FORECAST  3
?
10.9
ENTER THE DEBT NEEDS FOR THE 16 PERIODS IN MILLIONS $
?
0. 0. 17. 41. 52. 76. 92. 103. 124. 147.
?
180. 188. 196. 209. 239. 246.540
WOULD YOU LIKE TO PLACE MAX. CONSTRAINTS ON ANY
NOTE OR BOND GROUP? ENTER 1 FOR YES, 2 FOR NO
?
1
WOULD YOU LIKE TO PLACE MAX. CONSTRAINTS ON THE
DISCOUNT NOTES? ENTER 1 FOR YES, 2 FOR NO
?
1
ENTER THE MAXIMUM FOR EACH OF THE 16 DISCOUNT NOTES
?
50. 50. 50. 50. 50. 50. 50. 50.
?
50. 50. 50. 50. 50. 50. 50. 50.
WOULD YOU LIKE TO PLACE MAX. CONSTRAINTS ON THE
SIX-MONTH BONDS? ENTER 1 FOR YES, 2 FOR NO
?
1
ENTER THE MAXIMUM FOR EACH OF THE 12 SIX-MONTH BONDS
?
75. 75. 75. 75. 75. 75. 75. 75. 75. 75. 75. 75.
WOULD YOU LIKE TO PLACE MAX. CONSTRAINTS ON THE
NINE-MONTH BONDS? ENTER 1 FOR YES, 2 FOR NO
?
1
ENTER THE MAXIMUM FOR EACH OF THE 12 NINE-MONTH BONDS
?
75. 75. 75. 75. 75. 75. 75. 75. 75. 75. 75. 75.
WOULD YOU LIKE TO PLACE MAX. CONSTRAINTS ON THE
```

```
LONG-TERM BONDS? ENTER 1 FOR YES, 2 FOR NO
?
1
ENTER THE MAX. FOR THE  4.00 YEAR TERM BOND FOR MONTH  3
?
50.
ENTER THE MAX. FOR THE  5.00 YEAR TERM BOND FOR MONTH  4
?
50.
ENTER THE MAX. FOR THE  5.00 YEAR TERM BOND FOR MONTH  7
?
50.
ENTER THE MAX. FOR THE  4.50 YEAR TERM BOND FOR MONTH 12
?
50.
ENTER THE MAX. FOR THE  1.00 YEAR TERM BOND FOR QUARTER  1
?
25.
ENTER THE MAX. FOR THE  2.00 YEAR TERM BOND FOR QUARTER  2
?
25.
ENTER THE MAX. FOR THE  4.00 YEAR TERM BOND FOR QUARTER  2
?
25.
ENTER THE MAX. FOR THE  7.00 YEAR TERM BOND FOR QUARTER  2
?
25.
ENTER THE MAX. FOR THE  3.00 YEAR TERM BOND FOR QUARTER  3
?
25.
ENTER THE MAX. FOR THE  6.00 YEAR TERM BOND FOR QUARTER  3
?
25.
ENTER THE MAX. FOR THE 10.00 YEAR TERM BOND FOR QUARTER  3
?
25.
ENTER THE MAX. FOR THE  4.00 YEAR TERM BOND FOR QUARTER  4
?
25.
ENTER THE MAX. FOR THE  8.00 YEAR TERM BOND FOR QUARTER  4
?
25.
ENTER THE MAX. FOR THE 12.00 YEAR TERM BOND FOR QUARTER  4
?
25.
WOULD YOU LIKE TO PLACE MIN. CONSTRAINTS ON ANY
NOTE AND BOND GROUP? ENTER 1 FOR YES, 2 FOR NO
?
2
THE QPRAND MATRIX IS BEING GENERATED
THE QPRAND MATRIX HAS BEEN CREATED ON FILE 12
INFO. FOR THE REPORT WRITER HAS BEEN PLACED ON FILE 13
```

THE FOLLOWING ARE DEBT ISSUANCE STRATEGIES DERIVED BY A QUADRATIC PROGRAM

THE PROCEDURE WAS WRITTEN BY

LOREN TAUER
DEPT. OF AG. ECON.
CORNELL UNIVERSITY

DEBT ISSUANCE FOR THE NEXT 12 MONTHS STRATEGY NUMBER 1
(IN MILLIONS OF DOLLARS)

	NINE-MONTH BONDS	SIX-MONTH BONDS	DISCOUNT NOTES 10, 20, OR 30 DAY
FIRST MONTH	0.0	0.0	0.0
LAST THIRD			0.0
SECOND MONTH	0.0	0.0	17.000
THIRD MONTH	0.0	0.0	0.0
FOURTH MONTH	0.0	0.0	0.0
LAST THIRD			8.207
FIFTH MONTH	24.207	0.0	0.0
SIXTH MONTH	11.000	0.0	0.0
SEVENTH MONTH	21.000	0.0	0.0
LAST THIRD			23.000
EIGHT MONTH	0.0	6.000	50.000
NINTH MONTH	8.000	0.0	50.000
TENTH MONTH	21.000	0.0	37.000
LAST THIRD			50.000
ELEVENTH MONTH	37.540	0.0	42.460
TWELFTH MONTH	0.0	0.0	50.000

LONG-TERM BONDS

MONTH OR QUARTER	MATURITY	AMOUNT
3-M	4.00	41.000
4-M	5.00	11.000
7-M	5.00	0.0
12-M	4.50	0.0
1-Q	1.00	0.0
2-Q	2.00	0.0
2-Q	4.00	15.793
2-Q	7.00	0.0
3-Q	3.00	0.0
3-Q	6.00	0.0
3-Q	10.00	0.0
4-Q	4.00	0.0
4-Q	8.00	0.0
4-Q	12.00	0.0

EXPECTED DISCOUNTED COST = 12.566
STANDARD DEVIATION = 0.444

DEBT ISSUANCE FOR THE NEXT 12 MONTHS STRATEGY NUMBER 3
(IN MILLIONS OF DOLLARS)

	NINE-MONTH BONDS	SIX-MONTH BONDS	DISCOUNT NOTES 10, 20, OR 30 DAY
FIRST MONTH	0.0	0.0	0.0
LAST THIRD			0.0
SECOND MONTH	0.0	0.0	17.000
THIRD MONTH	0.0	0.0	0.0
FOURTH MONTH	0.0	0.0	0.0
LAST THIRD			7.875
FIFTH MONTH	23.875	0.0	0.0
SIXTH MONTH	11.000	0.0	0.0
SEVENTH MONTH	21.000	0.0	0.0
LAST THIRD			23.000
EIGHT MONTH	0.0	6.000	50.000
NINTH MONTH	8.000	0.0	50.000
TENTH MONTH	21.000	0.0	37.000
LAST THIRD			50.000
ELEVENTH MONTH	37.540	0.0	42.460
TWELFTH MONTH	0.0	0.0	50.000

LONG-TERM BONDS

MONTH OR QUARTER	MATURITY	AMOUNT
3-M	4.00	41.000
4-M	5.00	11.000
7-M	5.00	0.0
12-M	4.50	0.0
1-Q	1.00	0.0
2-Q	2.00	0.0
2-Q	4.00	16.125
2-Q	7.00	0.0
3-Q	3.00	0.0
3-Q	6.00	0.0
3-Q	10.00	0.0
4-Q	4.00	0.0
4-Q	8.00	0.0
4-Q	12.00	0.0

EXPECTED DISCOUNTED COST = 12.565
STANDARD DEVIATION = 0.444

DEBT ISSUANCE FOR THE NEXT 12 MONTHS STRATEGY NUMBER 6
(IN MILLIONS OF DOLLARS)

	NINE-MONTH BONDS	SIX-MONTH BONDS	DISCOUNT NOTES 10, 20, OR 30 DAY
FIRST MONTH	0.0	0.0	0.0
LAST THIRD			0.0
SECOND MONTH	0.0	0.0	17.000
THIRD MONTH	0.0	0.0	0.0
FOURTH MONTH	0.0	0.0	0.0
LAST THIRD			8.842
FIFTH MONTH	24.842	0.0	0.0
SIXTH MONTH	11.000	0.0	0.0
SEVENTH MONTH	21.000	0.0	0.0
LAST THIRD			23.000
EIGHT MONTH	6.000	0.0	50.000
NINTH MONTH	8.000	0.0	50.000
TENTH MONTH	21.000	0.0	37.000
LAST THIRD			50.000
ELEVENTH MONTH	37.540	0.0	42.460
TWELFTH MONTH	0.0	0.0	50.000

LONG-TERM BONDS

MONTH OR QUARTER	MATURITY	AMOUNT
3-M	4.00	41.000
4-M	5.00	11.000
7-M	5.00	0.0
12-M	4.50	0.0
1-Q	1.00	0.0
2-Q	2.00	0.0
2-Q	4.00	15.158
2-Q	7.00	0.0
3-Q	3.00	0.0
3-Q	6.00	0.0
3-Q	10.00	0.0
4-Q	4.00	0.0
4-Q	8.00	0.0
4-Q	12.00	0.0

EXPECTED DISCOUNTED COST = 12.561
STANDARD DEVIATION = 0.444

DEBT ISSUANCE FOR THE NEXT 12 MONTHS STRATEGY NUMBER 9
(IN MILLIONS OF DOLLARS)

	NINE-MONTH BONDS	SIX-MONTH BONDS	DISCOUNT NOTES 10, 20, OR 30 DAY
FIRST MONTH	0.0	0.0	0.0
LAST THIRD			0.0
SECOND MONTH	0.0	0.0	17.000
THIRD MONTH	0.0	0.0	0.0
FOURTH MONTH	0.0	0.0	0.0
LAST THIRD			16.487
FIFTH MONTH	32.487	0.0	0.0
SIXTH MONTH	11.000	0.0	0.0
SEVENTH MONTH	21.000	0.0	0.0
LAST THIRD			23.000
EIGHT MONTH	6.000	0.0	50.000
NINTH MONTH	8.000	0.0	50.000
TENTH MONTH	21.000	0.0	37.000
LAST THIRD			50.000
ELEVENTH MONTH	75.000	0.0	5.000
TWELFTH MONTH	0.0	0.0	12.540

LONG-TERM BONDS

MONTH OR QUARTER	MATURITY	AMOUNT
3-M	4.00	41.000
4-M	5.00	11.000
7-M	5.00	0.0
12-M	4.50	0.0
1-Q	1.00	0.0
2-Q	2.00	0.0
2-Q	4.00	0.0
2-Q	7.00	7.513
3-Q	3.00	0.0
3-Q	6.00	0.0
3-Q	10.00	0.0
4-Q	4.00	0.0
4-Q	8.00	0.0
4-Q	12.00	0.0

EXPECTED DISCOUNTED COST = 12.487
STANDARD DEVIATION = 0.450

DEBT ISSUANCE FOR THE NEXT 12 MONTHS STRATEGY NUMBER 12
(IN MILLIONS OF DOLLARS)

	NINE-MONTH BONDS	SIX-MONTH BONDS	DISCOUNT NOTES 10, 20, OR 30 DAY
FIRST MONTH	0.0	0.0	0.0
LAST THIRD			0.0
SECOND MONTH	0.0	0.0	17.000
THIRD MONTH	0.0	0.0	0.0
FOURTH MONTH	0.0	0.0	0.0
LAST THIRD			9.474
FIFTH MONTH	25.474	0.0	0.0
SIXTH MONTH	11.000	0.0	0.0
SEVENTH MONTH	21.000	0.0	0.0
LAST THIRD			23.000
EIGHT MONTH	0.0	6.000	50.000
NINTH MONTH	8.000	0.0	50.000
TENTH MONTH	21.000	0.0	37.000
LAST THIRD			50.000
ELEVENTH MONTH	75.000	0.0	5.000
TWELFTH MONTH	0.0	0.0	12.540

LONG-TERM BONDS

MONTH OR QUARTER	MATURITY	AMOUNT
3-M	4.00	41.000
4-M	5.00	11.000
7-M	5.00	0.0
12-M	4.50	0.0
1-Q	1.00	0.0
2-Q	2.00	0.0
2-Q	4.00	0.0
2-Q	7.00	14.526
3-Q	3.00	0.0
3-Q	6.00	0.0
3-Q	10.00	0.0
4-Q	4.00	0.0
4-Q	8.00	0.0
4-Q	12.00	0.0

EXPECTED DISCOUNTED COST = 12.442
STANDARD DEVIATION = 0.458

DEBT ISSUANCE FOR THE NEXT 12 MONTHS STRATEGY NUMBER 15
(IN MILLIONS OF DOLLARS)

	NINE-MONTH BONDS	SIX-MONTH BONDS	DISCOUNT NOTES 10, 20, OR 30 DAY
FIRST MONTH	0.0	0.0	0.0
LAST THIRD			0.0
SECOND MONTH	0.0	0.0	17.000
THIRD MONTH	0.0	0.0	0.0
FOURTH MONTH	0.0	0.0	0.0
LAST THIRD			8.002
FIFTH MONTH	24.002	0.0	0.0
SIXTH MONTH	11.000	0.0	0.0
SEVENTH MONTH	21.000	0.0	0.0
LAST THIRD			23.000
EIGHT MONTH	0.0	6.000	50.000
NINTH MONTH	0.0	8.000	50.000
TENTH MONTH	21.000	0.0	37.000
LAST THIRD			50.000
ELEVENTH MONTH	75.000	0.0	5.000
TWELFTH MONTH	12.540	0.0	0.0

LONG-TERM BONDS

MONTH OR QUARTER	MATURITY	AMOUNT
3-M	4.00	41.000
4-M	5.00	11.000
7-M	5.00	0.0
12-M	4.50	0.0
1-Q	1.00	0.0
2-Q	2.00	0.0
2-Q	4.00	0.0
2-Q	7.00	15.998
3-Q	3.00	0.0
3-Q	6.00	0.0
3-Q	10.00	0.0
4-Q	4.00	0.0
4-Q	8.00	0.0
4-Q	12.00	0.0

EXPECTED DISCOUNTED COST = 12.431
STANDARD DEVIATION = 0.462

DEBT ISSUANCE FOR THE NEXT 12 MONTHS STRATEGY NUMBER 18
(IN MILLIONS OF DOLLARS)

	NINE-MONTH BONDS	SIX-MONTH BONDS	DISCOUNT NOTES 10, 20, OR 30 DAY
FIRST MONTH	0.0	0.0	0.0
LAST THIRD			0.0
SECOND MONTH	0.0	0.0	17.000
THIRD MONTH	0.0	0.0	0.0
FOURTH MONTH	0.0	0.0	0.0
LAST THIRD			0.0
FIFTH MONTH	16.000	0.0	0.0
SIXTH MONTH	11.000	0.0	0.0
SEVENTH MONTH	21.000	0.0	0.0
LAST THIRD			23.000
EIGHT MONTH	7.301	0.0	48.699
NINTH MONTH	0.0	6.699	50.000
TENTH MONTH	21.000	0.0	37.000
LAST THIRD			50.000
ELEVENTH MONTH	75.000	0.0	5.000
TWELFTH MONTH	12.540	0.0	0.0

LONG-TERM BONDS

MONTH OR QUARTER	MATURITY	AMOUNT
3-M	4.00	41.000
4-M	5.00	11.000
7-M	5.00	0.0
12-M	4.50	0.0
1-Q	1.00	0.0
2-Q	2.00	0.0
2-Q	4.00	0.0
2-Q	7.00	24.000
3-Q	3.00	0.0
3-Q	6.00	0.0
3-Q	10.00	0.0
4-Q	4.00	0.0
4-Q	8.00	0.0
4-Q	12.00	0.0

EXPECTED DISCOUNTED COST = 12.366
STANDARD DEVIATION = 0.495

DEBT ISSUANCE FOR THE NEXT 12 MONTHS STRATEGY NUMBER 21
(IN MILLIONS OF DOLLARS)

	NINE-MONTH BONDS	SIX-MONTH BONDS	DISCOUNT NOTES 10, 20, OR 30 DAY
FIRST MONTH	0.0	0.0	0.0
LAST THIRD			0.0
SECOND MONTH	0.0	0.0	17.000
THIRD MONTH	0.0	0.0	10.156
FOURTH MONTH	0.0	0.0	0.0
LAST THIRD			0.0
FIFTH MONTH	16.000	0.0	0.0
SIXTH MONTH	11.000	0.0	0.0
SEVENTH MONTH	21.000	0.0	0.0
LAST THIRD			23.000
EIGHT MONTH	14.000	0.0	42.000
NINTH MONTH	0.0	0.0	50.000
TENTH MONTH	26.000	0.0	32.000
LAST THIRD			45.000
ELEVENTH MONTH	75.000	0.0	0.0
TWELFTH MONTH	7.540	0.0	0.0

LONG-TERM BONDS

MONTH OR QUARTER	MATURITY	AMOUNT
3-M	4.00	30.844
4-M	5.00	21.156
7-M	5.00	0.0
12-M	4.50	0.0
1-Q	1.00	0.0
2-Q	2.00	0.0
2-Q	4.00	0.0
2-Q	7.00	24.000
3-Q	3.00	0.0
3-Q	6.00	0.0
3-Q	10.00	0.0
4-Q	4.00	0.0
4-Q	8.00	0.0
4-Q	12.00	0.0

EXPECTED DISCOUNTED COST = 12.323
STANDARD DEVIATION = 0.528

DEBT ISSUANCE FOR THE NEXT 12 MONTHS STRATEGY NUMBER 24
(IN MILLIONS OF DOLLARS)

	NINE-MONTH BONDS	SIX-MONTH BONDS	DISCOUNT NOTES 10, 20, OR 30 DAY
FIRST MONTH	0.0	0.0	0.0
LAST THIRD			0.0
SECOND MONTH	0.0	0.0	17.000
THIRD MONTH	0.0	0.0	39.000
FOURTH MONTH	0.0	0.0	0.0
LAST THIRD			0.0
FIFTH MONTH	16.000	0.0	0.0
SIXTH MONTH	11.000	0.0	0.0
SEVENTH MONTH	21.000	0.0	0.0
LAST THIRD			23.000
EIGHT MONTH	40.000	0.0	16.000
NINTH MONTH	0.0	0.0	24.000
TENTH MONTH	0.0	0.0	32.000
LAST THIRD			45.000
ELEVENTH MONTH	75.000	0.0	0.0
TWELFTH MONTH	7.540	0.0	0.0

LONG-TERM BONDS

MONTH OR QUARTER	MATURITY	AMOUNT
3-M	4.00	2.000
4-M	5.00	50.000
7-M	5.00	0.0
12-M	4.50	0.0
1-Q	1.00	0.0
2-Q	2.00	0.0
2-Q	4.00	0.0
2-Q	7.00	24.000
3-Q	3.00	0.0
3-Q	6.00	0.0
3-Q	10.00	0.0
4-Q	4.00	0.0
4-Q	8.00	0.0
4-Q	12.00	0.0

EXPECTED DISCOUNTED COST = 12.210
STANDARD DEVIATION = 0.621

DEBT ISSUANCE FOR THE NEXT 12 MONTHS STRATEGY NUMBER 27
(IN MILLIONS OF DOLLARS)

	NINE-MONTH BONDS	SIX-MONTH BONDS	DISCOUNT NOTES 10, 20, OR 30 DAY
FIRST MONTH	0.0	0.0	0.0
LAST THIRD			0.0
SECOND MONTH	0.0	0.0	17.000
THIRD MONTH	0.0	0.0	39.000
FOURTH MONTH	0.0	0.0	0.0
LAST THIRD			0.0
FIFTH MONTH	16.000	0.0	0.0
SIXTH MONTH	11.000	0.0	0.0
SEVENTH MONTH	21.000	0.0	0.0
LAST THIRD			23.000
EIGHT MONTH	56.000	0.0	0.0
NINTH MONTH	8.000	0.0	0.0
TENTH MONTH	8.000	0.0	0.0
LAST THIRD			13.000
ELEVENTH MONTH	43.000	0.0	0.0
TWELFTH MONTH	7.540	0.0	0.0

LONG-TERM BONDS

MONTH OR QUARTER	MATURITY	AMOUNT
3-M	4.00	2.000
4-M	5.00	50.000
7-M	5.00	0.0
12-M	4.50	0.0
1-Q	1.00	0.0
2-Q	2.00	0.0
2-Q	4.00	0.0
2-Q	7.00	24.000
3-Q	3.00	0.0
3-Q	6.00	0.0
3-Q	10.00	0.0
4-Q	4.00	0.0
4-Q	8.00	0.0
4-Q	12.00	0.0

EXPECTED DISCOUNTED COST = 12.175
STANDARD DEVIATION = 0.657

DEBT ISSUANCE FOR THE NEXT 12 MONTHS STRATEGY NUMBER 31
(IN MILLIONS OF DOLLARS)

	NINE-MONTH BONDS	SIX-MONTH BONDS	DISCOUNT NOTES 10, 20, OR 30 DAY
FIRST MONTH	0.0	0.0	0.0
LAST THIRD			0.0
SECOND MONTH	0.0	0.0	17.000
THIRD MONTH	0.0	0.0	39.000
FOURTH MONTH	0.0	0.0	0.0
LAST THIRD			0.0
FIFTH MONTH	0.0	0.0	16.000
SIXTH MONTH	0.0	0.0	27.000
SEVENTH MONTH	0.0	0.0	0.0
LAST THIRD			23.000
EIGHT MONTH	56.000	0.0	0.0
NINTH MONTH	8.000	0.0	0.0
TENTH MONTH	8.000	0.0	0.0
LAST THIRD			13.000
ELEVENTH MONTH	43.000	0.0	0.0
TWELFTH MONTH	0.0	7.540	0.0

LONG-TERM BONDS

MONTH OR QUARTER	MATURITY	AMOUNT
3-M	4.00	2.000
4-M	5.00	50.000
7-M	5.00	48.000
12-M	4.50	0.0
1-Q	1.00	0.0
2-Q	2.00	0.0
2-Q	4.00	0.0
2-Q	7.00	24.000
3-Q	3.00	0.0
3-Q	6.00	0.0
3-Q	10.00	0.0
4-Q	4.00	0.0
4-Q	8.00	0.0
4-Q	12.00	0.0

EXPECTED DISCOUNTED COST = 12.078
STANDARD DEVIATION = 1.142

***** END OF THE SOLUTIONS *****

APPENDIX B

Contains:

(1) Matrix generator program QPMAT

(2) Report writer program QPRWT

(3) Modification necessary to the Rand Quadratic Program

FILE: QPMAT FORTRAN A CORNELL VM/SP CMS IEVEL 104

```
      DIMENSION R(70,10),DEV(70,10),Z(8,10),CON(70),E(70),S(12,10),      QPM00010
     $P(20),PROB(10),VC(70,70),DEM(16),CM(70),NT(12),NTM(12),TTM(12,4),  QPM00020
     $NTQ(4),TTQ(4,4),TTME(12,4),TTQE(4,4),ZTM(20,10),ZTQ(20,10)         QPM00030
      DATA NTM/12*0/                                                     QPM00040
      DATA NTQ/4*0/                                                      QPM00050
      DATA NZ,NZ1,NZ2,NZ3,NZ4/5*2/                                       QPM00060
      DATA NY,NY1,NY2,NY3,NY4/5*2/                                       QPM00070
      DATA CM/70*0./                                                     QPM00080
      DATA CON/70*0./                                                    QPM00090
      NO=2                                                               QPM00100
      NT6=12                                                             QPM00110
      NT7=13                                                             QPM00120
C                                                                        QPM00130
      WRITE(6,220)                                                       QPM00140
220   FORMAT( ' THIS IS A QPRAND MATRIX GENERATOR',/)                    QPM00150
      WRITE(6,221)                                                       QPM00160
221   FORMAT( ' WRITTEN BY',/)                                           QPM00170
      WRITE(6,222)                                                       QPM00180
      WRITE(6,223)                                                       QPM00190
      WRITE(6,224)                                                       QPM00200
222    FORMAT( 10X, ' LOREN TAUER')                                      QPM00210
223   FORMAT( 10X, ' DEPT. OF AG. ECON.')                                QPM00220
224   FORMAT( 10X, ' CORNELL UNIVERSITY',//)                             QPM00230
C                                                                        QPM00240
C THIS SECTION IS WHERE THE DATA IS READ                                 QPM00250
C                                                                        QPM00260
      DO 810 J=1,12                                                      QPM00270
      WRITE(6,700)J                                                      QPM00280
700   FORMAT( ' IS THERE A TERM BOND(S) FOR MONTH',I3,                   QPM00290
     $' ? ENTER 1 FOR YES, 2 FOR NO')                                    QPM00300
      READ(5,*)NT(J)                                                     QPM00310
      IF(NT(J).EQ.NO) GO TO 810                                          QPM00320
      WRITE(6,702)J                                                      QPM00330
702   FORMAT( ' ENTER THE NUMBER OF TERM ISSUES FOR MONTH',I3,           QPM00340
     $', THE LIMIT IS 4')                                                QPM00350
      READ(5,*)NTM(J)                                                    QPM00360
      NTMJ=NTM(J)                                                        QPM00370
      DO 810 J2=1,NTMJ                                                   QPM00380
      WRITE(6,703)J2,J                                                   QPM00390
703   FORMAT( ' ENTER THE TERM OF TERM BOND',I3,' FOR MONTH',I3)         QPM00400
      READ(5,*)TTM(J,J2)                                                 QPM00410
      WRITE(NT7,860)TTM(J,J2),J,J2                                       QPM00420
810   CONTINUE                                                           QPM00430
      DO 811 J=1,4                                                       QPM00440
      WRITE(6,200)J                                                      QPM00450
200   FORMAT( ' ENTER THE NUMBER OF TERM ISSUES FOR QUARTER',I3,         QPM00460
     $', THE LIMIT IS 4')                                                QPM00470
      READ(5,*)NTQ(J)                                                    QPM00480
      NTQJ=NTQ(J)                                                        QPM00490
      DO 811 J2=1,NTQJ                                                   QPM00500
      WRITE(6,704)J2,J                                                   QPM00510
704   FORMAT( ' ENTER THE TERM OF TERM BOND',I3,' FOR QUARTER',I3)       QPM00520
      READ(5,*)TTQ(J,J2)                                                 QPM00530
      WRITE(NT7,870)TTQ(J,J2),J,J2                                       QPM00540
811   CONTINUE                                                           QPM00550
```

```
      WRITE(6,201)                                                      QPM00560
201   FORMAT( ' ENTER THE NUMBER OF INTEREST RATE FORECASTS, THE LIMIT  QPM00570
     $IS 10')                                                           QPM00580
      READ(5,*)M                                                        QPM00590
      DO 11 J=1,M                                                       QPM00600
      WRITE(6,203)J                                                     QPM00610
203   FORMAT( ' ENTER THE PROBABILITY OF FORECAST',I3)                  QPM00620
      READ(5,*)PRCB(J)                                                  QPM00630
      WRITE(6,204)J                                                     QPM00640
204   FORMAT( ' ENTER THE 12 MONTHLY DISCOUNTING RATES FOR FORECAST',I3)QPM00650
      READ(5,*)(S(I,J),I=1,12)                                          QPM00660
      WRITE(6,205)J                                                     QPM00670
205   FORMAT( ' ENTER THE 16 DISCOUNT NOTE RATES FOR FORECAST',I3)      QPM00680
      READ(5,*)(R(I,J),I=1,16)                                          QPM00690
      WRITE(6,206)J                                                     QPM00700
206   FORMAT( ' ENTER THE 12 SIX-MONTH RATES FOR FORECAST',I3)          QPM00710
      READ(5,*)(R(I,J),I=17,28)                                         QPM00720
      WRITE(6,207)J                                                     QPM00730
207   FORMAT( ' ENTER THE 12 NINE-MONTH RATES FOR FORECAST',I3)         QPM00740
      READ(5,*)(R(I,J),I=29,40)                                         QPM00750
      I=40                                                              QPM00760
      DO 812 K=1,12                                                     QPM00770
      IF(NT(K).EQ.NO) GO TO 812                                         QPM00780
      NTMK=NTM(K)                                                       QPM00790
      DO 812 K2=1,NTMK                                                  QPM00800
      I=I+1                                                             QPM00810
      WRITE(6,813)TTM(K,K2),K,J                                         QPM00820
813   FORMAT( ' ENTER THE RATE FOR THE',F6.2,' YEAR TERM BOND FOR MONTH'QPM00830
     $,I3,' FORECAST',I3)                                               QPM00840
      READ(5,*)R(I,J)                                                   QPM00850
812   CONTINUE                                                          QPM00860
      DO 814 K=1,4                                                      QPM00870
      NTQK=NTQ(K)                                                       QPM00880
      DO 814 K2=1,NTQK                                                  QPM00890
      I=I+1                                                             QPM00900
      WRITE(6,815)TTQ(K,K2),K,J                                         QPM00910
815   FORMAT( ' ENTER THE RATE FOR THE',F6.2,' YEAR TERM BOND FOR QUARTEQPM00920
     $R',I3,', FORECAST',I3)                                            QPM00930
      READ(5,*)R(I,J)                                                   QPM00940
814   CONTINUE                                                          QPM00950
      WRITE(6,1209)                                                     QPM00960
1209  FORMAT( ' WOULD YOU LIKE TO USE DEBT TERMINATION ACTIVITIES?',/,  QPM00970
     $'  ENTER 1 FOR YES, 2 FOR NO')                                    QPM00980
      READ(5,*)KL                                                       QPM00990
      IF(KL.EQ.2) GO TO 11                                              QPM01000
            WRITE(6,209)J                                               QPM01010
209   FORMAT( ' ENTER THE 8 ENDING RATES FOR 1- TO 8-MONTH BONDS, FORECAQPM01020
     $ST',I3)                                                           QPM01030
      READ(5,*)(Z(N,J),N=1,8)                                           QPM01040
      I=40                                                              QPM01050
      DO 816 K=1,12                                                     QPM01060
      IF(NT(K).EQ.NO) GO TO 816                                         QPM01070
      NTMK=NTM(K)                                                       QPM01080
      DO 816 K2=1,NTMK                                                  QPM01090
      I=I+1                                                             QPM01100
```

```
      ITME(K,K2)=TTM(K,K2)-(13.-K)/12.                                  QPM01110
      WRITE(6,817)TTME(K,K2),J                                          QPM01120
817   FORMAT(' ENTER THE ENDING RATE FOR A',F6.2,' YEAR TERM BOND, FOREQPM01130
     $CAST',I3)                                                         QPM01140
      READ(5,*)ZTM(I,J)                                                 QPM01150
816   CONTINUE                                                          QPM01160
      DO 818 K=1,4                                                      QPM01170
      NTQK=NTQ(K)                                                       QPM01180
      DO 818 K2=1,NTQK                                                  QPM01190
      I=I+1                                                             QPM01200
      TTQE(K,K2)=TTQ(K,K2)-(4.77777778-K)/4.                            QPM01210
      WRITE(6,819)TTQE(K,K2),J                                          QPM01220
819   FORMAT(' ENTER THE ENDING RATE FOR A',F6.2,                       QPM01230
     $' YEAR TERM BOND, FORECAST',I3)                                   QPM01240
      READ(5,*)ZTQ(I,J)                                                 QPM01250
818   CONTINUE                                                          QPM01260
11    CONTINUE                                                          QPM01270
      NCOI=I                                                            QPM01280
      NSTOP=1000+NCOI                                                   QPM01290
      WRITE(6,211)                                                      QPM01300
211   FORMAT(' ENTER THE DEBT NEEDS FOR THE 16 PERIODS IN MILLIONS $')  QPM01310
      READ(5,*)(DEM(KK),KK=1,16)                                        QPM01320
      WRITE(6,218)                                                      QPM01330
218   FORMAT(' WOULD YOU LIKE TO PLACE MAX. CONSTRAINTS ON ANY',/,      QPM01340
     $' NOTE OR BOND GROUP? ENTER 1 FOR YES, 2 FOR NO')                 QPM01350
      READ(5,*)NY                                                       QPM01360
      IF(NY.EQ.NO) GO TO 79                                             QPM01370
      WRITE(6,820)                                                      QPM01380
820   FORMAT(' WOULD YOU LIKE TO PLACE MAX. CONSTRAINTS ON THE',/,      QPM01390
     $' DISCOUNT NOTES? ENTER 1 FOR YES, 2 FOR NO')                     QPM01400
      READ(5,*)NY1                                                      QPM01410
      IF(NY1.EQ.NO) GO TO 821                                           QPM01420
      WRITE(6,212)                                                      QPM01430
212   FORMAT(' ENTER THE MAXIMUM FOR EACH OF THE 16 DISCOUNT NOTES')    QPM01440
      READ(5,*)(CON(I),I=1,16)                                          QPM01450
821   CONTINUE                                                          QPM01460
      WRITE(6,822)                                                      QPM01470
 822   FORMAT(' WOULD YOU LIKE TO PLACE MAX. CONSTRAINTS ON THE',/,     QPM01480
     $' SIX-MONTH BONDS? ENTER 1 FOR YES, 2 FOR NO')                    QPM01490
      READ(5,*)NY2                                                      QPM01500
      IF(NY2.EQ.NO) GO TO 823                                           QPM01510
      WRITE(6,213)                                                      QPM01520
213   FORMAT(' ENTER THE MAXIMUM FOR EACH OF THE 12 SIX-MONTH BONDS')   QPM01530
      READ(5,*)(CON(I),I=17,28)                                         QPM01540
823   CONTINUE                                                          QPM01550
      WRITE(6,824)                                                      QPM01560
 824   FORMAT(' WOULD YOU LIKE TO PLACE MAX. CONSTRAINTS ON THE',/,     QPM01570
     $' NINE-MONTH BONDS? ENTER 1 FOR YES, 2 FOR NO')                   QPM01580
      READ(5,*)NY3                                                      QPM01590
      IF(NY3.EQ.NO) GO TO 825                                           QPM01600
      WRITE(6,214)                                                      QPM01610
214   FORMAT(' ENTER THE MAXIMUM FOR EACH OF THE 12 NINE-MONTH BONDS')  QPM01620
      READ(5,*)(CON(I),I=29,40)                                         QPM01630
825   CONTINUE                                                          QPM01640
      I=40                                                              QPM01650
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      WRITE(6,826)                                                      QPM01660
826   FORMAT( ' WOULD YOU LIKE TO PLACE MAX. CONSTRAINTS ON THE',/,     QPM01670
     $' LONG-TERM BONDS? ENTER 1 FOR YES, 2 FOR NO')                    QPM01680
      READ(5,*)NY4                                                     QPM01690
      IF(NY4.EQ.NO) GO TO 79                                           QPM01700
      DO 827 K=1,12                                                    QPM01710
      IF(NT(K).EQ.NO) GO TO 827                                        QPM01720
      NTMK=NTM(K)                                                      QPM01730
      DO 827 K2=1,NTMK                                                 QPM01740
      I=I+1                                                            QPM01750
      WRITE(6,828)TTM(K,K2),K                                          QPM01760
828   FORMAT( ' ENTER THE MAX. FOR THE',F6.2,' YEAR TERM BOND FOR MONTH'QPM01770
     $,I3)                                                             QPM01780
      READ(5,*)CON(I)                                                  QPM01790
827   CONTINUE                                                         QPM01800
      DO 829 K=1,4                                                     QPM01810
      NTQK=NTQ(K)                                                      QPM01820
      DO 829 K2=1,NTQK                                                 QPM01830
      I=I+1                                                            QPM01840
      WRITE(6,830)TTQ(K,K2),K                                          QPM01850
830   FORMAT( ' ENTER THE MAX. FOR THE',F6.2,' YEAR TERM BOND FOR QUARTEQPM01860
     $R',I3)                                                           QPM01870
      READ(5,*)CON(I)                                                  QPM01880
829   CONTINUE                                                         QPM01890
79    CONTINUE                                                         QPM01900
      WRITE(6,225)                                                     QPM01910
225   FORMAT( ' WOULD YOU LIKE TO PLACE MIN. CONSTRAINTS ON ANY',/,     QPM01920
     $' NOTE AND BOND GROUP? ENTER 1 FOR YES, 2 FOR NO')               QPM01930
      READ(5,*)NZ                                                      QPM01940
      IF(NZ.EQ.NO) GO TO 80                                            QPM01950
      WRITE(6,831)                                                     QPM01960
831   FORMAT( ' WOULD YOU LIKE TO PLACE MIN. CONSTRAINTS ON THE',/,     QPM01970
     $' DISCOUNT NOTES? ENTER 1 FOR YES, 2 FOR NO')                    QPM01980
      READ(5,*)NZ1                                                     QPM01990
      IF(NZ1.EQ.NO) GO TO 832                                          QPM02000
      WRITE(6,226)                                                     QPM02010
226   FORMAT( ' ENTER THE MINIMUM FOR EACH OF THE 16 DISCOUNT NOTES')   QPM02020
      READ(5,*) (CM(I),I=1,16)                                         QPM02030
832   CONTINUE                                                         QPM02040
      WRITE(6,833)                                                     QPM02050
833   FORMAT( ' WOULD YOU LIKE TO PLACE MIN. CONSTRAINTS ON THE',/,     QPM02060
     $' SIX-MONTH BONDS? ENTER 1 FOR YES, 2 FOR NO')                   QPM02070
      READ(5,*)NZ2                                                     QPM02080
      IF(NZ2.EQ.NO) GO TO 834                                          QPM02090
      WRITE(6,227)                                                     QPM02100
227   FORMAT( ' ENTER THE MINIMUM FOR EACH OF THE 12 SIX-MONTH BONDS')  QPM02110
      READ(5,*) (CM(I),I=17,28)                                        QPM02120
834   CONTINUE                                                         QPM02130
      WRITE(6,835)                                                     QPM02140
835   FORMAT( ' WOULD YOU LIKE TO PLACE MIN. CONSTRAINTS ON THE',/,     QPM02150
     $' NINE-MONTH BONDS? ENTER 1 FOR YES, 2 FOR NO')                  QPM02160
      READ(5,*)NZ3                                                     QPM02170
      IF(NZ3.EQ.NO) GO TO 836                                          QPM02180
      WRITE(6,228)                                                     QPM02190
228   FORMAT( ' ENTER THE MIN. FOR EACH OF THE 12 NINE-MONTH BONDS')    QPM02200
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      READ(5,*)(CM(I),I=29,40)                                          QPM02210
836   CONTINUE                                                          QPM02220
      I=40                                                              QPM02230
      WRITE(6,837)                                                      QPM02240
837   FORMAT(' WOULD YOU LIKE TO PLACE MIN. CONSTRAINTS ON THE',/,      QPM02250
     $' LONG-TERM BONDS? ENTER 1 FOR YES, 2 FOR NO')                    QPM02260
      READ(5,*)NZ4                                                      QPM02270
      IF(NZ4.EQ.NO) GO TO 80                                            QPM02280
      DO 838 K=1,12                                                     QPM02290
      IF(NTM(K).EQ.NO) GO TO 838                                        QPM02300
      NTMK=NTM(K)                                                       QPM02310
      DO 838 K2=1,NTMK                                                  QPM02320
      I=I+1                                                             QPM02330
      WRITE(6,839)TTM(K,K2),K                                           QPM02340
839   FORMAT(' ENTER THE MIN. FOR THE',F6.2,                            QPM02350
     $' YEAR TERM BOND FOR MONTH',I3)                                   QPM02360
      READ(5,*)CM(I)                                                    QPM02370
838   CONTINUE                                                          QPM02380
      DO 840 K=1,4                                                      QPM02390
      NTQK=NTQ(K)                                                       QPM02400
      DO 840 K2=1,NTQK                                                  QPM02410
      I=I+1                                                             QPM02420
      WRITE(6,841)TTQ(K,K2),K                                           QPM02430
841   FORMAT(' ENTER THE MIN. FOR THE',F6.2,                            QPM02440
     $' YEAR TERM BOND FOR QUARTER',I3)                                 QPM02450
      READ(5,*)CM(I)                                                    QPM02460
840   CONTINUE                                                          QPM02470
80    CONTINUE                                                          QPM02480
      WRITE(6,216)                                                      QPM02490
216   FORMAT(' THE QPRAND MATRIX IS BEING GENERATED')                   QPM02500
C                                                                       QPM02510
C THIS SECTION IS WHERE THE COSTS ARE COMPUTED                          QPM02520
C                                                                       QPM02530
C THE DISCOUNT FACTORS ARE COMPUTED HERE                                QPM02540
            DO 20 J=1,M                                                 QPM02550
            P(1)=(1.+S(1,J)/1200.)                                      QPM02560
            DO 81 K=2,12                                                QPM02570
            P(K)=P(K-1)*(1.+S(K,J)/1200.)                               QPM02580
81    CONTINUE                                                          QPM02590
      DISAD=1.+S(12,J)/1200.                                            QPM02600
      DO 2100 K=13,20                                                   QPM02610
      P(K)=P(K-1)*DISAD                                                 QPM02620
2100  CONTINUE                                                          QPM02630
            K=0                                                         QPM02640
            N=1                                                         QPM02650
C DISCOUNT NOTES                                                        QPM02660
            DO 12 I=1,4                                                 QPM02670
      R(K+1,J)=(R(K+1,J)*.55555556)/P(N)                                QPM02680
            R(K+2,J)=(R(K+2,J)*.27777778)/P(N)                          QPM02690
      R(K+3,J)=(R(K+3,J)*.83333333)/P(N+1)                              QPM02700
      R(K+4,J)=(R(K+4,J)*.83333333)/P(N+2)                              QPM02710
            K=K+4                                                       QPM02720
            N=N+3                                                       QPM02730
12    CONTINUE                                                          QPM02740
C SIX-MONTH BONDS                                                       QPM02750
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            DO 13 I=17,23                                                   QPM02760
            R(I,J)=(R(I,J)*5.)/P(I-11)                                      QPM02770
13      CONTINUE                                                            QPM02780
        IF(KL.EQ.2) Z(1,J)=R(24,J)                                          QPM02790
        R(24,J)=(R(24,J)*5.-Z(1,J)*.83333333)/P(13)                         QPM02800
        IF(KL.EQ.2) Z(2,J)=R(25,J)                                          QPM02810
        R(25,J)=(R(25,J)*5.-Z(2,J)*1.6666667)/P(14)                         QPM02820
        IF(KL.EQ.2) Z(3,J)=R(26,J)                                          QPM02830
        R(26,J)=(R(26,J)*5.-Z(3,J)*2.5)/P(15)                               QPM02840
        IF(KL.EQ.2) Z(4,J)=R(27,J)                                          QPM02850
        R(27,J)=(R(27,J)*5.-Z(4,J)*3.3333333)/P(16)                         QPM02860
        IF(KL.EQ.2) Z(5,J)=R(28,J)                                          QPM02870
        R(28,J)=(R(28,J)*5.-Z(5,J)*4.1666667)/P(17)                         QPM02880
C NINE-MONTH BONDS                                                          QPM02890
        DO 14 I=29,32                                                       QPM02900
        R(I,J)=(R(I,J)*7.5)/P(I-20)                                         QPM02910
14      CONTINUE                                                            QPM02920
        DO 15 I=33,40                                                       QPM02930
        IF(KL.EQ.2) Z(I-32,J)=R(I,J)                                        QPM02940
        R(I,J)=(R(I,J)*7.5-Z(I-32,J)*(I-32)*.83333333)/P(I-20)              QPM02950
15      CONTINUE                                                            QPM02960
C LONG-TERM BONDS                                                           QPM02970
        RTN=(S(12,J)/1200.+1.)**6.-1.                                       QPM02980
        RTE=RTN                                                             QPM02990
        IF(S(12,J).EQ.0.) RTE=1.                                            QPM03000
        I=40                                                                QPM03010
        DO 842 K=1,6                                                        QPM03020
        IF(NT(K).EQ.NO) GO TO 842                                           QPM03030
        NTMK=NTM(K)                                                         QPM03040
        DO 842 K2=1,NTMK                                                    QPM03050
        I=I+1                                                               QPM03060
        IF(KL.EQ.2) ZTM(I,J)=R(I,J)                                         QPM03070
        R(I,J)=(R(I,J)*5.)/P(K+5)+(R(I,J)*5.-ZTM(I,J)*.83333333*(K-1))/     QPM03080
     $P(K+11)+(R(I,J)-ZTM(I,J))*5.*(1.-1./(1.+RTN)**((TTME(K,K2)-           QPM03090
     $.08333333*(K-1))*2))/RTE/P(K+11)                                      QPM03100
842     CONTINUE                                                            QPM03110
        DO 843 K=7,12                                                       QPM03120
        IF(NT(K).EQ.NO) GO TO 843                                           QPM03130
        NTMK=NTM(K)                                                         QPM03140
        DO 843 K2=1,NTMK                                                    QPM03150
        I=I+1                                                               QPM03160
        IF(KL.EQ.2) ZTM(I,J)=R(I,J)                                         QPM03170
        R(I,J)=(R(I,J)*5.-ZTM(I,J)*.83333333*(K-7))/P(K+5)+(R(I,J)-         QPM03180
     $ZTM(I,J))*5.*(1.-1./(1.+RTN)**((TTME(K,K2)-.083333333*(K-7))          QPM03190
     $*2))/RTE/P(K+5)                                                       QPM03200
843     CONTINUE                                                            QPM03210
        NTQ1=NTQ(1)                                                         QPM03220
        DO 844 K2=1,NTQ1                                                    QPM03230
        I=I+1                                                               QPM03240
        IF(KL.EQ.2) ZTQ(I,J)=R(I,J)                                         QPM03250
        R(I,J)=R(I,J)*5./P(6)+R(I,J)*5./P(12)+(R(I,J)-ZTQ(I,J))*5.*         QPM03260
     $(1.-1./(1.+RTN)**(TTQE(1,K2)*2))/RTE/P(12)                            QPM03270
844     CONTINUE                                                            QPM03280
        NTQ2=NTQ(2)                                                         QPM03290
        DO 845 K2=1,NTQ2                                                    QPM03300
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      I=I+1                                                              QPM03310
      IF(KL.EQ.2) ZTQ(I,J)=R(I,J)                                        QPM03320
      R(I,J)=R(I,J)*5./P(9)+(R(I,J)*5.-ZTQ(I,J)*2.5)/P(15)+(R(I,J)-      QPM03330
     $ZTQ(I,J))*5.*(1.-1./(1.+RTN)**((TTQE(2,K2)-.25)*2))/RTE/P(15)      QPM03340
845   CONTINUE                                                           QPM03350
      NTQ3=NTQ(3)                                                        QPM03360
      DO 846 K2=1,NTQ3                                                   QPM03370
      I=I+1                                                              QPM03380
      IF(KL.EQ.2) ZTQ(I,J)=R(I,J)                                        QPM03390
      R(I,J)=(R(I,J)*5.)/P(12)+(R(I,J)-ZTQ(I,J))*5.*(1.-1./(1.+RTN)**    QPM03400
     $(TTQE(3,K2)*2))/RTE/P(12)                                          QPM03410
846   CONTINUE                                                           QPM03420
      NTQ4=NTQ(4)                                                        QPM03430
      DO 1847 K2=1,NTQ4                                                  QPM03440
      I=I+1                                                              QPM03450
      IF(KL.EQ.2) ZTQ(I,J)=R(I,J)                                        QPM03460
      R(I,J)=(R(I,J)*5.-ZTQ(I,J)*2.5)/P(15)+(R(I,J)-ZTQ(I,J))*5.*(1.-1./QPM03470
     $(1.+RTN)**((TTQE(4,K2)-.25)*2))/RTE/P(15)                          QPM03480
1847  CONTINUE                                                           QPM03490
20    CONTINUE                                                           QPM03500
C                                                                        QPM03510
C THIS SECTION COMPUTES THE EXPECTED VALUES AND DEVIATIONS               QPM03520
C                                                                        QPM03530
      DO 19 I=1,NCOL                                                     QPM03540
      E(I)=0.                                                            QPM03550
      DO 17 J=1,M                                                        QPM03560
      E(I)=E(I)+R(I,J)*PROB(J)                                           QPM03570
17    CONTINUE                                                           QPM03580
      DO 18 J=1,M                                                        QPM03590
      DEV(I,J)=R(I,J)-E(I)                                               QPM03600
18    CONTINUE                                                           QPM03610
19    CONTINUE                                                           QPM03620
C                                                                        QPM03630
C THIS SECTION CREATES THE VARIANCE-COVARIANCE                           QPM03640
C                                                                        QPM03650
      DO 66 I=1,NCOL                                                     QPM03660
      DO 67 J=I,NCOL                                                     QPM03670
      VC(I,J)=0.                                                         QPM03680
      DO 68 K=1,M                                                        QPM03690
      VC(I,J)=DEV(I,K)*DEV(J,K)*PROB(K)+VC(I,J)                          QPM03700
68    CONTINUE                                                           QPM03710
      IF(I.NE.J) VC(I,J)=2.*VC(I,J)                                      QPM03720
67    CONTINUE                                                           QPM03730
66    CONTINUE                                                           QPM03740
C                                                                        QPM03750
C THIS SECTION IS WHERE THE RAND QP MATRIX IS GENERATED                  QPM03760
C                                                                        QPM03770
      WRITE(NT6,501)                                                     QPM03780
501   FORMAT( 4HROWS)                                                    QPM03790
      WRITE(NT6,502)                                                     QPM03800
502   FORMAT( 11X,4H$OBJ)                                                QPM03810
      DO 71 I=1001,1016                                                  QPM03820
      WRITE(NT6,503) I                                                   QPM03830
503   FORMAT( 12X,1HR,I4)                                                QPM03840
71    CONTINUE                                                           QPM03850
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C WRITE ROWS FOR ANY CONSTRAINTS                                        QPM03860
      NC=NCOL+1200                                                      QPM03870
      NI=NCOL+1100                                                      QPM03880
      IF(NY.EQ.NO) GO TO 72                                             QPM03890
504   FORMAT( 11X,2H+R,I4)                                              QPM03900
      IF(NY1.NE.NO) WRITE(NT6,504) (I,I=1101,1116)                      QPM03910
      IF(NY2.NE.NO) WRITE(NT6,504) (I,I=1117,1128)                      QPM03920
      IF(NY3.NE.NO) WRITE(NT6,504) (I,I=1129,1140)                      QPM03930
      IF(NY4.NE.NO) WRITE(NT6,504) (I,I=1141,NI)                        QPM03940
72    CONTINUE                                                          QPM03950
      IF(NZ.EQ.NO) GO TO 74                                             QPM03960
505   FORMAT( 11X,2H-R,I4)                                              QPM03970
      IF(NZ1.NE.NO) WRITE(NT6,505) (I,I=1201,1216)                      QPM03980
      IF(NZ2.NE.NO) WRITE(NT6,505) (I,I=1217,1228)                      QPM03990
      IF(NZ3.NE.NO) WRITE(NT6,505) (I,I=1229,1240)                      QPM04000
      IF(NZ4.NE.NO) WRITE(NT6,505) (I,I=1241,NC)                        QPM04010
74    CONTINUE                                                          QPM04020
      WRITE(NT6,405)                                                    QPM04030
C WRITE THE MATRIX SECTION                                              QPM04040
      WRITE(NT6,401)                                                    QPM04050
401   FORMAT( 6HMATRIX)                                                 QPM04060
C WRITE THE DISCOUNT NOTES                                              QPM04070
      DO 31 I=1001,1016                                                 QPM04080
      WRITE(NT6,402)I,E(I-1000)                                         QPM04090
402   FORMAT( 6X,1HP,I4,1X,3HOBJ,3X,F12.6)                              QPM04100
      WRITE(NT6,403)I,I                                                 QPM04110
403   FORMAT( 6X,1HP,I4,1X,1HR,I4,1X,'1.')                              QPM04120
      I2=I+100                                                          QPM04130
      I3=I+200                                                          QPM04140
      IF(NY1.NE.NO) WRITE(NT6,403)I,I2                                  QPM04150
      IF(NZ1.NE.NO) WRITE(NT6,403)I,I3                                  QPM04160
      DO 32 J=I,NSTOP                                                   QPM04170
      WRITE(NT6,404)I,J,VC(I-1000,J-1000)                               QPM04180
404   FORMAT( 6X,1HP,I4,1X,1HP,I4,1X,F12.6)                             QPM04190
32    CONTINUE                                                          QPM04200
31    CONTINUE                                                          QPM04210
C WRITE THE SIX-MONTH BONDS                                             QPM04220
      I=1017                                                            QPM04230
      WRITE(NT6,402)I,E(I-1000)                                         QPM04240
      DO 34 J=1001,1008                                                 QPM04250
      WRITE(NT6,403)I,J                                                 QPM04260
34    CONTINUE                                                          QPM04270
      I2=I+100                                                          QPM04280
      I3=I+200                                                          QPM04290
      IF(NY2.NE.NO) WRITE(NT6,403)I,I2                                  QPM04300
      IF(NZ2.NE.NO) WRITE(NT6,403)I,I3                                  QPM04310
      DO 35 J=I,NSTOP                                                   QPM04320
      WRITE(NT6,404)I,J,VC(I-1000,J-1000)                               QPM04330
35    CONTINUE                                                          QPM04340
      N=1003                                                            QPM04350
      DO 36 I=1018,1020                                                 QPM04360
      WRITE(NT6,402)I,E(I-1000)                                         QPM04370
      NN=N+7                                                            QPM04380
      DO 37 J=N,NN                                                      QPM04390
      WRITE(NT6,403)I,J                                                 QPM04400
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37    CONTINUE                                                    QPM04410
      I2=I+100                                                    QPM04420
      I3=I+200                                                    QPM04430
      IF(NY2.NE.NO) WRITE(NT6,403)I,I2                            QPM04440
      IF(NZ2.NE.NO) WRITE(NT6,403)I,I3                            QPM04450
      DO 38 J=I,NSTOP                                             QPM04460
      WRITE(NT6,404)I,J,VC(I-1000,J-1000)                         QPM04470
38    CONTINUE                                                    QPM04480
      N=N+1                                                       QPM04490
36    CONTINUE                                                    QPM04500
      N=1007                                                      QPM04510
      DO 39 I=1021,1023                                           QPM04520
      WRITE(NT6,402)I,E(I-1000)                                   QPM04530
      NN=N+7                                                      QPM04540
      DO 40 J=N,NN                                                QPM04550
      WRITE(NT6,403)I,J                                           QPM04560
40    CONTINUE                                                    QPM04570
      I2=I+100                                                    QPM04580
      I3=I+200                                                    QPM04590
      IF(NY2.NE.NO) WRITE(NT6,403)I,I2                            QPM04600
      IF(NZ2.NE.NO) WRITE(NT6,403)I,I3                            QPM04610
      DO 41 J=I,NSTOP                                             QPM04620
      WRITE(NT6,404)I,J,VC(I-1000,J-1000)                         QPM04630
41    CONTINUE                                                    QPM04640
      N=N+1                                                       QPM04650
39    CONTINUE                                                    QPM04660
      N=1011                                                      QPM04670
      DO 42 I=1024,1026                                           QPM04680
      WRITE(NT6,402)I,E(I-1000)                                   QPM04690
      DO 43 J=N,1016                                              QPM04700
      WRITE(NT6,403)I,J                                           QPM04710
43    CONTINUE                                                    QPM04720
      I2=I+100                                                    QPM04730
      I3=I+200                                                    QPM04740
      IF(NY2.NE.NO) WRITE(NT6,403)I,I2                            QPM04750
      IF(NZ2.NE.NO) WRITE(NT6,403)I,I3                            QPM04760
      DO 44 J=I,NSTOP                                             QPM04770
      WRITE(NT6,404)I,J,VC(I-1000,J-1000)                         QPM04780
44    CONTINUE                                                    QPM04790
      N=N+1                                                       QPM04800
42    CONTINUE                                                    QPM04810
      N=1015                                                      QPM04820
      DO 45 I=1027,1028                                           QPM04830
      WRITE(NT6,402)I,E(I-1000)                                   QPM04840
      DO 46 J=N,1016                                              QPM04850
      WRITE(NT6,403)I,J                                           QPM04860
46    CONTINUE                                                    QPM04870
      I2=I+100                                                    QPM04880
      I3=I+200                                                    QPM04890
      IF(NY2.NE.NO) WRITE(NT6,403)I,I2                            QPM04900
      IF(NZ2.NE.NO) WRITE(NT6,403)I,I3                            QPM04910
      DO 47 J=I,NSTOP                                             QPM04920
      WRITE(NT6,404)I,J,VC(I-1000,J-1000)                         QPM04930
47    CONTINUE                                                    QPM04940
      N=N+1                                                       QPM04950
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45    CONTINUE                                                    QPM04960
C WRITE THE NINE-MONTH BONDS                                      QPM04970
      I=1029                                                      QPM04980
      WRITE(NT6,402)I,E(I-1000)                                   QPM04990
      DO 48 J=1001,1012                                           QPM05000
      WRITE(NT6,403)I,J                                           QPM05010
48    CONTINUE                                                    QPM05020
      I2=I+100                                                    QPM05030
      I3=I+200                                                    QPM05040
      IF(NY3.NE.NO) WRITE(NT6,403)I,I2                            QPM05050
      IF(NZ3.NE.NO) WRITE(NT6,403)I,I3                            QPM05060
      DO 49 J=I,NSTOP                                             QPM05070
      WRITE(NT6,404)I,J,VC(I-1000,J-1000)                         QPM05080
49    CONTINUE                                                    QPM05090
      N=1003                                                      QPM05100
      DO 50 I=1030,1032                                           QPM05110
      WRITE(NT6,402)I,E(I-1000)                                   QPM05120
      NN=N+11                                                     QPM05130
      DO 51 J=N,NN                                                QPM05140
      WRITE(NT6,403)I,J                                           QPM05150
51    CONTINUE                                                    QPM05160
      I2=I+100                                                    QPM05170
      I3=I+200                                                    QPM05180
      IF(NY3.NE.NO) WRITE(NT6,403)I,I2                            QPM05190
      IF(NZ3.NE.NO) WRITE(NT6,403)I,I3                            QPM05200
      DO 52 J=I,NSTOP                                             QPM05210
      WRITE(NT6,404)I,J,VC(I-1000,J-1000)                         QPM05220
52    CONTINUE                                                    QPM05230
      N=N+1                                                       QPM05240
50    CONTINUE                                                    QPM05250
      N=1007                                                      QPM05260
      DO 53 I=1033,1035                                           QPM05270
      WRITE(NT6,402)I,E(I-1000)                                   QPM05280
      DO 54 J=N,1016                                              QPM05290
      WRITE(NT6,403)I,J                                           QPM05300
54    CONTINUE                                                    QPM05310
      I2=I+100                                                    QPM05320
      I3=I+200                                                    QPM05330
      IF(NY3.NE.NO) WRITE(NT6,403)I,I2                            QPM05340
      IF(NZ3.NE.NO) WRITE(NT6,403)I,I3                            QPM05350
      DO 55 J=I,NSTOP                                             QPM05360
      WRITE(NT6,404)I,J,VC(I-1000,J-1000)                         QPM05370
55    CONTINUE                                                    QPM05380
      N=N+1                                                       QPM05390
53    CONTINUE                                                    QPM05400
      N=1011                                                      QPM05410
      DO 56 I=1036,1038                                           QPM05420
      WRITE(NT6,402)I,E(I-1000)                                   QPM05430
      DO 57 J=N,1016                                              QPM05440
      WRITE(NT6,403)I,J                                           QPM05450
57    CONTINUE                                                    QPM05460
      I2=I+100                                                    QPM05470
      I3=I+200                                                    QPM05480
      IF(NY3.NE.NO) WRITE(NT6,403)I,I2                            QPM05490
      IF(NZ3.NE.NO) WRITE(NT6,403)I,I3                            QPM05500
```

```
      DO 58 J=I,NSTOP                                                    QPM05510
      WRITE(NT6,404)I,J,VC(I-1000,J-1000)                                QPM05520
58    CONTINUE                                                           QPM05530
      N=N+1                                                              QPM05540
56    CONTINUE                                                           QPM05550
      N=1015                                                             QPM05560
      DO 59 I=1039,1040                                                  QPM05570
      WRITE(NT6,402)I,E(I-1000)                                          QPM05580
      DO 60 J=N,1016                                                     QPM05590
      WRITE(NT6,403)I,J                                                  QPM05600
60    CONTINUE                                                           QPM05610
      I2=I+100                                                           QPM05620
      I3=I+200                                                           QPM05630
      IF(NY3.NE.NO) WRITE(NT6,403)I,I2                                   QPM05640
      IF(NZ3.NE.NO) WRITE(NT6,403)I,I3                                   QPM05650
      DO 61 J=I,NSTOP                                                    QPM05660
      WRITE(NT6,404)I,J,VC(I-1000,J-1000)                                QPM05670
61    CONTINUE                                                           QPM05680
      N=N+1                                                              QPM05690
59    CONTINUE                                                           QPM05700
C WRITE THE LONG-TERM BONDS                                              QPM05710
      KM=1000                                                            QPM05720
      I=1040                                                             QPM05730
      DO 64 K=1,12                                                       QPM05740
      IF(K.EQ.2.OR.K.EQ.5.OR.K.EQ.8.OR.K.EQ.11) KM=KM+1                  QPM05750
      KM=KM+1                                                            QPM05760
      IF(NT(K).EQ.NO) GO TO 64                                           QPM05770
      NTMK=NTM(K)                                                        QPM05780
      DO 64 K2=1,NTMK                                                    QPM05790
      I=I+1                                                              QPM05800
      WRITE(NT6,402)I,E(I-1000)                                          QPM05810
      DO 63 J=KM,1016                                                    QPM05820
      WRITE(NT6,403)I,J                                                  QPM05830
63    CONTINUE                                                           QPM05840
      I2=I+100                                                           QPM05850
      I3=I+200                                                           QPM05860
      IF(NY4.NE.NO) WRITE(NT6,403)I,I2                                   QPM05870
      IF(NZ4.NE.NO) WRITE(NT6,403)I,I3                                   QPM05880
      NAB=NCOL+1000                                                      QPM05890
      DO 64 J=I,NAB                                                      QPM05900
      WRITE(NT6,404)I,J,VC(I-1000,J-1000)                                QPM05910
64    CONTINUE                                                           QPM05920
      N=998                                                              QPM05930
      DO 62 K=1,4                                                        QPM05940
      N=N+4                                                              QPM05950
      NTQK=NTQ(K)                                                        QPM05960
      DO 62 K2=1,NTQK                                                    QPM05970
      I=I+1                                                              QPM05980
      WRITE(NT6,402)I,E(I-1000)                                          QPM05990
      DO 847 J=N,1016                                                    QPM06000
      WRITE(NT6,403)I,J                                                  QPM06010
847   CONTINUE                                                           QPM06020
      I2=I+100                                                           QPM06030
      I3=I+200                                                           QPM06040
      IF(NY4.NE.NO) WRITE(NT6,403)I,I2                                   QPM06050
```

```
      IF(NZ4.NE.NO) WRITE(NT6,403)I,I3                                  QPM06060
      NAD=NCOL+1000                                                     QPM06070
      DO 848 J=I,NAD                                                    QPM06080
      WRITE(NT6,404)I,J,VC(I-1000,J-1000)                               QPM06090
848   CONTINUE                                                          QPM06100
62    CONTINUE                                                          QPM06110
      WRITE(NT6,405)                                                    QPM06120
405   FORMAT( 3HEND)                                                    QPM06130
C WRITE THE RHS                                                         QPM06140
      WRITE(NT6,406)                                                    QPM06150
406   FORMAT( 3HRHS)                                                    QPM06160
      DO 65 I=1001,1016                                                 QPM06170
      WRITE(NT6,407)I,DEM(I-1000)                                       QPM06180
407   FORMAT( 6X,'E',5X,1HR,I4,1X,F12.6)                                QPM06190
65    CONTINUE                                                          QPM06200
      IF(NY.EQ.NO) GO TO 1070                                           QPM06210
      IF(NY1.EQ.NO) GO TO 1850                                          QPM06220
      DO 850 I=1101,1116                                                QPM06230
      WRITE(NT6,407)I,CON(I-1100)                                       QPM06240
850   CONTINUE                                                          QPM06250
1850  CONTINUE                                                          QPM06260
      IF(NY2.EQ.NO) GO TO 1851                                          QPM06270
      DO 851 I=1117,1128                                                QPM06280
      WRITE(NT6,407)I,CON(I-1100)                                       QPM06290
851   CONTINUE                                                          QPM06300
1851  CONTINUE                                                          QPM06310
      IF(NY3.EQ.NO) GO TO 1852                                          QPM06320
      DO 852 I=1129,1140                                                QPM06330
      WRITE(NT6,407)I,CON(I-1100)                                       QPM06340
852   CONTINUE                                                          QPM06350
1852  CONTINUE                                                          QPM06360
      IF(NY4.EQ.NO) GO TO 1070                                          QPM06370
      DO 70 I=1141,NI                                                   QPM06380
      WRITE(NT6,407)I,CON(I-1100)                                       QPM06390
70    CONTINUE                                                          QPM06400
1070  CONTINUE                                                          QPM06410
      IF(NZ.EQ.NO) GO TO 1069                                           QPM06420
      IF(NZ1.EQ.NO) GO TO 1854                                          QPM06430
      DO 854 I=1201,1216                                                QPM06440
      WRITE(NT6,407)I,CM(I-1200)                                        QPM06450
854   CONTINUE                                                          QPM06460
1854  CONTINUE                                                          QPM06470
      IF(NZ2.EQ.NO) GO TO 1855                                          QPM06480
      DO 855 I=1217,1228                                                QPM06490
      WRITE(NT6,407)I,CM(I-1200)                                        QPM06500
855   CONTINUE                                                          QPM06510
1855  CONTINUE                                                          QPM06520
      IF(NZ3.EQ.NO) GO TO 1856                                          QPM06530
      DO 856 I=1229,1240                                                QPM06540
      WRITE(NT6,407)I,CM(I-1200)                                        QPM06550
856   CONTINUE                                                          QPM06560
1856  CONTINUE                                                          QPM06570
      IF(NZ4.EQ.NO) GO TO 1069                                          QPM06580
      DO 69 I=1241,NC                                                   QPM06590
      WRITE(NT6,407)I,CM(I-1200)                                        QPM06600
```

FILE: QPMAT FORTRAN A CORNELL VM/SP CMS LEVEL 104

```
69    CONTINUE                                                          QPM06610
1069  CONTINUE                                                          QPM06620
      WRITE(NT6,405)                                                    QPM06630
      WRITE(NT6,408)                                                    QPM06640
408   FORMAT( 3HEOF)                                                   QPM06650
860   FORMAT( 1HM,2X,F6.2,I3,I3)                                        QPM06660
870   FORMAT( 1HQ,2X,F6.2,I3,I3)                                        QPM06670
      WRITE(6,217)NT6                                                   QPM06680
217   FORMAT( ' THE QPRAND MATRIX HAS BEEN CREATED ON FILE',I3)         QPM06690
      WRITE(6,2)NT7                                                     QPM06700
2     FORMAT( ' INFO. FOR THE REPORT WRITER HAS BEEN PLACED ON FILE',I3) QPM06710
      STOP                                                              QPM06720
      END                                                               QPM06730
```

FILE: QPRWT FORTRAN A CORNELL VM/SP CMS LEVEL 104

```
      DIMENSION S(70),MQ(30),TTQM(30),M1(30),M2(30)                    QPR00010
      REAL*8 V(12)                                                     QPR00020
      DATA V(1),V(2),V(3),V(4),V(5),V(6),V(7),V(8),V(9),V(10),V(11),   QPR00030
     $V(12)/'FIRST   ','SECOND  ','THIRD   ','FOURTH  ','FIFTH   ',    QPR00040
     $'SIXTH   ','SEVENTH ','EIGHT   ','NINTH   ','TENTH   ',         QPR00050
     $'EIEVENTH','TWELFTH'/                                            QPR00060
      DATA CK/'NEAR'/                                                  QPR00070
      DATA AK/'P10'/                                                   QPR00080
      ALINL=0.                                                         QPR00090
      ISCI=1                                                           QPR00100
      NT5=5                                                            QPR00110
       NT7=13                                                          QPR00120
      AQUAI=0.                                                         QPR00130
      WRITE(6,201)                                                     QPR00140
201   FORMAT( ' THE FOLLOWING ARE DEBT ISSUANCE STRATEGIES DERIVED BY A QPR00150
     $QUADRATIC PROGRAM',/)                                            QPR00160
      WRITE(6,202)                                                     QPR00170
      WRITE(6,203)                                                     QPR00180
      WRITE(6,204)                                                     QPR00190
      WRITE(6,205)                                                     QPR00200
202   FORMAT( ' THE PROCEDURE WAS WRITTEN BY',/)                       QPR00210
203   FORMAT( 10X,' IOREN IAUER')                                      QPR00220
204   FORMAT( 10X,' DEPT. OF AG. ECON.')                               QPR00230
205   FORMAT( 10X,' CORNELL UNIVERSITY'////)                           QPR00240
      N4=0                                                             QPR00250
300   CONTINUE                                                         QPR00260
      N4=N4+1                                                          QPR00270
      READ(NT7,301,END=302)MQ(N4),TTQM(N4),M1(N4),M2(N4)               QPR00280
301   FORMAT( A1,2X,F6.2,I3,I3)                                        QPR00290
      GO TO 300                                                        QPR00300
302   N4=N4-1                                                          QPR00310
      N5=N4+40                                                         QPR00320
C READ FILE UNTIL LINEAR TERM IS REACHED                               QPR00330
30    CONTINUE                                                         QPR00340
      READ(NT5,10,END=99)BCK                                           QPR00350
10    FORMAT( 61X,A4)                                                  QPR00360
      IF(BCK.NE.CK) GO TO 30                                           QPR00370
31    CONTINUE                                                         QPR00380
      READ(NT5,11,END=99)ALIN,AQUA                                     QPR00390
11    FORMAT( 54X,F17.6,5X,F19.6)                                      QPR00400
      IF(AQUA.LE.0.) AQUA=0.                                           QPR00410
      AQUA=SQRT(AQUA)*.001                                             QPR00420
      ALIN=ALIN*.001                                                   QPR00430
      IF(ALIN.EQ.ALINL.AND.AQUA.EQ.AQUAL) GO TO 30                     QPR00440
      READ(NT5,16)B1,B2,B3,B4                                          QPR00450
16    FORMAT(A4/A4/A4/A4)                                              QPR00460
      DO 23 J=1,N5                                                     QPR00470
      S(J)=0.                                                          QPR00480
23    CONTINUE                                                         QPR00490
24    CONTINUE                                                         QPR00500
      READ(NT5,12,END=41,ERR=99)ACK,M,B                                QPR00510
12    FORMAT( 3X,A3,I2,1X,F20.6)                                       QPR00520
      IF(ACK.NE.AK) GO TO 41                                           QPR00530
      DO 22 J=1,N5                                                     QPR00540
      IF(J.EQ.M) GO TO 50                                              QPR00550
```

FILE: QPRWT FORTRAN A CORNELL VM/SP CMS LEVEL 104

```
22    CONTINUE                                                          QPR00560
50    CONTINUE                                                          QPR00570
      S(J)=B                                                            QPR00580
      GO TO 24                                                          QPR00590
41    CONTINUE                                                          QPR00600
      WRITE(6,101)ISOL                                                  QPR00610
101   FORMAT('1',18X,' DEBT ISSUANCE FOR THE NEXT 12 MONTHS',2X,        QPR00620
     $'STRATEGY NUMBER',I3)                                             QPR00630
      WRITE(6,87)                                                       QPR00640
87    FORMAT( 25X,' (IN MILLIONS OF DOLLARS)',//)                       QPR00650
      WRITE(6,102)                                                      QPR00660
102   FORMAT( 22X,'NINE-MONTH',4X,'SIX-MONTH',4X,'DISCOUNT NOTES')      QPR00670
      WRITE(6,103)                                                      QPR00680
103   FORMAT( 24X,'BONDS',9X,'BONDS',7X,                                QPR00690
     $'10, 20, OR 30 DAY',/)                                            QPR00700
104   FORMAT( 2X,A8,1X,'MONTH',5X,F11.3,2X,F11.3,5X,F11.3)              QPR00710
105   FORMAT( 4X,'LAST THIRD',36X,F11.3)                                QPR00720
      WRITE(6,104)V(1),S(29),S(17),S(1)                                 QPR00730
      WRITE(6,105)S(2)                                                  QPR00740
      WRITE(6,104)V(2),S(30),S(18),S(3)                                 QPR00750
      WRITE(6,104)V(3),S(31),S(19),S(4)                                 QPR00760
      WRITE(6,104)V(4),S(32),S(20),S(5)                                 QPR00770
      WRITE(6,105)S(6)                                                  QPR00780
      WRITE(6,104)V(5),S(33),S(21),S(7)                                 QPR00790
      WRITE(6,104)V(6),S(34),S(22),S(8)                                 QPR00800
      WRITE(6,104)V(7),S(35),S(23),S(9)                                 QPR00810
      WRITE(6,105)S(10)                                                 QPR00820
      WRITE(6,104)V(8),S(36),S(24),S(11)                                QPR00830
      WRITE(6,104)V(9),S(37),S(25),S(12)                                QPR00840
      WRITE(6,104)V(10),S(38),S(26),S(13)                               QPR00850
      WRITE(6,105)S(14)                                                 QPR00860
      WRITE(6,104)V(11),S(39),S(27),S(15)                               QPR00870
      WRITE(6,104)V(12),S(40),S(28),S(16)                               QPR00880
      WRITE(6,401)                                                      QPR00890
401   FORMAT( //,30X,'LONG-TERM BONDS',/)                               QPR00900
      WRITE(6,402)                                                      QPR00910
402   FORMAT( 15X,'MONTH OR QUARTER',5X,'MATURITY',10X,'AMOUNT')        QPR00920
      DO 769 J=1,N4                                                     QPR00930
      WRITE(6,303)M1(J),MQ(J),TTQM(J),S(J+40)                           QPR00940
303   FORMAT( 20X,I2,1H-,A1,14X,F6.2,5X,F11.3)                          QPR00950
769   CONTINUE                                                          QPR00960
      WRITE(6,106)ALIN                                                  QPR00970
106   FORMAT( /,25X,'EXPECTED DISCOUNTED COST = ',F11.3)                QPR00980
      WRITE(6,107)AQUA                                                  QPR00990
107   FORMAT( 31X,'STANDARD DEVIATION = ',F11.3,///)                    QPR01000
      ALINI=ALIN                                                        QPR01010
      AQUAL=AQUA                                                        QPR01020
      ISOL=ISOL+1                                                       QPR01030
      GO TO 30                                                          QPR01040
99    CONTINUE                                                          QPR01050
      WRITE(6,108)                                                      QPR01060
108   FORMAT( 20X,'***** END OF THE SOLUTIONS *****')                   QPR01070
      STOP                                                              QPR01080
      END                                                               QPR01090
```

Changes in Rand QP

The following changes are necessary in the Rand Quadratic Program to make it operable as part of the Farm Credit Debt Selection Model.

```
2       ,A(30000)                                                MAIN0120
  DATA MINDMI,MINDM2,MINDM3          /15000,500,500/             MAIN0350
2       ,A(30000)                                                BGN 0050
  DO 350 I=5, 13, 2                                              CAP 1680
  KBCD(NTAL+1)=KM2(21)                                           OUP 0440
```