MAT1856/APM466 Assignment 1

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Fundamental Questions - 25 points

1.
   (a) Because printing more money is in danger of inflation, so the government cannot simply print money.
   (b) Arbitrage is one example. Because of the existence of arbitrage, even if the yield curve fluctuates greatly in the early stage (it may be an increase), people will rush in when they see it profitable, which eventually makes the price stable, and then the yield curve tends to be stable.
   (c) The central bank reduces the interest rate by purchasing other bonds, which increases the loan, and finally stimulates the economic market and restores the market economy and the Federal Reserve supports the smooth operation of the depressed market in the epidemic by Purchasing Treasury bonds and institutional mortgages.

2. CA135087E679,CA135087F825,CA135087H235,CA135087K528,CA15087K940,

   CA135087L443,CA135087L518,CA135087M847,CA135087L930,CA135087D507 First of all, the first common point of these 10 bonds is that the issuance range is greater than five years. Because we need to build a yield of 0-5 years, it is necessary to be greater than five years. Secondly, I mainly select bonds whose Issuance Date and Maturity Date are at the beginning or end of the month, which is conducive to subsequent calculation. Finally, the coupon rates of these 10 bonds are also similar.

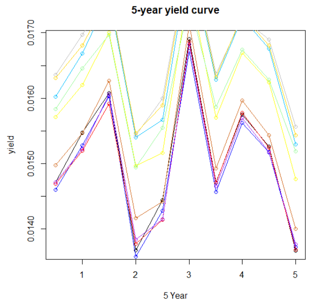
3. The purpose of principal component analysis is to simplify complex data and find the most critical variables. Because eigenvectors are vectors, they play a role in determining the directionality of variables. For example, the positive direction represents a positive effect and the negative direction represents a negative effect. Eigenvalues play a quantitative role and represent the value of variables. Combining eigenvectors and eigenvalues, we can distinguish the importance of different variables, and finally simplify the data.

Empirical Questions - 75 points

4.
   (a) Use bond in R language calculates YTM by bond.yield and plot a curve. (see code for details)
   (b) First, according to bond.TCF calculates the dirty price and cash flow, then calculates the daily spot rate of each bond separately, and finally summarizes it into a matrix and plots it.(see code for details)
   (c) Select the half year period of five cross years as the forecast (note that the duration is greater than the original data), and calculate the 4-year forward matrix according to the spot matrix made by Part B. finally, use the formula to solve the equation to calculate the result and draw the graph.(see code for details)

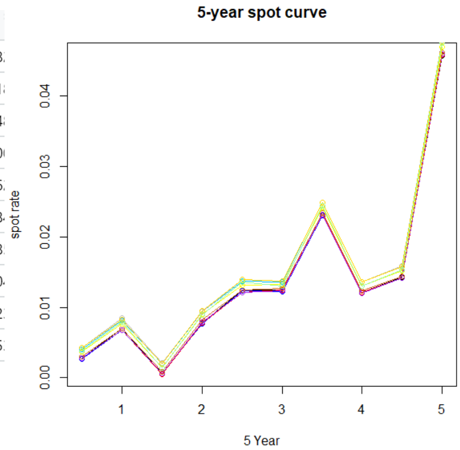
	V1	V2	V3	V4	V5	V6	V7	V8
1	0.0147156755660776	0.0154708642658976	0.0160823207555021	0.0136731683792992	0.0144475562671125	0.0169046849256844	0.0147133261619681	0.015
2	0.0145975449526223	0.0152764858362837	0.0160317674597561	0.0135760567275618	0.0142815995450443	0.0167155992336125	0.0145673034699914	0.015
3	0.014691680401242	0.0152003036635993	0.0159159593866463	0.0137735079682471	0.0141443605500209	0.0168605275801132	0.01470397460767	0.015
4	0.0147150936474199	0.0152226195037231	0.0160611423916159	0.0138402209432495	0.0141513097791961	0.0168255800409911	0.014660684355956	0.015
5	0.0149750725491336	0.0154620764537992	0.0162654572411478	0.0141698619567441	0.0144184439606896	0.0171254111641508	0.0149265253849071	0.015
6	0.0157112884780437	0.0162037143530087	0.0170061336397342	0.0149662422056522	0.01516580673389	0.0177319715731512	0.0157021120063563	0.016
7	0.0160214496201183	0.0166844651407878	0.0175492143271896	0.0153987056954881	0.0156687319990914	0.018126075704787	0.0162824634530643	0.017
8	0.016356347546207	0.016967196185818	0.017647419770161	0.0154344195421476	0.0159980625065854	0.0182474732109021	0.0163698456817829	0.017
9	0.0163093472629194	0.0168109277829487	0.0175802526619506	0.0154702005754834	0.0158895390184188	0.0181862980623277	0.0163270961202673	0.017
10	0.0158322675631424	0.0164552191031753	0.0169681978316092	0.0149418171281033	0.0155471410095238	0.0174880117348848	0.0158677489028127	0.016

Figure 1: bonds‘ yield(part)



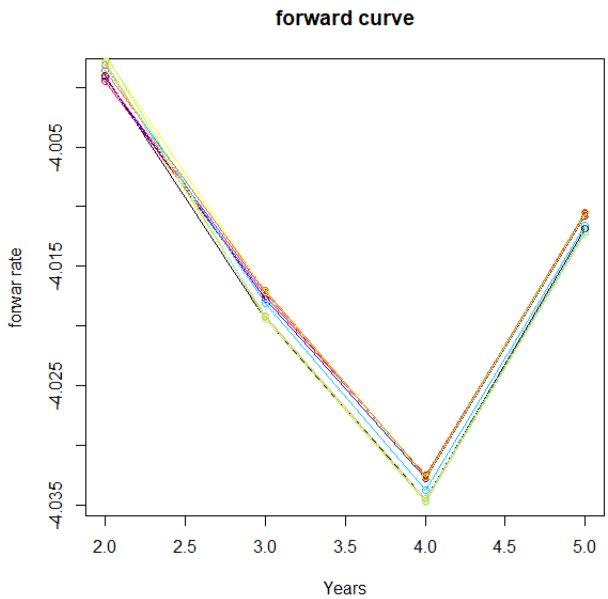
	V1	V2	V3	V4	V5	V6	V7
1	0.002768918	0.007003648	0.0006300444	0.007730126	0.01246928	0.01245065	0.0231618
2	0.002644899	0.006808626	0.0005743985	0.007628332	0.01229934	0.01226424	0.0230161
3	0.002730410	0.006729459	0.0004549486	0.007819984	0.01215995	0.01240513	0.0231634
4	0.002745537	0.006746891	0.0005891082	0.007880657	0.01216591	0.01236921	0.0231240
5	0.002990434	0.006977159	0.0007810626	0.008202865	0.01243566	0.01266091	0.0234046
6	0.003682638	0.007691204	0.0014316316	0.008977475	0.01319061	0.01324864	0.0242248
7	0.003976288	0.008158740	0.0019634826	0.009401148	0.01370001	0.01363185	0.0248318
8	0.004293987	0.008431942	0.0020492878	0.009430580	0.01397105	0.01374868	0.0249280
9	0.004240597	0.008273865	0.0019787281	0.009461064	0.01392034	0.01368749	0.0248892
10	0.003769360	0.007920102	0.0013638850	0.008930779	0.01356814	0.01300306	0.0244195

Figure 2: bonds‘ yield(part)



	V1	V2	V3	V4
1	-3.999049	-4.019479	-4.034458	-4.011814
2	-3.999257	-4.017746	-4.032748	-4.010748
3	-3.999487	-4.017437	-4.032512	-4.010573
4	-3.999179	-4.017169	-4.032703	-4.010675
5	-3.998592	-4.017045	-4.032576	-4.010492
6	-3.997342	-4.017098	-4.032721	-4.010634
7	-3.998176	-4.018142	-4.033752	-4.011574
8	-3.998042	-4.019222	-4.034469	-4.012116
9	-3.997904	-4.019240	-4.034632	-4.012271
10	-3.997137	-4.019414	-4.034730	-4.012284

Figure 3: forwa matrix



	V1	V2	V3	V4	V5
1	0.013308585	0.0027329397	0.0023639890	0.0023812809	0.0022110321
2	0.002732940	0.0006227158	0.0005217254	0.0005516424	0.0004759081
3	0.002363989	0.0005217254	0.0004591144	0.0004660141	0.0004023193
4	0.002381281	0.0005516424	0.0004660141	0.0005067686	0.0004336333
5	0.002211032	0.0004759081	0.0004023193	0.0004336333	0.0004745222

Figure 4: yield co-variance matrix

	V1	V2	V3	V4
1	2.355868e-08	1.825165e-09	1.150664e-09	3.237076e-09
2	1.825165e-09	4.239375e-08	3.765548e-08	2.699423e-08
3	1.150664e-09	3.765548e-08	3.579161e-08	2.547960e-08
4	3.237076e-09	2.699423e-08	2.547960e-08	1.871009e-08

Figure 5: forward co-variance matrix

	V1
1	1.510424e-02
2	1.637856e-04
3	8.469441e-05
4	1.235221e-05
5	6.634531e-06

Figure 6: yield eigenvalue

	V1	V2	V3	V4	V5
1	0.9380141	0.3380113	0.02492234	-0.04275054	0.05855893
2	0.1947548	-0.4632229	-0.32924763	-0.46851443	-0.64775410
3	0.1681080	-0.2994184	-0.30926966	0.86336226	-0.20259857
4	0.1704314	-0.6002415	-0.24870659	-0.16074262	0.72316673
5	0.1577749	-0.4703527	0.85642991	0.08622093	-0.11388227

Figure 7: yield eigenvectors

5. Firstly, according to the data of 10 days and the yield matrix obtained in 4A, it is easy to build a new YTM matrix according to the time sequence, and then use the log return method to calculate the covariance matrix of YTM. Similarly, it is easy to calculate the forward covariance matrix by using the forward matrix obtained in 4C and log return.

6. The largest eigenvector represents the best growth trend, and the largest eigenvalue represents the most important data (according to PCA).

References and GitHub Link to Code

Reference: https://www.rdocumentation.org/packages/jrvFinance/versions/1.4.3
github: https://github.com/ZCZCZCNB/APM-466-assignment-1.git

	V1
1	9.511471e-08
2	2.358048e-08
3	1.546252e-09
4	2.127002e-10

Figure 8: forwar eigenvalue

	V1	V2	V3	V4
1	-0.04644104	0.99512612	-0.02377506	-0.08367779
2	-0.66031716	-0.04768412	-0.74937029	0.01231417
3	-0.60819872	-0.06506706	0.53041712	-0.58695679
4	-0.43808538	0.05671418	0.39564705	0.80518825

Figure 9: forward eigenvector