VALUE-at-RISK (VaR) COMPUTATIONS under VARIOUS VaR MODELS and STRESS TESTING

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Abstract

Bank for International Settlements (BIS) proposes that all banks calculate and report amount of market risk they incur and allocate sufficient amount of capital starting form beginning of year 2002. BIS also suggests that value-at-risk (VaR) models in computing market risk should be used. The Turkish Bank Regulation and Supervision Agency already required all Turkish banks to compute and periodically report market risk and reserve adequate amount of capital starting from February, 2002. This study mimics an average trading marketable securities portfolio of four largest Turkish Banks subject to market risk. The publicly available quarterly financial reports of year 2001 of Isbank, Garanti, Yapı Kredi and Akbank are examined and a mimicking portfolio composition is determined as bond investments of 60% in Turkish currency (TRL), 20% in American dollar (USD) and 20% in Euro (EUR). The VaR amounts of mimicking portfolio are computed by applying Historical Simulation, Monte Carlo Simulation, Delta-Normal and Standard Methods. Finally, stress test is applied to each of the models by using crisis scenarios. The Turkish financial crises in November, 2000 and February 2001 are simulated as stress scenarios. The results of stress testing reveal that all methods except standard method can stand the crisis in November 2000, but none of the models can stand the crisis in February 2001.

VALUE-at-RISK (VAR) COMPUTATIONS under VARIOUS VAR MODELS and STRESS TESTING

1. Introduction

Financial markets and institutions have operated in a fast changing economic environment in recent years. There could be more than 100 crises cited in the economic literature over the last 20 years. This makes, on the average, five financial crises per year. Therefore, someone might argue that the importance of risk management for financial institutions has kept increasing at an increasing rate. Lately, the overview of banks about risk management has been proactive. As a result of this understanding, banks have concentrated on identifying all kinds of risks which likely affect banks' financial position, and measuring and managing financial risks by applying various value-at-risk (VaR) models. The crisis often occurred in recent years have led financial managers to be precautious. Then, the need for questioning stress testing of employed VaR models has come across. Stress testing attempts to identify the weakest points of a portfolio by pinpointing the crucial risk factors causing the losses in the portfolio most. Stress testing is applied for banks' portfolio by simulating likely worst case scenarios. Financial crisis actually occurred in the past might be a good approximation for the worst case scenarios.

This research computes the amount of VaR of a mimicking portfolio under various VaR models and examines the effects of stress scenarios on banks' capital adequacy. By using publicly available quarterly financial reports of year 2001 of four largest Turkish banks (namely; Garanti, YapiKredi, Isbank and Akbank), a mimic trading marketable securities portfolio is composed. The examination of marketable securities portfolio of the underlying banks reveals that their trading portfolios on the average are included 1.5 units of securities denominated in Turkish currency (TRL) for every 0.5 unit of security denominated in US dollar (USD) and 0.5 unit of security denominated in euro (EUR). Based on this analysis and knowing that the trading securities portfolios of the Turkish banks are almost completely composed of bond investments, it is assumed that a mimic bond portfolio (nominal value of 2,500 trillion TRL) is currently held, which is composed of %60 TRL, 20% USD and %20 EUR denominated bonds. The bonds invested in the portfolio are chosen as the ones traded most heavily in the secondary market. The definition of the bonds invested is presented in Table 1.

Table 1: Definition of Investments in Bonds in the Mimic Portfolio

Code of Bond		Type of Bond	Currency	Maturity (dd.mm.yy)	Time to Mat. (Month)	Nominal Amount (Mil. USD/EUR, Bil.	Present Value
Bond 1	US900123AL40	Eurobond	USD	15.01.2030	335.4	66	340.688
Bond 2	US900123AM23	Eurobond	USD	27.11.2006	53.7	66	153.741
Bond 3	US900123AP53	Eurobond	USD	19.03.2008	69.6	66	158.811
Bond 4	US900147AB51	Eurobond	USD	15.06.2010	96.9	66	187.872
Bond 5	XS0086996310	Eurobond	USD	12.05.2003	10.5	66	117.565
Bond 6	DE0001972354	Eurobond	EURO	06.02.2003	7.4	72	127.435
Bond 7	DE0002938727	Eurobond	EURO	15.03.2004	20.8	72	136.217
Bond 8	DE0003544904	Eurobond	EURO	17.12.2002	5.7	72	128.661
Bond 9	DE0007751752	Eurobond	EURO	07.02.2005	31.8	72	148.421
Bond 10	DE0008553470	Eurobond	EURO	08.05.2007	59.1	72	155.609
Bond 11	TRB231002T17	T-Bill	TRL	23.10.2002	3.8	300,000	261.207
Bond 12	TRT050203T18	T-Bond	TRL	05.02.2003	7.3	300,000	220.557
Bond 13	TRT210104T18	T-Bond	TRL	21.01.2004	19.0	300,000	319.865
Bond 14	TRT170304T12	T-Bond	TRL	17.03.2004	20.9	300,000	334.577
Bond 15	TRB050303T17	T-Bill	TRL	05.03.2003	8.3	300,000	211.439
Total					**TRL**	**2,500,000**	**3,002,665**

2. Methodology and Data

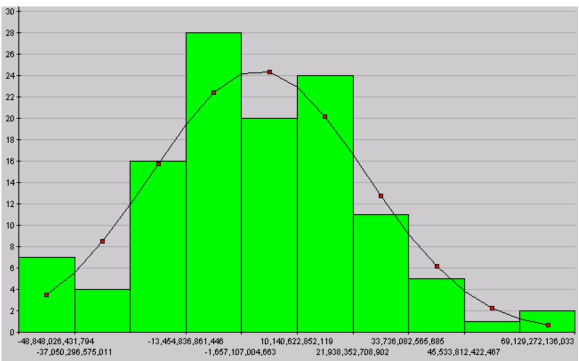
This study employs Historical Simulation, Monte Carlo Simulation, Delta-Normal and Standard Methods for market risk computations of the mimicking bond portfolio. Among these, Delta-Normal and standard methods are parametric; Historical and Monte Carlo models are based on simulations.

BIS suggests that market risk computations under VaR models should use 10-day holding period and 99% confidence level. On the other hand, JP Morgan suggests that 1-day holding period and 95% confidence level should be used. This study employs both 95% and 99% confidence level, and 1-day and 10-day holding period intervals in all VaR computations except in standard model. BIS also suggests that one-year historical observations on the asset returns should be utilized in VaR computations. This study uses 200 working day historical observations (exchange and interest rates), which approximates one calender year. The KVaR 3.6 software program developed by Reuters is applied for the computation of VaR values of the mimicking portfolio under Historical Simulation and Monte Carlo Simulation models. JP Riskmetrics methodology is employed for variance-covariance matrix computations in Delta-Normal model . The maturity interval form PR200A required by Turkish Bank Regulatory and Supervisory Agency for market risk calculations is used to apply the standard model.

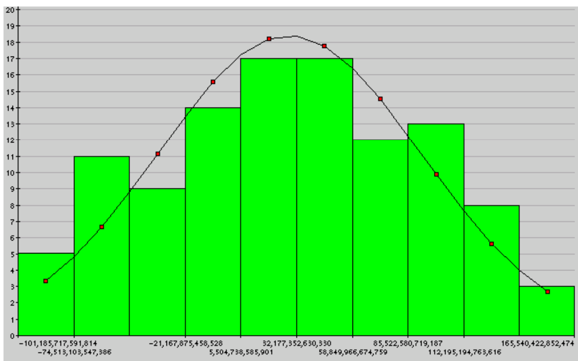
Historical Simulation Method does not assume any specific distribution for asset returns. It presumes that a defined portfolio is held at a particular point in time and previously observed various return scenarios are applied to the portfolio to measure the value changes in portfolio value. First, an expected interest rate for each of bond in the portfolio considering its time to maturity is determined using a previously developed yield curve. Then, daily changes in bond values are computed by using daily historical changes in interest rates. Considering the weights of each group of bonds in the portfolio and the correlations among the bonds, daily profits/losses are computed backward for 200 days for each bond and the whole portfolio. As a result of this process, a number of different portfolio values are obtained and these values are mapped from highest to lowest. Then, the VaR value of the portfolio is read on the map for a given confidence level and holding period. The VaR value is determined to be the worst loss in the portfolio on the 190th observation at 95% confidence level and on the 198th observation at the 99% confidence level. Graph 1 presents the expected profits/losses of the portfolio for 1-day and 10-day holding periods under Historical Simulations. Graph 2 shows the variations from normal distribution at 95% and 99% confidence level for 1-day and 10-day holding periods. (Also see Table 2).

Graph 1: Distributions under Historical Simulation

Holding Period = 1-Day

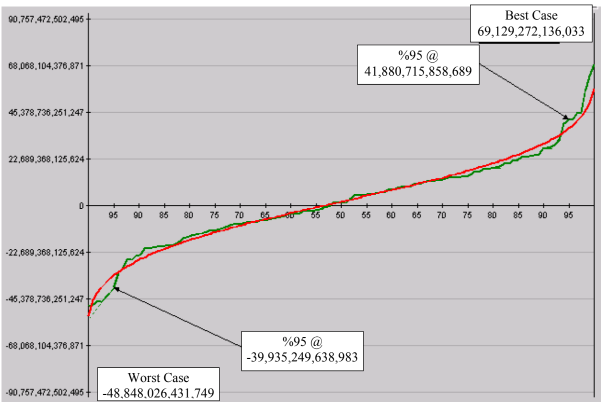


Holding Period = 10-Day

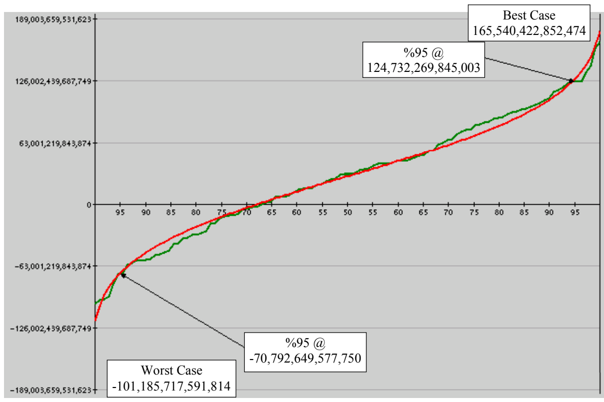


Graph 2: Variations from Normal Distribution

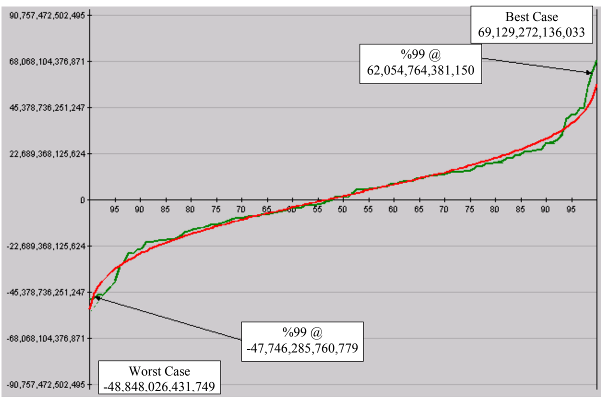
CL = 95%, T = 1-Day



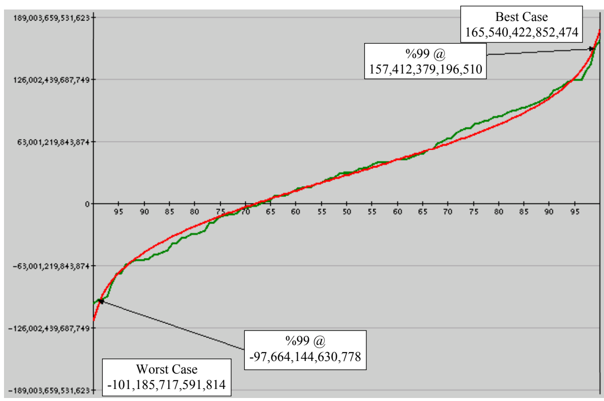
CL = 95%, T = 10-Day



CL = 99%, T = 1-Day



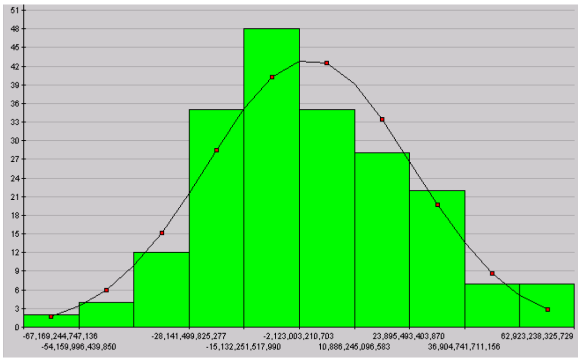
CL = 99%, T = 10-Day



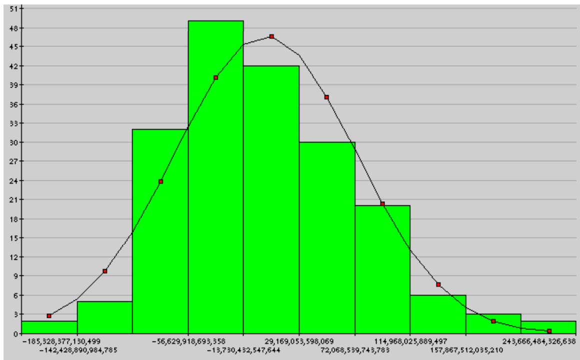
Monte Carlo Simulation model uses historical observations to identify the correlations among risk factors and then computes variance-covariance matrix. By utilizing this computed variance-covariance matrix, randomly produced expected asset returns are generated. The asset returns generation process is repeated 300 times, and daily expected profits/losses of each bond and the whole portfolio are computed. The resulted VaR values at 95% and 99% confidence level are obtained. Graph 3 shows the expected profits/losses of the portfolio for 1-day and 10-day holding periods under Monte Carlo Simulation. Graph 4 presents the variations from normal distribution at 95% and 99% confidence level for 1-day and 10-day holding period. (Also see Table 3).

Graph 3: Distributions under Monte Carlo Simulation

Holding Period = 1-Day

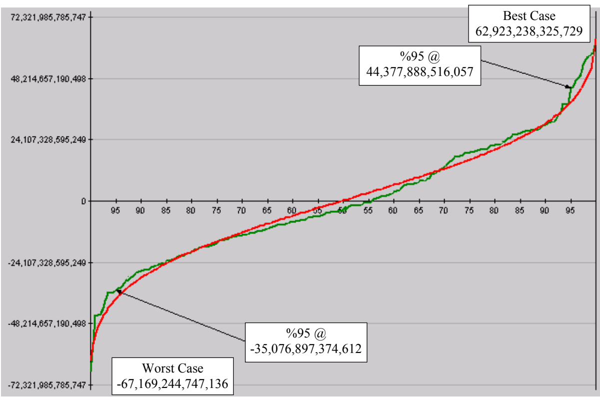


Holding Period = 10-Day

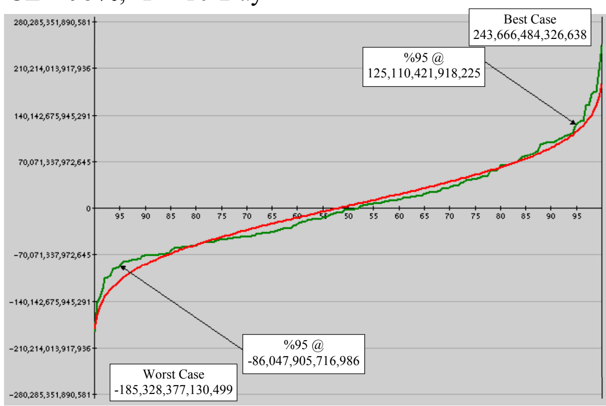


Graph 4: Variations from Normal Distribution

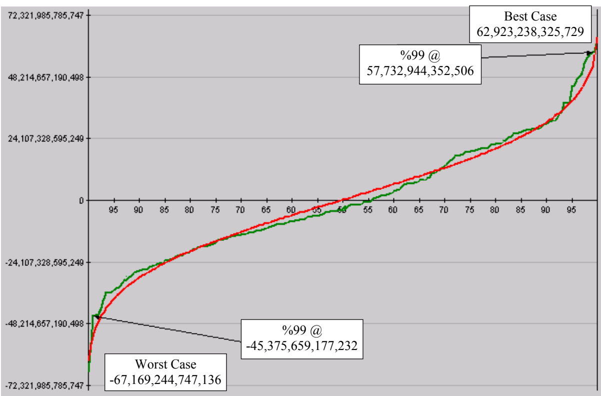
CL = 95%, T = 1-Day

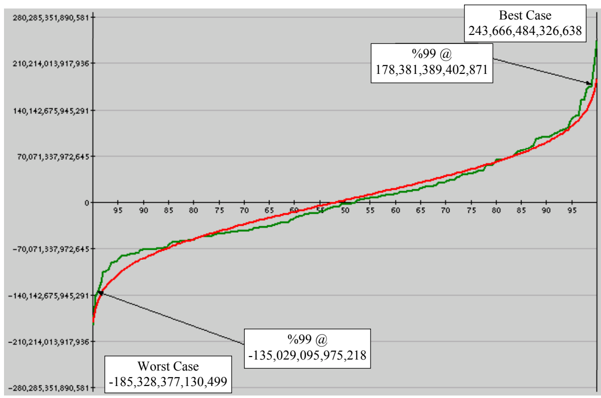


CL = 95%, T = 10-Day



CL = 95%, T = 1-Day





Delta-Normal method was developed by JP Morgan know as riskmetrics. Although application is very simple for a single asset, it gets very complicated as more assets added to the portfolio because of correlations among asset returns. The most important restricted assumptions of the model are that all asset returns are distributed normally and linear function of time. This parametric model uses mean and standard deviation of the distribution of the portfolio in computing VaR amount.

VaR = (Market Value of Port.)(Volatility of Port.)(Confidence Level)(Hold. Period)

$= (MV_p)(\sigma_p)(CL)(\sqrt{t})$

First, the time to maturity of each bond is determined. Then, all bonds in the portfolio are placed in the standard time intervals of riskmetrics. Next, the interest rates related to time intervals are determined using the derived yield curves. Later, the correlation matrix is computed representing the correlations among various interest rates for various time intervals (see Table 4). Since the number of assets (bonds) in the portfolio exceeds two, the portfolio VaR can be computed only in a vector solution.

$$\sigma^2_p = (V)\,(R)\,(V^T)$$

$$\sigma_P = \sqrt{\left(w_1, w_2, w_3, w_4, ...w_n\right) X \begin{pmatrix} Co\,\text{var}\,iance \\ Matrix..of \\ Portfolio \end{pmatrix} X \begin{pmatrix} w_1 \\ w_2 \\ w_3 \\ w_4 \\ . \\ . \\ w_n \end{pmatrix}}$$

V : (n x 1) vector of weight of each bond.

R : (n x n) correlation matrix

V^T : (1 x n) transpose of vector V

Portfolio volatility is calculated by multiplying above three matrixes (see Table 5). Then, the portfolio VaR value is obtained by multiplying the market value of the portfolio, volatility of the portfolio, square root of holding time period and z value of confidence level.

The use of *standard method* is mandatory for all Turkish Banks to report market risk to the Turkish Bank Regulatory and Supervisory Agency since January, 2002. This method places each asset into a time interval considering its time to maturity . Next, the present values of bonds placed into time intervals are multiplied by predetermined risk percentages. After few steps of netting short and long positions and differencing time intervals, the portfolio VaR is computed. The portfolio VaR under this method is actually a simple addition of VaR amount of each bond.

4. Stress Testing

VaR models measure the maximum amount of losses incurred in a portfolio for a given confidence level over a period of time. However, the models must be tested for cases of unexpected and extraordinary conditions. Stress testing is a technique to measure the strength of the model under sharp variations in prices and correlations among asset returns. Initially, it is to be decided what kind of a scenario (changes in correlations and prices) is applied for stress testing. The scenarios to be applied for stress testing may be the crises happened in the past. This way, the strength of the portfolio can be measured when the behaviour of risk factors changes in the periods of crisis. On the other hand, the stress scenarios could be the sensitivity of the portfolio for portfolio specific risks.

In this study November 2000 and February 2001 financial crisis of Turkey are employed as stress scenarios on the mimicking portfolio. The examination of financial data supports that the extraordinary behaviour of risk factors during these crisis periods can be analyzed over a 10-day period. By utilizing Monte Carlo Simulation, a variance–covariance matrix for each crisis is computed considering changes in returns and correlations over 10-day crises period. Based on this computed variance-covariance matrix, the expected returns in simulated crisis are derived by repeating the simulation 300 times. Finally, the stress VaR values are obtained.

5. Analysis of Computations

The VaR computations for each model are repeated for 95% and 99% confidence level, and 1-day and 10-day holding period except the standard model (see Table 6). The application results for Historical Simulation and Monte Carlo Simulation are presented in Table 2 and Table 3. The simulation results are analyzed by risk type (interest, currency and residual risk) and by currency type (USD, EUR and TRL). Comparing bond investments in USD, EUR and TRL, the largest VaR values are produced for currency risk in USD and EUR (TRL is not subject to currency risk) under both method. It also appears that bond investments in TRL are subject to the highest interest rate risk compared to other two currencies. However, bond investments in USD have the largest total VaR and portfolio VaR although USD bonds have only 20% weight in the whole portfolio. Notice that total VaR values are considerably lower than the portfolio VaR since correlations among the bonds in the portfolio have balance-off effect in risk reduction. The computed portfolio VaR values at 99% confidence level and 10-day holding period are about 98 trillion TRL under Historical Simulation and 135 trillion TRL under Monte Carlo Simulation methods.

Table 6 summarises the VaR values of all four methods by type of bonds. The VaR values of individual bonds under different methods could considerably vary. For instance, the VaR value of Bond 4 at 99% confidence level and 10-day holding period is 10.8 billion TRL under Historical Simulation, 17.2 billion TRL under Monte Carlo Simulation and only 7 billion TRL under standard method. The portfolio VaR values at 99% confidence level and 10-day holding period are about 98 trillion TRL under Historical Simulation, 135 trillion TRL Monte Carlo Simulation, 60 trillion TRL under standard method and 141 trillion TRL under Delta-Normal method. Similarly, the portfolio VaR values as a percentage of the present value of the portfolio are 3.25%, 4.50%, 2% and 4.71%, respectively. It appears that the Delta-Normal method requires the highest amount of capital while the standard method requires the lowest amount of capital for the same mimicking portfolio.

Table 7 presents the results of the stress testing. It is viewed that each bonds responds the shocks differently. For example, Bond 5, 6, 7 and 8 respond each shock similarly by making close amount of losses. However, the response of Bond 1, 13 and 14 are very much different for each shock. The fist shock causes only 3.72% losses in value while the second shock wipes 11.51% of the bond value. Overall effects of shock 1 and shock 2 are about 89 and 165 trillion TRL losses in the bond portfolio.

6. Concluding Remarks

The summary of results of all applied VaR models at 99% confidence level and 1-day holding period is presented in Table 8. Shock 1 representing November 2000 financial crises period produces a loss of about 89 trillion TRL (2.97% loss) while shock 2 representing February 2001 crises period causes a loss of rounding 164 trillion TRL (5.48% loss) in the portfolio. The portfolio VaR values are about 48 trillion TRL for Historical Simulation, 45 trillion TRL for Monte Carlo Simulation, 45 trillion TRL for Delta-Normal and 60 trillion TRL for the standard method. None of the models can apparently stand any of the shocks. However, the regulatory agency requires that the calculated VaR values for market risk must be multiplied by a factor of three. Then, all VaR models can stand the shock 1 and shows a good amount of resistance for shock 2, while the standard model shows no resistance for any of the shocks.

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Table 2: VaR Values by Type of Risks under Historical Simulation

	HISTORICAL SIMULATION															
	USD				EUR				TRL				TOTAL			
	CL : 95%		CL : 99%		CL : 95%		CL : 99%		CL : 95%		CL : 99%		CL : 95%		CL : 99%	
Risk Type	1-Day	10-Day	1-Day	10-Day	1-Day	10-Day	1-Day	10-Day	1-Day	10-Day	1-Day	10-Day	1-Day	10-Day	1-Day	10-Day
Interest Risk	8,245	26,664	11,107	30,024	896	2,349	1,156	3,499	13,215	36,648	16,602	47,499	12,468	29,471	18,440	36,337
Currency Risk	17,605	32,677	25,951	38,321	14,473	34,615	19,788	44,077	0	0	0	0	33,430	65,043	43,043	82,047
Residual Risk	65	341	129	629	12	52	21	123	0	0	0	0	67	366	132	678
Total	25,915	35,682	37,187	68,974	15,381	37,016	20,695	47,699	13,215	36,648	16,602	47,499	45,965	94,880	61,615	119,062
Portfolio VaR	21,714	53,451	27,886	62,570	15,017	35,264	20,038	45,688	13,215	36,648	16,602	47,499	39,935	70,793	47,746	97,664

Table 3: VaR Values by Type of Risks under Monte Carlo Simulation

	MONTE CARLO SIMULATION															
	USD				EUR				TRL				TOTAL			
	CL : 95%		CL : 99%		CL : 95%		CL : 99%		CL : 95%		CL : 99%		CL : 95%		CL : 99%	
Risk Type	1-Day	10-Day	1-Day	10-Day	1-Day	10-Day	1-Day	10-Day	1-Day	10-Day	1-Day	10-Day	1-Day	10-Day	1-Day	10-Day
Interest Risk	7,306	26,577	8,476	33,016	999	2,147	1,177	2,790	9,371	32,983	13,443	39,420	12,849	38,392	16,512	49,138
Currency Risk	19,019	47,178	26,518	64,976	14,336	33,154	22,140	45,343	0	0	0	0	31,981	76,378	46,943	114,440
Residual Risk	93	970	141	1373	7	75	17	126	0	0	0	0	99	991	157	1437
Total	26,418	74,725	35,135	99,365	15,342	35,376	23,334	48,259	9,371	32,983	13,443	39,420	44,929	115,761	63,612	165,015
Portfolio VaR	21,258	63,066	29,284	94,793	15,070	33,659	22,563	44,655	9,371	32,983	13,443	39,420	35,077	86,048	45,376	135,029

Table 4: Correlation Matrix under Delta-Normal Method

	TL BOND RATES				USD BOND RATES								EUR BOND RATES						
Priod	**3M**	**6M**	**1Y**	**2Y**	**6M**	**1Y**	**4Y**	**5Y**	**7Y**	**9Y**	**20Y**	**30Y**	**3M**	**6M**	**1Y**	**2Y**	**3Y**	**5Y**	**10Y**
3M	**1.000**	0.170	0.736	0.868	0.668	0.412	0.474	0.368	0.454	0.171	-0.147	-0.028	-0.435	-0.207	-0.511	-0.550	-0.299	0.100	0.443
6M	0.170	**1.000**	0.043	0.179	0.145	0.272	0.246	0.275	0.252	0.298	0.287	0.298	-0.048	0.259	0.136	0.119	-0.079	-0.043	0.310
1Y	0.736	0.043	**1.000**	0.969	0.213	-0.133	-0.064	-0.185	-0.087	-0.398	-0.634	-0.558	-0.754	-0.697	-0.828	-0.836	-0.179	-0.056	-0.154
2Y	0.868	0.179	0.969	**1.000**	0.378	0.055	0.123	0.003	0.100	-0.212	-0.486	-0.392	-0.695	-0.554	-0.756	-0.775	-0.232	-0.014	0.053
6M	0.668	0.145	0.213	0.378	**1.000**	0.885	0.932	0.869	0.921	0.745	0.421	0.556	-0.016	0.449	0.180	0.136	-0.279	0.101	0.711
1Y	0.412	0.272	-0.133	0.055	0.885	**1.000**	0.993	0.998	0.996	0.908	0.642	0.760	0.311	0.714	0.468	0.422	-0.240	0.098	0.805
4Y	0.474	0.246	-0.064	0.123	0.932	0.993	**1.000**	0.989	1.000	0.895	0.614	0.737	0.243	0.672	0.419	0.374	-0.250	0.102	0.803
5Y	0.368	0.275	-0.185	0.003	0.869	0.998	0.989	**1.000**	0.993	0.929	0.682	0.794	0.342	0.743	0.512	0.468	-0.222	0.100	0.812
7Y	0.454	0.252	-0.087	0.100	0.921	0.996	1.000	0.993	**1.000**	0.903	0.629	0.750	0.262	0.687	0.438	0.393	-0.244	0.102	0.806
9Y	0.171	0.298	-0.398	-0.212	0.745	0.908	0.895	0.929	0.903	**1.000**	0.901	0.961	0.411	0.827	0.673	0.638	-0.138	0.139	0.831
20Y	-0.147	0.287	-0.634	-0.486	0.421	0.642	0.614	0.682	0.629	0.901	**1.000**	0.986	0.480	0.805	0.777	0.760	-0.004	0.149	0.693
30Y	-0.028	0.298	-0.558	-0.392	0.556	0.760	0.737	0.794	0.750	0.961	0.986	**1.000**	0.464	0.833	0.755	0.731	-0.056	0.149	0.763
3M	-0.435	-0.048	-0.754	-0.695	-0.016	0.311	0.243	0.342	0.262	0.411	0.480	0.464	**1.000**	0.626	0.644	0.633	0.030	0.145	0.301
6M	-0.207	0.259	-0.697	-0.554	0.449	0.714	0.672	0.743	0.687	0.827	0.805	0.833	0.626	**1.000**	0.899	0.875	-0.037	0.045	0.569
1Y	-0.511	0.136	-0.828	-0.756	0.180	0.468	0.419	0.512	0.438	0.673	0.777	0.755	0.644	0.899	**1.000**	0.998	0.086	-0.017	0.317
2Y	-0.550	0.119	-0.836	-0.775	0.136	0.422	0.374	0.468	0.393	0.638	0.760	0.731	0.633	0.875	0.998	**1.000**	0.105	-0.030	0.273
3Y	-0.299	-0.079	-0.179	-0.232	-0.279	-0.240	-0.250	-0.222	-0.244	-0.138	-0.004	-0.056	0.030	-0.037	0.086	0.105	**1.000**	0.022	-0.170
5Y	0.100	-0.043	-0.056	-0.014	0.101	0.098	0.102	0.100	0.102	0.139	0.149	0.149	0.145	0.045	-0.017	-0.030	0.022	**1.000**	0.297
10Y	0.443	0.310	-0.154	0.053	0.711	0.805	0.803	0.812	0.806	0.831	0.693	0.763	0.301	0.569	0.317	0.273	-0.170	0.297	**1.000**

Table 5: Covariance Matrix under Delta-Normal Method

	TL BOND RATES				USD BOND RATES								EUR BOND RATES						
Priod	**3M**	**6M**	**1Y**	**2Y**	**6M**	**1Y**	**4Y**	**5Y**	**7Y**	**9Y**	**20Y**	**30Y**	**3M**	**6M**	**1Y**	**2Y**	**3Y**	**5Y**	**10Y**
3M	**8.E-03**	4.E-04	5.E-03	5.E-03	1.E-04	1.E-04	1.E-04	1.E-04	1.E-04	4.E-05	-4.E-05	-7.E-06	-1.E-04	-5.E-05	-1.E-04	-1.E-04	-4.E-04	7.E-06	6.E-05
6M	4.E-04	**8.E-04**	9.E-05	3.E-04	7.E-06	3.E-05	2.E-05	3.E-05	2.E-05	2.E-05	2.E-05	2.E-05	-4.E-06	2.E-05	9.E-06	8.E-06	-3.E-05	-1.E-06	1.E-05
1Y	5.E-03	9.E-05	**5.E-03**	4.E-03	3.E-05	-3.E-05	-1.E-05	-5.E-05	-2.E-05	-7.E-05	-1.E-04	-1.E-04	-2.E-04	-1.E-04	-1.E-04	-1.E-04	-2.E-04	-3.E-06	-2.E-05
2Y	5.E-03	3.E-04	4.E-03	**3.E-03**	4.E-05	1.E-05	2.E-05	7.E-07	2.E-05	-3.E-05	-8.E-05	-6.E-05	-1.E-04	-8.E-05	-1.E-04	-1.E-04	-2.E-04	-7.E-07	5.E-06
6M	1.E-04	7.E-06	3.E-05	4.E-05	**3.E-06**	5.E-06	4.E-06	5.E-06	5.E-06	3.E-06	2.E-06	3.E-06	-8.E-08	2.E-06	8.E-07	6.E-07	-7.E-06	1.E-07	2.E-06
1Y	1.E-04	3.E-05	-3.E-05	1.E-05	5.E-06	**1.E-05**	9.E-06	1.E-05	9.E-06	8.E-06	6.E-06	7.E-06	3.E-06	6.E-06	4.E-06	3.E-06	-1.E-05	3.E-07	4.E-06
4Y	1.E-04	2.E-05	-1.E-05	2.E-05	4.E-06	9.E-06	**7.E-06**	9.E-06	7.E-06	6.E-06	5.E-06	5.E-06	2.E-06	5.E-06	3.E-06	2.E-06	-9.E-06	2.E-07	3.E-06
5Y	1.E-04	3.E-05	-5.E-05	7.E-07	5.E-06	1.E-05	9.E-06	**1.E-05**	9.E-06	8.E-06	6.E-06	7.E-06	3.E-06	6.E-06	4.E-06	4.E-06	-1.E-05	3.E-07	4.E-06
7Y	1.E-04	2.E-05	-2.E-05	2.E-05	5.E-06	9.E-06	7.E-06	9.E-06	**8.E-06**	6.E-06	5.E-06	5.E-06	2.E-06	5.E-06	3.E-06	2.E-06	-9.E-06	2.E-07	3.E-06
9Y	4.E-05	2.E-05	-7.E-05	-3.E-05	3.E-06	8.E-06	6.E-06	8.E-06	6.E-06	**6.E-06**	6.E-06	6.E-06	3.E-06	5.E-06	4.E-06	4.E-06	-5.E-06	3.E-07	3.E-06
20Y	-4.E-05	2.E-05	-1.E-04	-8.E-05	2.E-06	6.E-06	5.E-06	6.E-06	5.E-06	6.E-06	**8.E-06**	7.E-06	4.E-06	6.E-06	5.E-06	5.E-06	-1.E-07	3.E-07	3.E-06
30Y	-7.E-06	2.E-05	-1.E-04	-6.E-05	3.E-06	7.E-06	5.E-06	7.E-06	5.E-06	6.E-06	7.E-06	**7.E-06**	3.E-06	5.E-06	5.E-06	4.E-06	-2.E-06	3.E-07	3.E-06
3M	-1.E-04	-4.E-06	-2.E-04	-1.E-04	-8.E-08	3.E-06	2.E-06	3.E-06	2.E-06	3.E-06	4.E-06	3.E-06	**8.E-06**	4.E-06	4.E-06	4.E-06	1.E-06	3.E-07	1.E-06
6M	-5.E-05	2.E-05	-1.E-04	-8.E-05	2.E-06	6.E-06	5.E-06	6.E-06	5.E-06	5.E-06	6.E-06	5.E-06	4.E-06	**6.E-06**	5.E-06	5.E-06	-1.E-06	9.E-08	2.E-06
1Y	-1.E-04	9.E-06	-1.E-04	-1.E-04	8.E-07	4.E-06	3.E-06	4.E-06	3.E-06	4.E-06	5.E-06	5.E-06	4.E-06	5.E-06	**6.E-06**	5.E-06	3.E-06	-3.E-08	1.E-06
2Y	-1.E-04	8.E-06	-1.E-04	-1.E-04	6.E-07	3.E-06	2.E-06	4.E-06	2.E-06	4.E-06	5.E-06	4.E-06	4.E-06	5.E-06	5.E-06	**5.E-06**	3.E-06	-5.E-08	9.E-07
3Y	-4.E-04	-3.E-05	-2.E-04	-2.E-04	-7.E-06	-1.E-05	-9.E-06	-1.E-05	-9.E-06	-5.E-06	-1.E-07	-2.E-06	1.E-06	-1.E-06	3.E-06	3.E-06	**2.E-04**	2.E-07	-3.E-06
5Y	7.E-06	-1.E-06	-3.E-06	-7.E-07	1.E-07	3.E-07	2.E-07	3.E-07	2.E-07	3.E-07	3.E-07	3.E-07	3.E-07	9.E-08	-3.E-08	-5.E-08	2.E-07	**6.E-07**	4.E-07
10Y	6.E-05	1.E-05	-2.E-05	5.E-06	2.E-06	4.E-06	3.E-06	4.E-06	3.E-06	3.E-06	3.E-06	3.E-06	1.E-06	2.E-06	1.E-06	9.E-07	-3.E-06	4.E-07	**2.E-06**

Table 6: VaR Values By Type of Bonds

Bond Type		Historical Simulation				Monte Carlo Simulation				Standard Method	Delta Normal Method			
		CL:95%		CL:99%		CL:95%		CL:99%			CL:95%		CL:99%	
		1-Day	10-Day	1-Day	10-Day	1-Day	10-Day	1-Day	10-Day		1-Day	10-Day	1-Day	10-Day
Bond 1	USD	9,972	26,907	10,655	31,530	8,511	29,220	11,570	42,087	20,442	-	-	-	-
Bond 2	USD	3,207	6,537	4,271	7,876	3,156	8,310	4,438	12,275	4,228	-	-	-	-
Bond 3	USD	3,346	7,192	4,440	8,755	3,211	8,736	4,646	13,435	5,161	-	-	-	-
Bond 4	USD	4,080	9,334	5,314	10,826	3,989	11,107	5,594	17,230	7,045	-	-	-	-
Bond 5	USD	2,213	4,081	3,222	4,876	2,357	5,726	3,314	7,751	823	-	-	-	-
Bond 6	EUR	2,657	6,336	3,647	8,106	2,602	6,122	4,072	8,313	892	-	-	-	-
Bond 7	EUR	2,926	6,881	3,910	8,936	2,922	6,550	4,393	8,704	1,703	-	-	-	-
Bond 8	EUR	2,677	6,394	3,671	8,156	2,646	6,092	4,087	8,370	515	-	-	-	-
Bond 9	EUR	3,193	7,575	4,285	9,841	3,275	7,215	4,859	9,500	2,597	-	-	-	-
Bond 10	EUR	3,276	8,273	4,591	10,802	3,460	7,772	5,211	10,030	4,279	-	-	-	-
Bond 11	TRL	1,138	2,279	1,889	3,230	1,037	3,085	1,374	3,844	1,045	-	-	-	-
Bond 12	TRL	1,257	5,164	2,284	6,516	1,365	3,664	1,739	4,741	1,544	-	-	-	-
Bond 13	TRL	3,542	11,038	5,504	15,098	3,108	10,513	3,956	12,863	3,998	-	-	-	-
Bond 14	TRL	4,063	12,712	6,355	17,398	3,547	12,088	4,573	14,779	4,182	-	-	-	-
Bond 15	TRL	1,438	5,669	2,377	6,959	1,358	4,183	1,968	5,131	1,480	-	-	-	-
Total		48,985	126,372	62,425	158,905	46,544	130,389	65,794	179,053	59,934	-	-	-	-
Portfolio VaR		39,935	70,793	47,746	97,664	35,077	86,048	45,376	135,029	59,934	31,671	100,152	44,723	141,426
Reduction in VaR		18.47%	43.98%	23.51%	38.54%	24.63%	34.01%	31.03%	24.59%	0.00%				
VaR as % of Port. Value		1.33%	2.36%	1.59%	3.25%	1.17%	2.87%	1.51%	4.50%	2.00%	1.05%	3.34%	1.49%	4.71%

Table 7: Result of Stress Testing

Bond Type		Present Value (TRL)	Stress Testing		% Loss in Bonds	
			Shock 1	Shock 2	Shock 1	Shock 2
Bond 1	USD	340,688	12,678	39,205	3.72%	11.51%
Bond 2	USD	153,741	4,337	6,677	2.82%	4.34%
Bond 3	USD	158,811	4,517	7,872	2.84%	4.96%
Bond 4	USD	187,872	5,409	11,000	2.88%	5.86%
Bond 5	USD	117,565	2,615	3,368	2.22%	2.86%
Bond 6	EUR	127,435	3,016	3,609	2.37%	2.83%
Bond 7	EUR	136,217	3,545	4,281	2.60%	3.14%
Bond 8	EUR	128,661	3,015	3,630	2.34%	2.82%
Bond 9	EUR	148,421	4,064	5,441	2.74%	3.67%
Bond 10	EUR	155,609	4,516	7,692	2.90%	4.94%
Bond 11	TRL	261,207	2,724	24,890	1.04%	9.53%
Bond 12	TRL	220,557	4,460	14,700	2.02%	6.66%
Bond 13	TRL	319,865	20,825	51,519	6.51%	16.11%
Bond 14	TRL	334,577	23,869	58,999	7.13%	17.63%
Bond 15	TRL	211,439	5,562	17,452	2.63%	8.25%
Total		3,002,665	105,153	260,335	3.50%	8.67%
Portfolio VaR			89,162	165,411	2.97%	5.51%

Shock 1 = The Turkish financial crises of November 2000.

Shock 2 = The Turkish financial crises of February 2001.

Table 8: Summary of VaR Results

	Historical Simulation	Monte Carlo Simulation	Delta Normal	Standard Methods	Stress Testing	
					Shock 1	Shock 2
Portfolio VaR	47,746	45,376	44,722	59,934	89,162	164,411
VaR as % of Portfolio Value	1.59%	1.51%	1.49%	2.00%	2.97%	5.48%